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Wyndham Grand
Salzburg Conference Centre
Fanny-von-Lehnert-Strasse 7
5020 Salzburg (AT)
www.wyndhamgrandsalzburg.com

Conference website
www.csrs-salzburg2017.com

Hosting society
Cervical Spine Research Society – European Section (CSRS–ES)

Congress chairs
Assoc. Prof. Dr. Heiko Koller
Chief Physician
Center for Spinal and Scoliosis Therapy
Schön Klinik Nürnberg Fürth
Fürth (DE)

Priv. Doz. Dr. Michael Mayer
Consultant
Center for Spinal and Scoliosis Therapy
Schön Klinik Nürnberg Fürth
Fürth (DE)

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Editorial Deadline May 11, 2017
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Dear colleagues and friends,

On behalf of the Cervical Spine Research Society – Europe, we are delighted to welcome you to the 33rd annual meeting in Salzburg, Austria!

It has been a great honour to prepare for you another scientific and socially appealing meeting that will focus on news, trends and challenges in cervical spine medicine. The very highest level of research will be presented long before it will become generally published. Experts from all over the world will share their experiences, including both successes and failures, as everyone earnestly strives to improve the treatment of patients with these complex cervical spine disorders.

The CSRS-Europe is one of the leading specialist spine societies, with an excellent scientific and clinical reputation. Thrilling debates and lively ‘round table’ discussions with acknowledged cervical spine leaders, as well as presentations of the most recent scientific evidence in treating cervical spine pathologies, continue to build the foundation of our highly successful meeting. You can expect meaningful, lively discussions with new sessions for the first time that focus specifically on clinical case specific questions.

For this year’s CSRS-Europe annual meeting, the number of excellent abstracts submitted exceeded 250! We appreciate that our meeting has developed its role as an annual ‘magnet’ for researchers and clinicians form all over the world that want to improve their knowledge and understanding of cervical disorders.

Also, to acknowledge and accommodate the increasing number of excellent high quality abstracts submitted, the number of presentations at the meeting will be increased this year while the presentation times will be marginally reduced in length. The evenings will be led by outstanding guest lecturers – so make sure you don’t miss them!

The main topic of the meeting this time will be ‘cervical trauma, post-traumatic deformity, myelopathy and spinal cord injury’ – a theme which affects all physicians that treat cervical spine pathologies.
Salzburg city is one of the many Austrian ‘diamonds’ and hospitality experience here will always be remembered. The social programme, our lunch symposia and multiple breaks will offer many opportunities to network with experts and friends from all over the world – so make use of this important chance to join the CSRS-Europe family at this, our 33rd annual meeting!

We thank you, our faculty and industry partners for your invaluable support in preparing an unforgettable meeting. We are delighted to welcome you to the city of the ‘sound of music’.

Heiko Koller, Assoc. Prof. Dr.
Board Member, Local Host

Michael Mayer, Priv. Doz. Dr. med.
Local Host
My dear guests,

It is such a great pleasure for me to welcome you to this, the 33rd annual meeting of the Cervical Spine Research Society – Europe. We trust that the main topic of the meeting, “cervical trauma, post-traumatic deformity, myelopathy and spinal cord injury” will be of particular interest to both yourself and also for the wider audience. As diverse medical specialists, physiotherapists, residents, researchers and patients, we all regularly encounter problems related to the main topic in our daily practice and lives, so we sincerely trust that the programme developed for this, our 33rd annual meeting will be of particular interest and help to you all in dealing with these complex challenges.

The scientific content and the opportunity to meet colleagues is one of the success factors of our annual meetings. The huge efforts of our local hosts Heiko Koller and Michael Mayer in developing the programme will, no doubt, contribute to the great success of this meeting. I sincerely hope that you will enjoy both a fruitful meeting and also have a very pleasant stay in Salzburg.

Ronald H. M. A. Bartels
President of CSRS – Europe

Ronald Bartels was born on August 24, 1962 in Maastricht, the Netherlands. After completing his gymnasium he attended Medical School at the Catholic University in Nijmegen. In 1987 he graduated. After completing his military service, he became a resident in neurosurgery (Raboud University Medical Center, Nijmegen, the Netherlands). In 1996 he was board certified and started working as a staff member in the same institute and focused on spine surgery. In October 2010 he was appointed as Chairman of department of Neurosurgery of the Radboud University Medical Center, and in June 2015 as full Clinical Professor in Neurosurgery. From 2009 until 2015 he was the secretary of the CSRS–ES, and since May 2016 president of the CSRS–Europe.
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Invited special guest lecturers

Thursday, May 25 • 17:10–17:30

Advances in the treatment of spinal cord injury: current milestones and future visions
Michael Fehlings (Toronto/CA)

At the University of Toronto, Dr. Michael Fehlings is Vice Chair Research for the Department of Surgery, Co-Director of the Spine Program and a Professor of Neurosurgery. As Head of the Spinal Program at Toronto Western Hospital, he combines an active clinical practice in complex spinal neurosurgery with a vibrant, translationally-oriented research program. His mentorship and teaching includes clinical fellows as well as undergraduate lectures and postgraduate research supervision. His research focuses preclinically on translationally relevant models of spinal cord and brain injury, including developmental brain injury, and clinically on disorders of the spine/spinal cord. He has developed cervical and thoracic models of spinal cord injury to facilitate translational research. The lab is currently working with induced pluripotent stem cells (iPSCs) and neural stem cells (NSCs) with a focus on combinatorial therapies as the most likely way in which stem cells will ultimately be used in a clinical setting. Dr. Fehlings is currently involved in clinical trials of therapies including the sodium blocker, Riluzole, and the use of stem cells in spinal cord injury.

With over 700 highly-cited publications, impacting clinical practice and research directions, he is established as a leading international expert investigating CNS repair and regeneration for brain and spinal cord injury.
Thomas Bubendorfer is one of the most successful active climbers. Already at age 16 he became the youngest solo climber of hard severe rock mountain faces. He perfected his solo climbing style in hundreds of solo climbs and finally gained international fame when, at 21, he became the first climber to solo climb (this means no ropes!) the north face of the Eiger, the highest and hardest mountain face in the Alps, in the record time of less than five hours. To this day he has achieved more than 90 first rope-free solo ascents, record ascents and first ascents in the mountains of the world, the latest one in January 2015 in the Austrian Alps. Many of his climbs remain unparalleled.

While climbing remains the most important and influential activity in his life, Thomas, now 54, is not just a climber. Inspired by his grandfather, he has always sought to balance his intense physical activities - training up to 400 hours per year, and climbing 120 days per year - by training his mind. He speaks four languages and has written seven books. Presently he is working on his first book in English. He keeps studying subjects as varied as chaos science, neurobiology, brain science, philosophy and history.

An international keynote speaker since 1985, Thomas has shared his views on performance, self-responsibility, goal-setting, quality, crisis, teamwork and many more related topics with audiences of many of the leading companies in the world.

Thomas is a father of three children and travels around the world giving a maximum of 30 keynote speeches in Asia, the US and Europe. He coaches and consults business leaders in the art of „intelligent performance” and is brand ambassador to Porsche.
Jeffrey C. Wang (Los Angeles, CA/US)

representing Darrel S. Brodke, current president of the CSRS–NA

Jeffrey C. Wang earned a Bachelor of Science degree in Biological Sciences at Stanford University and his M.D. degree cum laude at the University of Pittsburgh School of Medicine. He did his residency in Orthopaedic Surgery at UCLA and completed a fellowship in Spine Surgery at Case Western Reserve University. In 1997, he joined the David Geffen School of Medicine at UCLA and was named Vice Chair of the Department of Orthopaedic Surgery and was the spine fellowship director since 1997. In 2013, he was recruited to lead the building of the University of Southern California Spine Center. He is currently a Professor of Orthopaedic Surgery and Neurosurgery at the Keck Medical Center at USC. He is Co-Director of the USC Spine Center and Fellowship Director of the USC Spine Fellowship. To date, Dr. Wang has published over 300 articles, 23 book chapters, and several textbooks. Moreover, he has made over 800 presentations regionally and internationally and has been a visiting professor throughout the United States, Europe, and Asia. He has been the honored guest speaker at several international Spine, Orthopaedic, and Neurosurgery Society Meetings. He also serves on multiple editorial boards, and is the Editor-in-Chief of the Global Spine Journal. He is currently the Past Chairman of AOSpine, and on the board of directors of several major spine societies (North American Spine Society, Cervical Spine Research Society, Collaborative Spine Research Society). He is currently the President-Elect of the Cervical Spine Research Society, and the 2nd Vice President of the North American Spine Society. He continues to run a basic science research laboratory and is in full-time academic practice at the University of Southern California.
Darrel S. Brodke, MD, professor and senior vice-chair in the Department of Orthopaedics at the University of Utah, has a joint appointment in the Department of Neurosurgery, and holds the Louis and Janet Peery Presidential Endowed Chair. He is the director of the Orthopaedic Spine Program and the co-director of the spine fellowship at the University of Utah. Dr. Brodke specializes in degenerative conditions, deformity, and traumatic injuries of the cervical, thoracic and lumbar spine. His primary clinical interests are cervical spine disorders and complex spine reconstruction.

Dr. Brodke received the M.D. at the University of California, San Francisco, completed an Orthopaedic residency at the University of Wisconsin, Madison, and a fellowship in Spine Surgery at the University of Washington in Seattle before joining the faculty at the University of Utah. He is a diplomate of the American Board of Orthopaedic Surgery and a member of the North American Spine Society, Cervical Spine Research Society, American Academy of Orthopaedic Surgeons, American Orthopaedic Association, Association of Bone and Joint Surgeons, and AOSpine. He is the current President of the Cervical Spine Research Society and is Chairman of AOSpine North America.

Dr. Brodke has authored 130 peer-reviewed publications, as well as 54 reviews and book chapters. He has numerous published abstracts and presentations. His current research involves general spine clinical outcomes research and the use of the PROMIS PRO measures, clinical outcomes with Proximal Junctional Failure following Adult Deformity Surgery, and in vitro biomechanical research, looking at force, motion and stiffness of spinal fusion and non-fusion constructs.
representing Shanmuganathan Rajasekaran, current president of the CSRS–AP

Dr. Kuniyoshi Abumi graduated from the Hokkaido University School of Medicine in 1977. He has since been focusing on spine surgery for the last 35 years. His major clinical subjects have been reconstruction of the cervical spine and correction surgery of spine deformities. He is an active member of the Scoliosis Research Society since 1995, and a corresponding member of the Cervical Spine Research Society (CSRS) since 1999. He is also one of the founding members of the CSRS-Asia Pacific Section, and served as the president of the inaugural meeting of the society on April 2010 in Kobe, Japan. In addition, Dr Abumi has been working as the president of the Asia Pacific Spine Society (APSS) from 2015. He was working as a Professor in the Hokkaido University Graduate School of Medicine and in Hokkaido University Hospital until March 2013. Currently, he is the President and the Chief Director of the Sapporo Orthopaedic Hospital-Centre for Spinal Disorders in Sapporo, Japan and Professor Emeritus of Hokkaido University. His present major subject is cervical spinal reconstruction and correction of cervical deformities.

Shanmuganathan Rajasekaran (Coimbatore/IN)
Current president of the CSRS–AP

Prof. Rajasekaran is the Chairman of the Department of Orthopaedics, Trauma & Spine Surgery, Ganga Hospital, Coimbatore.

Dr Rajasekaran is the Current Chair, International Research Commission of AOSpine (2016–2019) and the President of SICOT (2016–2018). He is the President Elect of CSRS-AP and will be the president in 2018.

He has held the distinguished posts of the President of the Indian Orthopaedic Association (2012), President of the Association of Spine Surgeons of India for four years (2008–2012) and Chief National Delegate of Asia Pacific Orthopaedic Association. He was the President of International Society for the Study of Lumbar Spine, Canada (2012), a prestigious international research society. He has the rare distinction of being appointed as the Hunterian Professor for the year 2011–2012 by the Royal College of Surgeons of England.

He is the Deputy Editor of the Journal of SPINE, USA. He is also the Deputy Editor of Global Spine Journal, USA, and is on the Editorial board of European Spine Journal.
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Lungau

17:30–18:00  CSRS–Europe general assembly  
Salzburg I

18:15–18:30  Welcome lecture  
Salzburg I 
Chairs  Heiko Koller, Michael Mayer (Fürth/DE)  
Herbert Resch (Salzburg/AT)  
Dean of University of Salzburg

18:30–19:30  Cocktail hour
EVERYDAY LIFE IS EVERYTHING

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08:15–08:25 Welcome address by local hosts
Heiko Koller, Michael Mayer (Fürth/DE)

Presentation of progress of the CSRS–Europe book project
and CSRS–Europe travel fellowship programme
Heiko Koller (Fürth/DE)

08:25–09:25 Lecture session 1
Salzburg I

Chairs
Claes Olerud (Uppsala/SE), Carmen Vleggeert-Lankamp (Utrecht/NL)

08:25 Randomized, placebo-controlled, double-blinded trial of granulocyte colony
stimulating factor-mediated neuroprotection for acute spinal cord injury
Masao Koda, Takeo Furuya, Yasushi Ijima, Junya Saito, Mitsuhiro Kitamura
Seiji Ohtori, Masashi Yamazaki, Hideki Hanaoka
G-SPIRIT group

08:35 Adjacent level degeneration of the cervical spine – assessment of a
quantitative radiological scoring system
Jelle Verhoeven, Joost Dejaegher, Marie Cappelle, Philippe Demaerel
Jan Goffin, Bart Depreitere

08:45 A comparative analysis of the posterior decompression surgery for
ossification of posterior longitudinal ligament of the cervical spine:
a multicenter study
Yoshiomi Kobayashi, Junichi Yamane, Narihito Nagoshi
Soraya Nishimura, Osahiko Tsuji, Ken Ninomiya, Nobuyuki Fujita
Mitsuru Yagi, Kota Watanabe, Takeshi Ikegami, Eijiro Okada
Masaya Nakamura, Morio Matsumoto, Ken Ishii
KSRG members

08:55 No benefits for artificial disc replacement over fusion in patients with cervical
degenerative disc disease – a five-year follow-up of a prospective randomized
controlled study
Anna M. Mac Dowall, Martin Skeppholm, Nuno Canto Moreira
Katharina Marques, Yohan Robinson, Claes Olerud
09:05 Maintaining endotracheal tube cuff pressure at 20 mm Hg to prevent dysphagia after anterior cervical spine surgery – a double blind randomized controlled trial
Mark P. Arts, Jasper F. C. Wolfs, Thijs C. D. Rettig, Naomi de Heij, Jessica de Vries, Bastiaan A. in ’t Veld

09:15 Does the sagittal alignment of the cervical spine have an impact on disc degeneration? 20-year follow-up of asymptomatic volunteers
Eijiro Okada, Kenshi Daimon, Hirokazu Fujiwara, Yuji Nishiwaki, Nobuyuki Fujita, Takashi Tsuji, Masaya Nakamura, Morio Matsumoto, Kota Watanabe

09:25–09:35 Introduction and presentation of the CSRS–ES cervical kyphosis study
Salzburg I
Heiko Koller (Fürth/DE) and Christopher P. Ames (San Francisco/US) for the multi-centre study group

09:35–10:40 Lecture session 2
Salzburg I
Björn Zoëga (Stockholm/SE), Hugues Pascal-Mousselard (Paris/FR)

09:35 The health impact of adult cervical deformity in patients presenting for surgical treatment – comparison to population norms and chronic disease states based on the EQ-5D
Justin S. Smith, Bret Line, Shay Bess, Christopher I. Shaffrey, Han Jo Kim, Greg Mundis, Justin Scheer, Eric Klineberg, Munish Gupta, Alan Daniels, Michael Kelly, Jeffrey Gum, Frank Schwab, Virginie Lafage, Reanud Lafage, Tamir Ailon, Peter Passias, Themi Protopsaltis, Robert Hart, Doug Burton, Vedat Deviren, Christopher P. Ames
International Spine Study Group
The mirror placement is useful for standardized head position when whole spine radiographs are taken in standing position
Shin Oe, Daisuke Togawa, Go Yoshida, Tomohiko Hasegawa
Yu Yamato, Sho Kobayashi, Tatsuya Yasuda, Tomohiro Banno
Yuki Mihara, Yukihiro Matsuyama

Perioperative complications after the cervical anterior surgery for degenerative cervical spine
Atsuomi Aiba, Macondo Mochizuki, Ryo Kadota, Takeo Furuya

Three-column osteotomy for correction of cervical deformity – alignment changes and early complications in a multicenter prospective series of 24 patients
Justin S. Smith, Christopher I. Shaffrey, Han Jo Kim, Brian Neuman
Eric Klineberg, Frank Schwab, Virginie Lafage, Renaud Lafage
Justin Scheer, Themistoklis Protopsaltis, Peter Passias, Greg Mundis
Robert Hart, Vedat Deviren, Shay Bess, Christopher P. Ames
International Spine Study Group

Clinical and radiological spectrum of patients with Klippel-Feil-Syndromes with analysis of operative results
Jörg Klekamp

The diagnostic accuracy of somatosensory evoked potentials in evaluating new neurological deficits after posterior cervical fusions
Alexander Vladimirovich Burtsev, Olga Mikhailovna Pavlova

Preoperative patient characteristics and pedicle screw placement accuracy influence postoperative complication rates in patients with fusion surgery at the Cervicothoracic Junction (CTJ)
Heiko Koller, Axel Hempfing, Michael Mayer

Outcomes of operative treatment for adult cervical deformity – a prospective multicenter assessment with one-year follow-up
Justin S. Smith, Christopher I. Shaffrey, Han Jo Kim, Greg Mundis
Munish Gupta, Eric Klineberg, Frank Schwab, Virginie Lafage, Renaud Lafage
Peter Passias, Themistoklis Protopsaltis, Brian Neuman, Alan Daniels, Tamir Ailon
Justin Scheer, Alex Soroceanu, Khal Kebaish, Robert Hart, Michael O'Brien
Doug Burton, Vedat Deviren, Todd Albert, K. Daniel Riew, Shay Bess
Christopher P. Ames, International Spine Study Group
10:40–10:45  Presidential words  
Ronald H. M. A. Bartels (Nijmegen/NL)

10:45–11:15  Industrial and poster exhibition, coffee break

11:15–11:55  Session of experience  
Salzburg I  Worst case scenarios and learning from failure  
Moderators  Andre Jackowski (London/GB), Philippe Bancel (Paris/FR)

International faculty exchange  
Faculty  Hossein Mehdian (Nottingham/GB), Takachika Shimizu (Takasaki/JP)  
Dezső Jeszenski (Zurich/CH), Bradford L. Currier (Rochester, NY/US)

11:55–12:15  Presidential lecture CSRS North America  
Jeffrey C. Wang (Los Angeles, CA/US)  
President elect  
representing Darrel S. Brodke (Lake City, UT/US)  
current president of the CSRS–NA
12:15–13:15 Medtronic lunch symposium*
Attersee
Chair Björn Zoëga (Stockholm/SE)

12:15 Introduction

12:20 An overview on Value Based Health Care (VBHC)
What does VBHC really mean (concept/theory)?
VBHC in the Swedish reimbursement system
Björn Zoëga (Stockholm/SE)

12:35 What does VBHC means to my practice?
Patient pathways before and after degenerative spinal surgeries
Fast-tracking surgeries for the degenerative spine patients
Nuno Neves (Lisbon/PT)

12:50 Discussion

* lunch will be served
Introduction
Current and emerging data illustrates a direct correlation between spinal alignment and long term clinical outcomes. Specific spinal and spinopelvic parameters are key predictors in determining successful patient outcomes in all spinal procedures from single- to multi-level pathologies. Sagittal malalignment of the cervical spine has also been associated with worsened postsurgical outcomes. For better operative planning of fusion and alignment restoration, improved knowledge of ideal fusion angles and interdependences between upper and lower cervical spine alignment is needed. Because spinal and spinopelvic parameters might play a role in cervical sagittal alignment, their associations should be assessed.
NuVasive is committed to a global approach for assessing, preserving, and restoring spinal alignment in an effort to promote surgical efficiencies, lasting patient outcomes, and improved quality of life.

Learning objectives
1. Understand association between cervical sagittal alignment and spinal and spinopelvic parameters.
2. Learn how to calculate alignment parameters with preoperative planning tools.
3. Know the technical aspects of anterior and posterior cervical column reconstruction with comprehensive procedural solutions with real-time intraoperative assessment.
4. Obtain an overview of the latest clinical evidence.
5. Acquire tips and trick through case based discussions.
14:00–15:15  Lecture session 3
Salzburg I
Chairs  Anton Kathrein (Zams/AT), Christoph-Eckhard Heyde (Leipzig/DE)

14:00  Collateral flow for vertebrobasilar region evaluated by digital subtraction angiography
Takeki Aoyama, Naoshi Obara

14:08  Risk factors and prognosis for acute progression of myelopathic symptoms in patients with ossification of the posterior longitudinal ligament after minor trauma
Jong-myung Jung, Chun Kee Chung, Chi Heon Kim

14:16  Trauma of the extracranial brain arteries due to trauma of the cervical spine
Vladimir S. Klimov, Muragon A. Kasimshoev

14:24  Odontoid fractures in multi-morbid elderly patients – percutaneous posterior trans-articular atlantoaxial fixation – a prospective study
Mohamed Alhashash, Mootaz Shousha, Hassan Allouch, Heinrich Boehm

14:32  Minimally invasive stabilization of the upper cervical fractures – a new technique of C1 lateral mass screw insertion via a direct posterolateral approach
Takamitsu Tokioka, Takahiro Hayashi, Keitaro Tada

14:40  Posttraumatic syringomyelia related to cervical injuries
Jörg Klekamp

14:48  A finite element analysis of the occipitoatlantal capsular ligaments as the primary stabilizers of the craniocervical junction
Andrew T. Dailey, Richen Phuntsok, Douglas L. Brockmeyer, Benjamin J. Ellis

14:56  Do patients with traumatic cervical spinal cord injury benefit from very early surgical decompression under 5 hours after injury?
Maria Gollwitzer, Georg Mattiassich, Stephanie Aschauer-Wallner, Wolfgang Hitzl

15:04  Bicortical facet screws as a new option for posterior C2 fixation: anatomical study and clinical experience
Angelo Rusconi, Cedric Barrey, Kone Noukhoum, Eurico Freitas-Olim
15:15–15:55 Round table session I
Salzburg I Cervical spine revision surgery
Moderators Heiko Koller (Fürth/DE), Ronald H. M. A. Bartels (Nijmegen/NL)
Discussants Claes Olerud (Uppsala/SE)
Abolfazl Rahimizadeh (Teheran/IR)
Christopher P. Ames (San Francisco, CA/US)

15:15 1. case: Failed posterior C1-2 surgery
15:17 Discussion

15:27 2. case: Failed subaxial reconstruction
15:29 Discussion

15:39 3. case: Failed anterior C2 surgery
15:41 Discussion

15:55–16:25 Industrial and poster exhibition, coffee break

At Silony Medical we work with passion and commitment, doing everything possible to achieve the best results. We work in partnership with clinicians, solving problems, going beyond the accepted standard and looking at new trends that improve patient outcomes and best practices. Our core values – quality, integrity and teamwork – guide our work every day and with every patient.
<table>
<thead>
<tr>
<th>Time</th>
<th>Session Details</th>
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<tr>
<td>16:25–16:55</td>
<td>Lecture session 4</td>
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<tr>
<td>Salzburg I</td>
<td>Mario Boni grant nominated posters</td>
</tr>
<tr>
<td>Chairs</td>
<td>Ronald H. M. A. Bartels (Nijmegen/NL), Carlos Villas Tomé (Pamplona/ES)</td>
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<tr>
<td>16:25</td>
<td>The accuracy of three different ways of cervical pedicle screw insertion</td>
</tr>
<tr>
<td>024</td>
<td>Hisanori Ikuma, Shinichiro Takao</td>
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<tr>
<td>16:31</td>
<td>Comparison of the AO Spine subaxial cervical spine injury classification system and the Allen classification</td>
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<td>025</td>
<td>Toshiya Tachibana, Kazuki Kusuyama, Kazuya Kishima, Shinichi Yeshiva</td>
</tr>
<tr>
<td>16:37</td>
<td>Predictive model for distal junctional kyphosis after cervical deformity surgery</td>
</tr>
<tr>
<td>026</td>
<td>Peter Passias, Dennis Vasquez-Montes, Gregory W. Poorman,Themistocles Protopsaltis, Samantha Horn, Bassel Diebo,Christopher P. Ames, Justin Smith, Virginie LaFage, Renaud LaFage,Eric Klineberg, Christopher Shaffrey, Shay Bess, Frank Schwab,International Spine Study Group (ISSG)</td>
</tr>
<tr>
<td>16:43</td>
<td>Percutaneous ultrasonographic observation of the spinal cord after cervical laminoplasty at the postoperative early periods</td>
</tr>
<tr>
<td>027</td>
<td>Yoshiharu Nakaya, Atsushi Nakano, Kenta Fujiwara, Takashi Fujishiro,Sachio Hayama, Toma Yano, Masashi Neo</td>
</tr>
<tr>
<td>16:49</td>
<td>Trunk shift and head tilt in congenital scoliosis of the cervicothoracic junction</td>
</tr>
<tr>
<td>028</td>
<td>Peter Obid, Gregor Ostrowski, Tobias Pitzen, Jörg Drumm, Michael Ruf</td>
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<tr>
<td>16:55–17:10</td>
<td>Preview upon future CSRS meetings 2018</td>
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<tr>
<td>Salzburg I</td>
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<td>16:55</td>
<td>Europe</td>
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<td></td>
<td>Óscar L. Alves (Porto/PT)</td>
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<tr>
<td>17:00</td>
<td>North America</td>
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<td>Jeffrey C. Wang (Los Angeles, CA/US), representing Darrel S. Brodke, current president of the CSRS–NA (Lake City, UT/US)</td>
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<tr>
<td>17:05</td>
<td>Asia-Pacific</td>
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<tr>
<td></td>
<td>Kuniyoshi Abumi (Sapporo/JP), representing Shanmuganathan Rajasekaran, current president of the CSRS–AP (Coimbatore/IN)</td>
</tr>
</tbody>
</table>
17:10–17:30 Invited special guest lecture
Salzburg I
Chairs Michael Mayer (Fürth/DE), Andrés Combalia (Barcelona/ES)

17:10 Advances in the treatment of spinal cord injury – current mile-stones and future visions
Michael Fehlings (Toronto/CA)

17:30–18:00 Get-together in the exhibition
08:30–09:30 Lecture session 5
Salzburg I
Chairs Petr Suchomel (Liberec/CZ), Thomas Freude (Salzburg/AT)

08:30 Safety and efficacy of a novel anterior decompression technique (vertebral body sliding osteotomy) for ossification of posterior longitudinal ligament of the cervical spine: comparison of postoperative outcomes between vertebral body sliding osteotomy and anterior corpectomy and fusion
Dong-Ho Lee, Jae Hwan Cho

08:38 Evaluation and clinical use of DTI-MRI in patients with cervical spondylotic myelopathy
Cevat Akinci, Ismail Bozkurt, Omer Faruk Ates, Omer Faruk Turkoglu
Giyas Ayberk

08:46 Endogenous inflammatory response in cervical spondylotic myelopathy: a pilot series
Christian Blume, Hans Clusmann, Maximillian Schmeisser, Lars Brandenburg
Christian Andreas Mueller

08:54 The causes of failed various types of posterior surgery for cervical myelopathy due to OPLL and clinical outcomes of anterior decompression and arthrodesis as a revision surgery for failed posterior surgery
Macondo Mochizuki, Atuomi Aiba, Ryo Kadota, Masao Koda

09:02 Correlation between novel classification of cervical myelopathy and spinal cord compression form
Hisanori Mihara, Yasunori Tatara, Takanori Niimura, Yohei Itoh

09:10 Upper cervical spine fixation for Bow-hunter syndrome
Hiroyuki Nakase, Yasuhiro Takeshima, Yasushi Motoyama
Young-Su Park

09:18 Dural tube continues to expand after muscle sparing cervical laminectomy
Ryoma Aoyama, Tateru Shiraishi, Junichi Yamane, Ken Ninomiya
Kazuya Kitamura, Satoshi Nori, Satoshi Suzuki
09:30–10:30 Lecture session 6
Salzburg I
Chairs Anton Kathrein (Zams/AT), Yasushi Yukawa (Nagoya/JP)

09:30 Dose additional uncinate resection increase pseudarthrosis following anterior cervical discectomy and fusion?
Dong-Ho Lee, Jong-Min Baik, Jae Hwan Cho, Chang Ju Hwang Choon Sung Lee

09:38 Long-term follow-up of adjacent segment degeneration after anterior cervical discectomy and fusion
Marcus D. Mazur, Andrew T. Dailey, Lubdha M. Shah, Joel D. MacDonald

09:46 Re-operation rate after anterior cervical fusion using standalone cages in degenerative cervical spondylosis based on 2078 patients – long term follow up
Mohamed Alhashash, Mootaz Shousha, Hassan Allouch, Hany Gendy Heinrich Boehm

09:54 What is the best surgical treatment for patients with cervical radiculopathy due to single-level degenerative disease, anterior cervical discectomy without fusion, with fusion by cage stand-alone, or with arthroplasty? a randomised controlled trial
Roland D. Donk, Andre Verbeek, Wim im Verhagen Allard J. F. Hosman, Ronald H. M. A. Bartels

10:02 Unintended fusion in cervical artificial disc replacement – a prospective study on heterotopic ossification with 5 years follow-up
Catarina Marques, Nuno Canto Moreira, Anna MacDowall Martin Skeppholm, Claes Olerud

10:10 The Leuven cervical disc prosthesis study at 10 years of follow-up: progression of degeneration at the level cranial to the prosthesis and associated variables
Jelle Verhoeven, Joost Dejaegher, Marie Cappelle, Philippe Demaerel Jan Goffin, Bart Depreitere
10:18 Comparing cost-effectiveness of arthroplasty with fusion in treatment for one level cervical radiculopathy
Oddrun A. Fredriksli, Jarle Sundseth, Frode Kolstad, Hege Andresen
Kay Müller, Erling Myrseth, John A. Zwart, Oystein P. Nygaard
Lars G. Johnsen

10:30–11:00 Industrial and poster exhibition, coffee break

11:00–11:40 Round table session II
Salzburg I Traumatic injuries of the cervical spine
Moderators Björn Zoëga (Stockholm/SE), Michael Mayer (Fürth/DE)

Discussants Petr Suchomel (Liberec/CZ)
Claudius Thomé (Innsbruck/AT)
Jan Štulík (Prague/CZ)

11:00 1. case: Cranio-cervical injury
11:02 Discussion

11:12 2. case: Subaxial injury
11:14 Discussion

11:24 3. case: Cervico-thoracic injury
11:26 Discussion

11:40–12:00 Presidential lecture CSRS–Asia Pacific
Kuniyoshi Abumi (Sapporo/JP)
representing Shanmuganathan Rajasekaran, current president of the CSRS – AP (Coimbatore/IN)

12:00–12:10 Message by CSRS–Europe president
Ronald H. M. A. Bartels (Nijmegen/NL)
There are many challenges associated with the surgical treatment of Post-traumatic Cervical Deformities. Post-traumatic cervical osseous and disco-ligamentous lesions, if left undiagnosed, may result in irreducible extreme kyphosis and other complications. The correction of such deformities therefore requires major surgery and often necessitates a combined anterior and posterior approach. The surgical goal is therefore to correct bony compression of vascular and neural structures, reduce deformity and achieve circumferential fusion with physiological alignment. Such complex surgeries, however, are not without considerable associated neurological risks. Extensive pre-operative planning of the intervention and substantial surgical experience is therefore mandatory to achieve good results.

The symposium will focus on the major challenges faced from interventions associated with Post-traumatic Cervical Deformities surgeries and will seek to better understand, how different surgical techniques and strategies, can be potentially incorporated to improve outcomes. The workshop will primarily consist of an interactive case presentation and discussion format.
Lecture session 7

Salzburg I

Chairs: Carmen Vleggeert-Lankamp (Utrecht/NL), Andre Tomasino (Munich/DE)

14:10 Trends in utilization and cost of cervical spine surgery using the National Inpatient Sample Database, 2001–2013

Corinna Zygourakis, Caterina Liu, Seungwon Yoon, Tamara Kliot, John Ratliff, Christopher Moriates, R. Adams Dudley, Ralph Gonzales, Praveen Mummaneni, Christopher P. Ames

14:16 Multi-level anterior cervical fusion – Do low levels of vitamin D increase the risk of revision?

Doniel Drazin, Christine Piper, Zachary Barnard, Faris Shweikeh, Alex Rasouli, Joseph O’Brien, Warren Yu, Edward Nomoto, Ray Chu, Robert Pashman, Dan Norvell, Eli Baron, Terrence Kim, J. Patrick Johnson

14:22 Global balance and pathology in patients with cervical spondylotic myelopathy

Go Yoshida, Abdulmajeed Alzakri, Yu Yamato, Tomohiko Hasegawa, Shin Oe, Daisuke Togawa, Vincent Pointillart, Jean Marc Vital, Yukihiro Matsuyama, Oliver Gille

14:28 Mortality, complication and fusion rates after C1-C2 injury – results from a prospective observational multicenter study

Cedric Y. Barrey, Eurico Freitas, Laurent Barresi, Benjamin Blondel, Stéphane Fuentes, Benjamin Nicot, Vincent Challier, Maxime Lleu, Joel Godard, Pascal Kouyoumdjian, Nicolas Lonjon, Julien Berthiller, Yann-Philippines Charles

14:34 The importance of the occipitocervical region in patients with ankylosing spondylitis (AS) analysis of a cohort of 86 cervical fractures in surgically treated patients with AS

Augusto Covaro, Nodoka Manabe, Yohan Robinson, Claes Olerud

14:40 Posttraumatic syringohydromyelia, diagnosis of the progression and treatment

Alexander Valentinovich Beletsky, Sergey Alexandrovich Karcheuxki, Inessa Alexandrovna Ilyasevich, Oleg Ivanovich Dulub
<table>
<thead>
<tr>
<th>Time</th>
<th>Session Title</th>
<th>Authors/Moderators</th>
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</thead>
<tbody>
<tr>
<td>14:46</td>
<td>Influence of correction surgery for cervical kyphosis on foraminal stenosis in the cervical spine</td>
<td>Terumasa Ikeda, Masao Akagi, Kazuki Hshimoto, Hiroshi Miyamoto</td>
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<tr>
<td>14:58</td>
<td>Removal of foraminal cervical disc prolapse from anterior avoiding fusion or artificial without touching the disc – longterm results</td>
<td>Heinrich Boehm, Mootaz Shousha, Hassan Allouch</td>
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<tr>
<td>15:04</td>
<td>Free-hand placement of C7 laminar screws – accuracy and safety in 38 consecutive patients</td>
<td>Jiwon Park, Hyo Sae Ahn, Quan You Li, Ho-Joong Kim, Bong-Soon Chang, Choon-Ki Lee, Jin S Yeom</td>
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<tr>
<td>15:10–15:45</td>
<td>Debate session – pro vs. contra</td>
<td>Tobias Pitzen (Karlsbald-Langensteinbach/DE)</td>
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<tr>
<td></td>
<td>Post-traumatic disorders – kyphosis, myelopathy and spinal cord injury Surgical realignment is important vs. is not important!</td>
<td>Óscar L. Alves (Lisbon/PT), Philippe Bancel (Paris/FR)</td>
</tr>
<tr>
<td>15:10</td>
<td>Pro</td>
<td>Tobias Pitzen (Karlsbald-Langensteinbach/DE)</td>
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<tr>
<td>15:20</td>
<td>Contra</td>
<td>Ronald H. M. A. Bartels (Nijmegen/NL)</td>
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<tr>
<td>15:30</td>
<td>Discussion</td>
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<td>15:45–16:15</td>
<td>Industrial and poster exhibition, coffee break</td>
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<tr>
<td>16:15–17:00</td>
<td>Lecture session 8 – case presentations</td>
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<tr>
<td></td>
<td>Challenges in cervical surgeries, complications and solutions</td>
<td>Ronald H. M. A. Bartels (Nijmegen/NL), Peter Winkler (Salzburg/AT)</td>
</tr>
<tr>
<td>16:15</td>
<td>Neglecting osteoporosis in cervical spine surgery has high potential for severe complications</td>
<td>Sebastian Decker, Axel Hempfing, Oliver Meier, Heiko Koller, Michael Mayer</td>
</tr>
</tbody>
</table>
16:22  Secondary atlanto-axial deformities by reason on neglected odontoid axis fracture  
Vladimir S. Klimov, Alexey V. Evsyukov, Muragon A. Kasimshoev

16:29  Basilar invagination with asymmetrical cross-block of C0–C1–C2–C3, Chiari I and syringomyelia – rare anomaly and its management  
Olga M. Pavlova, Sergey O. Ryabykh, Alexander V. Burcev, Konstantin A. Dyachkov

16:36  Progressive loss of already heavily impaired motor function of the upper extremities – Should we dare to treat it and how?  
Heiko Koller, Juliane Koller

16:43  Total En Bloc Spondylectomy of C3 – a new surgical technique  
Jan Štulík, Petr Nesnidal, Jan Kryl, Tomas Vyskocil, Michal Barna

16:50  Tuberculous subacute painful torticollis in a young woman? a challenging case  
Abolfazl Rahimizadeh

17:00–17:20  Invited special guest lecture  
Salzburg I  
Chairs  
Michael Mayer (Fürth/DE), Anton Kathrein (Zams/AT)

17:00  Risk management in special challenges  
Thomas Bubendorfer (Monaco/FR)

17:20–17:25  Announcement of Mario Boni grant winners and announcement of poster prize winners  
Salzburg I  
Chairs  
Claes Olerud (Uppsala/SE), Carmen Vleggeert-Lankamp (Utrecht/NL)

17:25–17:30  Final remarks  
Salzburg I  
Chairs  
Heiko Koller, Michael Mayer (Fürth/DE)

from 19:00  Social evening  
(see p.40, not included in registration fee)
German Spine Conference
12th Annual Meeting of the German Spine Society

30 November–2 December 2017
International Congress Center Stuttgart

SPINAL MICROSURGERY 23
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HANDS-ON COURSE
September 14–15, 2017 • Munich, Germany
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Providence Medical Technology (Walnut Creek, CA/US)
Silony Medical Europe GmbH (Bern/CH)
SpineGuard (Vincennes/FR)
Zimmer Biomet (Sainte Savine/FR)
Rooms Pongau and Lungau are located on the first floor.

Exhibitors

1. Zimmer Biomet
2. B. Braun Aesculap
3. SpineGuard
4. ASCIS – Austrian Spinal Cord Injury Study
5. DePuy Synthes
6. Silony Medical Europe GmbH
7. Medtronic
8. Group FH Ortho
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Silony Medical signifies achieving clinical benefits through providing surgical solutions in the field of spinal surgery. We combine established and diverse experience in patient care and hospital management together with expertise and innovation from clinical users. Providing surgical solutions tailored exactly to the needs of spinal surgeons, clinical staff and patients. Our products and services are intelligently designed that simplify the work of physicians and hospital personnel throughout the patient pathway. We are proud of our – Made in Germany – which symbolises high quality in manufacturing and engineering.

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SOCIAL AND CULTURAL PROGRAMME

Cocktail hour
Date: May 24, 2017
Time: 19:30–20:30
Location: Wyndham Grand Salzburg, Fanny-von-Lehnert-Strasse 7, 5020 Salzburg (AT)

Get-together
Date: May 25, 2017
Time: 17:30–18:00
Location: Wyndham Grand Salzburg, Fanny-von-Lehnert-Strasse 7, 5020 Salzburg (AT)

Social evening
Date: May 26, 2017
Time: from 19:00
Location: Restaurant Zistelalm, Am Gaisberg, 5026 Salzburg (AT)
Fee: 95 EUR

Shuttle
from hotel to Zistelalm: 19:00
from Zistelalm to hotel: 23:30/24:00

Taxi for individual travel arrangements: +43 662 22 20
+43 664 910 09 12
Registration
Registration for the conference is required.

Registration fees

- On-site fee from May 2
  - Delegate 790 EUR
  - Trainee* 520 EUR

Social evening
- 95 EUR
Welcome acc. person
- 80 EUR

Day tickets

- May 24 May 25 May 26
  - Delegate 350 EUR 350 EUR 300 EUR
  - Trainee* 190 EUR 190 EUR 150 EUR

* Please send a confirmation of your status either to registration@conventus.de, Fax +49/03641 31 16-244 or by mail to Conventus GmbH • indicating the keyword: CSRS2017 • Carl-Pulfrich-Strasse 1 • 07745 Jena, Germany

Payment and confirmation of payment
An invoice or confirmation of registration will be sent to you via postal or electronic mail within 14 days. This invoice is a valid invoice which may be submitted to the local tax and revenue office. All fees are due upon receipt of invoice/registration confirmation. Payment transfers must include participant’s name and invoice number. Payment is also accepted by credit card (Master-/Eurocard, American Express, VISA). Should you transfer your invoice amount within 10 days of the start of the event, please present your transfer remittance slip on-site.

General terms and conditions
Please find our general terms and conditions at www.csrs-salzburg2017.com.

The registration fees include:
- Admission to all scientific sessions and access to our industrial exhibition
- Cocktail hour
- Get-together
- Congress materials (bag, final programme and abstracts, name badge, etc.)
- Refreshments as indicated in the programme
Certification
The congress will be certified by the Austrian Medical Chamber (DFP) with 8 points. The credits will be accepted by German Medical chambers.

Proof of attendance
For certification you must provide proof of attendance. Therefore, please sign/add your bar code to the list at the check-in desk, on-site every day at the conference.

Certificate of attendance
Certificates of attendance will first be made available on the last day of the conference at the check-in.

Name badge
Please wear your name badge during all conference events, including the networking activities. Admission to scientific sessions and to the industrial exhibition is restricted to participants wearing their badge. Participants will receive their name badge when collecting their conference/congress documents at the check-in desk.

Evaluation
Please take a few moments to fill out the evaluation form to help us refine and improve our programme. You can hand in your evaluation form at the check-in.

Cloakroom
Cloak racks are located within the lecture halls. On May 26 your luggage can be dropped off at the hotel reception.
GENERAL INFORMATION

Opening hours
Industrial exhibition 17:00–19:30 08:00–18:00 08:00–16:30
e-poster exhibition 17:00–19:30 08:00–18:00 08:00–17:00
Check-in 14:00–19:00 07:30–18:00 08:00–18:00
Speakers’ ready room 17:00–18:30 07:30–18:00 08:00–17:00

WIFI access
A wireless network will be available throughout the entire building and will be free of charge.
If you are accommodated in the congress hotel, you can easily access the internet by using your room number and last name.
If you are accommodated in another hotel, they need to retrieve a voucher (1 per device) at the check-in.

Conference language
The conference language is English.

Awards
The Mario Boni grant nominated oral paper will be rewarded with 1,000 EUR.
The Mario Boni grant nominated poster will be rewarded 500 EUR.

Poster prizes
The three best posters will be selected for a poster prize and awarded 500 EUR each.
All potential awardees will be informed in time and are kindly asked to attend the award session on Friday, May 26, 17:20 in Salzburg I.
Please check your e-mail account for notification if your poster has been nominated for a poster prize.

The prizes are kindly sponsored by the Spondylos GmbH.

Awards and poster prizes will be presented on Friday, May 26 during the award session 17:20 in Salzburg I.
Submission of a presentation/Technical information
The presentation should be prepared as PDF, MS Office PowerPoint for Windows or Keynote for Macintosh in format 16:9.
A presentation notebook with a PDF reader and MS Office PowerPoint 2016 will be provided. The use of personal notebooks is possible upon agreement. However, it may interrupt the flow of the programme in the lecture hall. Please provide an adapter for VGA if necessary. To guarantee a smooth running programme please upload your presentation in due time – at least 2 hours before your presentation is due to start. Should you wish to use non-digital equipment, please contact us at csrs@conventus.de.

Presentation upload
The speakers’ ready room for uploading your presentation is located on the first floor, room Pongau. For submission, please use a USB flash drive, CD or DVD disc that is not protected by any software. Professional staff and equipment will be available for you to arrange and preview your presentation.

Time allocation
Please prepare your presentation for the allotted amount of time. Chairs and moderators may interrupt should you overrun your time limit.

Allotted time is assigned as follows (speaking + discussion time):

Presidential lectures
Presentation time is 15min.

Invited special guest lectures
Presentation time should be max. 20 min.

Standard lecture sessions, e.g. session 2 and others
Presentation time is 5 min + 3 min discussion and changing time.

Mario Boni grant nominated oral papers
Presentation time is 7 min + 3 min discussion and change.

Mario Boni grant nominated posters
Presentation time is 3 min + 3 min discussion.

Presenters at “Session of experience: worst case scenarios and learning from failure”
Presentation time is 5 min + 5 min discussion and change.
General hints for authors and presenters

Round table sessions
Presentation time is 2 min. There is 8 min time for discussion.

Debate session – pro vs. contra
Presentation time for each lecture is 10 min + discussion at the end of both lectures 10 min.

Case presentations
Presentation time is 3 min for the case report + 4 min time for discussion.

Preview upon future CSRS meeting 2018
Presentation time is 3 min.

e-posters
For creating your e-poster please note the following points:
• Each abstract author is requested to upload the e-poster as PDF or JPG file in the abstract system.
• e-posters need to be prepared in vertical/portrait format 16:9 (resolution wide 3840 x high 2160 pixel, 72 dpi). Use your PC or MAC screen to decide whether the text size is readable on a screen!
• Use the template file for creating your e-poster, available online.
• Save the e-poster in PDF or JPG format
• On-site, the presentation will be provided at self-study stations with a screen of 60 inches.
• Please use name for file as follows: New Programme ID_Surname (such as P125_Smith)
• Deadline for upload was May 1, 2017.
CERVICAL SPINE RESEARCH SOCIETY

CSRS 17
EUROPEAN SECTION

33RD ANNUAL MEETING
OF THE CSRS-ES
Salzburg/Austria

MAY 24–26, 2017
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ABSTRACTS
Characteristics of deformity surgery for patients with severe and rigid cervical kyphosis (CK) – Results of the CSRS international multicenter study
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Introduction: There is little information on surgical characteristics, complications and outcomes with corrective surgery for severe and rigid cervical kyphosis (CK). To summarise the international expert experiences, the CSRS-Europe initiated an international multicenter retrospective study project.

Material and methods: All members of the CSRS were invited to participate. Included were patients with a rigid CK between 2 and 90 years treated surgically between 2003 and 2014. were summarized in a detailed instructional booklet. Rigid CK was defined as per intervertebral synostosis on CT-scans. Surgical and patient specific characteristics, complications and outcomes were studied. Radiographic assessment included global and regional sagittal parameters. Cervical sagittal balance was stratified in perspective of regional and global balance (Fig.1).

Results: The study included 88 pts with age of 58 yrs and F/U of 28 mos. CK etiologies included ankylosing spondylitis (n=34), iatrogenic (n=25), degenerative (n=9), syndromatic (n=6), neuromuscular (n=4), posttraumatic (n=5), and RA (n=5). Preop CK was angular in 27% and arcary in 73%. Sagittal balance was Type A in 36%, B in 34%, and C in 19%. Blood loss averaged 957ml and osteotomy grade 4.2. CK-correction and blood loss sig. increased with osteotomy grade (r=0.4/0.6,p<.01). Posterior-only surgery was sig. more often in Type C (94%) compared to B (56%) and A (28%) deformities (p<.001). Pts with different sagittal balance type had sig. different preop deformity parameters and alignment changes (e.g.,C7-slope, C2-7 SVA, translation).

Correction of regional kyphosis angle (RKA) was 34°(p<.0001). Preop RKA was 27° and postop RKA was -8°. Segmental translation measured 13% (-25-63%) and was sig. correlated with RKA-correction(r = 0.4, p = .004) and preop RKA(r = .51, p < .001) as was the correction of C2-C7 SVA (r = .2, p = .047) and C2-S1 SVA(r = .34, p = .018). Preop to postop translation was sig. larger in pts with correction of angular vs. arcuary CK(p = .002).

Any immediate postop complication occurred in 43% and the risk increased with age (p = .01), BMI (p = .048), surgery time (p = .03) and blood loss (p = .001). Any major long-term complication occured in 22% of pts and revision surgery was indicated in 14%. Pts with complication had larger preop RKA (p = .01), RKA-change(p = .005), and sig. higher postop increase of DJK-angle (p = .02). Complications were more frequent in smokers (p = .07) as was the need for revision surgery (p = .03). Osteoporotic patients (OP) had more often postop complication (p < .0001) and revision surgery (p = .02). Pts with revision surgery had larger RKA-change (p = .003), postop translation (p = .037), and blood loss (p = .06). A postop segmental motor deficit occured in 21% and the risk was elevated in OP (p = .001).

At F/U, NDI-improvement was 18.5 (p < .01). Pts with larger residual C2-7 angle had worse NDI scores at F/U (r = .45, p = .002). Better deformity correction (sagittal parameters) was related to larger NDI-improvement (r = 0.4-0.5,p <.03). 89% of pts were very satisfied/satisfied. These pts had better correction of C2-C7 SVA (p = .03) and C2-S1 SVA (p = .01). Pts. with complications or revision had worse NDI.

Conclusions: The results of this largest multicenter study on rigid CK stress that preop demographic, radiographic and surgical parameters had significant bearing on alignment changes, complications and outcomes.
Randomized, placebo-controlled, double-blinded trial of granulocyte colony stimulating factor-mediated neuroprotection for acute spinal cord injury

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Introduction: Granulocyte Colony Stimulating Factor (G-CSF) is generally used for neutropenia. In addition, previous research showed that G-CSF suppressed neuron apoptosis in cerebral infarction models. Thus, we investigated the neuroprotective effects of G-CSF using spinal cord injury models based on a hypothesis that G-CSF would be effective for acute spinal cord injury. Experimental studies revealed that G-CSF promoted neurological recovery after SCI via various mechanisms including mobilization of bone marrow stem cell into injured spinal cord, suppression of neuronal/glial apoptosis, suppression of inflammatory cytokines and promotion of angiogenesis. Next we moved to early phase of clinical trials. In a phase 1/2a trial, no adverse events were observed. Next, we conducted a non-randomized, non-blinded, comparative trial, which suggested the efficacy of G-CSF for promoting neurological recovery. We are now performing a phase 3 trial to confirm G-CSF treatment efficacy for acute SCI.

Materials and methods: The current trial includes cervical SCI (severity of American Spinal Injury Association (ASIA) Impairment Scale B/C) within 48 hours after injury. Patients are re-assessed for neurological status at 48 hours after injury, and those whose palsy is AIS B/C are enrolled, and patients with neurological recovery to AIS D are excluded. Patients are randomly assigned to G-CSF and placebo groups. The G-CSF group is administered 400 μg/m2/d × 5d of G-CSF in normal saline via intravenous infusion for 5 consecutive days. The placebo group is similarly administered a placebo. Allocation is concealed between blinded evaluators of efficacy/safety and those for laboratory data, as G-CSF markedly increases white blood cell counts that can reveal patient treatment. Efficacy and safety is evaluated by blinded observer. Our primary endpoint is changes in ASIA motor scores from baseline to 3 months. Each group includes 44 patients (88 total patients). Our protocol was approved by the Pharmaceuticals and Medical Device Agency and this trial is funded by the Center for Clinical Trials, Japan Medical Association.

Conclusion: G-CSF is one of possible candidates for novel therapeutic agents for SCI.
**ORAL PRESENTATIONS**

**002**  
Adjacent level degeneration of the cervical spine: assessment of a quantitative radiological scoring system  
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**Introduction:** Cervical disk arthroplasty was developed in an effort to reduce adjacent level disc degeneration in patients otherwise needing cervical fusion after decompression. In order to assess cervical adjacent level disc degeneration a radiological scoring system was developed by Goffin et al. that grades the amount of cervical disc height loss, anterior osteophytosis and end-plate sclerosis. We used this scoring system in a ten-year follow-up study of patients that were implanted with a cervical disc prosthesis.

**Materials and methods:** A total of 97 patients were implanted with a subaxial cervical disc prosthesis in our center between January 2000 and November 2002. Patients were followed for a total of ten years. Neutral lateral cervical radiographs were obtained immediately after implantation and at 2, 4, 6, 8 and 10 years after implantation. Two independent radiologists assessed the evolution of disc degeneration during the follow-up period at the level above the prosthesis. All radiographs were randomized such that each observer was unaware of patient identity, year of follow-up and the score given by the other observer. The interobserver association and agreement of the degeneration scoring system was assessed using Kendall-Tau and weighted Kappa statistics respectively.

**Results:** A total of 582 radiographs were assessed. During the follow-up period, mean degeneration score increased with 1.4 points (p<0.05). Kendall-Tau and weighted Kappa statistics showed an interobserver association coefficient of 0.700 (p<0.05) and an interobserver agreement coefficient of 0.633 (p<0.05) respectively.

**Conclusion:** This is the first study that assessed a custom developed cervical spine adjacent level disc degeneration score during a ten-year follow-up study. The score provided good association and agreement in cervical degeneration. We conclude that the degeneration score can be used in long term follow up.

**003**  
A comparative analysis of the posterior decompression surgery for ossification of posterior longitudinal ligament of the cervical spine – a multicenter study  
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**Introduction:** Several posterior decompression surgeries for ossification of posterior longitudinal ligament (OPLL) such as open-door laminoplasty (O group), double-door laminoplasty (D group) and selective laminectomy with muscle preservation (S group) were previously established. However, there was no comparative study of these three methods. The purpose of this study was to compare the surgical outcomes among three posterior decompression surgeries for OPLL.

**Materials and methods:** 236 patients who underwent posterior decompression surgeries for cervical OPLL at 17 institutions in Japan were enrolled in this study. All patients were observed with more than 2 years after surgery. Patients were divided by the methods of posterior decompression into three groups: O group, D group and S group. Age, gender, height, body weight, body mass index (BMI), operating time, estimated blood loss (EBL), Japanese Orthopedic Association (JOA) score, JOA recovery rate, range of motion of cervical spine (ROM) and perioperative complications including C5 palsy were evaluated.

**Results:** Of the 236 participants, 98 were classified as O group, 60 as D group and 78 as S group. There were no significant differences in age, male-to-female ratio and BMI. Operating time in S group was significantly longer than the other groups (104min in O group, 91min in D group and 167min in S group, respectively) (p<0.0001). EBL in O group was significantly greater than other groups (92ml in O group, 55ml in D group and 51ml in S group, respectively) (p<0.05). Postoperative cervical ROM was significantly limited in D group than in other groups (-5.7 degrees in O group, -10.1 degrees in D group and -4.0 degrees in S group, respectively) (p<0.05). There were no significant differences in functional recovery and occurrence of C5 palsy among three groups.

**Conclusion:** Operating time was significantly longer in S group, EBL was greater in O group and postoperative ROM was decreased in D group. On the other hand, there was no significant difference in JOA recovery rate.
and incidence of C5 palsy between the three groups. Based on the results of this study, it was suggested that a surgical procedure should be selected according to the each cases.

**004**
No benefits for artificial disc replacement over fusion in patients with cervical degenerative disc disease: a five-year follow-up of a prospective randomized controlled study

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*Introduction:* Artificial disc replacement (ADR) is an optional treatment to fusion after anterior decompression for cervical degenerative disc disease (DDD). The purpose of this study was to compare ADR with anterior cervical decompression and fusion (ACDF) at five-years of follow-up. The objectives were patient reported outcome measurements (PROM), possible predictors to outcome and the incidence of reoperations, preserved motion, heterotopic ossification (HO) and adjacent segment pathology (ASP).

*Materials and methods:* A prospective randomized controlled study with 151 patients undergoing surgery for cervical radiculopathy due to DDD was performed. The patients were randomized to either ACDF or anterior decompression and insertion of an ADR. A questionnaire including baseline data, Neck disability index (NDI), visual analogue scale (VAS), EQ-5D, Hospital anxiety and depression scale (HADS) and Dysphagia short questionnaire were distributed to the patients preoperatively and after five years. The radiology examinations were plain x-rays in flexion/extension and Magnetic Resonance Imaging (MRI) preoperatively and after five years. The ADR was defined as moving if the variance in Cobb-angle were >5°. HO was graded according to Mehren/Suchomels classification. MRI was graded according to Miyazaki et al.

*Results:* There were no differences between groups in PROMS at five years of follow-up. Higher values on HADS and preoperative NDI were negative predictors to outcome. Seventeen ADR-patients and seven ACDF-patients had secondary surgery. Reoperations were more frequent in women receiving an ADR, p = 0.017. Fifty percent of the patients in the ADR group had preserved motion > 5° after five years of follow-up and 66% had severe HO, grade 3-4. Five patients in each group had secondary surgery due to clinical ASP and the annual proportional incidence was 1.5% (ADR) and 2% (ACDF).

*Conclusion:* There are no differences between groups according to PROMS five years after surgery. Twenty-one percent in the ADR group have secondary surgery compared to nine percent in the ACDF group. Twenty-five percent of the ADR patients are spontaneously fused. Preserved motion on the index level does not prevent ASP.

**005**
Maintaining endotracheal tube cuff pressure at 20 mm Hg to prevent dysphagia after anterior cervical spine surgery – a double blind randomized controlled trial

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*Introduction:* In anterior cervical spine surgery (ACSS) retractor placement may raise endotracheal tube (ETT) cuff pressure. Previous studies have shown that maintaining ETT cuff pressure between 15 and 25 mm Hg may reduce endotracheal intubation-related complications in patients undergoing general anaesthesia. These studies are however, inconclusive. In this larger randomised clinical trial, we evaluated whether ETT cuff pressure adjustment after retractor placement had any influence on the occurrence of postoperative dysphagia, sore throat, and hoarseness.

*Methods:* In a single centre, observer and patient blinded randomized controlled trial patients, having anterior cervical spine surgery, were randomized into adjustment of the ETT cuff pressure or into no adjustment. Patients were followed-up to two months after surgery to investigate whether adjustment of ETT cuff pressure would lead to reduction of postoperative dysphagia, hoarseness and sore throat. Outcomes were measured using the Bazaz dysphagia score, GRBAS-scale and numeric rating scales. The primary outcome of this study was the incidence of post-operative dysphagia in both intervention and control group. This was evaluated 24 hours en 2 months after the operation.
ORAL PRESENTATIONS

Results: Data of 162 patients was available for analyses; both 81 patients were randomised for the intervention- and control group. The overall incidence of dysphagia after 24 hours was 75.9% and after two months 34.6% (Wilcoxon Signed Ranks-test: P <0.001). The overall incidence of dysphagia after two months was lower in the intervention group albeit not statistically significant. In addition, adjustment of cuff pressure did not result in an altered risk of voice problems as compared to the control group.

Conclusion: Anterior cervical spine surgery is related with high rates of postoperative dysphagia, which lasted until at least 2 months after the operation in over a third of the patients. Maintaining cuff pressure at 20 mm Hg, as compared to controls, does not lower the risk for both short- and long-term dysphagia.

O06
Does the sagittal alignment of the cervical spine have an impact on disc degeneration? – 20-year follow-up of asymptomatic volunteers
Eijiro Okada, Kenshi Daimon, Hirokazu Fujiwara, Yuji Nishiwaki, Nobuyuki Fujita, Takashi Tsuji, Masaya Nakamura, Morio Matsumoto, Kota Watanabe

Introduction: Few studies have investigated and clarified the association between sagittal alignment of the cervical spine and progression of degenerative changes of intervertebral discs.

Purpose: To longitudinally evaluate the association between sagittal alignment of the cervical spine and progression of degenerative changes of intervertebral discs and development of clinical symptoms in healthy subjects.

Materials and methods: 90 volunteers (30 males and 60 females) who had undergone MRI and plain radiography of the cervical spine between 1994 and 1996 and had been originally asymptomatic were enrolled in this 20-year follow-up study. All subjects underwent second MRI at an average of 21.6 years after the initial study. The mean age at the time of the initial study was 35.5 – 13.4 years (11-65 years). The items assessed on MRI were 1) decrease in signal intensity of the intervertebral discs, 2) posterior disc protrusion, and 3) disc space narrowing from C2-3 to C7-T1. The subjects were divided into groups according to the age and sagittal alignment of the spine at baseline, i.e., subjects under or over the age of 40 years, and subjects with the lordosis type or the non-lordosis type of sagittal alignment of the cervical spine. The MRI findings and neck pain, stiff shoulders and numbness of the upper limbs at follow-up were evaluated.

Results: During the 20-year period, progression of decrease in signal intensity of the disc, posterior disc protrusion, and disc space narrowing were observed in 84.4 %, 86.7% and 17.8% of the subjects, respectively. No significant associations were observed between sagittal alignment and progression of decrease in signal intensity, posterior disc protrusion or progression of disc space narrowing. Progression of the degenerative change at C7-T1 was significantly more frequent in the non-lordosis over 40 years group (90.9%) than those in older the lordosis group (54.2%) (p=0.032). No significant differences were observed between sagittal alignment and the onset of clinical symptom at follow-up.

Discussions and conclusions: The present 20-year follow up study showed that non-lordotic cervical alignment may be related to progression of disc degeneration. However, cervical alignment had no impact on development of the clinical symptom in healthy subjects.

O07
The health impact of adult cervical deformity in patients presenting for surgical treatment – comparison to population norms and chronic disease states based on the EQ-5D

Introduction: Although adult cervical deformity (ACD) has been empirically associated with significant pain and disability, the magnitude of this impact has not been quantified. Our hypothesis was that symptomatic ACD patients will have substantial negative health impact based on the EQ-5D compared with normative and chronic disease state values.
Materials and methods: ACD patients presenting for surgical evaluation were identified from a prospectively collected multicenter database. Baseline demographics, deformity characteristics and EQ-5D-3S scores were collected. EQ-5D scores were compared with normative and chronic disease state values.

Results: Of 121 ACD patients, 115 (95%) completed the EQ-5D (61% women, mean age 61 years, previous cervical surgery in 46%). Diagnoses included: cervical sagittal malalignment (63%), cervical kyphosis (60%), proximal junctional kyphosis (9%) and coronal deformity (8%). Posterior fusion was performed in 86% (mean levels=10), and anterior fusion was performed in 49% (mean levels=5). Three-column osteotomy was performed in 21%. The mean EQ-5D index was 0.511, which is 35% below the bottom 25th percentile score (0.790) for a similar age- and gender-weighted normative population and worse than the bottom 25th percentile for several other chronic disease states, including diabetes (0.708), ischemic heart disease (0.708), and myocardial infarction (0.575).

The EQ-5D index of 0.511 seen in this ACD cohort is comparable to the bottom 25th percentile for blindness (0.543), emphysema (0.508) and heart failure (0.437). Based on EQ-5D subscores, patients reported impact on mobility (87%), daily self-care (47%), daily activities (91%), pain/discomfort (98%), and anxiety/depression (67%).

Discussion and conclusion: The health impact of symptomatic ACD is substantial, with an EQ-5D index that is 35% below the bottom 25th percentile for a similar age- and gender-weighted normative population. The mean ACD EQ-5D index score demonstrates comparable or greater health impact than multiple other chronic disease states, including ischemic heart disease, blindness, and emphysema. Recognizing this impact is important for healthcare providers who encounter and treat these patients. Recognition of this impact is also important in payer decisions regarding treatment coverage and in decisions regarding allocation of resources for research efforts.

008
The mirror placement is useful for standardized head position when whole spine radiographs are taken in standing position
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Introduction: Recently, a whole spine radiographs are frequently taken to assess spinal sagittal alignment. However, there is no definition of the line of sight at the time of taking it. In our elderly health screening study (TOEI study) in 2012, whole spine radiographs were taken with most relaxed fist on clavicle position and horizontal gaze. But, in TOEI study 2014, the mirror was placed in front of their faces to unify their line of sight. To our knowledge, there are no reports how the sagittal alignment changes when the radiographs were taken with mirror placement setting.

Objective: to investigate how the mirror placement impacted on the sagittal spinal alignment in whole spine radiographs taken in standing position.

Methods: The volunteers who participated in both TOEI 2012 and 2014 studies were recruited. Pelvic tilt(PT), lumbar lordosis(LL), thoracic kyphosis(TK), T1 slope(TS), cervical lordosis(CL), slope of McGregor’s line (McGS; angle between McGregor’s line and horizontal line), C7 SVA, and EuroQOL 5 dimension(EQ-5D) were examined using software.

Results: A total of 354 volunteers (142 males, 212 females, average age: 72 in 2012) whose radiographs could be evaluated both study were enrolled. The average parameters between 2012 and 2014 were as follows; PT ;18 and 21° (P<0.01), LL; 40 and 40°, TK; 34 and 34°, TS; 32 and 28°(P<0.01), CL; 13 and 23° (P<0.01), McGS; 2±11° and ~9±8°(P<0.01), C7 SVA; 46 and 23mm (P<0.01), and EQ-5D; 0.83 and 0.81 (P<0.01). In Levene-test, the variation of McGS in 2014 (95%CI 0.9-3.4) was significantly smaller than that in 2012 (95%CI -9.7- -8.0, P<0.01).

Discussion: These results showed that the mirror placement made cervical alignment retroflexion, head position lean backward, and global alignment better. Moreover, the smaller variation of McGS in TOEI 2014 suggested that the mirror placement could achieve standardized head position. It is important that mirror placement is set to unify the line of sight.
Conclusion: The mirror placement to unify the line of sight is useful for standardized head position when whole spine radiographs are taken in standing position.

O09
Perioperative complications after the cervical anterior surgery for degenerative cervical spine
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Introduction: For CSM/cervical spondylotic myelopathy or OPLL, anterior decompression and arthrodesis provide sufficient neurological recovery and rare axial symptoms. On the other hand, many authors have reported serious complications after this procedure. The purpose of this study is to describe details about perioperative complications after this procedure for degenerative cervical spine to obtain the essence to avoid them.

Materials and methods: Materials include 523 degenerative cervical spine cases which have undergone anterior decompression and arthrodesis during 2006-14 in our institute. They consist of 361 males and 162 females, age ranges 26-93, avg.63yo. CSM cases are 409 and OPLL cases are 114. Surgical levels ranges 1 to 5, 157/1, 174/2, 117/3, 68/4 and 6/5(cases/levels). In 1 or 2 level cases the patients are extubated just after the surgery and in multilevel cases the patients have been intubated overnight. For 484 cases we use dynamic plate and for 40 cases halo vest. We surveyed perioperative complications of these cases retrospectively.

Results: Perioperative complications occurred much higher rate in OPLL (31/114) than in CSM (52/409) cases. In detail, CSF leakage/21, C5 palsy/17, swallowing dysfunction/11, aspiration pneumonia/8, harvest site infarction/7, transient deterioration&delirium/6, and harvest site fracture/5. VA injury, cerebral infarction, subcutaneous hemorrhage and stomach ulcer are 2 and 12 other complications one each, including one hematoma case and one airway obstruction case which needed re-intubation. There are no lethal complications in this series.

Discussion: As complications after cervical anterior surgery, CSF leakages were most frequent in this series especially in OPLL case, which has dural defect sometimes. We managed them without lumbar drainage. C5 palsy was second frequent, occurred in 3.2% especially in multilevel OPLL case. We suppose it mainly depends on the vulnerability of the spinal cord with severe compression. Airway complications were very rare due to careful management including overnight intubation, but there were not a few cases of swallowing dysfunction, some of them complicated aspiration pneumonia in multilevel elderly cases. For elderly cases, this result suggests limiting operative levels as short in pathological levels.

Conclusion: By careful management, cervical anterior surgery provides sufficient clinical results with rare lethal or irreversible complications.

O10
Three-column osteotomy for correction of cervical deformity – alignment changes and early complications in a multicenter prospective series of 24 patients

Introduction: Although three-column osteotomy (3CO; pedicle subtraction osteotomy [PSO] or vertebral column resection VCR) can provide powerful alignment correction and disability improvement in adult cervical deformity (ACD), these procedures are complex and tend to have high complication rates. Our hypothesis was that prospective assessment of ACD patients treated with 3CO will demonstrate significant improvement of alignment but have high complication rates.

Materials and methods: ACD patients treated with 3CO with minimum 90-day follow-up were identified from a prospectively collected multicenter ACD database. Complications within 90 days of surgery were collected. Baseline and 90-day standing radiographs were obtained.

Results: All 24 ACD patients treated with 3CO (15 PSO/9 VCR) had minimum 90-day follow-up (71% women, mean age 62 years, previous surgery in 54%). Diagnoses included: cervical sagittal imbalance (92%), cervical kyphosis (38%), proximal junctional kyphosis (17%), coronal deformity (8%), and distal junctional kyphosis.
(4%). The mean number of posterior fusion levels was 13, and 4% also had an anterior fusion. The most common 3CO levels were T1 (38%), T2 (29%) and T3 (21%). A total of 25 (19 major/6 minor) complications were reported, with 14 (58%) and 6 (25%) patients affected, respectively. Overall, 17 (71%) patients had at least one complication. The most common complications were excessive blood loss (>1.7L, 25%), neurologic deficit (17%), distal junctional kyphosis (DJK; 8%), wound infection (13%) and cardiorespiratory failure (8%). 4 (17%) patients required re-operation within 90 days (2 for nerve root motor deficit, 1 for deep wound infection, and 1 for implant pain/prominence). Cervical sagittal alignment improved significantly following 3CO: cervical lordosis (3° to 13°, p=0.031), C2-C7 sagittal vertical axis (66 mm to 44 mm, p<0.001) and T1-slope minus CL (TS-CL; 46° to 27°, p<0.001).

Discussion and conclusion: Among 24 ACD patients treated with 3CO, cervical sagittal alignment improved significantly following surgery. Overall, 17 (71%) patients had at least one complication (19 major/6 minor) within 90 days of surgery. The most common complications were excessive blood loss (>1.7L), neurologic deficit, DJK, wound infection and cardiorespiratory failure.

O11
Clinical and radiological spectrum of patients with Klippel-Feil-Syndromes with analysis of operative results
Jörg Klekamp

Introduction: Segmentation anomalies of the cervical spine (Klippel-Feil-Syndrome) lead to restrictions of head movements and increased functional demands in adjacent levels throughout life. Therefore, such patients are at an increased risk for cervical myelopathy. The clinical and radiological spectrum of this entity will be outlined and results of treatment presented.

Materials and methods: 94 patients with Klippel-Feil-Syndromes presented between 1993 and 2016 (mean age 40.4±17.3 years, mean history 52 months). Females predominated by a factor of 2:1. In 77 patients the craniocervical junction was involved (Chiari I malformation 73 patients and/or basilar invagination 57 patients), while 17 patients presented with clinical symptoms related to the subaxial spine due to degenerative changes of adjacent levels (n = 11) or additional dysraphic anomalies in the thoracic or lumbar spine (n = 6). 13 patients showed spinal deformities.

Results: 51 patients underwent 54 operations: 22 foramen magnum decompressions without fusion for Chiari I malformations, 32 decompressions with fusion in the craniocervical junction (n = 28) or subaxial spine (n = 4). Average follow up was 56 months. Among patients treated without fusion, 3 demonstrated a clinical deterioration in the long-term related to instabilities. In two of these, a ventral compression by the odontoid had been present before surgery. Among patients undergoing decompression and fusion 2 patients had to be reoperated for implant failures with no long-term deteriorations.

Discussion: Patients with Klippel-Feil-Syndromes should undergo imaging studies of their entire spine and craniocervical junction as Chiari I malformations, basilar invaginations or dysraphic malformations in the lumbar spine are common. Treatment has to be individualized according to these associated pathologies. Long-term results of surgery are comparable to those without segmentation anomalies.

Conclusions: In the majority of patients, clinical symptoms are not related to adjacent level diseases in the cervical spine but to pathologies associated with it. Decompressions without fusions in the upper cervical spine should be reserved for patients requiring treatment for a Chiari I malformation provided no ventral compression by the odontoid is present. For all other patients, surgery should include fusions of spinal levels adjacent to the Klippel-Feil anomaly.
012
The diagnostic accuracy of somatosensory evoked potentials in evaluating new neurological deficits after posterior cervical fusions
Alexander Vladimirovich Burtsev, Olga Mikhailovna Pavlova

Study design: This study examined the diagnostic accuracy of significant changes of somatosensory evoked potentials (SSEPs) to evaluate and predict post-operative neurological deficits after posterior cervical fusions (PCF). 846 eligible patients underwent PCF at the University of Pittsburgh Medical Center (UPMC), from 2010 to 2012. Objective: to assess the specificity and sensitivity of intraoperative monitoring in predicting post-operative neurological deficits during PCF.

Summary of background data: We calculated the predictive value, including sensitivity and specificity, of changes in SSEPs to identify neurological deficits post-operatively. We used a receiver operating characteristic (ROC) curve with SSEP categories as cutoff values to further evaluate the diagnostic accuracy of change in SSEPs and post-operative neurological deficit.

Methods: All patients had preposition baselines and continuous SSEP monitoring throughout the surgery. Statistical analysis was completed using SPSS version 22.

Results: Age and gender did not influence outcomes. Obesity affected patient outcome. The SSEP categories of significant changes and loss of responses resulted in a sensitivity/specificity of 0.30/0.96 and 0.16/0.98, respectively. The receiver operating characteristic curve has an area under the curve for significant change in loss of SSEPs of 0.62/0.65 with a 95% confidence interval of 0.525-0.714/0.509-0.797.

Conclusions: Significant SSEP changes during PCF are a very specific but poorly sensitive indicator of post-operative neurological deficits. The odds ratio for significant changes in SSEPs and loss of waveforms was 9.80 and 11.82, respectively, with a 95% confidence interval of 4.695-20.46 and 4.45-31.41, respectively.

013
Preoperative patient characteristics and pedicle screw placement accuracy influence postoperative complication rates in patients with fusion surgery at the Cervicothoracic Junction (CTJ)
Heiko Koller, Axel Hempfing, Michael Mayer

Introduction: Fusion of the CTJ implicates distinct biomechanical and soft-tissue challenges. Immobilization of this transition zone is demanding and loads increase with sagittal imbalance. Complications are frequent and related to non-union, fatigue loading of screw-bone interfaces, distal junctional kyphosis or failure (DJK/DJF) and wound-related concerns. This study analyzed risk factors for mechanical failure, wound-related complication and revision surgery after CTJ surgery with a special focus on the influence of pedicle screw (PS) placement accuracy at the lowest instrumented vertebra (LIV).

Methods: 133 pts with CTJ fusion surgery during a 6 yrs period were retrospectively analysed. Inclusion criteria were: Surgery ≥4 levels, ambulatory status, preop full-spine standing x-rays, no evidence of Parkinson’s or infection. Preop x-rays were analysed for the C2-7 sagittal vertical axis (C2-7 SVA) and C7-Slope (C7-S). On postop CT-scans PS accuracy at the LIV (Fig.1) was stratified into correct placement (Type A), pedicle breach by 1/3 to 1/2 of PS diameter (Type B), and pedicle breach ≥50% of PS diameter = In-out-in screws (Type C). The worst accuracy type at the LIV was selected for analysis. Postop complications were stratified into early (≤1 mo) and late (>1 mo). Any wound-related complication were recorded including deep fascial dehiscence. Causes of revision were stratified into wound-related, DJK/DJF, and mechanical failure indicating revision. For statistics, pts were grouped acc. to a LIV ≤T2 or >T2.

Results: 91 pts fulfilled inclusion criteria. Age was 60±14 yrs, follow-up 18±14 months, and ASA score 2.5±0.6. 57 pts had previous surgeries and 25 pts had 360°-reconstruction at C7-T1. Most pts had degenerative disease or iatrogenic instability (n=45), rheumatoid arthritis (RA) or a syndromatic disease (n=24), or ankylosing spondylitis (AS, n=19). 24 pts were obese. Blood loss was 902ml. Pts with obesity and pts with
AS had sig. larger blood loss (p = .01/p < .01). Fusion rate was 95%. Preop SVA was 44 ± 29 mm and C7-Slope 41 ± 25°. Number of revisions per patient averaged 0.5 (0-3). Early complications occurred in 28 pts, late ones in 7 pts. In total, 34 pts (37%) had revision surgery incl. distal extensions in 18%, wound-related complications in 20%, mechanical failure in 23%. Any wound-related complication occurred in 52%. Postop CT-scans were done in 91% of pts. PS accuracy was Type A in 53% of pts, Type B in 23% and Type C in 24%. Mechanical failure, the need for distal extension, and revision surgery was sig. more often in RA or syndromatic pts (p < .01) and pts with lower PS accuracy (Type B or C, p < .01; Type C vs. A or B, p < .01), but sig. less often in AS pts (p < .01). Notably, AS pts included had CTJ corrective surgery using 3-column osteotomies (3-CO). Notably, if pts without 3-CO were analysed separately those pts w/ larger preop SVA and C7-Slope were at higher risk for mechanical failure and revision surgery (p < .05). Also, revision rate was sig. lower in pts that had 3-CO with cervical realignment surgery.

Conclusion: This is the first study stressing that in CTJ surgery preop patient characteristics, etiology, sagittal imbalance and PS placement accuracy have a sig. bearing on the occurrence of surgical complications. The presented results can support surgeons in preventing complications in CTJ surgery.

O14 Outcomes of operative treatment for adult cervical deformity – a prospective multicenter assessment with one-year follow-up

Introduction: Despite the potential for profound impact of adult cervical deformity (ACD) on function and health-related quality of life, there remains a paucity of high-quality studies that assess outcomes of surgical treatment for these patients. Our hypothesis was that prospective multicenter assessment of outcomes following surgery for ACD will demonstrate significant improvement in pain and function.

Materials and methods: Surgically treated ACD patients eligible for one-year follow-up were identified from a prospectively collected multicenter database. Standardized outcomes measures included: Neck Disability Index (NDI, range 0-100), neck pain numeric rating scale (NRS) score (range 0-10), and EQ-5D-3S index (range 0-1) and subscores (range 1-3). Baseline deformity characteristics, surgical parameters, and one-year outcomes were assessed.

Results: Of 77 ACD patients, 55 (71%) had one-year follow-up (64% women, mean age 61 years, mean Charlson Comorbidity Index [CCI] of 0.6, previous cervical surgery in 44%). Diagnoses included: cervical sagittal imbalance (62%), cervical kyphosis (60%), proximal junctional kyphosis (8%), and coronal deformity (10%). Posterior fusion was performed in 85% (mean number of vertebral levels = 10), and anterior fusion was performed in 29% (mean number of vertebral levels = 5). Three-column osteotomy was performed in 24% of patients. Mean operative time was 6.5 hours and mean estimated blood loss was 0.9 L. At one-year following surgery, ACD patients had significant improvement in NDI (50.5 to 38.0, p < .001), neck pain NRS (6.9 to 4.3, p < .001), EQ-5D index (0.51 to 0.66, p < .001), and EQ-5D subscores: mobility (1.9 to 1.7, p = 0.019), usual activities (2.2 to 1.9, p = 0.007), pain/discomfort (2.4 to 2.1, p < .001), and anxiety/depression (1.8 to 1.5, p = 0.014). A nonsignificant trend favoring improvement was observed for EQ-5D self-care (1.5 to 1.3, p = 0.070). Compared with patients that achieved one-year follow-up, those lost to follow-up did not differ significantly with regard to age, gender, CCI, number of fused vertebral levels, or baseline NDI, neck pain NRS, or EQ-5D scores.

Discussion and conclusion: Based on a prospective multicenter series of ACD patients, surgical treatment provided significant improvement in multiple measures of pain and function, including NDI, neck pain NRS score and EQ-5D. Further follow-up will be necessary to assess the durability of these improved outcomes.
015
Collateral flow for vertebrobasilar region evaluated by digital subtraction angiography
Takeshi Aoyama, Naoshi Obara

Introduction: In cervical spine surgery, one side VA injury usually doesn't lead to serious complication due to collateral flow circulation. Posterior communicating artery (PcomA) supply blood flow from internal carotid artery (ICA) to vertebro-basilar region. Both side VAs join and compose basilar artery (BA), so the opposite side VA can work as collateral vessel. However, some cases are lacking of these collateral flow. For evaluation of cerebral vessels, there are some methods like MR or CT angiography. Digital subtraction angiography (DSA) is invasive, but can detect subtle artery, flow direction. So DSA is gold standard for evaluation of cerebral vessels. Frequency of PcomA, VA union, and other abnormality relating to VA injury risk are investigated in this study.

Materials and methods: DSA of consecutive 240 cases between July 2013 and December 2015 are analysed retrospectively. They were 119 man and 121 woman, age was 13-94yrs (67.8±15.4). Reasons receiving DSA were cerebral aneurysms, brain tumors, cerebral ischemic disease, etc. Since invasiveness, vessels only with necessity are investigated. So some patients didn't receive 4 vessels study. Patients, in whom only one side VA or ICA can be evaluated, are excluded.

Results: 157 cases received carotid angiography. In 97 cases (62%) of them, at least one side PcomA are recognized. Contrary in 60 cases (38%), this collateral flow lacked: lacking of both side PcomA (53 cases, 34%) or fetal type PcomA, posterior cerebral artery is feeded only by PcomA (7 cases, 5%). 149 cases received vertebral angiography. In 125 cases (84%), VA union is recognized. Contrary in 8 cases (5%), one side VA wasn’t found. And in 16 cases (11%), one side VA was end-artery, i.e., PICA end VA. It meant collateral flow from opposite side VA couldn’t be expected in 24 cases (16%).

Conclusions: Willis arterial circle and VA union are collateral vessels to VA-BA region. This DSA study reveals that collateral flow can’t be expected from anterior circulation in 38% cases, from the other side VA in 16% cases. Preoperative evaluation of cerebral vessels is essential for cervical spine surgery. And surgical strategy should be considered with the condition of vessels.

016
Risk factors and prognosis for acute progression of myelopathic symptoms in patients with ossification of the posterior longitudinal ligament after minor trauma
Jong-Myung Jung, Chun Kee Chung, Chi Heon Kim

Objective: Although the prevalence of ossification of the posterior longitudinal ligament (OPLL) among patients with cervical myelopathy is high, little is published about the risk factors for acute progression of myelopathic symptoms (PMS) associated with OPLL. The aim of this study is to identify risk factors for acute PMS associated with OPLL after minor trauma and to compare the prognosis of acute PMS group and chronic PMS group.

Methods: Patients with OPLL who had minor trauma history and underwent surgery were divided by clinical course into the acute (n=38) and the chronic PMS group (n=32). Type of trauma, clinical and radiologic characteristics were compared. Clinical outcomes were also compared at admission, post-operative 1 year and 2 years.

Results: Slip down was the most common type of trauma in both acute PMS group and chronic PMS group (22 patients, 17 patients respectively). However, type of trauma in both group were different significantly (p<0.05). Univariate analysis revealed that older age, narrower space available for cord and higher stenosis rate of spinal canal were associated with acute PMS after minor trauma (p=0.014, 0.020 and 0.006, respectively). However, stenosis rate of spinal canal was the only risk factor identified on multivariate analysis (p=0.023; OR, 0.872; 95% CI, 0.774-0.982). The Japanese Orthopedic Association score upon the initial, post-operative 1 year and 2 years was lower significantly in the acute PMS group than that in the chronic PMS group (p<0.001, <0.001 and <0.001, respectively).
Conclusion: Minor trauma can cause the unexpected PMS in patients with cervical OPLL. Risk factor for acute PMS in patients with OPLL after minor trauma was higher stenosis rate of spinal canal. Patients with acute PMS showed unfavorable neurologic outcome. Preventive surgical treatment may be recommended in patients with significant OPLL with mild cervical myelopathy.

017
Trauma of the extracranial brain arteries due to trauma of the cervical spine
Vladimir S. Klimov, Muragon A. Kasimshoev

Introduction: Cervical spine injuries are immanently accompanied by trauma to cerebral neck arteries.

Material and methods: A prospective cohort study, from oct. 2013 to oct. 2015. Overall 76 Patients (39W/37M) of mediane age 77 years, with either fractures or discoligamentary injuries have been examined with duplex-sonography and/or CT-angiograpy. About 80 Patients with a cervical-spine-distorsion have been evaluated with the same modalities as well. We used the statistics-program Bias 11.01.

Results: The overall incidence of traumatic a.carotis-interna-dissection was 2.5%, in 50% of cases (1.2%) with neurological symptomatology. For the vertebral artery seems the incidence of 10.5%, with 25% of symptomatic patients (2.6%) comparatively high. We´ve identified the osteophytes and dislocation as the major risk factors. The canalis vertebralis and the skull-base are regions mostly prone to vascular injury. In the case of distorsions we found so far no vascular trauma.

Conclusion: One should look for vascular injuries in case of cervical spine trauma. The curent therapy option is the anticoagulation in a case of neurologically asymptomatic lesions. The symptomatic patients could benefit from endovascular techniques.

018
Odontoid fractures in multi-morbid elderly patients – percutaneous posterior trans-articular atlantoaxial fixation: a prospective study
Mohamed Alhashash, Mootaz Shousha, Hassan Allouch, Heinrich Boehm

Introduction: Odontoid fractures are the most common cervical spine fractures in patients above the age of 65 years. Despite numerous publications on this subject, with a trend toward primary operative stabilization the appropriate treatment for this frequent and potentially life threatening injury remains controversial. In this group of patients compliance for complex treatment measures, be it conservative or postoperative, is usually not sufficient. Above that open posterior spinal techniques are associated with problems of wound healing.

Aim of the study: The purpose of this study is to analyse the outcome after percutaneous minimally invasive posterior trans-articular atlantoaxial (C1/C2) stabilisation of odontoid fractures in elderly patients with multiple Co-morbidities.

Materials and methods: Inclusion criteria were; 65 years or older with type II dens fractures, high risk according to ASA classification; absence of neurological deficits and the general condition of the patients allowing prone positioning for the operation. Minimally invasive posterior trans-articular screw fixation using 2 intraoperative perpendicular C-arms to guide the direction of the screws insertion are used, the screws are percutaneously inserted through 2 cm incision in the level of Th2-3 vertebrae.

Results: 27 patients were treated 20 of them (11 females and 9 males) mean age of 81 years (range 65 to 96) completed minimum of one year postoperative follow up (mean 14.5 months range 12-24), all of them had multiple comorbidities. Reduction of the fracture and screw insertion was possible in all cases. The mean operative time was 40 (range 35-85) minutes and mean blood loss was 50 ml (range 10-100). 3 patients (15%) died within 3 months postoperatively, healing of the fracture occurred in 14 patients (82, 5%), asymptomatic screw loosening in 3 patients, and screw fracture in one patient. There were no reoperations. Mean VAS (visual analogue scale) was 2.4 (range 0-7), and mean patient satisfaction score was 7.1 (range 1-10).
Conclusion: Percutaneous trans-articular posterior atlantoaxial fixation in elderly patients offers a good minimally invasive operative treatment in multi-morbid elderly patients with healing rate up to 82% of patients with no need for surgical revision in short and mid-term results.

O19
Minimally invasive stabilization of the upper cervical fractures – a new technique of C1 lateral mass screw insertion via a direct posterolateral approach
Takamitsu Tokioka, Takahiro Hayashi, Keitaro Tada

Introduction: Minimally invasive stabilization of the upper cervical spine via the posterolateral approach was introduced.

Materials and methods: 18 patients underwent this new method. Mean age at operation was 71.4 years old with range of 36 to 88. The diagnoses were axis fractures in 15 patients, mal-union of odontoid process in 3. Surgical techniques: A posterolateral 4-cm skin incision was applied and the splenius muscles were split using fingers from C1, C2 lateral masses. Blunt dissection was performed along the upper border of obliquus capitis inferior (OCI) laterally and cranially in the suboccipital triangle. The medial border of the OCI attachment of C1 was used as an entry point of C1 lateral mass screw and a 1.4mm K-wire was inserted through a navigated guide tube. Cannulated pedicle screws were followed using the Iso-C 3D navigation system. Screw insertion angle to axis (α-angle) measured on postoperative CT were evaluated and compared to 13 patients of conventional Goel-Harms method performed in our institute in past.

Results: The average bleeding volume was 108ml versus 352ml in conventional group (C-group), and surgical time was 198 minutes relative to 260 minutes in C-group. 32 screws were inserted in C1 lateral masses, 9 screws were inserted in C2 pedicles, 24 screws in C3 pedicles and 3 screws were in opposite transarticular C1/2. The average α-angle of C1 lateral mass screws was 36 degrees relative to 7.1 degrees in C-group. The diameter of all screws was 4.0 mm in MIS group, 3.5 mm in C-group. No major complication and no LM screw misplacement occurred. Each patient showed evidence of solid fusion after 6 months on plain X-ray in MIS-group, whereas 2 patients in C-group showed postoperative subluxation due to loosening of C1 LMS.

Discussion: Goel-Harms technique has become an effective alternative to Magerl’s transarticular fixation, however, requires extensive posterior exposure which has been associated with superficial infections and occipital nerve injury.

Conclusion: This method provided direct oblique exploration of C1 lateral masses and allowed the correct oblique angle of screw position which results to less lateral deviation and subsequently reduces muscle damages and bleeding from the venous plexus.

O20
Posttraumatic syringomyelia related to cervical injuries
Jörg Klekamp

Introduction: Posttraumatic syringomyelia may lead to progressive, ascending neurological symptoms in patients already compromised by traumatic cord lesions. Management of these patients requires to analyze clinical symptoms carefully to decide, whether they are related to posttraumatic cord tethering, affections of cervical roots or syringomyelia. This paper presents presents results of treatment for these patients.

Materials and methods: 43 patients with cervical trauma leading to syringomyelia presented between 1991 and 2016 at an average age of years. The free interval between injury and symptoms related to syringomyelia was extremely variable (mean 135 + 137 months), the average history related to syringomyelia was 40 months. 24 patients underwent 39 operations: 26 decompressions with duraplasty at the injury level, 4 cordectomies, 3 shunts between syrinx and peritoneal or subarachnoid space, 2 shunts between cervical subarachnoid space and peritoneal cavity, while 4 surgeries involved ventral fusions for degenerative changes of the cervical spine. Average follow up was 57 months.
Results: All but 2 patients undergoing decompressions or cordectomies could be stabilized preserving their neurological status. This required multiple operations for 8 patients. Permanent surgical morbidity was restricted to one patient. All 3 patients undergoing syrinx shunting procedures deteriorated within 1 year of surgery. For patients treated with subarachnoid to peritoneal shunts no long-term results are available so far.

Discussion: Decompression at the injury site with untethering of the cord and duraplasty to preserve a free CSF-pathway is the treatment of choice for patients with posttraumatic syringomyelia. For patients with a complete traumatic cord lesion cordectomy is an excellent alternative with the best long-term results compared to any other surgical method. Whenever a decompression at the injury level is not feasible a shunt from the cervical subarachnoid space to the peritoneal cavity may be chosen. Syrinx shunts, on the other hand, were associated with the worst postoperative results.

Conclusions: Posttraumatic syringomyelia can be a devastating problem particularly for patients who had suffered a high-level cord injury already. Although it may require more than one procedure, neurological progression can be stopped by decompression and duraplasty in almost all cases.

O21
A finite element analysis of the occipitoatlantal capsular ligaments as the primary stabilizers of the craniocervical junction
Andrew T. Dailey, Richen Phuntsok, Douglas L. Brockmeyer, Benjamin J. Ellis

Introduction: Cadaveric biomechanical testing of the craniocervical junction (CCJ) demonstrates that the occipitoatlantal (OA) joint relies on three ligamentous structures for stability: the tectorial membrane (TM), the transverse ligament (TL) and occipitoatlantal capsular ligaments (OACL). Studies demonstrate that the TM plays the dominant role in stability. Stability studies involving transection of OA are less common. In this study, our goal is to examine the contributions of the TM, TL and OACL on OA joint stability in an adult FEM model of the CCJ. Injury scenarios of the TM, TL and OACLs are examined in isolated and combined fashion.

Methods: A validated adult FEM was used for injury simulations. The model was generated from the CT scan of a single, fresh frozen female cadaveric spine (age: 64 year, height: 170 cm, weight: 74kg). The meshes from this model were imported into FEBio’s preprocessor, PreView. The intact normal FEM was modified to evaluate the sensitivity of the models when damage to TM, TL and OACL were simulated. Seven sets of scenarios were simulated for flexion-extension. These include 1) removal of TM, 2) TL, 3) removal of both TM and TL, 4) OACL injury model (i.e. reducing the stiffness of the OACL by 29.4 N/mm) 5) OACL injury model with TM, 6) TL, 7) both TM and TL removed. C0-C2 rotations were predicted for flexion-extension. Rotations are reported for normal models and percent increases from normal are reported for the injury models.

Results: The flexion-extension ROMs were within one standard deviation of previously reported cadaveric data. An isolated injury to the OACL caused the largest increase in flexion ROM. The adult FEM with an isolated OACL injury showed a 30.5% increase in flexion. Isolated TM, TL and TM-TL removal increased flexion ROM a maximum of 6%. An OACL injury combined with removal of TL, TM or both further increased flexion ROM from the isolated OACL injury by <5%.

Conclusions: Our results show that the OACL plays a major role in the stability of the CCJ. In contrast to other studies, we found the TM and TL to be small contributors to stability.
ORAL PRESENTATIONS

022
Do patients with traumatic cervical spinal cord injury benefit from very early surgical decompression under 5 hours after injury?
Maria Gollwitzer, Georg Mattiasich, Stephanie Aschauer-Wallner, Wolfgang Hitzl

Background: The purpose of our study was to assess the neurological outcome of surgical decompression and stabilization within 24 hours in general and very early spinal cord decompression within less than 5 hours after injury in particular.

Methods: We performed a multicenter, retrospective cohort study in Austria in adults aged 15-85 with cervical SCI at 6 Austrian trauma centers, participating at the Austrian Spinal Cord Injury Study (ASCIS) database. Neurological outcome was measured by the American Spinal Injury Association Impairment Scale (AIS) grade according to the ISNCSCI (International standards for neurological classification of spinal cord injury) form after at least 6 months follow up (FU).

Results: A total of 49 patients with acute CSCI were enrolled and 33 of these underwent surgical decompression less than 5 hours at a mean of 3.2 h (+/- 1.1h). The remaining 16 participants underwent surgical decompression between 5 and 24 hours post CSCI at a mean of 8.6h (+/- 5.5h). Significant neurological improvement was observed in the total study population between preoperative and FU. Improvement of one AIS grade was found in 31 percent of patients in the early group and in 42% of the very early group (p=0.75). Improvement of two AIS grades was found in 31 % of early group and 6% in the very early group (p=0.54). An improvement of at least three AIS grades was found in 6% in early and 3% in very early group (p=1.0)

Discussion: The question of what is “early” in treating traumatic CSCI has not been answered today. In a systematic review of Furlan et al. in 2009, analyzing 19 studies with decompression in several different animal SCI models, eleven favored a time dependent effect.

Conclusion: Significant neurological improvement could be confirmed in the total study population, if a surgical intervention was performed within 24 hours after injury. Very early surgical decompression within 5 hours does not seem to further improve the neurological outcome of affected individuals.

023
Bicortical facet screws as a new option for posterior C2 fixation – anatomical study and clinical experience
Angelo Rusconi, Cedric Barrey, Kone Noukhoum, Eurico Freitas-Olim

Introduction: Different techniques of C1-C2 arthrodesis have been developed and screw and rod constructs are actually the most commonly used. However, C2 pedicle or isthmic screw placement is technically demanding and carries the risk of neural and vascular injury. The inferior articular process (IAP) of the axis can be a safe alternative for screw placement in patients with bone or vascular variants of C1-C2 anatomy. We report the results of a CT study of C2 IAP anatomy, which can provide useful parameters for screw placement. We also present the preliminary clinical experience of 28 patients operated with this technique.

Material and methods: Morphological study: 50 CT angiographies of the vertebral arteries (VA) were used for this study, and therefore 100 IAP were considered. We measured on the axial and sagittal planes the length of the facet and the distance between the anterior cortex and the VA. We also measured the angle between the sagittal plane passing through the entry point and the external tangent line of the VA.

Clinical report: 28 patients were treated with C2 IAP screws at our Institution from January 2014 to January 2016. The screw entry point was located in the middle of the C2 IAP, and bicortical screws were inserted with a perpendicular trajectory on the sagittal plane and a lateral inclination of 15-20° on the axial plane.

Results: Morphological study: the mean length of C2 IAP was 12±2 mm, the mean distance between the anterior cortical layer and the VA was 5,2±1,4 mm, and the mean angle we found was 0,2±5,3°, with minimum and maximum values of -13,5° and 14,5° respectively.
Clinical report: 13 women and 15 men were treated with C2 IAP screws. 16 of the 28 patients presented post-traumatic C1-C2 instability, 8 patients presented degenerative disease, 1 patient was treated for pseudoarthrosis, 1 for tumor, 1 for OPLL and 1 for rheumatoid arthritis. All the screws were correctly positioned and there was no VA injury. **Conclusion:** IAP screws represent a safe alternative option for C2 fixation in some cases, and the morphological and clinical data we present in this study demonstrate that it is a feasible procedure.

O24
The accuracy of three different way of the cervical pedicle screw insertion
Hisanori Ikuma, Shinichiro Takao

**Introduction:** We report the accuracy about three different insertion techniques of the cervical pedicle screw (CPS) that we have ever performed so far along with the development of surgical assistive devices.

**Material and method:** The consecutive 402 CPS (C1-C7) during 2009 to 2016 were investigated about the perforation rate and the complication. The cervical pedicle probe (CP) or the cervical pedicle guide wire (CG) was used for making the trajectory of CPS in this series. The insertion technique of CPS was divided to three different groups (group PF (n=118): CP under the fluoroscopy, group PN group (n=123): CP under the intraoperative CT navigation, group GN group (n=161): CG and cannulated CPS under the intraoperative CT navigation). CPS has over 2mm deviation from the pedicle wall was extracted as the perforation in this study. Regarding the subaxial cervical spine, the impact of skin incision (median or lateral skin incision) for CPS insertion was also investigated.

**Result:** The perforation rate of CPS was 5.9% for group PF, 3.3% for group PN and 0.6% for group GN, respectively (group PF vs group GN: P<0.01). The perforation rate at the subaxial cervical spine regarding to the median and lateral skin incision were 6.4% and 6.1% for group PF, 4.1% and 2.8% for group PN, 1.1% and 0% for group GN, respectively. One postoperative cerebellar infarction due to the deviated CPS was experienced in group PF and there was no complication related CPS in the other group.

**Discussion:** The lowest perforation rate was confirmed in group GN. CG can reduce the friction compared to CP and this phenomenon can improve the accuracy. The misplacement of CPS after making the screw hole can also be prevented. The lateral skin incision could improve the accuracy compared to the median skin incision at the subaxial cervical spine and the lowest perforation rate was confirmed in group GN with the lateral skin incision.

**Conclusion:** The cannulated CPS insertion with CG under intraoperative CT navigation is the most useful technique, and the combination with the lateral skin incision can be the best way for the subaxial cervical spine.

O25
Comparison of the AO Spine subaxial cervical spine injury classification system and the Allen classification
Toshiya Tachibana, Kazuki Kusuyama, Kazuya Kishima, Shinichi Yoshiva

**Introduction:** The AOSpine group has launched a new subaxial cervical spine injury system (AOSCIS) based on morphology. The objective of this study was to use the AOSCIS and compare it to the widely used Allen classification (AC) based on mechanics for subaxial cervical spine injury.

**Materials and methods:** Nineteen consecutive patients with subaxial cervical spine injury who received posterior cervical fixation in our hospital were included in this study. Medical records were evaluated retrospectively. The evaluated factors were follows: preoperative ASIA impaired scale (AIS), AOSCIS, AC and diffuse idiopathic skeletal hyperostosis (DISH). A statistic analysis using Fisher’s exact test was performed for the relationship of AOSIS C or AOSIS except C and AC stage 1, or Stage 2, 3, and 4.

**Results:** There was AIS A in 8 patients, AIS C in 3 patients, AIS D in 3 patients and AIS E in 5 patients. Two Patients with AOSCIS B2 were classified as AC DF1. Two AOSCIS F3 patients were classified as AC CE1. Fifteen AOSCIS C patients were classified into multiple categories: five as AC DF2, two as DF3, one as CF4, two as DE2, three as CE3+DE1 and one as CE3+VC2. All of AOSICS B or F patients were classified as AC stage 1,
and all of the AOSCIS C were classified as AC stage 2 and higher (P<0.05). All of 6 patients with DISH were classified as AOSCIS C and CE3, DE2 or DF3.

**Conclusions:** AOSCIS and AC are correlated. Conducting an evaluation using both systems helps us to better comprehend the subaxial cervical spine injury.

**O26**

**Predictive model for distal junctional kyphosis after cervical deformity surgery**

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**Background:** Distal Junctional Kyphosis (DJK) is a primary concern of surgeons correcting cervical deformity. Identifying patients and procedures at higher risk for developing this condition is paramount in improving patient selection and care.

**Patient sample:** Patients queried were over the age of 18 meeting one of the following deformity cervical kyphosis (C2-7 Cobb angle >10°), cervical scoliosis (Cobb >10°), positive cervical sagittal imbalance (cSVA >4cm or T1-C6 >10 o), or horizontal gaze impairment (chin-brow vertical angle >25o).

**Methods:** DJK was defined by both clinical diagnosis (by enrolling surgeon) and post-hoc identification of development of an angle <-10 degrees from the end of fusion construct to the 2nd distal vertebra, as well as a change in this angle by <-10 from baseline. Conditional Inference Decision Trees were used to identify factors predictive of DJK incidence and the cut-off points at which they have an effect. A conditional Variable-Importance table was constructed based on a non-replacement sampling set of 2000 Conditional Inference Trees. 12 influencing factors were found, binary logistic regression for each variable at significant cut-offs indicated their effect size.

**Results:** Statistical analysis included 101 surgical patients (average age: 60.1 years, 58.3% female, BMI: 30.2) undergoing long cervical deformity correction (mean levels fused: 7.1, osteotomy used: 49.5%, Approach: 46.5% Posterior, 17.8% Anterior, 35.7% Combined). In two years after surgery 6% of patients were diagnosed with clinical DJK, however 23.8% of patients met radiographic definition for DJK. Patients with neurologic symptoms were at risk for DJK (OR:3.71 CI:0.11-0.63). However, no significant relationship was found between osteoporosis, age, or ambulatory status with DJK incidence. Baseline radiographic malalignments were more the most numerous and strong predictors for DJK: [1] C2-T1 Tilt >5.33 (OR:6.94 CI:2.99-16.14), [2] Kyphosis <-50.6° (OR:5.89 CI:0.07-0.43), [3] C2-C7 lordosis <-12° (OR:5.57 CI:0.08-0.41), [4] T1 Slope minus Cervical Lordosis>36.4 (OR:5.6 CI:2.28-13.57), [5] C2-C7 SVA >56.3° (OR:5.4 CI:2.20-13.23), and [6] C4 Tilt >56.7 (OR:5.0 CI:1.90-13.1). Clinically, combined approaches (OR:2.67 CI:1.21-5.89) and usage of Smith Petersen osteotomy (OR:2.55 CI:1.02-6.34) were the most important predictors for DJK.

**Conclusions:** Different procedures and patient malalignment predicted incidence of DJK up to 1-year. Preoperative C2-T1 Tilt, Cervical Kyphosis, SVA, and Cervical Lordosis all strongly predicted DJK at specific cut-off points.

**O27**

**Percutaneous ultrasonographic observation of the spinal cord after cervical laminoplasty at the postoperative early periods**

*Yoshiharu Nakaya, Atsushi Nakano, Kenta Fujiwara, Takashi Fujishiro, Sachio Hayama, Toma Yano, Masashi Neo*

**Introduction:** Some reports have been published about intraoperative ultrasonography of the spinal cord in cervical laminoplasty. However, there is no study that has investigated the postoperative changes over time. Double-door cervical laminoplasty with suture anchors keeps the split laminae widely open, and this method does not install any structures at the posterior part of the cervical spine. Therefore, we can observe the spinal cord by percutaneous ultrasonography (PUS). The objectives of this study are to confirm whether the spinal cord can be visualized clearly by PUS at the postoperative early periods after cervical laminoplasty, and to evaluate the changes over time.
Materials and methods: Twenty-five patients who underwent cervical laminoplasty were evaluated by intraoperative ultrasonography and postoperative (1 week, 2 weeks, and 3 months) PUS. In order to evaluate the decompression status of the spinal cord, we observed the ventral subarachnoid space, and classified into 3 grades (Noncontact, Contact and apart, Contact). And in order to evaluate the pattern of the spinal cord pulsation, we classified the spinal cord dynamics into 6 categories (Pulsating, Forward and Backward, Upward and Downward, Seesaw, Wave, No pulsation). Ultrasonography was performed using Noblus (Hitachi Aloka Medical, Ltd. Tokyo, Japan) with a 1-5 MHz sector transducer (EUP-C715).

Results: In all cases, the surroundings of the spinal cord could be observed clearly. The intraoperative status were not retained postoperatively in most of our cases. The decompression status were tended to improve postoperative over time. The pulsation patterns were various in each evaluation periods. However, spinal pulsation itself was observed at all periods in all cases. Exceptionally in only one case, the pulsation of the spinal cord disappeared at the time when the postoperative paralysis occurred by the epidural hematoma. Percutaneous ultrasonography demonstrated not only spinal cord compression due to hematoma, but also “no pulsation” pattern of the spinal cord.

Conclusion: We could observe the status of the spinal cord by PUS at the postoperative early periods after cervical laminoplasty. PUS was a very useful method to evaluate the postoperative status of the spinal cord, especially in the diagnosis of the postoperative epidural hematoma.

Trunk shift and head tilt in congenital scoliosis of the cervicothoracic junction
Peter Obid, Gregor Ostrowski, Tobias Pitzen, Jörg Drumm, Michael Ruf

Introduction: Congenital scoliosis at the cervicothoracic junction is often accompanied by head tilt due to limited compensation possibilities of the upper cervical spine in the coronal plane. The purpose of this study is to assess the impact of head position on the overall coronal spinal balance and the effect of surgical correction.

Materials and methods: A retrospective study of 23 patients was conducted. The following radiological parameters were measured: Cobb angle of the main and compensatory curves, head tilt in relation to horizon, and the trunk shift, defined as the angle between a line from the center of C7 to sacrum and the Center Sacral Vertical Line (CSVL). 14 patients underwent surgical correction. Postoperative parameters were measured as well.

Results: The mean Cobb angle of the main curve was 43.8°, upper compensatory curve 13.7°, lower compensatory curve 28.3°. Head tilt was 6.7°, and trunk shift was 4.0°. The amount of head tilt correlated significantly with the amount of trunk shift (p: 0.034, r: 0.443).

Postoperatively main curve was 11.8°, upper compensatory curve 6.6°, lower compensatory curve 12.1°. Head tilt was -0.3°, and trunk shift was 0.2°. Correction of the main curve had a significant impact on head tilt and trunk shift.

Discussion: The position of the head in coronal plane appears to play a significant role in the overall trunk balance. Failure to achieve a horizontal head position was followed by a compensatory trunk shift.

Conclusion: Correction of the deformity with balancing of the head resulted in a spontaneous correction of the trunk shift. Position of the head should be taken into consideration when planning correction of congenital scoliosis at the cervicothoracic junction to achieve an optimal result with a balanced spine in the coronal plane.
Oral Presentations

O29
Safety and efficacy of a novel anterior decompression technique (vertebral body sliding osteotomy) for ossification of posterior longitudinal ligament of the cervical spine — comparison of postoperative outcomes between vertebral body sliding osteotomy and anterior corpectomy and fusion
Dong-Ho Lee, Jae Hwan Cho

Introduction: Anterior corpectomy and fusion (ACF) for cervical ossification of the posterior longitudinal ligament (OPLL) is known to be associated with a higher incidence of surgery-related complications including cerebrospinal fluid (CSF) leakage and neurologic deterioration. To avoid these complications, we have developed a novel anterior decompression technique (vertebral body sliding osteotomy; VBSO). Its basic concept is to expand the spinal canal by anteriorly translating the involved vertebral bodies as well as ossified masses. The purpose of this study is to attest the efficacy and safety of VBSO by comparing conventional ACF.

Material and methods: Twenty-four patients who needed anterior decompression for cervical OPLL underwent VBSO by a single surgeon. Other 38 patients underwent ACF by another single surgeon. In 16 out of 38 ACF patients, OPLL masses were partially removed by the floating method due to severe dural adhesion. Operation time, estimated blood loss (EBL), neurologic outcomes, and the incidence of surgery-related complications were investigated. Various radiographic parameters including the canal widening, and sagittal alignment were also measured.

Results: The mean operation time and EBL in VBSO group were significantly smaller than those in ACF group. Sixteen patients in ACF group (42.1%) showed various surgery-related complications (neurologic deficit in 2 patients, CSF leak in 4, graft migration in 3, and pseudarthrosis in 7). On the contrary, there was no neurologic deterioration, no dural tear, and no graft migration except 2 pseudarthrosis (8.3%) in VBSO group. Neurologic improvements showed no significantly difference between the two groups. On radiographic data, the mean canal widening was significantly greater in VBSO group than in ACF group. Sagittal alignment of VBSO group had been improved postoperatively much more than that of ACF group.

Conclusion: The VBSO could provide similar neurologic outcomes with shorter operation time and less bleeding compared with the conventional corpectomy procedure. Since surgeons do not need to directly manipulate the OPLL mass or dissect the interspace between the OPLL and dura mater, this technique could significantly decrease the complications. Furthermore, as it is based on the multi-level discectomy and fusion technique, it would be more helpful to restore a physiologic lordosis.

O30
Evaluation and clinical use of DTI-MRI in patients with cervical spondylotic myelopathy
Cevat Akinci, Ismail Bozkurt, Omer F. Ates, Omer Faruk Turkoglu, Giyas Ayberk

Introduction: In this study, a prospective analysis of 27 cervical spondylotic myelopathy (CSM) diagnosed patients and 10 control patients with no symptoms and a normal MRI scan were evaluated. These patients who were admitted to the neurosurgery clinic between January 2015 and May 2016 were followed up on for at least 6 months. The objective of the study was to determine if DTI and DWI sequencing proved valuable addition to diagnosing CSM patients.

Materials and methods: All patients consented to take part in this study. Using diffusion tensor imaging magnetic resonance imaging (DTI-MRI) all of the patients were evaluated for anteroposterior (AP) spinal canal diameter, apparent diffusion coefficient (ADC), fractional anisotropy (FA) and modified Japanese Orthopaedic Association scale (mJOA). An experienced radiologist blinded to clinical findings evaluated the parameters obtained from MRI.

Results: Of the 27 patients, 15 were considered for surgery but 5 of the patients accepted surgical treatment. The remainder 12 patients were advised for follow up. Open door laminoplasty was performed for 8 patients and cervical lateral mass screw instrumentation and total laminectomy was performed for the other 2. The patients were then evaluated at routine follow ups for physical, neurological and radiological examination (cervical MRI, DTI, DWI). Preoperative and postoperative mJOA scores were compared. The subjects were divided into 3
groups. In the first group, preoperative and postoperative cervical FA and ADC measurements were compared. In the second group, preoperative and postoperative FA and ADC measurements of patients who did consent for surgery were compared to those that were operated on. In the third group normal subjects and CSM diagnosed patients were compared in accordance to their FA and ADC values.

**Conclusion:** In addition to T1 and T2 sequences of a standard cervical MRI, DTI and DWI sequencing may provide valuable information towards making a healthier decision for patients in subject to diagnosis and determining the modality of treatment – surgical or follow up choice supplementary to AP diameter, mJOA score and neurological examination.

**Keywords:** CCM, DWI, DTI, FA, ADC

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**031**

**Endogenous inflammatory response in cervical spondylotic myelopathy – a pilot series**

*Christian Blume, Hans Clusmann, Maximilian Schmeisser, Lars Brandenburg, Christian Andreas Mueller*

**Objective:** The aim of this prospective study was to evaluate the levels of inflammatory mediators in cerebrospinal fluid (CSF) and blood serum (BS) in patients with cervical spondylotic myelopathy (CSM).

**Methods:** In patients with CSM who underwent lumbar myelography CSF and BS were sampled. Patients were monitored for neurological symptoms including NDI and mJOA. Clinical follow up with examination, BS sampling for protein concentrations of inflammatory mediators, and questionnaires were performed preoperatively (preop) and 5 days, 6 weeks, 3, 6, 9, 12 and 18 months postoperatively (postop). A control group with preop CSF and BS samples was formed from patients with abdominal aortic aneurysm surgery (AAA-group), who had a lumbar drain for intradural pressure monitoring. The control group was monitored to exclude neurological signs of CSM (mJOA). The samples were evaluated with ELISA. The proinflammatory cytokine concentrations which were measured in CSF and BS in pg/ml: RANTES (regulated on activation, normal T cell expressed and secreted) and Interleukins (IL -1, 6, 8, 10, 17).

**Results:** Overall 26 patients were included. CSM-group 14 patients (mean age 64 years), AAA-group 12 patients (mean age 58 years (p=0.178)). Mean preop scores: mJOA CSM-group 9.2, AAA-group 17.0 (p= <0.001); NDI CSM-group 49.7, AAA-group 1.2 (p= <0.001). Following significant differences were found in CSF preop: IL-1alpha CSM-group 100.3±86.5 vs AAA-group 38.3±52.1 (p=0.047); IL-1beta CSM-group 20.9±25.9 vs AAA-group 0.9±0.6 (p=0.031). In BS no significant differences were detected. In the CSM clinical follow up examinations mJOA and NDI showed significant improvement from the third month postop.

**Discussion:** Preoperatively increased levels of some Interleukins in the CSF are associated with the diagnosis of CSM. Thus, they could contribute to a progressive endogenous inflammation and clinical deterioration in the course of CSM. A limitation for interpretation is the non-availability of postoperative CSF in patients, so that these results may at first trigger respective translational research in animal models for CSM.

**Conclusion:** These factors may serve as tools for further research on prognosis and pathophysiology.

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**032**

**The causes of failed various types of posterior surgery for cervical myelopathy due to OPLL and clinical outcomes of anterior decompression and arthrodesis as a revision surgery for failed posterior surgery**

*Macondo Mochizuki, Atuomi Aiba, Ryo Kadota, Masao Koda*

**Objectives:** Objectives of this study were to investigate causes of neurological deterioration after various types of posterior surgery for cervical myelopathy due to OPLL and to assess clinical outcomes of anterior decompression and arthrodesis as a revision surgery for failed posterior surgery.

**Materials and methods:** Thirteen cervical failed posterior cases that were revised from anterior in our institute between 2006 and 2016 were estimated. Mean age at previous posterior surgery and revision surgery was 58 y/o and 64 y/o respectively and mean F/U period from revision was 36months. Feature of initial symptom and time interval between the index procedures and neurological deterioration and revision surgery were investigated.
Radiographic parameters such as k-Line, extension of OPLL and the movement of cervical spine were analyzed. Perioperative complications of anterior surgery and union rate were investigated. JOA score (17 points) was used to assess neurological status before revision surgery and at final F/U.

**Results:** Pain or progression of numbness on U/E was noticed as an initial symptom of deterioration in 11 of 13 cases. The mean interval between the index procedure and deterioration and revision surgery were 42 months (1-122mo.) and 57 months (4-132mo.) respectively. Time course of deterioration was classified into two types; early type (6 cases) whose deterioration occurred within 2 years after previous posterior surgery and late type (7 cases). In early type, K-Line(−) was found to be a main cause of deterioration. In late type, progression or newly development of OPLL foci or re-stenosis in combination with local kyphosis and residual OPLL foci where segmental motion was preserved, were main causes of deterioration. With respect to clinical outcomes of anterior surgery, JOA score improved 8.9/13.5 in early group and 9.3/11.9 in late group. CSF leakage and transient dysphagia was found in one case in each group and bone union was acquired in 12 cases (92%).

**Conclusion:** We should know the possibility of late deterioration after posterior surgery for cervical OPLL however causes of early deterioration can be avoidable by another methods. Anterior surgery for failed posterior surgery was performed successfully with no serious sequel.

**O33**
**Correlation between novel classification of cervical myelopathy and spinal cord compression form**

Hisanori Mihara, Yasunori Tatara, Takanori Niumura, Yohei Itoh

**Introduction:** We proposed a novel classification system for cervical myelopathy according to estimated damage in the spinal cord cross-section and reported in this meeting. This study aimed to investigate how the cord compression form in preoperative MRI related to the type of myelopathy and to analyze the post-operative neurological improvement of each condition.

**Methods:** This study involved a total of 352 patients who were diagnosed with cervical myelopathy and underwent surgical treatments with at least one year follow-up. Neurological status was evaluated by the JOA score, performance tests, and quantitative sensory scores. Then the estimated damage on the spinal cord in cross-section was classified into five types consisting of Anterior (Type I), Central (Type II), Posterior (Type III), Unilateral (Type IV) and Transverse (Type V). In addition, the spinal cord compression form in preoperative MRI were analyzed at the most compressed level and graded as Impingement, Entrapment Minor (<50% entrapment), Entrapment Major (50-75%), and Total Entrapment (75-100%). This study analyzed how the cord compression form related to the type of myelopathy and postoperative neurological improvement.

**Results:** All patients were classified into five types according to neurological symptoms as Type I in 54 patients (15.3%), Type II in 41 (11.6%), Type III in 21 (6.0%), Type IV in 35 (9.9%) and type V in 201 (57.1%). As to the cord compression form, there were 38 patients (10.8%) of Impingement, 45 (12.8%) of Entrapment Minor, 106 (30.1%) of Entrapment Major and 163 (46.3%) of Total Entrapment. Majority of patients who had Impingement lesion showed Type I or II symptoms. Patients who had severer cord compression form likely showed advanced type of myelopathy except for Type IV. The JOA score recovery rate after a surgical treatment was highest in Type I with Impingement lesion (73.2%) and was lowest in Type V with Total Entrapment lesion (49.8%).

**Conclusion:** There were obvious correlations between the myelopathy type and the cord compression form. Types I or Type II patients who mainly involved segmental signs showed better neurological improvement compared to Types III or Type V patients having wider damage on the spinal cord.
Upper cervical spine fixation for Bow-hunter syndrome

Hiroyuki Nakase, Yasuhiro Takeshima, Yasushi Motoyama, Young-Su Park

Introduction: Bow hunter’s syndrome (BHS) is defined as symptomatic, vertebro-basilar insufficiency caused by mechanical occlusion of the vertebral artery (VA) at the atlanto-axial level during head rotation. Due to the rarity of this pathology, there are no guidelines for diagnosis and treatment. Conservative, surgical and endovascular concepts have been proposed. In surgical treatment, it is still controversial which way of VA decompression and upper cervical posterior fixation is better. In the present paper, we report our experiences of the management of 14 patients with BHS in our institute.

Materials and methods: During the last 10 years, we have treated 14 cases with BHS. The series consist of 11 males and 3 females; their ages ranged from 7 to 64 years old. Initial symptoms were dizziness in 11, visual disturbance in 2, unconsciousness in 1 case. Infarction occurred in 5 cases. Diagnosis was established by MRA, digital subtraction angiography, and three dimensional CT angiography (3D-CTA).

Results: Two patients were treated conservatively, posterior cervical fixation (C1-C2 fusion) underwent in 10 cases, occipito-cervical fixation (OC fusion) in one with rheumatoid arthritis, and carotid stent in 1 case. VA decompression was not performed in any case. Follow-up period ranges 9 to 116 months (mean 64.4 months). There were no perioperative neurological complications and recurrence during the follow up period.

Discussion and conclusions: BHS is a rare pathology but associated with a pathognomonic and serious clinical presentation. The gold standard of diagnosis is dynamic angiography and 3D-CTA, and the patients were well managed with tailored treatment including conservative, posterior stabilization of upper cervical instability, and endovascular surgery. Clinical and radiological results in Upper cervical spine fixation for BHS were excellent, and the treatment-related morbidity was low without any recurrences. Upper cervical posterior fixation is safe and quite effective for BHS without recurrence, and is better than VA decompression in cases with atlanto-axial instability and even without clear instability.
Oral Presentations

O35
Dural tube continues to expand after muscle-sparing cervical laminectomy
Ryoma Aoyama, Tateru Shiraishi, Junichi Yamane, Ken Ninomiya, Kazuya Kitamura, Satoshi Nori, Satoshi Suzuki

Background: Dural tube expands immediately after the laminectomy. But we often saw the late expansion of dural tube after the muscle-sparing laminectomies. The purpose of this study was to elucidate the duration for which the dural tube continues to expand after muscle-sparing cervical laminectomy, and to what extent the expansion affects surgical outcomes.

Materials and method: We analyzed consecutive 83 patients having cervical myelopathy who underwent muscle-sparing selective laminectomy of three consecutive laminae between C4 and C6 at one spine center between 2012 and 2014. On the lateral radiographs, parameters considered were C2-7 Cobb angles, range of flexion-extension neck motions (ROM), and C2-7 sagittal vertical axis (SVA). Neck alignment was classified into four types such as lordosis, straight, sigmoid and kyphosis with lateral radiographs. Anteroposterior (AP) diameter of the dural tube was measured at mid-level of C5 vertebral body on T2 sagittal image. Expansion ratio (ER) was defined as the extent of expansion at a particular time divided by the final extent of expansion of the dural tube diameter. Operative outcomes were examined with Japanese Orthopaedic Association scores.

Results: The mean age was 62.3 years and mean follow-up period was 2 years and 9 months. C2-7 angles, ROM, and SVA were well preserved postoperatively. AP diameter of dural tube averaged 8.5 mm pre-operatively, 12.4 mm at 6 months post-surgery, 13.3 mm at one year post-surgery, 13.6 mm at 1.5 years and 13.7 mm at more than 2 years. AP diameter of the dural tube had been expanding significantly until one year post-surgery. ER in cases with kyphosis was significantly lower at 6 months than that in cases without kyphosis, indicating that speed of dural expansion is slower in kyphotic cases. There was no correlation between the extent of expansion and neurological recovery.

Discussion and conclusions: The dural tube continued to expand for about one year post-surgery. The dural tube of kyphosis patients expanded slowly, possibly because dural tube was stretched according to neck curvature and difficult to expand. A small extent of dural expansion does not necessarily indicate bad surgical outcomes.

O36
Dose additional uncinate resection increase pseudarthrosis following anterior cervical discectomy and fusion?
Dong-Ho Lee, Jong-Min Baik, Jae Hwan Cho, Chang Ju Hwang, Choon Sung Lee

Introduction: In many patients with cervical radiculopathy, neural foramen narrows by osteophyte or hypertrophy of uncovertebral joints. However, uncovertebral joints may be an important structure to maintain the stability between two vertebral bodies in the subaxial cervical spine. If they are resected during ACDF procedures, it might affect on the fusion process by causing segmental instability. The purpose of this study was to investigate whether unilateral or bilateral uncinate resection combined with ACDF for the decompression of neural foramen would increase the risk of pseudarthrosis at long-term follow-up.

Materials and methods: We retrospectively analyzed 167 patients (89 men, 78 women; mean age, 58.4 ± 10.5 years) who consecutively underwent 1- or 2-level ACDF for cervical spondylotic myelopathy or radiculopathy and were followed for more than 2 years. Uncinate resection was not performed in 46 patients who did not have foraminal stenosis (N-UR group). On the other hand, 121 patients underwent uncinate resection for at least one foramen (UR group). Among them, 89 patients underwent UR unilaterally (U-UR group) and 32 patients, bilaterally (B-UR group). Solid fusion was diagnosed as interspinous motion <1 mm with superjacent interspinous motion ≥4 mm on the magnified plain dynamic lateral radiographs at final follow-up. Fusion rate was compared between N-UR and UR groups, and also between U-UR and B-UR groups.

Results: There was no significant difference between N-UR and UR groups on gender, age, and smoking history. The fusion rates after 1-level ACDF were not significantly different among N-UR, U-UR, and B-UR groups; 91.4% in N-UR group, 97.8% in U-UR group, and 88.2% in B-UR group (p = 0.290). Solid fusion was achieved
in 72.7% in N-UR group, 95.5% in U-UR group, and 86.7% in B-UR group after 2-level ACDF. There was no statistical difference on fusion rate among three groups (p = 0.071), either.

**Conclusion:** In this study, unilateral or even bilateral resection of uncinate process did not affect on the fusion rate after single- or double-level ACDF. Hence, additional uncoforaminotomy during ACDF.

**037**  
Long-term follow-up of adjacent segment degeneration after anterior cervical discectomy and fusion  
Marcus D. Mazur, Andrew T. Dailey, Lubdha M. Shah, Joel D. MacDonald

**Introduction:** ACDFs are generally limited to the levels that are causing neurologic symptoms. But there are situations where asymptomatic levels may be considered for inclusion in an anterior construct, such as if there is severe radiographic degeneration adjacent to symptomatic levels. We evaluated whether the presence of asymptomatic preoperative MRI abnormalities was predictive of reoperation for symptomatic adjacent segment degeneration (ASD) after ACDF.

**Methods:** We reviewed patients who underwent an ACDF and had MRIs both preoperatively and postoperatively at least 3 years after the index surgery to evaluate new neurologic symptoms. We intended to exclude patients who had inadequate treatment, residual disease, or early recurrence after the index ACDF. MRIs were scored for ASD severity using published criteria. Logistic and Cox regression analyses were used to evaluate the association between preoperative MRI abnormalities and reoperation for ASD after adjusting for covariates.

**Results:** Of 1038 patients who underwent an ACDF during the study period, 96 (9%) had MRI evaluation at least 3 years postoperatively for new symptoms. Mean follow-up was 78 months. Of the 195 adjacent segments evaluated, 14 (7%) underwent subsequent fusion procedures. The 10-year surgery-free survival estimate was 82.7% (73.4–93.2%). After adjusting for covariates, preoperative MRI abnormalities were predictive of reoperation only for the group with the highest severity score [HR 4.5 (1.0–19.8)] and those with foraminal stenosis [HR 4.2 (1.4–12.7)]. However, the prevalence of reoperation for ASD in these groups was only 16% and 15%, respectively. The prevalence of reoperation for ASD is low for patients who present with new symptoms several years after the index ACDF.

**Conclusion:** Our findings do not support including asymptomatic levels in an anterior fusion construct, even if severe MRI abnormalities are present.

**038**  
Re-operation rate after anterior cervical fusion using standalone cages in degenerative cervical spondylosis based on 2078 patients – long term follow up  
Mohamed Alhashash, Mootaz Shousha, Hassan Allouch, Hany Gendy, Heinrich Boehm

**Introduction:** Since the introduction by Smith and Robinson in 1958, there have been many advances in anterior cervical discectomy and fusion (ACDF) for cervical degenerative disease. Despite this long period of use, the data available regarding long term outcome of different fusion methods are contradictory. The use of additional stabilisation either anterior or posterior remains a subject of debate.

**Patients:** The rates and causes of re-operations in a series of patients with symptomatic cervical spondylosis operated through anterior decompression and fusion using standalone cervical spine cages are assessed. Total of 2078 patients, with a minimum of 2 years follow up, were included. They have been divided into 2 groups; (A) short segment fusion (one or two levels), and (B) long segment fusion (three or more). The Re-operations have been classified into; (I) early (within 1st 3 months), and (II) late reoperations.

**Results:** Mean age was 56.79 years (24 – 88), 1033 males and 1045 females, one level fusion in 765, two levels in 793, three levels in 380, four levels in 133, five levels in 6 and 6 levels were operated in one patient. Mean follow up was 37.81 months (24 - 95). Group A: 1558 patients, and group B: 520 patients. Re-operations were indicated in 117 patients (5.63%). Type I Re-operations in 43 cases (2.06%); hematomas in 24, cage dislocation in 7, cage subsidence necessitating posterior stabilisation in 6, inadequate decompression in 4
cases, wound infection and oesophagus injury a case in each. Type II re-operations (74 patients 3.56 %); adja-
cent segment disease in 62, and symptomatic pseudo arthrosis in 12 cases. Group A: had 80 (22 early and 58
late) re-operations (5.13 %), and group B: had 37 (21 early and 16 late) re-operations (7.1 %). Long segment
fusion had significantly more early reoperation (p = 0.05) and insignificantly less late reoperations (p=0.14).
Conclusion: Stand-alone fusion cages in degenerative cervical disease yields satisfactory long term results with
minimal need of reoperation in short and long segment fusion without additional anterior or posterior stabilisation.
Long segment fusion has significantly more risk of early reoperations than short segment fusion.

039
What is the best surgical treatment for patients with cervical radiculopathy due to single-level degenerative
disease, anterior cervical discectomy without fusion, with fusion by cage stand-alone, or with arthroplasty? a
randomised controlled trial

Introduction: To investigate the efficacy of adding supplemental fusion or arthroplasty after cervical anterior
discectomy for symptomatic mono-level cervical degenerative disease (radiculopathy), which has not been
substantiated in controlled trials until now.
Methods and findings: A randomized controlled trial is reported with 9 years follow up comparing anterior
cervical anterior discectomy without fusion, with fusion by cage standalone, or with disc prosthesis. Patients
suffering from symptomatic cervical disk degeneration at one level referred to spinal sections of department
of neurosurgery or orthopedic surgery of a large general hospital with educational facilities were eligible. Neck
Disability Index (NDI), McGill Pain Questionnaire Dutch language version (MPQ-DLV), physical-component
summary (PCS), and mental-component summary (MCS) of the 36-item Short-Form Health Survey (SF-36),
and re operation rate were evaluated.
142 patients between 18 and 55 years were allocated. The median follow-up was 8.9±1.9 years (5.6 to 12.2
years). The response rate at last follow-up was 98.5%. NDI at the last follow-up did not differ between the
three treatment groups, nor did the secondary outcomes as MPQ-DLV and PCS or MCS from SF-36. The major
improvement occurred within the first 6 weeks after surgery. Afterward, it remained stable. Thirteen patients
underwent surgery for recurrent symptoms and signs due to nerve root compression at the index or adjacent level.
Conclusions: Cervical anterior discectomy without any implant, with fusion by cage stand-alone, or with disk
prosthesis have clinically the same outcome at long-term follow-up. A difference in relation to reoperation due
to recurrent compression at the same level or adjacent segment was not found.

040
Unintended fusion in cervical artificial disc replacement – a prospective study on heterotopic ossification with
5 years follow-up
Catarina Marques, Nuno Canto Moreira, Anna MacDowall, Martin Skeppholm, Claes Olerud

Introduction: Cervical disc prosthesis for artificial disc replacement (ADR) sometimes fuse due to heterotopic
ossification (HO). Our study aims to determine the prevalence of HO, as well as its rate of development, matters
still under debate in the literature.
Material and methods: Multicentre prospective RCT. 151 patients randomized to ADR or ACDF, maximum two
levels. Of 81 ADR patients, we included the 42 (57 prosthesis) that had good-quality radiological follow-up
studies both at 2- and 5 years. 33 were women, 24 men, aged 35 to 59. HO was graded on X-ray at 2- and
5 years postoperatively (2 viewers, modified McAfee classification). Pre-operative and post-operative MRI at
5-years were also assessed.
Results: HO was found in 82.4%/91.2% of prosthesis at 2 and 5 years respectively. Severe HO (grade 3 or
4) existed in 66.7% and complete fusion (grade 4) in 24.6% at 5 years. Most prosthesis (63.2%) showed no
increase in severity of HO between 2- and 5-years follow-up. HO was not influenced by age, place/amount of
operated levels, or severity of preoperative degeneration at adjacent levels. Significant (p<0.05) lower amount and lower grades of HO were found in women.

Discussion: Disc prosthesis are meant to move, in order to be an alternative to fusion in the prevention of adjacent level disease. We found fusion of 24.6% of prosthesis at 5 years, more than previously described in literature. Ethnical reasons are not expected in the Nordic countries to explain that fact, as opposed to some Asian populations that are very prone to heterotopic ossification, so other yet unknown factors must be sought in order to explain this high incidence. HO occurs early in follow-up and then increases only slightly, suggesting that the earlier follow-up might suffice in predicting future ossification. Apart from female gender, which is clearly a protective factor, possible due to hormonal factors, no other predisposing/preventive factors to development of HO where identified.

Conclusion: High prevalence of HO and unintended complete fusion. Low increase rate of HO between two and five years follow-up. Female gender is clearly a protective factor in the development of HO.

O41
The Leuven cervical disc prosthesis study at 10 years of follow-up — progression of degeneration at the level cranial to the prosthesis and associated variables
Jelle Verhoeven, Joost Dejaegher, Marie Cappelle, Philippe Demaerel, Jan Goffin, Bart Depreitere

Introduction: Cervical disc arthroplasty techniques were introduced to reduce accelerated adjacent level degeneration after anterior decompression and fusion for (spondylotic) radiculopathy. In this study we report the results of ten-year follow-up data from our previously described patient population implanted with a cervical disc prosthesis. Our group previously developed and validated a scoring system to assess cervical degeneration based on plain radiographs. The effect of time and other variables on degeneration, cervical curvature and motion of the index level were investigated.

Materials and methods: Between January 2000 and November 2002 a cervical disc prosthesis was implanted following anterior discectomy in 97 patients. Each patient received a plain neutral radiograph of the cervical spine every two years after implantation. Degeneration on the level cranial to the prosthesis was assessed by two radiologists using the previously described degeneration score. In addition, cervical curvature (Ishihara score) and index level motion (custom made software) were calculated. A longitudinal data analysis of degeneration, cervical curvature and motion was performed using a linear mixed model (SPSS).

Results: Degeneration of the level cranial to the prosthesis was found to increase in a linear fashion over time (p<0.05), independent of age (p>0.951) and initial degeneration score (p=0.321). Patients with a higher preoperative motion at prosthesis level demonstrated slower degeneration of the cranial level over time (p=0.002) and those that maintained higher mobility at prosthesis level also had slower degeneration (p=0.027). Patients that started the study with a more pronounced cervical lordosis had a higher initial degeneration (p=0.019) but did not degenerate faster after prosthesis implantation (p=0.524). Cervical curvature did not change significantly over time (p=0.269). Motion of the prosthesis level and levels caudal and cranial to the prosthesis did not change significantly over time (p>0.05).

Conclusion: The cervical disc prosthesis was able to maintain motion at index level over 10 years. More motion was associated with less degeneration over time at the level cranial to the prosthesis. In this study, the progress of degeneration at the cranial level was a linear process over time independent of age and initial degeneration at the start of the study, but dependent on the motion of the index level.
Oral Presentations

042
Comparing cost-effectiveness of arthroplasty with fusion in treatment for one level cervical radiculopathy
Oddrun A. Fredriksli, Jarle Sundseth, Frode Kolstad, Hege Andresen, Kay Müller, Erling Myrseth, John A. Zwart, Oystein P. Nygaard, Lars G. Johnsen

Introduction: Operative treatment for cervical radiculopathy is rapidly increasing. Fusion is the most common method, however in recent years, use of cervical arthroplasty has increased worldwide. The objective of this study was to compare the cost-effectiveness of cervical arthroplasty with fusion in patients with symptomatic, single level C6 or C7 radiculopathy.

Material and methods: Patients were randomly allocated to arthroplasty (n=68) or fusion (n=68). Randomization was blinded for patients. Surgical team was blinded for type of implant until after decompression. Assessment of EuroQol -5D-3L and Short form-6D at 3, 6, 12 and 24 months, quality-adjusted life years (QALYs) after 2 years. Relevant direct and indirect costs were assessed from a societal perspective. Cost-effectiveness was presented by the incremental cost-effectiveness ratio (ICER).

Results: The dropout rate was 11.8% in the arthroplasty group and 10.3% in the fusion group. Mean QALYs gained (SD) for EQ-5D: 1.41 (0.36) in the arthroplasty group and 1.35 (0.37) in the fusion group, a difference of 0.05 (95% CI -0.08, 0.18). QALYs gained (SD) using SF-6D: 1.41 (0.21) in the arthroplasty group and 1.40 (0.19) in the fusion group, a difference of 0.003 (95% CI -0.068, 0.074). Mean total cost per patient in the arthroplasty group was €45760 (30906) compared with €39137 (29750) in the fusion group. Differences between the groups for total costs per patient were €6623 (95% CI -4300, 17545), p=0.23. Incremental cost-effectiveness ratio (ICER) for arthroplasty was €126293/QALY when using EQ-5D-3L (arthroplasty not cost-effective).

Discussion: Patients in both groups have a large improvement in quality of life. However, there is no difference in quality of life after 2 years. The higher cost of arthroplasty is mainly due to implant cost. This study’s strength, was the detailed collection of health care utilization data within a randomized controlled study design.

Conclusion: In this study, arthroplasty was not cost-effective compared with fusion after 2 years when using EQ-5D-3L for assessing QALYs gained and a willingness to pay of €66,900/QALY.

043
Trends in utilization and cost of cervical spine surgery using the National Inpatient Sample Database, 2001–2013
Corinna Zygourakis, Caterina Liu, Seungwon Yoon, Tamara Kliot, John Ratliff, Christopher Moriates, R. Adams Dudley, Ralph Gonzales, Praveen Mummaneni, Christopher P. Ames

Introduction: There has been an increase in the rate and cost of spinal surgery over the past decades in the United States, but there is little understanding of the drivers of cost variation at the national level. The goal of this study was to determine national rates of cervical spine surgery and to examine factors that underlie cost variation.

Materials and methods: We analyzed 419,830 patients who underwent cervical spine surgery (anterior cervical fusion, posterior cervical fusion, posterior cervical decompression, combined anterior/posterior cervical fusion) for degenerative conditions in the 2001-2013 NIS database. We determined the rates of surgery by time and geographic region, and then created univariate and multivariate models to evaluate the effect of these factors on total hospital costs: patient age, gender, race, insurance, income, county of residence, elective vs non-elective case, length of stay, risk of mortality, severity of illness, hospital bed size, wage index, hospital type, and geographic region.

Results: The most common type of cervical spine surgery was anterior fusion (80.6% of all surgeries). The national rates of all cervical spine surgery decreased slightly from 2001 to 2013 (75.34 to 72.20 per 100,000 adults), while the mean inflation-adjusted cost increased 64%, from $11,799 to $19,379, during this time period. Multivariate analyses showed that older age, male gender, black/other race, private insurance, greater risk of mortality/severity of illness, and longer length of stay were associated with higher costs. The wage index was positively correlated with cost, and hospitals in the western U.S. were 27% more expensive than those in the Northeast.
Discussion and conclusion: The rate of cervical spine surgery decreased slightly, while the mean case cost increased at a rate double that of inflation from 2001 to 2013. Even after controlling for patient and hospital factors including wage index, there was significant geographic variation in the cost for cervical spine surgery.

044
Multi-level anterior cervical fusion — Do low levels of vitamin D increase the risk of revision?
Doniel Drazin, Christine Piper, Zachary Barnard, Faris Shweikeh, Alex Rasouli, Joseph O’Brien, Warren Yu, Edward Nomoto, Ray Chu, Robert Pashman, Dan Norvell, Eli Baron, Terrence Kim, J. Patrick Johnson

Introduction: Vitamin D insufficiency is common in patients presenting for spinal surgery. It has been unclear whether this abnormality affects spinal fusion outcomes.

Methods: In a multi-center prospective comparative effectiveness study, we assessed vitamin D levels in patients undergoing multi-level anterior cervical discectomy and fusion. Exclusion criteria included previous cervical spine surgery, posterior approach and bone morphogenic protein product use. The primary outcome measure was revision defined by symptomatic non-union. Participants were classified into two Groups: normal (>25ng/mL) or insufficient (<25ng/mL) level, determined by vitamin D (serum 25-OHD) test. Post-operative fusion was assessed by upright lateral cervical spine flexion-extension radiographs and/or CT cervical spine. Patients were followed for over 1 year.

Results: Of 97 enrolled patients, 47 have had complete follow-up. There were no significant differences in baseline or operative characteristics between the groups. A greater proportion of patients with vitamin D deficiency underwent revision (57%) compared to those with normal levels (18%). This was statistically significant (p = .008). Mean vitamin D level of revision patients was 23.9 ± 9.2 compared to 35.6 ± 14.9 for non-revision patients. This was statistically significant (p = .009). There was no statistically significant association between age, BMI, gender, length of stay, or surgical level and the risk for revision. 12 of the 14 revisions occurred in non-smokers. In a multivariable logistic regression model, patients with normal vitamin D levels were at lower odds of undergoing revision. This was statistically significant (odd ratio = .14, 95% confidence interval: .03-.63; p = .01).

Conclusions: Patients with low Vitamin D levels who underwent multi-level anterior cervical fusion were at greater risk of revision, controlling for other important factors including primary diagnosis. To maximize chances for successful arthrodesis and optimal surgical outcomes, we recommend that vitamin D insufficiency be addressed and corrected.

045
Global balance and pathology in patients with cervical spondylotic myelopathy
Go Yoshida, Abdulmajeed Alzakri, Yu Yamato, Tomohiko Hasegawa, Shin Oe, Daisuke Togawa, Vincent Pointillart, Jean Marc Vital, Yukhiro Matsuyama, Oliver Gille

Introduction: Radiographic evaluation of cervical spondylotic myelopathy (CSM) comprises cervical magnetic resonance imaging (MRI) and regional cervical radiography, which cannot distinguish between cervical hyperlordosis with spinopelvic compensation and cervical lordosis with normal global alignment. The aim of this study is to clarify the pathophysiology of CSM, and use the characteristic of global spinal alignment for determining the surgical strategy.

Materials and methods: Our inclusion criteria were preoperative hole spine radiography, cervical MRI and HRQOL. Global spinal alignment was characterized by cervical lordosis (CL), C7 sagittal vertical axis (SVA), T1 slope (T1S), thoracic kyphosis (TK), lumbar lordosis (LL), pelvic incidence (PI), pelvic tilt (PT), sacral slope (SS), and knee flexion angle (KFA). Cervical alignment was characterized by O-C2, C2–4, C5–7, and C2–7 angles; cranial center of gravity (CCG) C7SVA; and C2–7 SVA. Responsible lesion determined using MRI was divided from C2/3 to C7/T1.
Results: Eighty-eight surgically treated CSM patients with hole spine imaging were prospectively analyzed. Responsible lesion significantly correlated with age ($r = -0.374$, $P = 0.0003$), TK ($r = -0.2632$, $P = 0.0132$), and SVA ($r = -0.4447$, $P < 0.0001$); however, it was not correlated with CL, LL, T1S, C2-C7SVA, T1S-CL, PI, PT, SS, or KFA. There were 72 normal (Type 1; SVA < 50 mm) and 16 positive (Type 2; SVA ≥ 50 mm) global balance patients. There were significant differences in age, T1S, KFA, T1S-CL, SVA, CCG-SVA, and C2–7 SVA between Type 1 and Type 2. C3/4 lesion was more common in Type 2 than in Type 1. There was a positive correlation between global sagittal, but not regional, balance and responsible lesion. C3/4 lesion was more frequent in older, male, high SVA, large T1S-CL, large KFA, and large cranial lordosis (C2–4/C5–7 angle) patients.

Discussion: The responsible lesion of CSM patients, particularly the upper segment, was associated with global malalignment resulting from compensation during aging. This finding expanded upon previous research that identified frequency of cranial lesion in elderly CSM patients.

Conclusions: Surgical strategy for cranial type CSM should be carefully selected considering global balance.

O46 Mortality, complication and fusion rates after C1–C2 injury – results from a prospective observational multicenter study
Cédric Y. Barrey, Eurico Freitas, Laurent Barresi, Benjamin Blondel, Stéphane Fuentes, Benjamin Nicot, Vincent Challier, Maxime Llieu, Joel Godard, Pascal Kouyoumdjian, Nicolas Lonjon, Julien Berthiller, Yann-Philippes Charles

Introduction: A prospective observational multicenter study on C1–C2 trauma was conducted by the French Society of Spine Surgery (SFGR) from June 2013 to May 2015. The purpose was to investigate mortality, complication and fusion rates in adult patients with C1–C2 injuries according to the age, comorbidities, fracture type and treatment (surgical/conservative).

Material and methods: 417 patients were included in the database. Demographic data, comorbidities, type of injury and conservative or surgical treatment were registered. Complications were classified as general, infectious, neurologic or mechanical within the first year after diagnosis. Death was also registered. A 1-year follow-up CT-scan was available in 327 patients to evaluate fracture consolidation.

Results: Mean age was 67.6 years-old, there were 228 males (55%) and 189 females (45%). The C1-C2 injury was isolated in 48.8%. C2 fractures represented 75.7% of patients, 15.5% for C1 fractures and 4.6% for C1-C2 subluxations. 94.6% of patients were intact neurologically. The treatment was conservative in 61.1% and surgical in 48.9%. The presence of comorbidity was associated with a higher risk of mortality (p<0.0001) and general complication (p<0.008). Posterior versus anterior surgery was associated with longer patient positioning and operative time, more blood loss and longer hospital stay, p<0.002. The overall mortality rate in the series was 8.4%. 23.7% of patients presented with at least 1 complication: 16.3% for patients <70 y-old versus 30.4% for ones >70 y-old, p<0.02. Rates of mortality and complications significantly increased with age, p<0.05. Mortality was not influenced by the fracture type, or conservative versus operative treatment. Mechanical complication (mainly pseudarthrosis) occurred in 16.5% and was the most frequent complication. Only 1 neurological deterioration was noted. Fracture consolidation was observed in 90.6% in patients <70 y-old, in 81.1% between 70 and 80 y-old, in 66.7% between 80 and 90 y-old and in only 41.4% after 90 years (p<0.05).

Conclusion: Age and comorbidities influenced mortality and general medical complication rates most, regardless of fracture type and treatment option. Pseudarthrosis represented the main complication, which significantly increased with age, especially after 80 y-old.
O47
The importance of the occipitocervical region in patients with ankylosing spondylitis (AS) analysis of a cohort of 86 cervical fractures in surgically treated patients with AS
Augusto Covaro, Nodoka Manabe, Yohan Robinson, Claes Olerud

Study design: Retrospective analysis of prospectively collected data.
Objective: The effect of C0-C1-C2 cervical ankylosis in these patients is not documented. The objective of this study is to describe the radiological characteristics of the occipitocervical junction in the EA patients operated by a cervical fracture and to correlate them with their clinical evolution.
Methods: Analysis of patients with AS treated in a single institution of a cervical vertebral fracture between 2007 and 2014 who were prospectively followed through the SWESPINE registry. The integrity of the C0-C1-C2 joints was determined and classified into fused and non-fused joints. By determining the angle between C0-C1 and C1-C2 joints in the coronal view of the CT-scan (X-angle) the progressive degeneration of these joints was described. Intra- and inter-observer reliability of this test was determined. The instruments of quality of life and disability were EQ5D and ODI, respectively.
Results: 86 patients with AS treated surgically for cervical fracture had complete facet ankylosis between C3 and T1 due to their pathology. Mean age 69.2 years (SD: 11.7). The most common level of fracture was in C5-C6. In 24 patients the C0-C1 joint was fused and in 15 patients C1-C2 joint was fused. The intra- and inter-class reliabilities for X-angle measurement were very high (ICC = 0.95, 0.98). The mean X-angle was 125 ° (SD: 12) in non-fused patients and 136 ° (SD: 14) in fused patients (p <0.001). There were no differences in quality of life and disability at 2 years between the two groups: EQ5D-index of 0.54 and 0.55 (P = 0.5), ODI of 26.4 and 24 (P = 0.35) respectively.
Conclusions: X-angle is a reliable way to measure joint integrity C0-C1-C2 in patients with AS. Total cervical ankylosis including the C0-C1-C2 segments is not related to poorer quality of life and disability in these patients

O48
Posttraumatic syringohydromyelia, diagnosis of the progression and treatment
Alexander Valentinovich Beletsky, Sergey Alexandrovich Karcheuski, Inessa Alexandrovna Il'yasevich, Oleg Ivanovich Dulub

Introduction: One of the most serious complication of spinal cord injury is the development of the syringohydromyelia in 1% -9% cases at the late posttraumatic period.
Materials and methods: We have verified 41 cases of distant cystic lesions of the spinal cord, requiring surgical correction in the most of patients. Syringohydromyelia was visualized by high-field MRI (1.5-3,0 T). EMG examination confirmed the progression of pathological process. The revision surgeries included a decompression of a spinal cord, meningolisis. Cysterno-peritoneal shunting performed in the most cases.
Results: Severe neurological manifestations have been noted with the progressive defeat of cervical spinal cord with the development of widespread and total forms cystic process. The pathological process manifested by progressive increase of weakness and numbness of the extremities. All patients got a high-energy injury. We developed new algorithm of EMG examination of the high cervical spinal cord affection, especially as a sign of defeat of interneuron of a rear longitudinal bunch adjacent dorsally to the central canal of a spinal cord.
It was compared the mean values of the latent period (X ± x) R1 and R2 components of blink reflex in patients with post-traumatic syringohydromyelia and control group. It was revealed reliable changes between control group and patients with cystic damage cervical spinal cord (at P < 0,05 by t-Student criteria) of a latention of the R2 component on ipsilateral (37,8 ± 1,0 ms and 42,5 ± 0,8 ms) and contralateral (38,9 ± 0,9 ms and 44,6 ± 1,3 ms) sides stimulation. EMG and clinical data showed high degree of their correlation: bulbar and/or cerebellar syndromes have been diagnosed in all patients with a total form pathologic process.
The surgical algorithm depended on existence or development of the vertebro-spinal conflict and degree of manifestation of adhesive process. It was carried out one or two stage surgery (primary or revision on a spine and a spinal cord and/or cysterno-peritoneal shunting).
Conclusion: Timeliness of the decompression or revision surgeries and cysterno-peritoneal shunting allowed reaching partial or complete regress of the secondary neurologic deficit in the majority of the patients. The surgical results correlated with postoperative data EMG.

049
Influence of correction surgery for cervical kyphosis on foraminal stenosis in the cervical spine
Terumasa Ikeda, Masao Akagi, Kazuki Hshimoto, Hiroshi Miyamoto

Introduction: Posterior correction surgery (Group P) for cervical kyphosis using screw-rod system has privilege of assuring strong fixation. However, it has been reported that this procedure causes more frequently having postoperative segmental nerve palsy, probably due to foraminal stenosis. We hypothesized that posterior fixation combined with anterior support (Group AP) may lessen the incidence because anterior support may prevent from iatrogenic foraminal stenosis. The purpose of the present study was to investigate the influence of correction surgery for cervical kyphosis on foraminal stenosis by comparing radiologic data from these two groups.

Methods: One hundred twenty-eight foramens (C3/4-C6/7) involved in the extent of fixation from 20 patients (male 10, female 10, a mean of 73.3 years old) who underwent correction surgery for cervical kyphosis (Group AP: 24 foramens and group P: 104 foramens) were investigated. The area of foramen, anteroposterior and cephalocaudad diameters of the foramen, kyphosis angle at each segment were measured on three-dimensional CT images pre- and postoperatively, and these data were compared between the groups.

Results: Transition of segmental kyphosis angle, the area of the foramen, anteroposterior and cephalocaudad diameters of the foramen between pre- and post-operation were 2.9 and 14.3 (degrees), 4.2 and 3.2 (mm²), 0.4 and 0.6 (mm), and 0.4 and 0.3 (mm) in Group P and Group AP respectively. There was statistical difference in change of segmental kyphosis angle between the groups. Gain of the area was significantly smaller in the patients whose correction of the segmental kyphosis were more than 10 degrees compared to those with correction 10 degrees or less in both Groups P and AP.

Discussion: The present study indicated that; (1) AP provided more segmental kyphosis correction than P, (2) both P and AP provided more area, anteroposterior/cephalocaudad diameters of the foramen postoperatively, (3) however, correction of segmental kyphosis more than 10 degrees may have a risk causing iatrogenic foraminal stenosis in not only Group P but also Group AP probably because of shortening of anteroposterior diameter of the foramen.

050
Direct cost analysis of 38 cervical spinal deformity operations across two major spinal deformity centers with implications for catastrophic costs and 90-day cost bundles
Corinna C. Zygourakis, Justin Scheer, Lizette Upton, Seungwon Yoon, Samrat Yeremaneni, Richard Hostin, Michael F. O’Brien, Christopher Shaffrey, Justin Smith, Vedat Deviren, Christopher P. Ames

Introduction: The Centers of Medicare and Medicaid Services (CMS) has recently implemented 90-day cost bundles for joint replacement surgery, and taken steps to expand the use of bundled payment programs. Our goal is to determine the 90-day costs associated with cervical spinal deformity cases across two major spinal deformity centers in order to guide the development of reasonable bundled payment plans.

Materials and methods: Retrospective evaluation of adults who underwent cervical spinal deformity surgery 2013-2016 at two major metropolitan spinal deformity centers. Inclusion criteria included adult patients with cervical kyphosis (C2-7 Cobb angle > 10°) or cervical scoliosis (coronal Cobb able > 10°). Direct hospital costs for the index surgery and all visits within the first 90 days after surgery were determined from hospital billing data. Direct costs include surgical supplies/implants, room/care, pharmacy; they exclude indirect costs such as overhead, administration, and utilities.
Results: 38 patients (25 females, 13 males; mean age = 60.4 ± 9.8 years) underwent fusions for cervical spinal deformity. 29 procedures were posterior fusions, 1 was anterior, 7 were anterior then posterior, and 1 was posterior-anterior-posterior. The average number of levels fused was 9.3 ± 3.3. The average direct hospital cost for the 90-day period including surgery was $64,480±23,816, and was similar between the two institutions ($62,569 versus $70,638). 4 of the 38 patients (10.5%) were re-admitted within 90-days, these re-admission costs constitute the majority of these patients’ post-index surgery costs. 2 of the 38 (5.3%) patients had catastrophic 90-day costs, which were greater than two standard deviations above the mean (>$112,112).

Discussion and conclusions: The average 90-day direct hospital costs for patients undergoing cervical spinal deformity surgery are $64,480. Readmissions and a greater number of operated levels contribute to higher costs, and as such, reasonable 90-day cost bundle plans must account for both of these issues. An important limitation is that our analysis includes costs at our main hospital only; it does not include post-operative outpatient medications, physical therapy, rehabilitation, or admissions to outside hospitals. It is therefore imperative that further studies utilizing national databases are performed to understand the full scope of 90-day costs.

051
Removal of foraminal cervical disc prolapse from anterior avoiding fusion or artificial without touching the disc. Longterm results
Heinrich Boehm, Mootaz Shousha, Hassan Allouch

Background: Root compression is the source of pain in acute cervical disc prolapse. In all established techniques the removal of a cervical disc prolapse is performed either through the disc space or through foramen or joint (Micro-Foraminotomy, Frykholm’s procedure). So either bradytrophic tissue with low healing potential is disturbed, or bone structures involved in weight bearing or movement are partially resected. In consequence, most of these decompression procedures have to be combined with fusion or disc replacement. In addition to potential complications of the hardware accelerated degeneration of adjacent segments can severely reduce the success of treatment.

Purpose: This study evaluates longterm results of a transosseous approach to the cervical disc circumventing structures with defect-healing. Particular emphasis is given to additional surgeries, cause and type of re-operatons and the timespans between them.

Methods and patients: This is part of a retrospective study comprising all cervical cases of a prospectively accumulated database of a major spine center and focusses on all degenerative patients who had at least 1 transosseous decompression (TrOD).

From july 2000 to dec. 2014 the transosseous decompression was performed in 386 cases. Indications were: Cervical soft disc herniations causing symptomatic root compression. Contraindications included: instability of the affected segment, central spinal cord compression, fractures or advanced degeneration of the affected segment with osteophyte formation. In order to analyse potential benefits of this treatment option patients with previous fusions were included when adjacent or distant foraminal prolapses caused the new pathology. Recorded were sex, age at TrOD, surgical time, blood loss, complications and reoperation rate. Regarding cases with multiple operations, pathology, type and interval to other surgeries was analysed.

Results: Between Jul. 2000 and Dec. 2014 the TrOD has been used in 386 cases, 10 of which in combination with open surgeries (interbody fusions or corpectomies in adjacent segments). In 67 patients more than 1 surgery has been necessary; in 301 cases the TrOD remained the only intervention till Jan 2017. Fusion of the index segment due to unsatisfactory result or recurrent prolapse was necessary in 36 cases after avg. 19.9m (1 week to 11y). Five patients needed a revision in the index segment, 1 due to hematoma, 4 as TrOK due to missed fragment or recurrence. A second TrOD for another prolapse was performed in 5 patients. TroD as the only treatment of lateral or foraminal prolapse at adjacent segments after previous fusion was performed and successful in 17 cases. The mean surg. time per level was 54.4 minutes and mean blood loss was 64.04 ml. There was no new neurol. deficit. One patient with history of GI cancer got infected needing fusion, The single
patient with a prolapse of Th1–2 in a lordoscoliosis suffered from extrusion of the bone cylinder out of the body of Th1 and esophageal perforation 10 weeks after surgery.

**Conclusion:** Removal of a lateral or foraminal disc prolapse in the cervical spine through a bony channel proved to be possible and safe. The TrOD in up to 17 years follow up yields excellent results in virgin cases and seems a valuable additional option to fusion or disk replacement.

**O52**
Neglecting osteoporosis in cervical spine surgery has high potential for severe complications

*Sebastian Decker, Axel Hempfling, Oliver Meier, Heiko Koller, Michael Mayer*

**Background:** Osteoporosis has a high potential for complications that can cause revision surgery in spinal instrumentations. Operative treatment for implant failure, adjacent segment failure as well as medicinal approaches to improve bone density are often challenging and interdisciplinary treatment is needed.

**Introduction and material:** A 65y old female with rheumatoid arthritis was operated on because of cervical stenosis as well as cervical kyphosis. Definition of case specific challenges:
- Initial need for cervical vertebral body replacement
- Cervical kyphosis
- Osteoporosis

**Treatment:** During initial surgery, anterior cervical discectomy and fusion C4-T1 including a vertebral body replacement (VBR) of C5 was performed due to spinal stenosis and kyphosis. Although being evident retrospectively, no particular value was attached to potential osteoporosis preoperatively.

**Complications and management:** One week postoperatively, the patient presented with asymptomatic implant dislocation including cage dislocation and loosening of the plate. Revision surgery included VBR of C6 and T1 because of severe bony defects and posterior fusion was performed from C2-T5. Again three weeks later a distal junctional kyphosis (DJK) was detected at the level of T5 and posterior instrumentation was extended to T10. Antiosteoporotic treatment was initiated using Teriparatid.

**Conclusion:** In patients who undergo elective cervical spine surgery, preoperative analysis of bone density should be mandatory in all patients with potential osteoporosis. Treatment should be initiated before surgery.

**Legend to the figure:** Repetitive implant failure after anterior cervical discectomy. a) Severe spinal stenosis accompanied by cervical kyphosis (b). c) Implant failure after initial surgery with plate and cage dislocation followed by anterior and posterior revision surgery (d). Posterior instrumentation to T5 results in DJK and required posterior revision surgery with fusion down to T10.
Background: Odontoid fractures account for 7 to 13% of all cervical spine fractures. Treatment of neglected cases secondary atlanto-axial deformities by reason on neglected odontoid axis fracture is difficult.

Introduction and material: A 35-year-old male fell from a height of two meters and felt the pain in the neck. Eight months after the injury he referred to our hospital complaining of increasing neck pain. On examination there was local intensive not radiating pain in neck and restriction of neck pain. The X-ray, CT and MRI of the neck revealed neglected odontoid axis fracture and atlanto-axial dislocation with kyphotic deformity at the C1-C2 joints complex (Figure 1).
ORAL PRESENTATIONS

Definition of case specific challenges.
1. Mobilize the odontoid.
2. Make reduction the odontoid and C1-C2 fixation

Treatment: The atlanto-axial vertebral was exposed anterior submaxillary approach. The partial fusion was resected to achieve reduction (Figure 2).

Then patient was turned to the prone position and we made instrumental rods C1-C2 fixation and reduction C1 (Figure 3).

The CT of the neck after the first operation revealed the space between odontoid and body axis (Figure 4).
The anterior wound was reopened and tricortical iliac bone graft was inserted in the area between odontoid and body axis (Figure 5).

Postoperatively, patient was mobilised in Philadelphia collar for eight weeks. There wasn’t postoperative neurological deficit and wound healing.

Follow-up eight months. CT after eight month revealed forming bone bridge between odontoid and body axis (Figure 6). Clinical and radiological signs were suggestive of a good outcome. Patient returned to work.

Conclusion: Treatment of secondary atlanto-axial deformities by reason on neglected odontoid axis fracture is difficult and associated with potential neurological complications operative intervention can substantially improve the quality of life in these patients.

O54
Basilar invagination with asymmetrical cross-block of C0-C1-C2-C3, Chiari I and syringomyelia – rare anomaly and its management
Olga M. Pavlova, Sergey O. Ryabykh, Alexander V. Burcev, Konstantin A. Dyachkov

Introduction: We present the clinical case of asymptomatic basilar invagination, partial asymmetrical cross-block of the occiput (C0), atlas (C1), axis (C2) and C3 vertebra, Chiari I type malformation and progressing syringomyelia. Case description: A 16-year-old girl presented to us with complaints in the periodic lumbar pain without neurological disorders and restriction of cervical movement. CVJ anomaly was accidentally discovered. Computed tomography (CT) of the CVJ revealed partial anterior left-sided C0-C1 block, partial posterior right-sided C1-C2 block and anterior C2–C3 block. Tip of odontoid tends to be above Chamberlain’s, McRae’s and Wackenheim’s lines.
Magnetic resonance imaging revealed impingement of cervicomedullary descent, syringomyelia, slight decrease of the posterior fossa volume and prolapsed cerebellum tonsils. CT angiography showed normal anatomic architecture of vertebral artery without any anomaly or compression. Surgery was performed with the patient in the prone position with Mayfield clamp, a posterior approach was undertaken. After dissecting of muscles a foramen magnum decompression was done and the C1 posterior arch was bited on the middle. T-shaped occipital plate was fixed with two screws in the midline, screws inserted in C1 lateral masses and in C2 pars interarticularis. After this, extension was made with a distraction, construction was fixed by rods and internal screws. Postoperative CT scan showed decrease in the invagination degree and impingement of cervicomedullary descent . Now at the time of reporting after 3 month, there is no sensory impairment, and muscle power is 5/5 around all joints.

Discussion:
In this clinical case rotary motion of the neck were between front edge of foramen magnum and front surface of odontoid process, these movements caused axial and sagittal instability, against the background of the basilar invagination and Chiari I, violated flow of cerebrospinal fluid at the level of the foramen magnum and lead to the formation of syringomyelia. The complexity of the defect correction is associated with the need to perform foramen magnum and C1 decompression, and performance of the distraction and extension to correct the position of the odontoid process to improve relationships between C0–C1–C2–C3 complex.

Conclusions:
We report the successful management of the rare congenital CVJ anomaly.

055
Progressive loss of already heavily impaired motor function of the upper extremities – Should we dare to treat it and how?
Heiko Koller, Juliane Koller

Background: In 1996, a 21y-old man suffered a MVA resulting in C2–6 burst fractures with incomplete tetraplegia, complete lesion of left brachial plexus, loss of function among right C5–C8 roots and diaphragmal paresis followed by septic tracheotomy and long-term ventilation. Initial treatment was posterior fusion C1–C3 (fig.1d). He recovered to ambulatory status with good grip function and elbow flexion on the right, but depended on nightly mask ventilation (Vital capacity(VC) 48%).

Introduction and material: After 14y he noticed progressive loss of upper (UE) and lower extremity(LE) function (deterioration of walking, loss of grip strength/sensory function, painful thermal dysaesthesia). After 20y he suffered severe gait difficulties and incapability to eat without assistance.

Definition of case specific challenges: Progressive cervical myelopathy with fixed cervical kyphosis, SCI, focal stenosis (fig.1e), multiple intradural cysts (fig.1*) after traumatic dural tears, history of anterior infection. Surgical treatment might cause complete loss of UE/LE function.

Treatment: Following extensive consultation he underwent anterior release, decompression with corpectomy of C5+C6, realignment and plated fusion C4–7, posterior instrumentated fusion C2-T2, laminectomies + nerveroot release C5–C7 resulting in 360°-decompression C4–7(fig.1f).

Complications and management: Intraoperative CSF-leak occurred at the focal stenosis. No attempt of suturing was made as cord remnants/roots sticked to the dura. The area was thinned off bony remnants and glue-sealed. Drains were placed for 36hrs. After 24hrs, cough attacks resulted in subcutaneous CSF-accumulation. Revision surgery was discussed, which might have caused VC deterioration and functional worsening. The wound was sealed and measures taken to reduce intradural/pulmonary pressure. The patient regained amazing functional benefits 1w after surgery including feeding ability, gait + sensory function improvements continuing at 6mo follow-up.

Conclusion: Even decades after incomplete tetraplegia, patients with functional deterioration can benefit from reconstructive surgery. The postop course can be complicated, therapeutic measures must be tailored to the specific conditions. Meticulous planning and patient consultation are mandatory.

Legend to the figure: ”dural cysts
Introduction: Radical resection of a vertebra is reserved only for specific tumors that invade the surrounding tissues and recur when not removed completely. The vertebra may be removed using a piecemeal technique or en bloc, using only two (in thoraco-lumbar spine) or more osteotomies (in cervical spine). We present our technique of en bloc resection of subaxial cervical vertebra for Ewing’s sarcoma of C3, with preservation of all nerve roots and both vertebral arteries. To our knowledge, this surgical technique has not been reported in the English literature. The aim of this study is to describe the new technique of radical resection of subaxial cervical vertebra.

Material and methods: A transoral biopsy of tumor tissue anterior to C2-C3 was performed in 8-year old boy, revealing a diagnosis of Ewing’s sarcoma. The patient was started on neoadjuvant chemotherapy. After 6 chemotherapy cycles with the VIDE regimen, the soft-tissue component completely regressed, with the only a residual deposit in C3 vertebral body. Based on further multi-disciplinary meeting, an en bloc spondylectomy of C3 was recommended, preferably with preservation of nerve roots and vertebral arteries. In August 2014, prior to the planned surgery, we performed another thorough examination of the patient using plain films, CT and MRI. Neither angiography nor embolization was performed.

Results: There were no complications during both surgeries. The follow-up CT examination 4 months after the operation revealed a clear bone fusion of C2-C4, both anteriorly between vertebral bodies and posteriorly between the arches. Clinically the patient has reached 8 month follow up and had no complaints, both he and his parents were satisfied. Physiotherapy is proceeding according to plan. The patient remains under supervision at our centre.

Conclusion: Total en bloc spondylectomy of a subaxial cervical vertebra with preservation of vertebral arteries and nerve roots is a radical surgery that should be used to treat only the most serious conditions. The risk of neurological deficit is outweighed by the benefits of oncological radicality. This new surgical technique has not yet been described and it is clear, that a larger cohort of patients is necessary to assess and potentially modify this technique so that it can be used more frequently in the future.
Oral Presentations

057
Tuberculous subacute painful torticollis in a young woman? a challenging case
Abolfazl Rahimizadeh

Objective: To present a case with atlantoaxial rotatory subluxation due to tuberculosis which is the first example of the literature

Method: This 24-year-old female developed painful torticollis after 3 weeks neck pain. CT scan revealed destruction of left lateral mass and deviation of the dens toward left. MRI also confirmed destruction. ESR was 53. Under general anesthesia and in prone position, after isolation the vertebral artery on the left side, the lateral mass was removed in piece meal fashion. C2 pedicle screw was done on both side. On the right side, the lateral mass was done easily and on the left a screw was inserted in the remaining upper part of C1. In addition an autogenous bone graft shaped into a lateral mass was inserted. Then, C1-C2 fixation was done on both sides. However, on the left sided, tightening of the C2 nut was done first and with subsequent tightening of C1, it was pulled back resulting in correction of subluxation.

Result: Post-operative, pain was ameliorated dramatically and torticollis was corrected. The pathology was compatible with tuberculosis. Anti-tuberculous medication for 18 months were continued. The patient is doing very well

Conclusion: Tuberculous affection of upper cervical spine is infrequent. Where several cases with atlantoaxial dislocation have been reported previously. But, this is the first example of rotatory atlantoaxial subluxation of the literature.

058
Free-hand placement of C7 laminar screws – accuracy and safety in 38 consecutive patients
Jiwon Park, Hyo Sae Ahn, Quan You Li, Ho-Joong Kim, Bong-Soon Chang, Choon-Ki Lee, and Jin S. Yeom

Introduction: Although being regarded as the first-line choice for C7 fixation, pedicle screws usually require radiographic or fluoroscopic guidance, take time for placement, and have a potential risk of neurovascular complications. Given such limitations, laminar screws might serve as a viable alternative. However, clinical reports on C7 laminar screws are quite limited. The purpose of this study was to determine the accuracy and safety of C7 laminar screw placement with a free-hand technique.

Materials and Methods: Forty-three consecutive patients who underwent C7 laminar screw fixation were enrolled. All screws were placed with a free-hand technique without radiographic or fluoroscopic guidance by the last author. The operating time for each screw placement was approximately 1-2 minute. Clinical information and radiologic data of the patients were analyzed. For those who All patients received postoperative CT scans., The accuracy of screw placement was evaluated by assessing the direction and degree of laminar cortical breach.

Results: A total of 61 C7 laminar screws were used: 25 for unilateral and 36 for bilateral fixation. All screws were 3.5 mm in diameter and 20-26 mm in length. Of the 61 screws placed in 43 patients who received postoperative CT scans, 14 screws (23%) breached the laminar cortical wall, including 3 dorsal and 11 ventral breaches. Of those 14 screws, 11 breached by <50% of screw diameter and 3 breached by 50% to 100%. Neither intraoperative nor postoperative neurovascular complications were observed in any patients. None of the patients required reoperation for any reasons and mechanical failure such as screw loosening or metal fractures has not been observed over the follow-up period averaging 15 20 months.

Conclusion: This is the largest clinical study ever performed on C7 laminar screw fixation as far as we know. Even though laminar cortical breach was common (23%) with our free-hand technique, most of them were trivial and all enrolled patients have shown neither clinically relevant neurovascular complications nor mechanical failure. Therefore, C7 laminar screw may provide a valuable alternative to pedicle screws for C7 fixation in terms of efficiency and safety. Long-term outcome including fusion status remains to be evaluated with further follow-up.
Severe AAI in patient with down syndrome – case report

Sergey Vissarionov, Sergey Belyanchikov, Nikita Khusainov

Background: About 1% of patients with Down’s syndrome develop symptomatic type of AAI, potentially life-threatening. Surgical stabilization is accompanied with high percentage of complications.

Introduction and material: We present an 11.5 year male with Down’s syndrome who gradually developed a tetraparesis starting at the age of 9.5 years. Examination revealed severe AAI with spinal stenosis at the level C1-C2 caused by os odontoideum. Canal width on MRI was 3.5 mm. with spot of myelomalation. Clinically patient was a non-ambulatory walker with marked trunk imbalance, lower limb spasticity, bladder incontinence. Hand function was preserved.

Definition of case specific challenges. Surgical decompression and stabilization was vital but also could be fatal due to pre-existing tetraparesis and severe spinal stenosis.

Treatment: Posterior decompression (resection of C1 posterior arc and foramen magnum) with occipitospondylodesis (C0 — C4/C5) and posterior fusion using intraoperative neuromonitoring (tMEP) was performed.

Complications and management: Total flail tetraparesis occurred immediately after the operation (tMEPs disappeared during the procedure) and resolved incompletely on the 40th day, didn’t improve in 6 months. On the 9th day neurogenic breathing insufficiency occurred – prolonged ventilation through the tracheostoma was performed – latter resolved on the 43th day. Spontaneous breathing, hand and bladder function restored, patient was able to stand in KAFOs.

Conclusion: Surgical treatment in patients with Down’s syndrome with pre-existing neurologic deficit is difficult and rarely successful. Indications for preventive stabilization should be identified.

Figure 1: a – pre-op CT shows os odontoideum (orthotopic type); b – MRI reveals severe stenosis and myelomalation; c, d – post-op X-ray and CT shows achieved amount of bone resection, reduction and proper implant position; e – post-op MRI shows slight improvement at the cord position and width, marked posterior edema; f – 6 mon. post-op reossification of C1 arc; g – same patients X-ray performed at the age of 4.5 (no treatment was suggested).
**P005**

Collet-sicard syndrome due to occipital condyle fracture  
**Jan Stulik, Petr Nesnidal, Jan Kryl, Tomas Vyškocil, Michal Barna**

**Introduction:** The case of a 63-year-old man diagnosed with Collet-Sicard syndrome due to a fracture of the right occipital condyle is presented. The cause of injury was falling off a bicycle. Dysphonia and dysphagia were present from the moment of injury, with the gradual development of light atrophy of the tongue muscles and right trapezius muscle.

**Material and methods:** Case report. The diagnosis was based on examination by CT and MRI methods, the act of swallowing and physical examination by an otorhinolaryngology specialist and a neurologist who confirmed the diagnosis of injury to cranial nerves IX, X and XI on the right side.

**Results:** The patient was treated conservatively with application of a Philadelphia collar.

**Conclusion:** Dysphagia required PEG tube insertion. Skull fracture healing was evident on a CT scan at 3-month follow-up. However, dysphonia with dysphagia and muscle atrophy remained persistent.

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**P006**

Minimally invasive percutaneous screw osteosynthesis for traumatic spondylolisthesis of the axis  
**Shuhei Osaki, Yasuo Ito, Takeshi Kikuchi**

**Introduction:** Stable traumatic spondylolistheses of the axis (hangman’s fractures) are usually treated by a halo vest fixation. However, in some instances, such as polytrauma or conservative therapy failed cases, operative treatment may be required. In this study, we describe a minimally invasive percutaneous screw osteosynthesis using intraoperative CT-based navigation for hangman’s fractures.

**Methods:** Eleven patients with hangman’s fractures were treated in this study. Mean age was 57.6 years. The fractures resulted from falls in 6 patients, motor-related accidents in 4 patients and a falling object in 1 patient. All fractures were evaluated by radiographs and CT imaging. Percutaneous osteosynthesis was performed in the patients with Levine-Edwards classification type I, and type II without disc injury at C2/3. Surgical procedure; a dynamic reference arc was attached to the spinous process of the axis through a small incision. After image acquisition, the fluoroscope workstation generated 3-dimensional reconstructions of imaged anatomy. We made two small lateral incision and guide-wires were inserted. Cancellous lag screws were inserted over the guide-wires. Bilateral screw positions could be assessed by intra-operative 3D fluoroscopy imaging. Postoperatively, patients wore a rigid cervical collar until bone union was achieved.

**Results:** Type I fractures were observed in 6 patients and type II in 5 patients. The average surgical time was 101 minutes. The average operative blood loss was 76 ml. No intraoperative complications occurred. Union was achieved in all patients. In a 72-year-old male with type II fracture, unilateral partial screw back-out was observed at the fifth postoperative week. After re-instruction of a cervical collar fixation and administration of intermittent parathyroid hormone, eventual union was achieved at the fifteenth postoperative week without screw back-out progression.

**Discussion and conclusions:** Percutaneous osteosynthesis using lag screws has the benefit of less muscle disruption, maintaining a normal cervical ROM and early rehabilitation. In this study, all patients underwent surgery without complications and achieved bone union. Minimally invasive percutaneous screw fixation using intraoperative CT-based navigation seems to be a safe and useful method for the treatment of hangman’s fractures.
Combining laminar hooks to massa lateralis screws in C1 for an improved angular stability in screw and rods constructs of the upper cervical spine

Jens A. Richolt

Background: Pathologic C2-fractures frequently require posterior stabilization. Following radiotherapy is known to impede a successful biologic fusion. The construct and its bony anchorage will be loaded much longer compared to cases with expected near-term fusion.

Case introduction and material: In the presented case of a 76-year-old female patient with instable pathologic C2-body fracture survival time was significantly more than one year. Tumor board agreed in stabilization followed by radio- and chemotherapy. Assessment of the fracture and individual anatomy was performed in a three-dimensional fashion based on CT. Accordingly, pedicles of C1, 3 and 4 were too small for pedicle screws.

Definition of case specific challenges: In the presented case it was the surgical goal to achieve a longer lasting instrumentation construct C1 to C4 without using pedicle screws and near-term biologic fusion. Our specific concern was the long-term angular stability of a single level C1-massa lateralis instrumentation above the C2-fracture.

Treatment: Massa lateralis screws in C1, 3 and 4 were implanted as most appropriate solution for the given anatomy. In order to improve angular stability of the C1 part of the construct we added laminar clamps on both sides. These were integrated into the massa lateralis screw construct. Attachment of the clamps to the lamina and attaching clamps to the longitudinal rod construct was simple and safe.

Follow-up after 9 months revealed a pain-free patient and no sign of construct failure or loosening.

Conclusion: By adding laminar hooks to a C1 massa lateralis screw instrumentation, angular stress in the ex/flex load onto the screws should be diminished significantly by its additional lever. We expect to have a longer lasting instrumentation by adding this feature.

Pitfalls and complications in traumatic bilateral cervical facet joint dislocation – report of three cases

Alexander Wels, Hermann Schnell

Introduction: Subaxial cervical spine dislocations following trauma are common and the management of facet dislocations is a controversial subject among surgeons. If not missed in radiographic assessment, still both reduction and fixation can be challenging procedures. Three cases should demonstrate typical pitfalls and complications including diagnosis and surgical treatment.

Material and methods: We present three cases of traumatic bilateral cervical facet dislocation. The first patient, a 26-year-old female with facet dislocation C6/C7 was initially missed on conventional plane X-rays. Another 28-year-old male patient who was severely injured in a motor vehicle accident, had a C2/C3 locked facet dislocation, where closed reduction with halo ring traction failed due to cut out of the pins, and consequently received an open posterior-anterior single stage reduction and fixation. In the third patient, a 51-year-old female with cervical spine dislocation C7/TH1 we performed a single anterior approach first after closed reduction but after postoperative CT imaging we finally had to include one more segment in a posterior approach because the bilateral facet dislocation included two different segments, C6/C7 on the right side and C7/TH1 on the left side.
Results: The first and the third patient had no neurologic deficit in the postoperative period and successfully returned to work. Unfortunately the 28-year-old male finally suffered from apallic syndrome due to severe traumatic brain injury.

Discussion: Because of the significant number of cervical facet dislocations among cervical spine injuries CT imaging should be routinely used in patients with neck pain after high impact trauma. Closed reduction is often successful and to date we had no case with an unnoticed herniated disc and neurologic deterioration. If reduction is not achievable this way, anterior versus posterior open reduction depends on our surgeon’s preference.

Conclusion: Patients with neck pain after high energy trauma should be evaluated thoroughly with radiographs and computed tomography. When bilateral cervical facet dislocation is diagnosed, both the reduction and the surgical strategy are demanding topics. Closed vs. open reduction and anterior vs. posterior and combined approaches still remain controversial issues.

P009
Endoluminal vacuum-therapy as salvage procedure for oesophageal lesions
Katrin Eberle, Heinrich Böhm, Mootaz Shousha

Report on 4 cases

Background: Injuries of the oesophagus represent a rare, frequently overlooked and often life-threatening complication after surgeries to the anterior cervical spine. Established treatment options are very demanding surgically and aim at providing a well vascularized cuff around the oesophagus derived from vascularized muscle (sternocleidomastoid or pectoralis).

We firstly attempted this method in a case of adult cervico-thoracic lordo-scoliosis with perforation of the oesophagus due to a dislocated bone graft at the disc-space Th1–2, due to the difficulty and invasivity of approaching this region by conventional surgery.

Method: To provide enteral nourishing, primarily a PEG was implanted. Under oesophagoscopic control then the primary perforation site was dilated to 10mm and widened caudally to open the abscess cavity by means of a needle-scalpell. Initially one endovac-sponge was placed inside the abscess cavity and a second at the same level, but intraluminally inside the oesophagus, to apply negative pressure of 120mm Hg.

After an average 20 days of treatment with changes of the endospone twice a week the abscess cavity granulated so well, that intraluminal suction sufficed. On avg. 30–40 days, when healing could be verified endoscopically, inflammatory parameters proofed regressing and the oesophageal integrity was demonstrated by performing a barium meal examination and endoscopy.

In 3 of these patients the treatment could be successfully stopped and the PEG was removed. In a 4th patient, where the injury of the oesophagus must have occurred and was not recognized during the second anterior revision, new erosions of the vertebral bodies and septic exacerbation led us to conversion to open surgery after 1 week of endoluminal treatment because of the fear of uncontrolled mediastinitis.

Conclusion: Even in cases with proximal oesophageal lesions the endoscopic vacuum therapy seems to be a very good treatment option. Though this procedure is taking time and poses substantial psychological stress on the patient, it avoids the surgical trauma of muscular flaps and thus can be a successful alternative worth to be considered.

P010
Concomitant fixation of subaxial cervical fracture and correction of neck flexion deformity via posterior C7 osteotomy in a patient with inflammatory bowel disease – a challenging case report
Abolfazl I. Rahimizadeh

Objective: To present a case of inflammatory bowel spondylarthro-ophathy with gradual, but marked flexion deformity of the spine who sustained cervical fracture after a trivial fall. Via posterior only approach, the fracture was fixed and the previous cervical deformity was corrected after posterior C7 osteotomy including the pedicles.
Method: this 75-year old man with history of ankylosis of the spine and flexion deformity of the neck due to IBD fell to the ground. Since then, his flexion deformity was increased to complete chin to chest deformity. His only complaint was paresthesia of the index and middle fingers. Surprisingly the deformity could be corrected in supine sleeping position. Neurological exam was normal. Cervical and whole spine X-ray showed C5-C6 fractures extending from posterior to anterior of vertebral column. Severe osteoporosis was also evident. In cervical MRI where the the neck deformity was corrected showed a line of fracture as a hyperintense line from posterior C5-C6 to anterior part. CT scan also confirmed the fracture. With the patient in prone position and head in Mayfield initially pedicle screws from C2 to T3 were done on the right side and in the left C2 pedicle and lateral masses of subaxial spine, plus T1, T2 and T3 pedicle screw were inserted. In order to correct the previous neck deformity posterior arch of C7 and removal of its pedicles were done. While a dual diameter rod was in place. The neck was gradually extended till almost normal lordosis of neck could be obtained, all under Neurmonitoring.

Result: Post op the patient was excellent. Lateral cervical x-ray showed good fixation. the patient used Minerva orthosis for 6 wks and whole spine x-ray after 6 months was very good and the patient’s desire to look forward was also became true. Further evaluation of pelvic and free bending of the patients clearly confirmed IB spondyloarthropathy as the cause.

Conclusion: The seronegative spondyloarthopathies such as ankylosing spondylitis, psoriasis and inflammatory bowel disease are the disorders that can result in stiffness or ankylosis of the spine. An ankylosed spine is suspectible where the cervical spine is the least common. With careful review of the literature we could not find a similar case. Our paper shows that it might be possible to fix the cervical fracture and the flexion deformity of the neck in one session via posterior only approach.

P011
Pathologic cervical fractures in multiple myeloma (MM)
Jeffrey D. Coe

Background: Pathologic cervical fractures in multiple myeloma (MM) can present significant challenges. This case reports the treatment of a catastrophic failure after apparently successful reconstruction for a cervical pathologic fracture.

Introduction and material: A 70-year-old woman diagnosed with MM developed a C6 pathologic burst fracture with spinal cord compression and progressive neck & upper extremity pain. She underwent a C6 corpectomy with allograft strut grafting and plating from C5-7 at another institution with improvement in her pain and preservation of neurologic function. One years after diagnosis she was treated for multiple lumbar and thoracic fractures with a combination of vertebroplasty, kyphoplasty and instrumented posterior fusion. Two years after diagnosis, an asymptomatic lower cervical deformity was noted on thoracic MRI as an incidental finding. Cervical imaging demonstrated an oblique coronal fracture through C7 with marked spondylolisthesis, kyphosis and subsidence. She declined treatment at that time. One year later she presented with progressive myelopathy and consented to reconstruction.

Definition of case specific challenges: 1) Severe deformity of the osseous cervical spine and spinal cord in the myelopathic but ambulatory patient, 2) Marked bone density loss due to MM, 3) Refusal of blood products at surgery (Jehovah’s Witness).

Treatment: First stage: Removal of plate and screws, C7 corpectomy, excision of residual C6 graft and expandable cage implantation. Second stage (4 days later): C3-T3 PSF and instrumentation (maintenance of halo traction between stages).

Complications and management: No complications were noted. A cervical orthosis was worn for 3 months. She remains well 4 years postoperatively.

Conclusion: Pathologic cervical fractures in patients with MM can present with major challenges that are manageable with appropriate preoperative planning and surgical execution.
Legend to the figure: 1a. Thoracic MRI with cervical deformity as “incidental finding”. 1b-e. Cervical MRI, CT and plain radiographs. 1e. 1-year postoperative radiograph.

P012
Percutaneous fixation of atypical hangman’s fracture
Petr Vachata

Background: Hangman’s fractures can be treated by use of different techniques depending on stability, degree of dislocation and surgeon preference (Philadelphia collar, halo fixation, C23 ACDF, C23 posterior fixation and fusion, direct transpedicular stabilization).

Introduction and material: A 35-year old man suffered a neck injury while sliding head-first on a water toboggan. Patient at admission complained of severe neck pain and showed limited cervical motion with no neurological deficit. A CT scan revealed an atypical hangman’s fracture with dislocation. There was no sign of C23 disc or ligament rupture on MRI.

Definition of case specific challenges: The goals of treatment in cases without C23 disc damage are reposition of dislocation and stable fusion with or without surgery to restore physiological alignment and preserve full range of motion. This can be achieved either by conservative treatment with halo traction or direct posterior fixation. Open procedures are inevitably associated with a certain amount of muscle damage. A few cases of transpedicular percutaneous C2 screws were recently described, but up to date there is no report of a percutaneous translaminar C2 screw insertion.

Treatment: Surgery was indicated after unsuccessful treatment by halo traction without any signs of reposition. Percutaneous reposition and fixation by transpedicular and translaminar cannulated screws was performed using intraoperative navigation by O-arm.

Complications and management: Surgery was uneventful and patient was fully recovered with stable fusion
without any limitations of the range of motion in 3 months. There are no signs of instability and pathological alignment one year after the surgery.

**Conclusion:** Percutaneous fixation of atypical hangman’s fracture by combination of transpedicular and translaminar screws is a new option of truly minimally invasive surgical management completely preserving range of motion.

**Legend to figures:** Preoperative (a, b, c, d) and postoperative (e, f, g, h) pictures after percutaneous fixation.

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**P014**

C1 lateral mass screw insertion caudally from C2 nerve root – an alternate method for insertion of C1 screws

Keiji Wada, Ryo Tamaki, Mitsuru Yui, Yasuaki Murata

**Introduction:** C1 lateral mass screw was widely used for fixation of the upper cervical spine. However, massive bleeding from the C1–2 venous plexus is sometimes encountered. In this study, we proposed an alternate method for C1 lateral mass screw insertion, which involves insertion of the screws caudally from the C2 nerve root to reduce bleeding from C1–2 venous plexus.

**Methods:** Ten patients with atlantoaxial lesions were included in this study. All patients underwent atlantoaxial fusion with C1 lateral mass screws, which were inserted caudally from the C2 nerve root. Operative time, blood loss, C2 nerve root injury, perioperative complications, and accuracy of C1 screws using postoperative computed tomography were evaluated.

**Results:** A total of 19 C1 lateral mass screws were inserted using this method. The mean operative time was 219 (144–305) min. The mean blood loss was 172 (35–357) g. One perioperative complication was observed, which was recurrent laryngeal nerve palsy. There were no vertebral artery or spinal cord injuries. No case of massive bleeding from the C1–2 venous plexus was observed. One patient complained of postoperative occipital neuralgia. No malposition of C1 lateral mass screws was observed on postoperative computed tomography.

**Discussion:** The advantage of our method is subperiosteal exposure of the C2 lamina and pedicle and identification of the C1/2 joint. In this step, the C1–2 venous plexus is not touched. After identification of the C1–2 joint, the C2 nerve root and venous plexus are elevated cranially, and the caudal–dorsal side of C1 lateral mass is easily exposed. As the screw is inserted from this point, the venous plexus is barely touched in all the steps. Postoperative occipital neuralgia due to C2 nerve root injury is a problem of the C1 lateral mass screw. In our case series, 1 of 19 screws caused postoperative numbness of the C2 area. Therefore, even in our method, C2 nerve root injury occurred.

**Conclusion:** The alternate method of C1 lateral mass screw insertion caudally from the C2 nerve root is effective with reduced perioperative blood loss from the C1–2 venous plexus.
P015
Levator scapulae muscle weakness induces supra-scapular sore syndrome
Kazuya Tajiri, Shinichi Yagishita, Satoru Kidani, Hiroyuki Nakanishi, Yu Hatsuchi

Ten patients levator scapulae muscle strength was measured using Mobie made by Sakai Med Corp. The relationship between the muscle strength and trapezius myalgia (Supra-Scapular Sore Syndrome(4S)) was considered. Patients with 4S was weaker than patients without pain. Levator scapulae muscle strength in especially Japanese people is weaker than than other races. So 4S is prevalent in Japanese.

P016
Cervical screw fixation in children – a series of 47 patients
Olga M. Pavlova, Alexander V. Burcev, Alexander V. Gubin, Sergey O. Ryabykh

Introduction: Several studies demonstrated safety and ability of implantation of modern instrumentation in children. Objectives: To prove the safety and the rationality of posterior screw fixation of the cervical spine in children and to compare the different types of fusion techniques of the cervical spine in children.

Materials and methods: A retrospective analysis of 47 pediatric patients with posterior instrumented fixation of the cervical spine, were treated at Ilizarov Center from 2010 to 2016.

Results: The mean patient age at the time of surgery was 9.2 ± 4.4-years-old. The mean duration of the follow-up was 2.1 ± 1.6 years. 186 screws were implanted, the number of screws introduced to one patient reached ten (mean 3.9 ± 2.4). Postoperative complications were observed in 5 patients (10.6%).

Discussion: Noninstrumented spondylodesis, wire and cable fixation require prolonged immobilization with halo-vest and involve a large number of re-operations, besides the use of a wire fixation associated with greater morbidity than screw fixation. The use of screw constructions for the treatment of cervical spine pathology has the following advantages: this biomechanically reliable method shortens recovery time, it increases the success of arthrodesis, provides stability and reduction of vertebral displacement intraoperatively. Among 430 children with posterior cervical screw fixation from literature review 26 patients had complications (6.0 %), 13 of them were need revision surgery (1.9%).

Conclusions: Standard posterior cervical screw instrumentation can be used in children over 2 years. C1 lateral mass screw fixation available in most children. Selection of the method of C2 screw fixation depends on the course of the vertebral artery and the structure of C2 isthmus. Pedicular, intralaminar and pars screw fixation of C2 provide a reliable basis for the fusion, as well as a good anchor for the reduction of subluxations. Subaxial lateral mass screw fixation is the method of choice for in children, because of insecurity of intralaminar and pedicular fixation in children. Posterior cervical screw fixation is a safe in children.

P017
Predictive factors for acute exacerbation of cervical compression myelopathy
Kazuya Kishima, Keishi Maruo, Fumihiro Arizumi, Kazuki Kusuyama, Shinichi Yoshiya

Introduction: Cervical compression myelopathy (CCM) such as cervical spondylotic myelopathy usually has a chronic course. However, we have experienced cases where, patients with CCM indicated early surgery because of acute exacerbation. The objective of this study was to evaluate the predictive factors of acute exacerbation of CCM.

Materials and methods: Fifty-nine consecutive patients with CCM who received laminoplasty with or without posterior cervical fixation in our department were included in this study. Nineteen patients received early surgery because of acute exacerbation such as acute gait disturbance or acute paralysis (acute group), and 40 patients received elective surgery (chronic group). Medical records were evaluated retrospectively. Evaluated factors were follows: preoperative JOA score, duration from onset to operation, age, falling, anterior spondylolisthesis (SL), single lesion or multiple lesions, and C3/4 lesion or not, and distractive spondyloarthrosis (DSA) or not. Evaluated factors were compared between the groups. A univariate analysis using a t-test or Fisher’s exact test was followed by a multivariate analysis using logistic regression analysis.
Results: The diagnosis of the patients were as fellows: cervical spondylotic myelopathy in 37 patients, cervical ossification of posterior longitudinal ligaments in 14 patients, DSA in 5 patients, cervical disc herniation in 2 patients and rheumatoid arthritis in one patients. The preoperative JOA score of the acute group was significantly lower than that of the chronic group (6.7 +/- 3.6 and 11.2 +/- 3.9, respectively, P<0.05). The duration from onset to operation of the acute group was significantly shorter than that of the chronic group (2.3 +/- 2.4 months and 11.2 +/- 3.9 months, respectively, P<0.05). The age of the acute group was significantly higher than that of the chronic group (78.6 +/- 8.6 years old and 68.1 +/- 12.0 years old, respectively, P<0.05). Frequency of falling, SL, single lesion and DSA were significantly higher in the acute group than the chronic group (P<0.05). Predictive factors of acute exacerbation of CCM were age, single lesion and SL in the multivariate analysis (P<0.05).

Conclusions: CCM patients with advanced age, single lesion or SL should be observed carefully for acute exacerbation of CCM.

P018
A prospective study of an ACDF plate capable of 60deg – total oblique angulation – implications for adjacent level ossification at 2-year follow-up

Brieta Ventimiglia, Chris Ferry, Gary Dix

Introduction: Anterior plate and screw fixation as an adjunct to discectomy and fusion (ACDF) is a readily practiced technique in the degenerative cervical spine. However, growing evidence has indicated that plating, when placed within a given proximity of contiguous levels, may increase the likelihood of adjacent level ossification (ALO). While a diminished plate height can help address these trends, traditional plate designs are limited in the extent to which they support oblique angulation. The purpose of this study was to prospectively assess a novel ACDF plate capable of 30o cephalad and caudal screw angulation (60o total) to support a small stature profile. Methods: Data was collected as part of a prospective, multi-center, study of subjects receiving single or multi-level ACDF for degenerative disc disease or/and myelopathy. The data presented here are specific to a single center (n=18 subjects). All procedures were performed via a standard anterior approach. Plate size and screw angulation was not standardized. Screw insertion was approximately 1.5mm from the index endplates. Subjects were followed out to 24months and radiographic analysis was performed to study the relationship between plate-to-endplate distance (P-to-EP), screw angulation, and subsequent rate of ALO. ALO Grades: 0–No ossification; I–Mild (<50% of adjacent disc space); II–Moderate (≥50% of the disc space); III–Severe (Complete bridging of adjacent disc). Results: At 24months 12 subjects had complete radiographic follow-up. 21 of 24 adjacent levels (87.5%) exhibited Grade O/I ALO. Three levels exhibited moderate ALO. No cases of severe ALO were observed. Mean P-to-EP was 5.8mm (Grade 0/I) and 5.4mm (Grade II). Mean screw angulation was 9.1deg (Grade 0/I) and 13.3deg (Grade II). Moderate ALO (n= 3 levels) was observed across 2 subjects. The first subject (2-level; C4-6) exhibited ALO at the caudal adjacent level only (P-to-EP: 5.3mm). The second subject (1-level; C5-6) exhibited ALO at both adjacent levels (Cephalad/Caudal P-to-EP: 2.33/8.47mm).

Discussion and conclusion: At 24mos, the novel plate supported a diminished presence of ALO with rates of occurrence comparable to those in the literature. Further radiographic assessment in the collective study population will help substantiate any definitive correlation between plate-to-endplate distance and presence of ALO.

P019
Feasibility and clinical outcomes of C1 lateral mass screw insertion via posterior arch for atlantoaxial instability
Yoshihiro Inui, Koki Uno, Hiroshi Miyamoto

Introduction: There were three kinds of technique for C1 lateral mass (CILM) screw insertion: Goel and Harms reported insertion directly into C1LM, Tan reported via posterior arch, and Liu reported Notch technique in which he inserts screws from the notch created at caudal edge of posterior arch. We have performed screw insertion via posterior arch (Tan’s or Notch technique). The purpose of this study is to investigate the feasibility of screw insertion and the clinical outcomes.
Methods: Thirty-two patients (mean 68 years) were followed up over 1 year. The indication was 14 RA, 9 idiopathic atlantoaxial instability, 3 pseudo tumor, 2 odontoid fracture, 2 os odontoideum, including 26 with myelopathy. Twenty-nine patients underwent C1-2 fusion, and 3 had C1-C7 fusion. 3.5-mm screws were used for all patients. Initially we attempted Tan’s technique, and Notch technique was selected in the last 8 patients. We measured the thickness of posterior arch in the area of screw placement from preoperative CT, and the presence or absence of cortical perforation from postoperative CT. The alignment and instability of C1-C2 were investigated from radiographs. JOA score was investigated through follow-up.

Results: A total of 64 screws was inserted in all patients. Only one screw was re-inserted directly into C1LM because of cranio-caudal break of posterior arch. There was no VA injury. The mean thickness of posterior arch was 3.9±0.8 mm and 34% were less than 3.5 mm. The posterior arch was perforated cranially in 1 (1%) and caudally in 52 (81%) including 16 Notch technique, and no perforation in 11 (17%). Dynamic radiographs of final follow-up showed no C1-C2 instability in all patients. The mean JOA score was improved from 8.9 to 12.2 at final follow-up (P<0.001).

Discussion: This study shows screw insertion via posterior arch made rigid fixation and good clinical outcomes. However, cortical perforation was often seen because the mean thickness of posterior arch was 3.9 mm which was too small to insert 3.5 mm screw without perforation. Cortical perforation may cause unexpected VA injury or break of posterior arch. Notch technique can keep cranial cortex intact because of insertion from the notch created at the caudal edge of posterior arch. This technique may be safer procedure especially for narrow posterior arch.

P021
Sternum-disc distance (sdd) method to identify skin level for approaching surgical segment without fluoroscopy guidance in Anterior Cervical Disectomy and Fusion (ACDF)
Bo Gun Suh, Jae Hyung Eoh, Gun Woo Lee, Jin S. Yeom

Introduction/Aim: To introduce the sternum-disc distance (SDD) method for approaching the exact surgical level without C-arm guidance in anterior cervical discectomy and fusion (ACDF) surgery and to evaluate its accuracy and reliability.

Materials and methods: A total of 103 patients who performed single-level ACDF surgery with SDD method were enrolled in the study. The primary outcome measure was the accuracy of the SDD method. Secondary outcome measures were (1) the mean SDD value at each cervical level from the cranial margin of the sternum in the neutral and extension positions of the cervical spine and (2) the inter- and intra-observer reliability of the SDD outcome with repeated measurements by three orthopedic spine surgeons.

Results: The SDD accuracy (primary outcome measure) indicated that in 99% of patients (102/103). Mean SDD values in the neutral position MRI were 108.8 mm in C3-C4, 85.3 mm in C4-C5, 64.4 mm in C5-C6, 44.3 mm in C6-C7, and 24.1 mm in C7-T1, and those in the extension position MRI were 112.9 mm in C3-C4, 88.7 mm in C4-C5, 67.3 mm in C5-C6, 46.5 mm in C6-C7, and 24.3 mm in C7-T1. Cohen’s kappa coefficient value for intra-observer reliability was 0.88 (excellent reliability), and the Fleiss kappa coefficient value for inter-observer reliability by three examiners was 0.89 (excellent reliability).

Discussion: The difficulty of determining skin level without fluoroscopic guidance for approaching the exact surgical segment in anterior cervical spine surgery, such as ACDF, is critical issue, and most spine surgeons must utilize C-arm fluoroscopy prior to and/or during surgical procedures to confirm that the level is correct.

Conclusion: Based on the current study, we recommend performing ACDF surgery with SDD method to determine a skin level at which to approach the surgical cervical segment without fluoroscopic guidance.
Double-door cervical laminoplasty with suture anchors to maintain canal expansion
Takashi Fujishiro, Atsushi Nakano, Ichiro Baba, Shingo Fukumoto, Yoshiharu Nakaya, Sachio Hayama, Toma Yano, Masashi Neo

Introduction: Cervical laminoplasty with suture anchors is a relatively new technique, and has been popularized recently because of its simplicity and safety. However, there has been limited information regarding this technique, because most studies have been small case series or technical notes. The purpose of the present study was to investigate the clinical outcomes and performance of the double-door cervical laminoplasty with suture anchors.

Materials and methods: We retrospectively reviewed patients, who underwent double-door cervical laminoplasty with suture anchors between November 2012 and February 2015. Clinical outcome was evaluated with JOA score. CT scans were obtained preoperatively, immediately after the operation, and at follow-up, evaluating bilateral hinges and laminae from C3 to C7, including hinge fracture, hinge bony fusion, implant failures and lamina angle. A lamina angle at follow up of <55° was defined as lamina closure.

Results: Thirty-seven patients (25 males, 12 females; mean age, 64.3 years) with 226 laminae and hinges were included in the present study. JOA scores improved significantly at an average of 18.1 months after the operation (from 10.4±2.9 to 13.4±2.5, p<0.001). CT scans showed that the hinge bony fusion was noted at 222 hinges (98.2%) at an average of 12.7 months after the operation, which was not affected by hinge fractures. One dislodged suture anchor was identified. 94.5 % of the lamina angle value immediately after the operation was maintained at follow-up. Lamina closure was observed in 4 patients at follow-up, however, associated neurological deteriorations were not found in these 4 patients. The lamina closure rate was significantly higher at C3 than at the other levels.

Discussion and conclusion: The clinical outcomes of the present technique were satisfactory, and the constructs prepared intraoperatively were maintained adequately at follow-up. Radiographic analysis demonstrated some advantages of the present technique: high hinge bony fusion rate, hinge fractures did not negatively affect bony fusion, and low lamina closure rate. However, if the procedure is performed at C3, special modifications should be made.

Correlation between posterior migration of spinal cord and cervical spine curvature after cervical laminoplasty
Hugues Pascal-Moussellard

Introduction: Cervical laminoplasty is an effective procedure for decompressing multilevel spinal cord compression. Spinal cord back shift has been considered the desired end point of posterior decompression procedures. The aim of our study was to correlate the posterior migration of the spinal cord after extensive laminoplasty to the cervical spine curvature.

Materials and methods: Twenty-nine patients who underwent bilateral open-door laminoplasty between C3 and C7 levels were included in this study. All patients presented with symptoms of neural compression and MRI findings were consistent with CSM. All patients underwent plain radiographs and MRI pre- and post-operatively. The distance from the posterior edge of each vertebral body to the anterior edge of the spinal cord was measured on sagittal MRI. Cervical sagittal alignment was assessed from pre-operative lateral cervical radiographs and classified as lordosis, kyphosis, straight or S-shaped.

Results: The posterior spinal cord shift ranged from a maximum of 6.2 mm to a minimum of -0.1 mm (average 1.8 mm). The peak shift was 2.8 mm at C5. The mean posterior spinal cord shifts in the different neck alignment groups were 1.8 mm for the lordosis group, 1.5 mm (straight group), 1.5 mm (kyphosis group) and 2.4 mm (S-shaped group). The peak shift was located at C5 in the lordosis group (2.8 mm) and in the straight-neck group (3.1 mm), C7 in the kyphosis group (2.8 mm) and C6 in the S-shaped group (3.9 mm). In the lordosis and the S-shaped groups we observed the greatest backward movement in the middle of the cervical spine, at the point of maximum concavity, like a bowstring.

Conclusions: The preoperative lordotic alignment of the cervical spine influences the degree of posterior movement of the spinal cord after extended laminoplasty. Cervical lordosis allows a maximal spinal cord back shift. Moreover, the final spinal cord position is different according to the preoperative alignment of
the spine, with a bowstring effect in lordosis and S-shaped cervical spines. Finally, the risk of C5 palsy should be anticipated in lordotic and straight spines where the peak shift is located at C5.

**P025**
Formulation protocol for management of cervical myelopathy secondary to cervical spondylosis and OPLL

*Abollazl Rahimizadeh, Mahan Amrizadeh*

**Aim:** Numerous articles on management of cervical myelopathy secondary to OPLL and spondylosis exist, but there is no consistent recommendation in this controversial issue. Herein we will express an easy formulation in order to facilitate preoperative planning for the most appropriate mode of surgical decompression in cervical myelopathy caused by spondylosis and OPLL.

**Method:** Review of the cervical radiographs (neuter & dynamics), MRI and reconstructed CT scan of 318 patients with cervical myelopathy secondary to cervical spondylosis and OPLL from 1995 to 2015 assist us to describe a formulation to help in preoperative planning. Our formulation is based on mode of anterior compressions whether it is derived from the disc, body or both (D/B), and the number and the intensity of the discs at affected levels (small, medium and prominent = Sm, Me ‘ Pro). Posterior compression by folded hypertrophied ligamentum flavum known as Pc which can be Mild, Moderate or Marked (Pc Mi, Pc Mo, Pc Ma). Curvature of the neck which can be lordotic, straight or kyphotic or angulated (L, S, K, A), presence or absence of instability known as Unstable or stable (UnSt versus St).

The age of the patient Old versus Young (O/Y), coexistence of developmental narrow canal (DvNa and presence of comorbidities (CoMor1 to 5)

**Result:** We found those patients who had undergone surgery with respect to this formulation protocol have shown the best results comparing their preoperative and postoperative MJOA in long-term follow-up.

**Conclusion:** In this formulation, the responsible surgeon should draw the model of cervical cord compression, number of the levels, curve of the spine, pattern and amount of posterior compression, size of the canal with further consideration of stability, age and associated co-morbidities. However, our formulation require comments of the colleagues in order to be written in a software as a guide for selection and achievement of the most appropriate method of decompression and necessary fixation.

**P027**
Combination of posterior decompression with instrumented fusion with robot therapy for severe myelopathy due to cervical and thoracic ossification of the posterior longitudinal ligament

*Kengo Fujii, Tetsuya Abe, Shigeki Kubota, Aiki Marushima, Toru Fuyanaya, Hiroshi Noguchi, Hiroaki Kawamoto, Yoshiyuki Sankai, Masashi Yamazaki*

**Introduction:** Slow recovery of the myelopathy after posterior decompression with instrumented fusion (PDF) for cervical and thoracic ossification of the posterior longitudinal ligament (OPLL) is one of important problem to be solved, though the safety and stable clinical results are major characteristics of PDF. We used a wearable robot suit designed to assist voluntary control of knee and hip joint motion by detecting bioelectric signals on the surface of the skin. The purpose of this study is to investigate the efficacy of robot therapy in early postoperative period of OPLL.

**Materials and methods:** We analyzed four patients (2 men, 2 women, mean age 57.5 years) who underwent PDF for cervical or thoracic OPLL. Pre-op JOA score was 2.25±0.87 points. Robot therapy started in 31.3±13.7 days postoperatively, and patients received robot therapy for 60 minutes two or three times per week (10 sessions). 10-meters walk test (consisting of speed, step length, and cadence) and the walking index for spinal cord injury II (WISCI II) before and after robot therapy, without wearing the robot suit were assessed.

**Results:** All patients completed 10 sessions of robot therapy, and there were no adverse events. The speed became more than 3 times (15.1±6.5 to 48.4±11.6 m/min, p=0.01), step length became about one time half (0.35±0.10 to 0.50±0.07 m/step, p=0.02), and cadence became more than twice (43.3±19.2 to 97.0±20.5
steps/min, p=0.01). WISCI II significantly improved (11.8±2.5 to 16.8±2.9, p=0.03). JOA score (recovery rate) was 6.9±0.5 points (56.6±101%) in post-op 3 months, 7.9±1.3 points (63.7±16.0%) in post-op 6 months, and 8.5±1.9 points (70.8±22.1%) in post-op 12 months.

**Discussion:** The efficacy of robot therapy remains unclear. However, we believe that the voluntary movement might induce motor learning and a feedback effect between the central and peripheral nervous systems. Based on our results, combination of robot therapy with PDF may enhance improvements in walking ability. Especially, early improvement of JOA score (recovery rate 36.7% in post-op 3months; Yamazaki et al. Eur Spine J 2010) was notable.

**Conclusion:** Combination of PDF and robot therapy may enhance the early postoperative improvement of myelopathy in OPLL patients.

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**P028**

The accuracy and safety of the screw guide template system for the screw insertion in cervical and thoracic spine

*Shuichi Kaneyama, Taku Sugawara, Naoki Higashiyama, Masatoshi Sumi, Masato Takabatake, Hiroaki Hirata*

**Introduction:** Safe and accurate insertion of spinal screws is imperative for posterior spinal instrumentation surgery. We have developed the patient-specific Screw Guide Template (SGT) system for safe and accurate placement of spinal screws. In this study, we report the reliability of the SGT system as an intraoperative navigation procedure for spinal screw insertion.

**Methods:** We attempted to place 428 screws for 51 patients. The accuracy of the screw track was assessed by deviation of the screw axis from preplanned trajectory on postoperative CT and the deviation less than 2mm was defined as accurate.

The safety of the screw insertion procedure was evaluated by the incidence of cortical breach of screw. In addition, the bone diameter available for screw trajectory (DAST) was measured and relations between bone breach and screw deviation or DAST were analyzed.

**Results:** Screw insertion procedures completed properly in 425 attempts, whereas the procedures failed to complete in 3 attempts due to mismatch of templates to the laminae. In 425 inserted screws, 418 screws (98.4%) were defined as accurate insertions and 402 screws (94.6%) were completely contained in the target bone structure. The average screw deviation and DAST were 0.55mm and 5.47mm respectively in overall. In cervical spine, there was no significant difference of screw deviation between breaching screws (0.57mm) and contained screws (0.43mm) (p=0.247), whereas the DAST for breaching screws (3.62mm) was significantly smaller than contained screws (5.33mm) (p<0.001). Cervical screws with the DAST 4.0 mm or more showed significantly lower incidence of bone breach (0.4%) than the DAST 3.9mm or less (28.3%) (p<0.001). In thoracic spine, both screw deviation and DAST had significant difference between breaching screws (1.54mm, 4.41mm) and contained screws (0.75mm, 6.07mm) (p<0.001). The incidence of bone breach was significantly higher in thoracic screws with the DAST 5.0mm or more (1.9%) than with 4.9mm or less (21.9%) (p<0.001).

**Conclusion:** This study demonstrated our SGT system could support the precise screw insertion for 98.4% of accuracy and 94.6% of safety. The DAST was recommended to be 4.0 mm or more in cervical spine and 5.0 mm or more in thoracic spine for safe screw insertion.

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**P029**

Occipitocervical Inclination (OCI) – new radiographic parameter of neutral occipitocervical position

*Woo-Kie Min, Seong-Dae Yoon*

**Introduction:** While several parameters of an occipitocervical neutral position were presented, they had a significant individual gap in landmarks and had large variance in values due to such factors as trauma, cervical kyphosis and rheumatoid arthritis. This study is to present an occipitocervical inclination(OCI), a new parameter that could make up for the defects of the existing radiographic parameters and define an occipitocervical neutral position. (Individual cross sectional study (Diagnostic level 2)).
Materials and methods: Neutral, flexion, and extension lateral cervical spine radiographs of two-hundred patients (100 males and 100 females) judged to be normal were analyzed. The mean age of the patients was 45.19 years (11-74 years; 42.84 for males and 47.53 for females). For OCI, the angle formed by the line connecting the posterior border in the C4 vertebral body and the Macgregor line was measured. And the occipitocervical angle (OCA) and the occipitocervical distance (OCD) were measured and compared with OCI.

Results: OCI on the standard neutral lateral cervical radiographs was measured to be $77.49 \pm 8.87^\circ$. There was no significant gender difference in neutral OCI: $77.19 \pm 7.93^\circ$ for males and $77.79 \pm 9.74^\circ$ for females ($P = 0.631$). The mean neutral OCA was $38.69 \pm 9.23^\circ$ and the mean neutral OCD was $22.98 \pm 5.10$ mm. The Pearson correlation coefficient between the value of the cervical lordosis angle and that of neutral OCI was $r = -0.274$ ($P < 0.001$). Intraclass correlation coefficient (ICC) values for inter- and intraobserver reliability for OCI were significantly higher than those for OCA ($P<0.001$) and seemed to be higher than those for OCD ($P = 0.087$).

Conclusion: OCI is expected to be helpful in determining an occipitocervical neutral position for trauma patients with C1 and C2 anatomy destruction and to be useful to monitor the neutral position during fusion.

Keywords: Occipitocervical fusion, Occipitocervical neutral position, Occipitocervical angle, Occipitocervical distance, Occipitocervical inclination

P030
Standard anterior cervical approach for the treatment of cervical axial and high thoracic levels
Ran Harel, Maya Nulman, Nachshon Knoller

Introduction: Application of the anterior sub-axial cervical approach to the axial spine or the thoracic spine has been previously described. Evaluation methods to determine the feasibility of these approach were also described but we did not find these methods useful for all our patients. We describe our experience expanding the boundaries of anterior cervical approach utilizing a novel algorithm for approach selection.

Materials and methods: A retrospective analysis of patients’ files and imaging data of all anterior cervical approach to treat pathologies above C2-3 disc space or below C7-D1 disc space. The decision to proceed with standard approach was based on CT or MRI scans and the pre-operative range cervical range of motion. Post-operative course and surgical complications will be discussed.

Results: During a two year period 13 patients had undergone anterior cervical approach to the axial spine (3 patients) or the thoracic spine (10 patients). Average age was 53 (range: 11-77), 62% were male. Ten patients were treated for tumor resection, one for trauma, one for myelopathy and the last for infective osteomyelitis with epidural abscess. Three patients were previously operated in another hospital via the posterior approach with remaining compressive mass necessitating anterior decompression. Average surgical duration was 96 minutes (range: 48-181 minutes) and estimated blood loss (EBL) was 1440cc (range: minimal-7000cc); two renal cell carcinoma metastases and one vertebral hemangioma patient’s EBL was over 2500cc. Complications were recorded in 30% of the patients including 1 case of prolonged ventilation, 1 case of CSF leak, 1 patient had post-operative hand weakness, 3 patients suffered temporary hoarseness due to vocal cord paralysis. Demonstrative cases will be presented.

Discussion: Treatment of sub-axial pathology by anterior cervical approach is well established as a safe and effective. Approach to the axial or the high thoracic spine is more challenging and harbors approach-related complication. Pre-operative evaluation of patients imaging allows for harnessing the standard approach for treatment of extreme levels with relative safety and efficiency.

Conclusion: Awareness of feasible anterior cervical approach to the axial and high thoracic levels can increase surgical efficacy while reducing the complication rates.
Biomechanical evaluation of a polycrystalline diamond cervical total disc arthroplasty device
Leonard Voronov, Robert Havey, Saeed Khayatzadeh, Gerard Carandang, Kenneth Blank, Avinash Patwardhan

Introduction: Anterior cervical discectomy and fusion has been associated with adjacent segment degeneration. Cervical total disc arthroplasty (TDA) has been proposed as an alternative. The objectives of this study were to assess the effect of an innovative design of polycrystalline diamond cervical TDA on cervical motion after 1- and 2-level arthroplasty.

Materials and methods: Nine cadaveric spines (C3-T1) (38.3±5.8 years) were used. The testing apparatus allowed continuous cycling in flexion-extension, lateral bending, and axial rotation to ±1.5 Nm. Compressive preload (150N) was used in flexion-extension. Vertebral motion was measured using optoelectronic measurement. Forces and moments were measured using a six-axis load cell.

TDA implantation was performed consistent with company guidelines. The PLL was resected, and uncinate processes were left mostly intact with only the medial portion removed to accommodate the prosthesis endplate.

Experimental protocol: Intact, C5-C6 TDA (n=9), C6-C7 TDA (n=7).

ANOVA was used for statistical analyses, p<0.05 shows significance.

Results:

1-level TDA, results from C5-C6, ROM (deg) changed from:
- Flexion-extension: 12.8±2.5 to 10.5±2.1 (p=0.03)
- Lateral bending: 8.5±2.8 to 3.7±1.0 (p<0.01)
- Axial rotation: 10.4±1.1 to 6.2±1.9 (p<0.01)

Change in segmental stiffness (Nm/deg):
- Flexion: 0.09±0.03 to 0.21±0.09 (p=0.004)
- Extension: 0.08±0.03 to 0.18±0.07 (p=0.003)

Change in neutral zone (deg):
- Flexion-extension 1.8±0.7 to 1.8±0.8 (p=0.966).

2-level TDA, results from C6-C7, ROM (deg) changed from:
- Flexion-extension: 10.0±3.4 to 11.4±3.0 (p=0.07)
- Lateral bending: 7.5±2.8 to 5.1±2.3 (p=0.07)
- Axial rotation: 7.7±1.7 to 5.3±0.9 (p=0.02)

Change in segmental stiffness (Nm/deg):
- Flexion: 0.13±0.06 to 0.15±0.08 (p=0.424)
- Extension: 0.12±0.05 to 0.11±0.04 (p=0.736).

Change in neutral zone (deg):
- Flexion-extension 1.5±1.0 to 2.1±0.9 (p=0.304).

Discussion: This innovative design of disc prostheses restored ROM in flexion-extension to intact levels. In lateral bending the TDA maintained 68% ROM at C6-C7 and 43% at C5-C6. In axial rotation 60% ROM was maintained at C5-C6 and 69% at C6-C7.

The decrease in lateral bending and axial rotation after TDA may be a multifactorial phenomenon. Device kinematics, placement and tensioning of the remaining lateral annulus fibers during prosthesis insertion may play a role in maintained motion.

Conclusions: The data suggest that this TDA provides similar cervical spine kinematics as compared to the preoperative condition.
Adaptive axis of rotation effect of total disc arthroplasty on motion segment center of rotation
Leonard Voronov, Saeed Khayatzadeh, Robert Havey, Gerard Carandang, Kenneth Blank, Avinash Patwardhan

Introduction: Anterior cervical discectomy and fusion is associated with adjacent segment degeneration (ASD). Cervical total disc arthroplasty (TDA) has been proposed to prevent ASD. However, some arthroplasty designs have been linked to facet degeneration possibly due to a center of rotation (COR) mismatch with the native segment. Cervical TDA using a disc with a mobile axis of rotation may better accommodate the unique COR of implanted segments. The study purpose was to assess the effect of a mobile axis of rotation TDA on the COR of cervical motion segments during flexion-extension (FE).

Materials and methods: Eight specimens (C3-T1) (38±6 years) were tested between maximum moment endpoints in FE to ±1.5 Nm with 150N of compressive preload. Vertebral motion was measured using optoelectronic motion measurement. Specimen-specific three-dimensional CT modeling was used to locate the segmental COR (projection of the FE axis of rotation on the sagittal plane) for the implanted motion segments. COR was measured between the start of the high flexibility zone (HFZ) in extension, to its end point in flexion (-0.1Nm extension to 0.65Nm flexion). Experimental protocol: Intact, C5-C6 TDA, C6-C7 TDA.

Results: Intact ROM at C5-C6 (12.2±2.2deg) was split into three zones: extension high stiffness zone (2.5±2.4deg), HFZ (6.7±2.9deg) and flexion high stiffness zone (3.0±1.8deg). The HFZ covers 23±5% (0.7±0.1Nm) of the applied FE moment, but contributes 54±17% of the total segmental ROM. C6-C7 intact ROM (10.0±2.9deg) yielded: extension high stiffness zone (1.9±0.4deg), HFZ (4.6±1.1deg) and flexion high stiffness zone (3.5±3.2deg). The HFZ covers 23±4% (0.7±0.1Nm) of the applied FE moment, but contributes 49±13% of the total ROM. The change in location of the C5-C6 HFZ-COR between intact and TDA was 1.0±1.1mm posteriorly (n=8, p<0.05) and 0.6±1.4mm caudally (n=8, p=0.3) Figure.
At C6-C7 the change in C6-C7 HFZ-COR between intact and TDA was 1.4±0.8mm posteriorly (n=7, p<0.01) and 0.3±2.0mm cranially (n=7, p=0.7).

Conclusions: A new COR measure has been presented to measure COR in the HFZ where it is less affected by the facets and tensioned soft tissues. This study shows the investigated TDA allowed individual motion segments to maintain their HFZ COR position in the anteroposterior direction within 1.2±1.0mm (p=0.00) and in the cranial-caudal direction to 0.2±1.7mm (p=0.70) of the intact COR location.

Occipital condyle syndrome: case presentation resembling in cervical disease
Takeshi Aoyama, Naoshi Obara

Introduction: Occipital condyle is part of skull base, pair protrusion positioning anterolateral part of foramen magnum. It contacts with C1 lateral mass, composes joint of craniovertebral junction. Pathology of this region arouse neck pain and neck movement disorder, as with cervical lesion. Additionally, it arouse specific symptom since anatomical structure, it is called as occipital condyle syndrome. A rare case of this syndrome is presented.

Materials and methods: Case presentation. 42-years-old male has one year history of hepatocellular carcinoma. He has feld headache and dysarthria for 20 days. Brain MRI revealed skull base metastasis. Radiation therapy and denosmab 120mg subcutaneous injection were performed. After falling on his buttocks, he had pain on right neck. And he felt movement limitation, sound from neck. So he introduced to out department. Neurological examination revealed right hypoglossal nerve palsy. CT revealed no lesion in cervical spine, however, fracture of right occipital condyle and destruction of both condyles and clivus.

Results: Occipitocervical fusion was not elected since his prognosis was less than 3 months. External fixation ameliorated neck pain, neurological deterioration was not occurred. He passed away due to primary disease.

Discussions: Occipital condyle syndrome shows one side occipital pain and ipsilateral hypoglossal nerve palsy. This derived from the position of hypoglossal canal, which exists close to occipital condyle, and in which hypoglossal nerve runs. This is rare condition, and many of this were aroused by metastatic tumors. Inflammatory
pseudotumor, Wegener granulomatosis, tuberculosis can also be etiology of this syndrome. Maybe due to it’s rarity and the position, border between skull and spine, it can easily overlooked.

**Conclusion:** Occipital condyle syndrome is a disease of skull. However the symptoms of this syndrome are similar to cervical disease. So the patients can come to spinal surgeon. Occipital condyles are usually seen in routine cervical spine CT, MRI. So this syndrome should also be kept in mind during diagnosis of neck pain.

**Keywords:** hypoglossal nerve palsy, neck pain, occipital condyle syndrome

**Table 1** Comparison 24hrs creatinine clearance and eGFR(CKD-EPI) with eGFRCysC

<table>
<thead>
<tr>
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<th>eGFR(CKD-EPI)</th>
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<th>24hrs creatinine clearance</th>
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<tr>
<td></td>
<td>normal range</td>
<td>80–90%</td>
<td>below 80%</td>
<td>normal range</td>
<td>80–90%</td>
<td>below 80%</td>
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<td>Pearson correlation</td>
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<tr>
<td>In incomplete SCI</td>
<td>0.724**</td>
<td>0.4</td>
<td>0.382</td>
<td>0.849**</td>
<td>0.659*</td>
<td>0.665*</td>
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<tr>
<td>Significance</td>
<td>p&lt;0.01</td>
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<td>p&lt;0.01</td>
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<tr>
<td>Pearson correlation</td>
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<tr>
<td>In complete SCI</td>
<td>0.435**</td>
<td>0.039</td>
<td>0.413*</td>
<td>0.578**</td>
<td>0.541*</td>
<td>0.476*</td>
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<td>Significance</td>
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**Table 2** Deviation of 24hrs creatinine clearance from eGFRCysC

<table>
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<th>Patient group</th>
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<th>Deviation from eGFRCysC less than</th>
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<td></td>
<td></td>
<td>±10%</td>
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<td>Normal range (90-110%)</td>
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<td>80-90%</td>
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<td>13%</td>
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**P037**

Clinical outcome of drop finger caused by C8 nerve root impairment

Masao Koda, Takeo Furuya, Yasushi Ijima, Junya Saito, Mitsuhiro Kitamura, Chikato Mannoji, Seiji Ohtori, Sumihisa Orita, Kazuhide Inage, Masashi Yamazaki

**Introduction:** Recently, it has been reported that impairment by an 8th cervical nerve root lesion can cause drop finger, namely C8 drop finger. Here, we report a clinical case series of C8 drop finger to reveal the clinical outcome of surgical treatments to allow for a better choice of treatment.

**Materials and methods:** The present study included 17 consecutive patients (11 male and 6 female) who were diagnosed as having C8 drop finger, in which muscle strength of the extensor digitorum communis (EDC) showed a manual muscle testing (MMT) grade of 3 or less. We retrospectively compared the EDC muscle power recovery between conservatively and surgically-treated patients.

**Results:** Nine cases showed recovery of muscle power of EDC, whereas the remaining 8 cases did not show any recovery including 2 cases of deterioration. None the conservatively treated patients showed any recovery. Surgically treated cases included 2 cases of deterioration. In the cases showing recovery, recovery began 9.9 months after
surgery on average and recovery took 13.8 months after surgery on average. There was a significant difference in the recovery of MMT grade between the groups treated conservatively and surgically ($p = 0.049$). Preoperative MMT grade of EDC showed a moderate correlation with postoperative recovery ($r^2 = 0.45, p = 0.003$). In other words, the severity of preoperative muscular weakness correlated negatively with postoperative recovery.

Conclusions: C8 drop finger is better treated by surgery than conservative therapy. It is important to perform surgery for C8 drop finger patients as soon as possible because the severity of the palsy negatively correlates to postoperative recovery.

P038
Addition of instrumented fusion to laminoplasty cannot suppress postoperative sagittal balance exacerbation

Masao Koda, Taigo Inada, Yasushi Iijima, Junya Saito, Mitsuhito Kitamura, Seiji Ohtori, Sumihisa Orita, Kazuhide Inage, Masashi Yamazaki

Introduction: Cervical sagittal imbalance can lead to pain and impairment of activities of daily living (ADL) and quality of life (QOL). Laminoplasty (LMP) can cause postoperative kyphosis, possibly resulting in aggravation of cervical sagittal balance. Addition of posterior instrumented fusion to LMP can prevent postoperative kyphosis. The aim of the present study was to elucidate the difference between LMP and posterior decompression with instrumented fusion (PDF) surgeries in postoperative alteration of cervical sagittal balance.

Materials and methods: We retrospectively evaluated a total of 53 patients who underwent LMP ($n = 30$) or PDF ($n = 23$) in our institute. Neck pain, ADL and QOL was assessed at final follow-up visit. C2–C7 angle, Center of the gravity head–C7 sagittal vertical axis (CGH–C7 SVA) and C7 tilt were measured before surgery and at final follow-up visit from plain lateral radiographs of the cervical spine in a neutral position obtained while the patients were standing.

Results: In the LMP group, the average C2–C7 angle decreased postoperatively, whereas C2–C7 angle was maintained postoperatively in the PDF group. CGH–C7 SVA increased postoperatively in both groups in a similar manner. There was a significant correlation between increase of CGH–C7 SVA and neck pain, ADL and QOL measurements.

Conclusions: The present study demonstrated that addition of instrumented fusion cannot prevent the increase of CGH–C7 SVA even though fusion could prevent progression of kyphosis.

P039
Brucella cervical spondylitis – report of 4 cases the characteristic clinical and radiological features of the condition

Erfan Ghorbani, Abolfazl Rahimizadeh, Housain Soufiani

Objective: To Report of 4 new cases Brucella cervical spondylitis with epidural abscess which is an extremely rare condition. The report that becomes more interesting if we know that the literature research yielded only 25 reports and the infection is seen sporadically in south Europe and in refugee coming from the middle east and north African countries.

Method: 4 cases including 2 males and two females are presented. All four patients had history of neck pain from 4 months to a year and all showed quadripareisis on admission. MRI showed extensive epidural collection with extensive rim enhancement in 3 and small amount in non-contrasted one. Serological tests were positive only in one. Therefore in the remaining 3 open surgery for obtaining material for PCR was needed. In the male of 18 years of age quadripareisis was so sever and rapid which underwent laminectomy by colleague. In the remaining three, anterior discectomy, debridement and removal of the epidural granulomatous material followed by interbody arthrodesis was the surgical modality. For securing interbody graft, Halo-vest was used in 2 and titanium plate in one.

Result: All three cases with anterior approach showed excellent recovery In the younger one who had undergone emergency laminectomy, remote severe cervical kyphosis developed which required combined 540 degree surgery. In the remaining three, anterior discectomy, debridement and removal of the epidural granulomatous material followed by interbody arthrodesis was the surgical modality. For securing interbody graft, Halo-vest was used in 2 and titanium plate in one.

Conclusion: Cervical Brucella spondylitis usually starts from a disc space and extend to epidural space. Long-standing history of neck pain and kyphosis or instability are strong clue of Brucella spondylitis. Surgery is
indicated, for correct diagnosis, for myeloradiculopathy, kyphosis and instability. Surgery is debridement and removal of the epidural abscess via affected disc space. Anterior interbody arthrodesis with autogenous/Vs allogenic bone graft are the best options. The graft can be secured with titanium plate although we preferred Halo vest subsequent to interbody fusion in two cases.

P040
Spontaneous regression of the acute sequestrated cervical soft disc herniation – a prospective study of 70 cases
Abolfazl Rahimizadeh

Objective: To recruit prospectively the possibility of spontaneous regression in 70 patients suffering from acute monoradiculopathy due to acute cervical soft disc herniation via periodic MRI. Moreover, to determine the ultimate outcome of waiting strategy and to evaluate the effect age, sex, level and the side of the sequestrated disc on final resolution of the sequestrated material and the duration necessary for disc disappearance.

Methods: 70 patients with acute cervical soft disc herniation causing acute monoradiculopathy were enrolled in this prospective study. 37 patients were male and 33 were female with age ranging from 20 to 60. The affected discs were at the right side in 33 and on the left in 37 cases. The discs were located at C5-C6, C6-C7, C4-C5, C3-C4 and C7-T1 levels in decreasing frequency. Pain intensity at the onset and its intensity at the time of its resolution were assessed via Visual Analogue Scale (VAS). Mixed-design repeated measures ANOVA and independent sample T-test were carried out to determine the effects of this kind of treatment on pain intensity. The influence of sex, level, body side and age on the effectiveness of conservative treatment with consideration of spontaneous resolution of the sequestrated disc were determined.

Results: Spontaneous resolution of the sequestrated disc material was observed in all 70 patients being confirmed in control MRI. ANOVA results revealed that pain intensity among the enrolled patients was dramatically reduced or disappeared at the time of complete resolution with (P<0.001). Where, the age, sex, side and the level of herniation had no influence on treatment efficacy, T-test results showed that side of the disc (P=0.029) and the level of affection (P=0.014) had some effect on treatment duration.

Conclusion: The details of the current study offer a strong clue about the validity of conservative management in certain type of cervical disc herniation. Accordingly, in a cervical sequestrated soft disc herniation located at the vicinity of a foramen, despite severity of the pain at the onset, with consideration of the scenario of spontaneous resolution, disappearance of radiculopathy as well as the sequestrated disc material are both very probable with time. In fact, the current report advocates the spine surgeons that in certain type of cervical disc herniation, it is better to allow the nature to resolve its problem with its own alterations in due time and don’t rush for surgery.

P041
In-vitro characterization of an anterior cervical plate capable of extreme oblique screw angulation: Does angulation affect construct rigidity?
Anup Gandhi, Jason Inzana, Sam Farmer, John Wanebo, Ripul Panchal

Introduction: Adjacent level ossification (ALO) following plated anterior cervical discectomy and fusion (ACDF) remains of primary concern when using the technique. Next-generation plate designs allow for greater oblique screw angulation to help diminish plate profile while averting the index endplates. However, limited consideration has been given in the literature to the implications of increased/extreme angulation on construct rigidity. The objective of this study was to assess a novel ACDF plate capable of 30deg cephalad and 30deg caudal screw angulation to determine whether a correlation exists between screw angulation and segmental rigidity.

Methods: Nineteen human cervical spine specimens (C3-T1) were tested. Bone quality was confirmed via DEXA scans and radiographs. Any specimens exhibiting previous surgery or excessive degeneration were excluded. C3 and T1 vertebral bodies were potted. Each spine was first tested in an intact state. A standard anterior discectomy (C5/C6) was performed, followed by instrumentation with the novel plate. Plate size selection and screw angulation was at the discretion of the surgeon in accordance with specimen anatomy. Screw insertion was approximately
1.5mm from the index endplates. Lateral and A/P fluoroscopic images were taken following instrumentation. A 2Nm moment was applied in flexion/extension (FE), lateral bending (LB), and axial rotation (AR) using a six degree-of-freedom kinematics testing frame. Segmental range-of-motion (ROM) was tracked using motion analysis software. Mean ROM relative to intact conditions was reported. Screw angle measurements were made using imagine analysis software. Measurements: 1) angle between cephalad and caudal screws (screw-to-plate sweep) and 2) sum of cephalad and caudal screw angulation relative to vertebral endplates (screw-to-endplate sweep). Pearson correlations between angulation and ROM were performed.

**Results:** Screw-to-plate sweep range: 6.4deg to 60.0deg; mean: 35.6deg. Screw-to-endplate sweep range: 17.9deg to 73.2deg; mean: 44.1deg. No correlations between angulation and ROM existed in any direction for either metric. Pearson correlations: Screw-to-plate: FE = -0.12; LB = 0.03; AR = 0.004; Screw-to-endplate sweep: FE = -0.115; LB = 0.066; AR = 0.046.

**Discussion and conclusion:** Outcomes show that plated ACDF stability may not be compromised when using greater oblique screw angulation. The ability to leverage greater angulation to support a smaller stature plate is clinically advantageous when considering the risk of ALO in longer profiles.

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**P042**

The relationship between lateral gutters and surgical results for double door laminoplasty by mid-sagittal splitting method

Go Hayasaka, Toshikatsu Mamada, Norihiko Nakata

**Introduction:** The distance of lateral gutters is important for cervical laminoplasty, but controversial. There are limited reports and papers about this details. We use the transverse diameters of the C5 spinal canal and the inner edge of the facet joints as the indicator in creating lateral gutters. The purpose of this study is to investigate the relationship between the distance of lateral gutters at C5 and surgical results.

**Materials and methods:** One hundred and one patients (66 men, 35 women, mean age 65.4 years, mean follow-up 30 months) who underwent cervical laminoplasty at our hospital between 2008 and 2014 were included in this study. The Surgical outcomes were evaluated by using transverse diameters of C5 spinal canal measured on preoperative CT, the distance of lateral gutters measured on postoperative CT, pre- and post-operative Japanese Orthopedic Association (JOA) scores, and Hirabayashi recovery rate.

**Results:** The mean preoperative JOA score was 8.9, at the final follow-up, it was 14.7. The mean recovery rate was 72.5%. The mean preoperative transverse diameter of C5 spinal canal was 25.3 mm (25.8 for men and 24.7 for women). The mean postoperative distance of lateral gutters at C5 was 24.7 (24.9 for men and 24.1 for women). There were no serious postoperative complications.

**Discussion:** In general, lateral gutters should be made at the inner edge of facet joints, or at transition area between the vertebral arch and facet joint. However, it is sometimes difficult to determine the position of lateral gutter in patents with significant pathological changes in facet joints or those with asymmetrical facet joints. If the distance between lateral gutters is shorter, enlargement of the spinal canal becomes insufficient, resulting in insufficient decompression. If the distance is longer, the risks for facet joint injury and neurovascular injury increase. This study shows transverse diameters of C5 spinal canal was the same as the distance between the lateral gutters.

**Conclusion:** The transverse diameters of C5 spinal canal may be useful for the indicator in creating lateral gutters.
P043
Three-dimensional gait motion analysis in dropped head syndrome – a supporting tool for determining the cervical surgery procedure
Kousei Miura, Hideki Kadone, Hiroshi Kumagai, Katsuya Nagashima, Kengo Fujii, Hiroshi Noguchi, Toru Funayama, Tetsuya Abe, Masashi Yamazaki

Introduction: Dropped head syndrome (DHS) is a cervical kyphotic deformity caused by weakness of the neck extensor muscles. The pathology of DHS has been reported to be unclear in many cases. The purpose of this study was to perform a preoperative evaluation of dynamic spinal alignment by using a gait motion analysis system developed independently.

Materials and methods: We analyzed the gait motion of 2 patients with DHS by using three-dimensional motion and wireless surface electromyographic analysis systems to measure two systems synchronously. We calculated the cervical and thoracolumbar sagittal curvature angles from the reflective markers on the selective spinous processes. Surface electromyographic data were collected bilaterally from the trunk and hip muscles.

Results: Case 1 is a 68-year-old man. Cervical kyphosis increased. Thoracolumbar lordosis was almost unchanged in the lordosis position. The patient underwent anterior discectomy and fusion followed by posterior fusion, which corrected the cervical kyphosis.
Case 2 is a 74-year-old woman. Cervical kyphosis decreased. Thoracolumbar kyphosis increased. For this case, we decided that corrective fixation only of the cervical kyphosis is insufficient.
No electromyographic changes were observed during the gait analysis in both cases.

Discussion and conclusion: The patient in case 1 could continue walking with balance because of compensatory thoracolumbar lordosis after the cervical kyphosis increased. However, in case 2, the cervical kyphosis decreased after the thoracolumbar kyphosis increased. DHS has been reported to be classified into a localized cervical kyphotic type and a whole spinal kyphotic type. We can understand the dynamic change in cervical kyphosis during gait for each classification. Case 1 is classified as a localized cervical kyphotic type. Case 2 is classified as a whole spinal kyphotic type. In addition to diagnostic imaging, which is a static evaluation of spinal alignment, our three-dimensional gait motion analysis system, which is a useful dynamic evaluation tool for understanding the difference in pathophysiology between the two types of DHS. It has potential usefulness for determining the appropriate corrective surgical procedure.

P044
Towards development of a defect classification for optimized treatment of degenerative cervical spine: needs and research findings
Mario Leimert, Sandra von Sachsen, Jürgen Meixensberger

Introduction: Degenerative disease of subaxial cervical spine frequently occurs. Current controversy over the best surgical approach indicates the need for a well-conducted classification. Currently there is no classification that takes into account the number of vertebral segments affected and concomitant pathologies that have an impact on the selection of treatment strategy.

Materials and methods: To determine key morphological features of cervical spine stenosis preoperative MRI scans from 127 patients were retrospectively studied. The patients were aged between 30 and 80 years (mean age: 55 ± 11 years). More than half of the patients are male (55%). The images were analyzed according to extend and position of stenosis, thickened ligaments and vertebral body disorder. To evaluate the classification 10 patients were classified by 53 neurosurgeons. The interobserver reliability was measured using the k-value according to Landis and Koch (range 0-1). The work experience of the participants as a specialist in neurosurgery is 11 ± 9 years. The majority treated more than 100 spinal canal stenoses so far.

Results: Studied patient collective exhibited spinal canal stenoses spanning one, two, three and more levels. Thickening of ligamentous structures was observed in 48 % and spondylolisthesis in 10 % of the studied patients.
The resulting classification scheme contains three main types and eight subtypes to describe cause, extent and position of stenosis. Furthermore there exists characters which indicate thickened ligamentum flavum, scoliosis and listhesis. Nearly every second neurosurgeon regarded the classification as useful. For type classification the interobserver reliability is fair (k-value: 0.23). Regarding classification down to sub-type (k-value: 0.19) and concomitant pathology (k-value: 0.14), the interobserver reliability is slight.

Discussion: The presented study demonstrate that a classification is possible and in demand. Further development of the introduced classification scheme is needed. It has to be reduced to one level to describe the type which can be enhanced with codes for defect position and concomitant pathologies. The resulting defect code should indicate the degree of severity.

Conclusion: Using the presented classification and combining it with others, even radiographical and clinical tools, may lead to guidelines for the management of patients with degenerative cervical spines.

P046
Intraoperative 3D-control of instrumentations of the upper cervical spine – optimization and improvement of safety?
Jan-Sven Jarvers, Ulrich Spiegl, Stefan Glasmacher, Anna Völker, Nicolas von der Höh, Christoph Josten, Christoph Heyde

Introduction: Depending on the type of fracture or pathology there are several operative treatment options such as the anterior lag screw osteosynthesis, the anterior transarticular C1/2-stabilisation or posterior techniques according Goel/Harms.

All methods have in common that for the screw placement intraoperative imaging is used, since the development of 3D- C-Arms intraoperative controls in Ct quality are possible. This allows an increased accuracy at lower radiation exposure for the patient, as a postoperative CT can be avoided. Secondly, the instrumentation in critical anatomical regions can be controlled intraoperatively.

The aim of this prospective study was to investigate the applicability and advantages of intraoperative imaging using a new 3D C-arm in the treatment of odontoid pathologies.

Patients and methods: Since 07/2015 at 33 patients (19f, 14m, age Ø72,6 years, r.: 28- 95) with pathologies of the dens (24 fractures Type II Anderson/ D'Alonzo, 1 pseudarthrosis, 4 pathologic fractures, 2 Pseudarthrosis, 2 Rheumatoid Arthritis) 19 were stabilized from anterior (13x transarticular C1/2, 3x2 odontoid lag screws, 3x1odontoid lag screw) and 15 via posterior (Goel/ Harms) stabilisation.

Intraoperative K-wires were placed, then an intraoperative 3D scan (3D RFD, Ziehm GmbH) was performed and the image quality and the K-wire position was controlled. In case of a correct placement of the wires the screws were placed, in case of an incorrect placement the implants were changed immediately.

Results: Out of a total 76 intraoperatively controlled implants 26 (88.15%) showed a regular position. In 9 (11.84%) cases an incorrect position was seen which was corrected intraoperatively. The image quality was evaluated in all cases as very good, the implementation of 3D scans was easy and fast to perform.

Conclusion: Intraoperative 3D imaging is simple and fast to perform and increases the safety of screw placement in the upper cervical spine. Dislocations can be intraoperatively detected and corrected. Thus neurovascular complications with subsequent revision surgeries and postoperative CTs with increased radiation exposure for the patient can be avoided.

P047
Diagnosis, treatment strategy, and clinical result of eosinophilic granuloma in adolescent cervical spine
Norimitsu Wakao, Mikinobu Takeuchi, Mitsuhiro Kamiya, Atsuhiko Hirasawa, Masataka Deie

Introduction: Eosinophilic granuloma (EG), a rare condition (1:2,000,000 per year) associated with vertebra plana, is a form of Langerhans cell histiocytosis. However, appropriate diagnosis and treatment strategy for this disease are still controversial. The need for vertebral biopsy is also debatable. The authors have conservatively treated EG patients without biopsies if the radiological findings met some of the required conditions.

Materials and methods: Patients with EGs of the cervical spine treated from 2010 to 2016 with a follow-up period
of more than a year were eligible. The radiological diagnosis criteria for EG comprised complete or incomplete collapse of the vertebral body; single skeletal lesion; preservation of pedicles, posterior elements, and adjacent disc spaces; absence of adjacent paravertebral soft tissue shadow; and increased radio-density of the collapsed body. Patients were conservatively treated with soft neck braces in case of pain. Clinical manifestations, radiologic findings, and vertebral height restorations at 3, 6, and 12 months after the initial visit to our hospital were assessed by lateral radiograms.

**Results:** Six patients (male, 3; female, 3; mean age, 10.2 years) were included in this study. The relevant spinal levels were C4, 2 cases; C5, 1 case; C6, 2 cases; and C7, 1 case. Initially, all cases presented with neck pain, which was significantly improved in 3 months. Laboratory findings were almost normal in all the patients. The vertebral body height was initially collapsed. The average collapse rates vertebral bodies were 22%, 35%, and 80% at 3, 6, and 12 months, respectively, after the treatment. Concurrently, the average Cobb’s angles were 20°, 15°, and 8°.

**Discussion and conclusions:** Pathological conditions, including aneurysmal bone cyst, lymphoma, acute leukemia, Ewing’s sarcoma, osteogenic sarcoma, and metastatic lesions, that produced vertebral collapse similar to EGs have rarely been reported. A biopsy is recommended for validating a diagnosis, but it may decrease the restoration capability of the bone itself. Therefore, we usually do not perform biopsies when the radiological findings meet some of the conditions. Observation with or without bracing was thought to be sufficient as treatment for EGs in single cervical spine lesions.

**P048**

**Loosening and breakage of screws in long-segment posterior cervical fusion surgery**

Katsuya Nagashima, Tetsuya Abe, Hiroshi Kumagai, Kousei Miura, Kengo Fujii, Hiroshi Noguchi, Toru Funayama, Masao Kouda, Chikato Mannouji, Masashi Yamazaki

**Background and objectives:** This study aimed to investigate the incidence and characteristics of implant failure in long-segment posterior cervical fusion surgery.

**Methods:** We retrospectively analyzed 54 cases of long-segment posterior cervical fusion surgery that involved the use of pedicle screws, lateral mass screws, or laminar screws. The mean age of the patients at the time of surgery was 62.2 years, and the mean follow-up period was >2 years. The cranial end of the fusion was C2 or C3, and the caudal end of the fusion was C7 or T1. All the patients were observed with computed tomography scans over 6 months after surgery. We evaluated the loosening and breakage of screws of these implants.

**Results:** In total, 268 pedicle screws, 10 laminar screws, and 249 lateral mass screws were placed in these 54 patients. Implant failure occurred in 31 patients (57.3%). Loosening occurred in 66 screws (12%), and breakage occurred in seven screws (1.3%). No rod fracture was observed. Implant failures were asymptomatic and did not require revision surgery. Implant failures were particularly observed at both ends of the fusion level. The incidence was 20%, 30%, and 40% in C2, C7, and T1 pedicle screws, respectively. When C7 was the end of the lower instrumented level, the incidence was 56% without C6 pedicle screws, 38% with unilateral C6 pedicle screws, and 0% with bilateral C6 pedicle screws. Implant failure tended to increase as the fusion level became longer, with 33%, 60%, and 67% failure at fusion level 4, 5, and 6, respectively.

**Conclusions:** The incidence of loosening and breakage of screws in long-segment posterior cervical fusion surgery was higher in our study because of longer fusion levels than those in previous studies. In long-segment posterior cervical fusion surgery, mechanical stress tends to be concentrated at the lower end of the screws. We suggest that when the fusion level ends at C7 vertebra, anchor screws should be inserted at both sides of C6 vertebra. These anchor screws may reduce the incidence of implant failure at C7.
P050
Anterior bone loss – a concerning radiographic finding of uncertain clinical significance in cervical disc replacements
David C. Kieser, Derek Cawley, Takashi Fujishiro, Celeste Tavolaro, Olivier Gille, Vincent Pointillart, Jean-Marc Vital

Introduction: Cervical disc replacements (CDR) are common, yet anterior bone loss (ABL) has not previously been described. This study documents the prevalence and natural history of ABL following CDR.

Materials and Methods: A radiographic review of 184 CDRs with a minimum 5-year follow-up was performed. ABL was recorded as a percentage of antero-posterior subchondral vertebral length immediately post-operatively compared to follow-up. ABL was grouped into: none, mild (1-5%), moderate (6-10%), severe (11-20%) and extreme (>20%). The prevalence and natural history were studied.

Results: ABL occurs in 50.4% of CDRs and affects all implant types studied. It typically commences within 3-months and follows a benign course, with static radiographic features and a stable implant after 1-year. Absence of ABL (none) is most common (49.6%), followed by mild ABL (41.8%), which appears as blunting of the anterior vertebra. Moderate ABL (5%) often results in anterior CDR uncoverage. Severe and extreme ABL is rare (0.7% and 2.8% respectively) and affects the subchondral bone. Implant collapse may occur, but the bone typically heals in the collapsed position with maintenance of prosthetic function or fusion. If collapse does not occur the bone usually reconstitutes.

Within the timeframe of this study, there was no evidence of progressive disease if significant ABL occurred.

Discussion: The natural history is of this condition is non-progressive early ABL, which favours bone remodeling and osteolysis. The cause of mild and moderate ABL is likely bone remodeling in the absence of the resected anterior longitudinal ligament or an osteolytic insult inflicted during the procedure. Severe and extreme ABL is more likely the result of avascular necrosis, the cause of which remains unknown.

Conclusion: ABL is common. It occurs early and follows a non-progressive natural history typically with stable radiographic features beyond the first year. It is likely due to bone remodeling, surgically induced osteolysis and avascular necrosis. Surgeons should be aware of this phenomenon, but treat patients expectantly.

P051
Cervical giant chondrosarcoma – presentation of recurrence with neurological symptoms after resection
Recep Öztürk

Background: In this study, we present a case of cervical chondrosarcoma, a rare entity. Tumor had no invasion to spinal canal. Resection was done with wide margins. Recurrence was detected in the patient who applied with ulnar nerve lesion findings. The lesion was extending through C7 transverse foramen. After the recurrence resection sympthoms were disappeared.

Introduction and material: Less than 10% of chondrosarcomas are located in the vertebrae and cervical vertebrae placement is even less common. There is 70% recurrence in intralesional resections and 10% recurrence in wide margin resections. In this study we present a case of a 33-year-old man with a cervical vertebral chondrosarcoma of the MHE, who had recurred after wide resection and successfully treated with recurrence resection. When radiographic images were examined, a giant solid mass with signal voiding features of calcification was observed in the right side of the C3-T1 vertebral level, including a large part of the soft tissue component, surrounding lamina and transverse processes.

Definition of case specific challenges: First of all, due to the fact that the patient’s age is very young, it requires a treatment that is as rigorous as possible and strives to minimize complications. It is also a rare case because of the presence of a large mass and proximity to vital neurovascular structures for that reason it requires difficult surgical procedure. These are the clinical presentations that we experienced.

Treatment: The mass was resected with wide borders.

Complications and management: Radiographic evaluations of the patient who presented with right ulnar nerve lesion findings at 4th postoperative month had a mass lesion of approximately 5x4.5x2 cm with c7 transverse foramen prolapse. On intraoperative evaluation no nerve invasion detected and mass excision was performed.
Ulnar nerve diseases disappeared. Patient has been under control of our clinic without complication for six months.

**Conclusion:** The preoperative evaluation of the tumor should be well established in relation to vital neurovascular structures. In the postoperative period, the patient should be closely followed for recurrence/ complications. In recurrent lesions, careful examination and radiographic evaluation should be performed during the surgical planning stage.

**P055**  
**The effect of 3D model simulation to prevent cervical pedicle screw malposition**  
Hiroyuki Tominaga, Masahiko Abematsu, Yasuhiro Ishidou, Takuya Yamamoto, Setsuro Komiya, Kazunori Yone

**Introduction:** Cervical pedicle screw (CPS) system was the strong fixator to be used for patients with spinal deformities or unstable conditions. But, malposition of CPS has a potential risk of injuries to vertebral arteries and nerve. To reduce the risk of CPS malposition, some surgeons often used CT navigation. However, there are few reports to evaluate the efficacy of preoperative simulation using three-dimensional printer model of real size (3D model). The aim of this study was to determine whether preoperative 3D model simulation reduces the risk of CPS malposition.

**Material and methods:** CPS were placed by freehand technique under the guidance of lateral fluoroscopy in these patients. In 8 patients of those, cervical 3D models were made before surgery (3D group) because of severe deformities, re-operation, and long fusion. Remained 11 patients were performed spinal fixation without making the 3D model (no-3D group). The positions of CPS were evaluated by CT examination and the ratios of CPS malposition were compared between two groups.

**Results:** Sixty-two screws were used in the 3D group (median; 7.75 screws/patient) and 48 screws in the no-3D group (median; 4.36 screws/patient). The malposition rate of CPS was 11.3% (7 screws) in the 3D group and 12.5% (6 screws) in the no-3D group. In the malposition rate of CPS, the statistically significant difference between two groups was not found. Cerebral infarction or neurological spinal deficients were not observed in the two groups.

**Discussion:** Some investigators reported that the malposition rates of CPS varied from 6.7 to 31.6 % using freehand technique and 1.2 to 18.7 % using CT-based navigation. In the present study, the malposition rate using 3D model simulation before surgery was as same as that using CT-based navigation. However, the cost of CT-based navigation system is extremely high, and image quality is sometimes inappropriate. To improve the risk of CPS malposition, the 3D model were considered to be useful.

**Conclusion:** CPS procedure using the 3D model simulation before surgery is helpful for the severe cervical deformity and long fusion because this procedure reduces the risk of injuries to vertebral arteries and spinal nerves.

**P056**  
**The C0-C2 X-angle describes occipito-cervical changes related to Ankylosing Spondylitis – Retrospective radiological cohort of 86 consecutive patients**  
Nodoka Manabe, Yohan Robinson, Augusto Covaro

**Study design:** Retrospective analysis of prospectively collected cohort data

**Objective:** Ankylosing spondylitis (AS) affects the axial skeleton and leads to progressive ankylosis of all spinal segments. Even though commonly observed, the progress of the ankylosis in the upper cervical spine is not well-documented. The aim of this study is to describe the radiographical features of the occipito-cervical (OC) junction in AS patients using a novel measure, the X-angle.

**Materials and methods:** Patients with AS treated in a single institution for a cervical spinal fracture between 2007 and 2014 were followed prospectively using the SWESPINE registry. The integrity of the C0-C1-C2 joints was determined and classified into fused and non-fused joints. By determining the angle between C0-C1 and C1-C2 joints in the coronal view of the CT-scan (X-angle) the progressive degeneration of these joints was described. Intra- and inter-observer reliability of this test was determined.
Results: 86 patients with surgically treated cervical fracture related to AS had a complete facet joint ankylosis between C3 and T1 due to their pathology. The most common level of fracture was at C5-C6. In 24 patients the C0-C1 joint was fused and in 15 patients the C1-C2 joint was fused. The X-angle was 125° in not fused patients and 136° in fused patients (p<0.001). The intra- and inter-class reliabilities for X-angle measurement were very high (ICC = 0.95, 0.98). OC ankylosis was not related to the level of fracture. There was no difference in the estimated survival rates between fused and not fused groups.

Conclusions: With the X-angle occipital-cervical joint changes could be described with exceptionally high inter-observer validity. In the future the X-angle should be correlated to AS-specific quality of life and function measures.

P057
Total disc arthroplasty using artificial disc: 8-years postoperative follow up
Thomas Apostolou, Petr Nesnidal, Jan Kryl, Tomas Vyskocil, Michal Barna

Introduction: Artificial disc placement in the degenerative cervical disc disease has the goal to relieve pain and to preserve level movement. In this study, we present the radiological evaluation with MRI and dynamic radiographs of the cervical spine after an 8-year postoperative follow-up.

Materials and methods: During the period 2007-2008 55 patients, 30 males and 25 females with middle age of 42.4 years, have been operated for degenerative cervical disc disease with anterior cervical approach. The procedure included microdiscectomy and disc arthroplasty with artificial disc alone or in conjunction with peek cages. In 35 patients the surgical approach concerned only 1 level and in 20 of them from 2 up to 4 levels. All patients were evaluated with dynamic radiographs after a period of 6 weeks and 6/12/24/60/96 months, also with cervical MRI after 60 and 96 months.

Results: We had no artificial disc migration in any patient. In all patients, movements of operated level (concerning the arthroplasty one) remained in the same range as in the 6-month postoperative follow up. The MRI findings revealed presence of Adjacent Segment Disease at 3 cases (5.4%), from which one concerned one level disease treated with artificial disc and two concerned two levels disease treated with peek cages at the lower levels and artificial disc at the upper one.

Discussion: The study aimed to assess the range of motion of the operated levels through dynamic radiographs and MRI scan of cervical spine. There were no major complications in this study and the results demonstrated unrestricted movement of the operated sites. The presence of Adjacent Segment Disease (5.4%) is an issue that should be of major concern, but it is much lower compared with the findings of other similar studies.

Conclusion: Total disc arthroplasty with artificial disc displayed same results as with peek cages usage, concerning the relief from brachial pain. It preserves its full mobility in 8-years follow-up, with no major surgical complications. Although we had lower percentage of prevalence of the Adjacent Segment Disease compared with peek cages, further investigation with bigger sample of patients is needed.

P059
Clinical outcomes of posterior cervical reconstruction for RA patients with high riding VA
Shigeki Oshima, Itaru Oda, Hirohito Takeuchi, Masaru Suzuki, Masanori Fujiya

Introduction: C2 pedicle screw (PS) provides excellent stability in posterior cervical reconstruction surgery. However, high riding VA (HRVA) is frequently observed in patients with RA and C2 PS is dangerous in such cases. The purpose of this retrospective study was to evaluate the clinical outcomes of cervical posterior reconstruction for RA patients with HRVA.

Materials and methods: Inclusion criteria were RA patients with HRVA, posterior cervical reconstruction including C2 in fusion area since 2005, and minimum 12 month follow-up. There were 19 cases and they were all female. Mean age at surgery and follow-up period were 67.5 years and 49.2 months, respectively. 5 patients were AAS, 12 were AAS with VS, and 2 were SAL. At C2, PS was used as a standard fixation anchor. When HRVA prohibited safe PS insertion, however, lamina screw (LS) was utilized alternatively. Bony union rates, revision rates, and complications were evaluated.
Results: Fusion levels were C12 in 5 cases, OC2 or 3 in 12, OT2 in 1, and C25 in 1 case. The average number of fusion levels was 2.4.

Four cases presented bilateral HRVA, while the other 15 had unilateral HRVA. By using LS instead of PS on the side of HRVA, extension of fusion was not performed in any cases. Bony union was confirmed in 16 of 19 cases (84.2%). Three OC2 fusion cases demonstrated non-union. However, because they showed mild instability without clinical symptoms, revision surgery was not performed. No major complications were observed.

Discussion and conclusion: Bony union rate was 84.2% in HRVA patients, and it was lower compared to that in patients without HRVA reported previously. Selection of fixation anchors is limited due to HRVA and it may lead to lower fusion rate. Despite of HRVA, extended reconstruction or VA injury could be avoided by using LS. Therefore, LS is useful to perform safe reconstruction and preserve the intact motion segment. However, non-union cases were all OC2 fusion cases with LS. Therefore, rigid external support, modification of the fixation technique, or extension of fusion should be considered when performing OC2 fusion.

P060
Feasibility of C2 pedicle screw insertion in posterior cervical spinal fusion surgeries
Hiroshi Noguchi, Tetsuya Abe, Katsuya Nagashima, Toru Funayama, Hiroshi Kumagai, Kousei Miura, Kengo Fujii, Masao Kouda, Takeo Furuya, Masashi Yamazaki

Introduction: The C2 pedicle screw (PS) is widely used as a biomechanically strong anchor in posterior cervical spinal fusion surgeries. However, it confers a considerable risk of intraoperative morbidity due to vertebral artery (VA) injury. In the present study, we evaluated the clinical feasibility of C2 PS screw insertion.

Materials and methods: We evaluated 84 patients (168 sides) who underwent cervical instrumentation surgery with C2 PS since November 2009. Placement of a C2 PS was scheduled in all the patients. However, based on 3-D computed tomographic angiography (CTA) findings, we judged that the C2 PS trajectory carried a high risk of VA injury. The presence of congenital skeletal anomalies (CSAs) and VA anomalies was also investigated.

Results: C2 PS insertion was adopted for only 116 sides (69%) at surgery. C2 PS was inserted for both sides in 46 patients, for one side in 24 patients, and for neither side in 14 patients. The risk of VA injury during C2 PS trajectories is high because of the limited width of the C2 pedicle isthmus (50/52 pedicles; 96.2%). An anomalous extraosseous VA course was detected in 7 of the 84 cases. A persistent first intersegmental artery was found in 5 cases (7 sides). Of the 6 sides (85.7%), we concluded as difficult cases those in which the risk of VA injury was high. Thirteen patients (26 sides) had CSA at the craniovertebral junction (CVJ). On 16 sides (61.5%), we terminated the C2 PS insertion. No spinal cord or vertebral artery injury occurred in this study.

Discussion: In previous studies that used dry specimens and cadavers, the incidence of a high-riding VA was found to be 10.0% to 22.5%, and the risk of VA injury higher in such cases. C2 PS insertion was not adopted in more than 30% of the 168 sides in this study. The result indicates a higher incidence of anomalous VA and CSA especially in instrumentation surgery at the CVJ.

Conclusion: C2 PS insertion was not adopted in more than 30% in this study. It was important to precisely identify anomalous VAs by using preoperative 3-D CTA, and reduce the risk of their intraoperative injury.

P061
Intermuscular approach for cervical posterior fixation utilizing cervical pedicle screw
Yukio Someya, Masaya Mimura, Sumio Ikenoue, Kan Takase, Hiroaki Sameda, Jun Shinbo

Introduction: A midline incision approach has been conventionally utilized when cervical pedicle screws (CPS) are inserted. However, in maintaining the trajectory of CPS, massive posterior part of cervical paraspinal muscles needs to be retracted laterally, which might lead to operators' burden physically and inaccurate CPS insertion. To resolve these drawbacks, lateral skin incision has been occasionally used. Still, as multiple skin incision should be demanded, the risk of skin infection could rise. Hence, we develop new intermuscular approach between longissimus muscle and semispinalis muscle with midline skin incision. Using this approach, the insertion of CPS
could be performed safer, physically easier and less invasively especially when decompression is not required. **Materials and methods:** Three patients (one male and two females) with cervical spine metastasis ($n=1$) and pyogenic spondylitis ($n=2$) underwent cervical posterior fixation with CPS using this intermuscular approach. All the patients had no or little neurological defect. Therefore, no decompression should be required. The average age was 63.3 years old (46–72 years). A CT scan was performed to evaluate the position of inserted CPSs. The operation method was as follows. 1) After a midline skin incision was made, nuchal ligament were precisely divided and then a trapezius, and a splenius muscle with the divided nuchal ligament were detached from the spinous process. 2) After the intermuscular plane between longissimus muscle and semispinalis muscle was identified and incised, the entry point of CPS on lateral mass was exposed. 3) CPSs were introduced using an X-ray image of the pedicle axis view and a rod was put to connect the screws. The amount of bleeding and the number of fixed vertebrae were recorded. **Results:** The average of the operative time was 250 minutes. The mean amount of bleeding was 40 g. The average of fixed number of vertebrae was 4.7 vertebrae. Eight CPSs inserted for all the patients were put inside the pedicles precisely. **Conclusion:** The intermuscular approach for cervical posterior fixation utilizing cervical pedicle screw could be less invasive and more accurate for cervical posterior fixation with CPS.

**Table 1. Radiologic data of fusion group and pseudarthrosis group**

<table>
<thead>
<tr>
<th></th>
<th>All segments (N = 125)</th>
<th>Fusion segments (N=100)</th>
<th>Pseudarthrosis segments (N=25)</th>
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<tr>
<td>Preoperative C2-C7 SVA (mm)</td>
<td>24.84±12.02</td>
<td>24.34±11.36</td>
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<td>Preoperative T1 sagittal slope (°)</td>
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<td>Preoperative segmental interspinous motion (mm)</td>
<td>6.69±3.18</td>
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<td>Preoperative segmental motion (°)</td>
<td>9.97±4.42</td>
<td>8.73±3.73</td>
<td>15.17±3.20</td>
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<td>Preoperative C2-C7 motion (°)</td>
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<tr>
<td>C4-5</td>
<td>31 (24.8%)</td>
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<tr>
<td>C5-6</td>
<td>55 (44.0%)</td>
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<td>C6-7</td>
<td>35 (28.0%)</td>
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<td>4 (4.0%)</td>
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<tr>
<td>C5-6</td>
<td>46 (45.5%)</td>
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<td>C6-7</td>
<td>23 (22.8%)</td>
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<th>Pseudarthrosis segments (N=25)</th>
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<tr>
<td>C4-5</td>
<td>3 (12.5%)</td>
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<tr>
<td>C5-6</td>
<td>9 (37.5%)</td>
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<td>C6-7</td>
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Introduction: Many reported cases of dropped head syndrome (DHS) have been shown from long ago. However, it had many unsolved problems with respect to this detailed theory, unfortunately definite therapy for DHS are not established yet. We investigate the pathosis and therapy on the basis of our clinical experience.

Materials and methods: The cases were 39 patients with a mean age of 78.8 years. They couldn’t keep looking forward without lift-up own head consciously. At first we try our conservative therapy using of backrest chair, in case of no effect, we consider surgical operation because of gait or eating disorder.

We measured angle of C2/C7, range of motion, Ishihara’s curve index, height from C2 to C7 (H), horizontal distance from C2 to C7 (D), in lateral view of x-ray images, so calculated D/H as index of DHS. Then, we investigated them in consideration of MRI findings, clinical findings, and complication.

Results: The patients with Parkinson’s disease had high value in D/H, and showed advanced dropped head appearance. However, they had little stenosis of cervical canal in MRI and slight deformation of vertebral body. On the other hand, the patients that had negative high value in C2/C7 angle with severe cervical kyphosis in spite of low value in D/H, showed more stenosis in MRI and advanced deformation of vertebral body. 9 cases that occurred suddenly without significant causes were recovered by our conservative therapy within 3—6 months. 3 cases were underwent surgical operation of fixation from anterior, other 6 cases were from both anterior and posterior. Their clinical results were almost good, but only one case that performed expansive laminoplasty from posterior, was getting worse gradually.

Discussion: DHS has been thought to be caused by loss of cervical support power according to various disease. In fact, some of DHS cases that occurred suddenly or comparative young were recovered by our original active exercise. We guess that their main causes of DHS were paresis of cervical back muscles without influence of cervical kyphosis. But, almost causes of DHS were unidentified and found in the aged.

Conclusion: We supposed that the causes of DHS were combined loss of cervical support power, with cervical kyphosis caused by aging process. In case of having too much disorder of daily living such as gait or eating disturbance, we had better to consider surgical therapy.

Purpose: To introduce safe posterior to anterior approach subtotal en bloc spondylectomy for C6 mesenchymal chondrosarcoma of a 29-year old male patient.

Methods: CT scan demonstrated a primary osteolytic lesion on C6 left transverse foramen and MRI demonstrated the tumor involved C6 vertebra from layers B, C and F sectors 4-6 encasing left vertebral artery. Preoperatively neurointerventional radiology service occluded the left vertebral artery and tumor feeding artery using coil embolization. Posterior approach consist of C5-C7 laminectomy, left sided C6 and C7 nerve root sacrifice, posterior disc removal and release of C5–6–7 and posterior reconstruction. Then, position was changed to supine, and the anterior approach was followed as C5-6, C6-7 discectomy, left vertebral artery ligation & cut, longus coli resection and C6 subtotal spondylectomy with en-bloc resection of mass, mesh cage insertion and C5-C7 anterior plate fixation. During operation, frozen biopsy was performed on 8 areas (longus coli, lateral margin, anteroinferior margin, posterior margin, posteroinferior margin, C5 transverse foramen, posteroinferior margin, inferior margin) after wide resection. Tumor free margin was confirmed.

Results: After operation, he complained of tingling sensation of left thumb and forearm medial side, and elbow extensor motor grade was checked to 4/5 postoperatively. In the followed-up radiograph, the tumor was completely removed, and the instability of joint was not seen. As a result of observing follow-up CT at a year after the surgery, recurrence findings haven’t been shown up to now, and the progression of neurologic symptoms hasn’t been shown either
Conclusion: We report the first case of mesenchymal chondrosarcoma occurring from the C6 cervical spine treated with cervical subtotal en-bloc spondylectomy. Successful en-bloc resection of the tumor was achieved using posterior to anterior approach.

KeyWords: cervical spine tumor, mesenchymal chondrosarcoma, subtotal en-bloc spondylectomy.

P065

10 years follow-up analysis of postoperative clinical outcome for the patients with cervical ossification of the posterior longitudinal ligament – Does the age at surgery influence postoperative outcome?

Kensuke Shinohara, Tomohiko Hirose, Kazuhiro Takeuchi, Shinnosuke Nakahara

Introduction: Ossification of the posterior longitudinal ligament (OPLL) causes myelopathy because of its compression to spinal cord. The majority of treatment for OPLL is surgical procedure. This study evaluates long term outcome of surgical treatment for cervical OPLL (C-OPLL).

Materials and methods: This study is retrospective clinical study. 82 patients who underwent surgery of C-OPLL from 1995 to 2006 (male / female, 61/21: mean age at surgery, 61.1 years old) were enrolled. The minimum follow up periods was 10 years after surgery. Preoperative and postoperative (discharge, 5 and 10 years after surgery) Japanese Orthopaedic Association score (JOA score: Maximum 17 points) and X-rays were obtained. We divided the patients into four groups (under fifty years old, fifties, sixties and over seventy years old) and two groups [K-line (+) and K-line (-)]. The significant differences and the correlation coefficients between the age and final follow-up score were measured.

Results: 69 patients received laminoplasty, two patients received anterior vertebra body fusion and one patient received laminectomy. The total average of JOA score was 11.6 before surgery, 12.9 at the discharge, 13.1 at 5 years after surgery, 13.2 at 10 years after surgery. There was no significant difference about the final JOA score in the four groups. The correlation coefficients between the age at surgery and final JOA score in four groups were 0.07, -0.04, -0.33 and -0.32, respectively. The JOA score of K-line (+) group (n=37) and K-line (-) group (n=45) was similar point and had no significant difference. The correlation coefficients between the age at surgery and final JOA score was R=-0.11 in K-line (+) group and R=-0.27 in K-line (-) group respectively.

Discussion and conclusion: The clinical outcome at ten years after surgery for C-OPLL maintained the state at the time of the discharge. The mean recovery rate of JOA score at final follow-up was 29.6%. The age at surgery and the cervical alignment didn’t affect the clinical outcome at ten years after surgery. However, this study shows the age at surgery was tend to deteriorate the JOA score in sixties and over seventies groups and K-line(-) group.

P066

Spinal surgery without laboratory investigations — a pilot study

Ruth M. Parks, Marcin Czyz, Nikolaos Paidakakis, Eyal Behrbalk, Howra Ktayen, Joysy George, Melanie Chrystal, Bronco M. M. Boszczyk

Introduction: Standard minor surgical procedures in healthy adults rarely require blood transfusions or any modification in blood parameters and have an estimated blood loss of less than 100mls. Ordering unnecessary blood laboratory investigations for simple procedures in healthy patients can be time-consuming, stressful for the patient and costly to the health service. The aim of this study is to pilot a ‘no bloods’ policy for patients with an ASA grade of 1, undergoing simple spinal surgery. The primary objective is to identify whether this is a safe and acceptable.

Materials and methods: Prospective epidemiological pilot study in a single tertiary spinal centre in the UK. Patients over the age of 18 with an ASA grade of 1 who consented for a minor surgical procedure (single level posterior decompressive or percutaneous procedures without instrument or single level anterior cervical fusion or disc replacement vertebroplasty and kyphoplasty) were invited to participate. Patients who consented did not receive any routine pre-operative blood tests. Need for blood tests was monitored pre-operatively, on the day of surgery and in the post-operatively period until first follow-up.
Results: 100 participants consented to participate in the study. 23 of these dropped out of the study at different time points (23%). Of the remaining 77 patients, 7 had blood tests taken at different time points, 3 in error and 4 due to clinical concern. 70 patients did not have bloods taken at any point and were seen at follow-up. Patient satisfaction at follow-up was rated 9.9/10. There were no adverse events observed, none of the operations needed to be modified due to lack of results of blood tests, no patient suffered undue harm.

Discussion: A ‘no bloods’ policy appears to be safe and feasible in a selected group of patients. Care must be taken when recruiting participants to explain and discuss expectations, in order to minimise drop-out rate. Communication with other members of the healthcare team is paramount, in order to prevent unnecessary blood letting.

Conclusion: This pilot study provides justification for a large scale multi-centre study to confirm these findings.

P068
Natural course in patients with cervical spondylotic myelopathy evaluated with spinal cord evoked potentials
Toru Yokoyama, Kazunari Takeuchi, Kazuki Oishi, Koutaro Aburakawa, Hiroya Ono, Kan- ichiro Wada, Toshihiro Tanaka, Gentaro Kumagai, Hitoshi Kudo, Taito Itabashi

Introduction: Natural course and prognostic factors in patients with cervical spondylotic myelopathy (CSM) remains unclear. We routinely examined the patients suspected of CSM with spinal cord evoked potentials (SCEP) that recorded from cervical and stimulated at lower thoracic epidural catheter electrodes from 2008. The purpose of this study was to investigate natural course and prognostic factors in patients with CSM evaluated with SCEP.

Materials and methods: Consecutive 81 patients with CSM evaluated with SCEP who did not choose surgery initially were followed over 1 year and enrolled (40 male, average age 71 y/o, average follow-up 42 months, follow-up rate 88%). The patients with deterioration in upper or lower extremities motor function of Japanese Orthopedic Association (JOA) scores were classified as group D, and others were in group C. To detect risk factors for deterioration, initial parameters (age, JOA scores, myelopathy level and degree of severity with SCEP, C2-7 alignment, ROM at C2-7, ROM at myelopathy level, local slippage in dynamic motion, T2 high signal and A-P diameter of the spinal cord at myelopathy level on MRI) were compared statistically between the two groups. Chi-square and Mann-Whitney U were used for statistical analysis (significance level 0.05).

Results: Deterioration occurred in 39 patients (48%, group D) (upper 10, lower 19, both 10). In group C (42 patients, 52%), improvements occurred in 22 patients (27%) (upper 3, lower 13, both 6), and 20 patients (25%) had no change. After average 19 months observation, 20 patients (25%) were shifted to the surgical intervention. Proportion of the patients underwent surgery was significantly larger in group D (15 of 39 patients, 38%) than in group C (5 of 42 patients, 12%). For average 49 months, 61 patients (75%) had been still observed. As for risk factors, no factors were statistically detected.

Discussion: Severities with SCEP directly reflected degradation in long tract of spinal cord. In our study, SCEP findings were not related to deterioration in motor function.

Conclusion: Deterioration in motor function occurred in 48% patients evaluated with SCEP for average 42

P069
Comparative study in utility between cervical laminoplasty and posterior fusion in patients with cervical compressive myelopathy
Kazuki Oishi, Toru Yokoyama, Kazunari Takeuchi, Kotaro Aburakawa, Hiroya Ono, Taito Itabashi, Kannichiro Wada, Toshihiro Tanaka, Kumagai Gentaro, Hitoshi Kudo, Yasuyuki Ishibashi

Introduction: Utility was unified score from 0 (death) to 1 (perfect health) of health-related quality of life. It was essential for cost-utility analysis. There were few reports about utility after cervical posterior decompression and fusion with instrumentation. The purpose of this study was to determine utility gain after cervical posterior decompression and fusion compared with laminoplasty in patients with cervical compressive myelopathy, retrospectively.

Materials and methods: Consecutive 76 patients with cervical compressive myelopathy (38 male, 34 female, spondylosis 39, OPLL 31, average age 65.0 ± 13.8, follow-up rate 85%) were enrolled. 51 patients underwent
laminoplasty alone (group LP) and other 21 patients were added fixation from C2 to T1 or below to laminoplasty (group PF). Utilities were determined by EuroQOL-5D (EQ) and Rating Scale (RS). All the patients fulfilled EuroQOL-5D, Rating Scale and were evaluated with Japanese Orthopaedic Association (JOA) score, preoperatively and at last follow-up. Utilities were statistically compared between groups. Mann-Whitney U test was used for statistical analysis (significance level 0.05).

Results: Follow up period after surgery was 37.5 ± 18.7 months. Preoperative JOA scores were not significantly different between groups (10.6 ± 2.7 in group LP, 10.7 ± 3.0 in group PF). Postoperative JOA scores were higher in group PF (14.4 ± 2.2) than in group LP (13.1 ± 2.7). The EQ before and after surgery were 0.62 ± 0.20 and 0.65 ± 0.21 in group LP, and 0.64 ± 0.16 and 0.72 ± 0.11 in group PF. The RS before and after surgery were 0.62 ± 0.20 and 0.61 ± 0.27 in group LP 0.61 ± 0.22 and 0.73 ± 0.21 in group PF. There were no significant differences in the gains of JOA score and utilities between groups.

Conclusion: Neurological outcome evaluated with JOA score was better after fixation than laminoplasty alone. However, Utilities were not always getting better after fixation. The symptoms except neurological status, such as axial pain or neck mobility, could impact utilities after posterior fixation.
P071
The effectiveness of Tomosynthes for the diagnosis of vertical subluxation in rheumatoid arthritis patients
Ryo Tamaki, Kaji Wada

**Introduction:** The X-ray of upper cervical spine is generally unclear, especially in bone destructive lesions such as rheumatoid arthritis. The computed tomography (CT) of upper cervical spine doesn’t reflect the weight of head, because it is taken in supine position. Therefore, the accurate diagnosis of vertical subluxation (VS) is sometimes difficult. Tomosynthes (TOMOS) is new high performance tomography which can be taken in standing or sitting position. In this study, we investigated the effectiveness of TOMOS for the diagnosis of VS in rheumatoid arthritis patients

**Methods:** Twenty three atlantoaxial lesions of rheumatoid arthritis patients were included in this study. All patients underwent X-ray, CT and TOMOS at the same time. The distance between McGregor line and the top of the dens (defined as VS value) was measured with above three radiographies. The VS value among three radiographies was investigated.

**Results:** A total of 19 cases were diagnosed as VS by TOMOS, 17 cases by CT, 12 cases by X-ray. In 8 cases, the dens was not clearly identified in X-ray. In 10 cases, the VS value of TOMOS increased compared to CT. In 8 cases, the VS value of X-ray increased compared to CT.

**Discussion:** In this study, we investigated the effectiveness of TOMOS for the diagnosis of VS in rheumatoid arthritis patients. With TOMOS, 19 cases were diagnosed as having VS, though 17 cases in T and 12 cases in X-ray. Furthermore, the clear dens was not identified with X-ray in 8 cases. Above results indicated that TOMOS is useful for the diagnosis of VS in rheumatoid arthritis patients, because it clearly shows the landmark of the upper cervical spine, and it can take the weight of head into consideration.

**Conclusion:** TOMOS is effective for the diagnosis of VS in rheumatoid arthritis patients.

P072
Restoring cervical lordosis – are cage-screw and plate-cage constructs the same?
Veerle Franken, Ferdinand A. Krappel

**Introduction:** The sagittal profile of the cervical spine is a recognized factor necessary to restore sagittal balance, reduce pain and improve results in spine surgery.
Cage screw constructs have become increasingly popular as they are an easy and time saving operation. However, the question remains whether they can restore lordosis as well as regular plate cage constructs particularly in multilevel operations.

**Material and methods:** We conducted a case control study with 20 patients in each group with a single level stenosis or disc extrusion after exhaustive conservative treatment warranting surgery. Patients were reviewed after 6 weeks, 6 months and one year by the first author.

**Results:** In this group, segmental lordosis seemed to be better restored by plate cage than cage screw constructs. One patient needed a revision in the cage screw construct due to aseptic loosening, however, whether this also was due to lack of lordosis and adequate loading remains to be questioned.

**Discussion:** From this preliminary results we feel that this subject ought to be studied in a proper randomized controlled study.
P074
Does preoperative T1 slope affect functional recovery in patients with cervical ossification of posterior longitudinal ligaments after laminoplasty?
Byeongwoo Kim, Do Heum Yoon, Yoon Ha, Seong Yi, Dong Ah Shin, Dong Youp Lee, Poong Gee Ahn, Keung Nyun Kim

Purpose: Recently, the impact of T1 slope has emerged as a predictor of kyphotic alignment change after laminoplasty. The authors previously reported that cervical alignment was compromised after laminoplasty and the degree of loss of cervical lordosis (LCL) was correlated with preoperative T1 slope. However, the relationship between preoperative T1 slope and postoperative functional recovery is not yet fully established. The goals of the present study were to investigate the relationship between T1 slope and postoperative functional recovery, and to identify the role of T1 slope as a predictor of surgical outcomes in patients with cervical ossification of posterior longitudinal ligaments (OPLL) after laminoplasty.

Materials and methods: Between January 2011 and January 2012, 64 consecutive patients who underwent cervical laminoplasty for OPLL were enrolled. Patients were divided into two groups (low-T1 group vs high-T1 group) according to preoperative T1 slope, and the postoperative cervical alignment change was compared between the groups. We investigated the effects of such variables as age, gender, type of OPLL, shape of the ossified lesion, occupying ratio of OPLL, and sagittal alignment of the cervical spine on surgical outcome. Neurologic assessment was conducted using the Japanese Orthopedic Association (JOA) scoring system for cervical myelopathy.

Results: A total of 28 patients completed final follow-up (male:female ratio = 21:7; mean age = 55.3 years; mean follow-up duration = 54 months). High-T1 group was more likely to exhibit postoperative LCL (p = 0.03), and when it occurred the degree of LCL was greater (p = 0.06). According to the preoperative T1 slope, Low-T1 group yielded better surgical outcomes than High-T1 group (p = 0.012). In multiple linear regression, higher preoperative T1 slope (p = 0.039) and higher occupying ratio (p = 0.069) of OPLL were significantly associated with a lower recovery rate.

Conclusions: Cervical alignment was compromised after laminoplasty. After laminoplasty for cervical OPLL, patients with higher T1 slope tended to exhibit a greater LCL yet did not drift into frank postoperative kyphosis. Higher T1 slope and higher occupying ratio of OPLL were significantly associated with a poor long-term surgical prognosis. T1 slope could be a predictor of kyphotic alignment change and surgical outcomes after laminoplasty.

P075
Does the plate maintain a sagittal plane correction after anterior cervical discectomy and fusion compared to a stand alone cage?
Abduljabbar Alhammoud, Mohanad Aboulebda, Fahed Falah, Ohmed Khilji, Abdul Moen Baco

Introduction: Anterior cervical discectomy and fusion is the treatment of choice for cervical degenerative disc disease which causes neurological symptoms such radiculopathy or myelopathy. It can be done by different techniques which include several options for implants such as disc spacers made of autograft or of allograft bone, porous metal as well as anterior plates and screws. Anterior cervical discectomy and fusion with stand alone cage (ACDF-CA) is a successful option to treat cervical disc disease, but long-term follow-up showed complications including cage subsidence as well as pseudoarthrosis. Thus, anterior cervical decompression and fusion with stand cage and plate (ACDF-CPA) was developed in order to decrease the complication of stand cage alone. However this has also been shown to have complications like dysphagia. The purpose of this study is to compare the role of anterior plate constructs (ACDF-CPC) and stand alone cage (ACDF-CA) in maintaining of sagittal plane correction.

Methods: We retrospectively reviewed the lateral cervical radiographs of all patients who underwent ACDF by stand cage alone or cage and plate at Hamad General Hospital, Doha, Qatar between 2011 and 2015. The choice of the operation was dependent on the surgeon’s preference and experience. Radiological findings (cervical lordosis, segmental lordosis, cage subsidence, disc height) are compared (pre-op, 3–6 months post op, 12 months post op).

Results: Sixty five patients underwent ACDF, 88 operative levels, 29 (44.6%) ACDF-CA and 36(55.6%) underwent
ACDF-CPC. There were 41(63.1%) males and 24(36.9%) females, average age 47.7 years (SD: 9.32), 40% done by orthopedic spine surgeons and 60% done by neurosurgeon. Most common operated level is C5-C6 followed by C6-C7. ACDF-CA showed better surgical correction than ACDF-CPC in regards to cervical lordosis and segmental lordosis (p value: 0.692, CI: (-4.8,7.28) whereas ACDF-CPC maintains correction more than ACDF-CA at final follow up despite insignificant statistically (p value: 0.506, CI: (-7.05,3.54). No difference detected in disc height and cage subsides between two groups.

**Conclusion:** Anterior cervical discectomy and fusion by stand cage alone or anterior plate achieved good clinical outcome and significant correction in sagittal plane. ACDF-CPC is superior to ACDF-CA in maintaining the post-operative sagittal plane correction after one year follow up. Improvement of sagittal plane leads to an improvement of the clinical outcome.

P076
Balloon kyphoplasty and additional anterior odontoid screw fixation for treatment of instable osteolytic lesions of the vertebral body C2
Anna Voelker, Nicolas H. von der Hoeh, Christoph-E. Heyde

**Introduction:** Instable osteolytic lesions of the occipitocervical junction are rare. This condition may occur in hematological malignancy or vertebral hemangioma, among others. Different case reports are published about vertebroplasty for treatment of spinal metastases of the upper cervical spine. Only few cases concern balloon kyphoplasty of C2. We present a case series including four patients with an instable osteolytic lesion of the vertebral body C2 without compression of the spinal cord treated with balloon kyphoplasty and an additional anterior odontoid screw fixation

**Materials and methods:** Four consecutive patients with an instable osteolytic lesion of the vertebral body of C2 were included. The definition of spinal instability was calculated by the Spine Instability Neoplastic Score (SINS). All patients presented with severe neck pain. The radiological imaging showed a lytic process of the vertebral body C2 with no vertebral collapse but involvement > 50% of the vertebral body in all patients.

**Results:** Three cases of instable osteolytic lesions of C2 by myeloma and one patient with vertebral hemangioma were presented to our clinic. Imaging including x-ray, CAT-Scan and MRI of the cervical spine was performed. All patients had a calculated SINS > 7.

In all cases, surgical treatment with an anterior balloon kyphoplasty of C2 and an additional anterior, bicortical odontoid screw placement was performed. Control x-rays showed sufficient osteosynthesis and cement placement in the vertebral body C2.

**Discussion:** Anterior balloon kyphoplasty and anterior odontoid screw placement is a safe treatment option for large osteolytic lesions of the dens axis. Balloon kyphoplasty has a known lower cement leakage rate than vertebroplasty. The cavity created by the balloon leads to more application of cement and therefore to more stability of the vertebral body. The additional odontoid screw placement has the advantage of providing more stabilization than the balloon kyphoplasty alone, and may prevent late complications, like odontoid fractures.

**Conclusion:** For patients with potentially instable or large osteolytic lesions of the dens without spinal cord compression or neurological symptoms we recommend the placement of an anterior odontoid screw when performing a balloon kyphoplasty. This should prevent late complications.
**P077**
Differentiated surgical treatment of patients with craniovertebral junction tumors using intraoperative neurophysiological monitoring

**Klimov Sergeevich Vladimir, Kelmakov Vladimirovich Vladislav**

**Objective:** To estimate the results of differentiated surgical treatment of patients with craniovertebral junction tumors using intraoperative neurophysiological monitoring.

**Materials and methods:** Outcomes of 24 patients being operated on craniovertebral junction tumors for the period from 2013 till 2016 were analyzed. Mean age was 54 ± 12 years, 7 (29%) were men, 17 (71%) – women. Intramedullary tumors – 2 (8%); extramedullary tumors – 16 (66%); spinal tumors – 6 (25%). Neurological status evaluation of patients was performed according to ASIA scale (American Spinal Injury Association), modified McCormick scale was applied for evaluation of functional status.

**Results:** Before surgery, the mean score of the functional status of the modified scale McCormick was 1,8 ± 0,6, to ASIA: E – 8 patients; D – 15; C – 1. Far lateral approach was applied in 15 cases (64%), dorsal midline approach – in 9 (38%). Dorsal stabilization was performed in 7 (29%) patients. According to ASIA scale in post-operational period: E – 4 patients; D – 17; C – 0; B – 1 patient. According to McCormick modified scale, the mean grade of functional status was 1,7 ± 0,8. Impairment of neurological status was noticed in 5 (21%) patients, in 4 of them impairment was connected with sensitive failures, and in 1 case impairment of tetraparesis was noticed. Decrease of urinary tract amplitude was registered in 3 (13%) patients, intramedullary tumor in 2 cases and extramedullary tumor meningioma in 1 case. Sensitivity was 0%, specificity – 87%, positive prognostic value (PPV) – 0%, negative prognostic value (NPV) – 100%, diagnostic efficiency (DE) – 87%. A mean follow-up was 1,5 years (min 3 month., max 3 years). Follow-up results: according to ASIA scale: E – 4 patients, D – 15; C – 1; B – 0 patients, according to modified McCormick scale functional status was in average 1,6 ± 0,8. Complications: deep wound infection – 1 case; postoperative cerebrospinal fluid cyst – 2 cases. Fatal outcome were in 3 (13%) patients: 2 of them died 3 months after the surgical procedure and 1 patient – after a year.

**P078**
Surgical management in metastatic cervical spine disease – clinical outcome of 24 patients.

**Farzam Vazifehdan, Vasilios G. Igoumenou, Ralf Langmantel, Esra Jungel, Robert Ebner, Firas Thaher, Martin Bork, Vasileios G. Karantzoulis**

**Introduction:** The management of cervical spine metastatic disease can be either conservative or surgical, and new treatment modalities emerge, despite a lack of conclusive evidence in the existing literature. Aiming to provide insights to the treating physicians concerning surgical management, we present a single-center series of patients who underwent surgery for cervical spine metastases during a six-year period.

**Materials and methods:** We retrospectively reviewed patients surgically treated for metastatic cervical spine disease, from December 2010 to December 2016. Epidemiological, clinical, and surgery-related data were analyzed. Pre- and postoperative pain level, neurological function, complications, and patients' mortality were further analyzed. Patients, who were lost during the follow-up period and/or with insufficient data recovered from their files, were excluded.

**Results:** The inclusion criteria were met by 24 patients (14 males, 10 females), with a mean age of 70.75 (range, 54–89) years. In 41.7% of patients the cervical spine metastasis was the first manifestation of their disease. Pain and neurological deficits, were present in 95.8% and 54.16% of patients, respectively. An anterior corpectomy or a posterior decompression, with instrumentation, was performed in 66.7% of patients. The numerical rating scale (NRS) scores for pain were significantly improved; mean NRS was 6.58 (range, 0–10) preoperatively, and 2.46 (range, 0–9) postoperatively (p<0.001). Of 13 patients with ASIA grades B, C, or D, a score improvement by one grade was recorded in 9 patients, and no change was noted in 4 patients. Of 5 non-ambulatory patients, 2 became and remained ambulatory, until they deceased. No neurological deterioration was recorded postoperatively. We experienced 6 surgical complications in 5 patients (20.8%), which were successfully managed. Median survival was 14.8 (range, 1–47) months; 12 patients died 1-year postoperatively.
Discussion: Increased pain levels, neurological deficits and impaired ambulation, can result into poor quality of life, and consequently poor prognosis. Conservative treatment, in certain only cases, can offer satisfying but short-term pain palliation.

Conclusion: Our results justify palliative surgery in metastatic cervical spine disease, improving patients’ quality of life and prognosis. Complications rate cannot be overseen; their impact, however, can be limited with appropriately selected patients, and well-prepared physicians being able to manage them.

P079
Minimally invasive resection of ventral and ventrolateral intradural extramedullary spinal lesions. Clinical outcomes and the addition of image merge technique
Rudolfo Maduri, Amani Belouaer, Lukas Bobinski, John Michael Duff

Introduction: Posterior translaminar approaches for resection of ventral and ventrolaterally placed intradural extramedullary lesions is challenging. Reports using these approaches for ventral lesions show a high neurological complication rate, likely due to spinal cord manipulation. Minimally access surgery (MAS) with image guidance minimizes soft tissue morbidity, and may potentially facilitate tumor resection and lower complication rates for tumors ventral to the spinal cord. We present our results of MAS image guided surgery for intradural ventral and ventrolateral lesions resected through a paramedian oblique tubular MAS approach.

Methods: Retrospective review of clinical, radiological and surgical records of patients operated for intradural mass lesions with MAS technique from 2004 to 2016. Preoperative status, lesion location, surgical technique (MAS vs IMTAR) and follow-up surgical results and complications were documented according to the type of MAS technique (image merged vs classic image guided).

Results: 54 patients operated using tubular techniques for intradural lesions, there were 11 ventrally located lesions. Mean age was 60 years (range 23-92), 6 males and 6 females. There were 6 meningiomas, 4 schwannomas, and 1 arachnoid cyst. 44 patients presented with myelopathy, 4 with radiculopathy, 2 dorsal pain. Surgery was performed with fluoroscopic guided tubular MAS technique in 7 cases while 5 patients were treated using the IMTAR technique (Maduri et al 2016), both using a posterolateral oblique transmuscular trajectory. Bone removal was tailored to resection needs. Mean blood loss was 253 mL. Miniextracavitary costotrasversectomy was necessary in 3 patients, complete facetectomy in 3 patients and complete pediculectomy in 1 patient. Mean hospital stay was 8 days (3-26). Postoperatively, there were no neurological complication and no CSF fistula. 2 patients with Schwannoma underwent deliberate nerve root sacrifice with expected postoperative radicular sensory loss. GRT was achieved in all 11 patients. Mean FU was 20.4 months (6-43), only 1 patient presents myelopathy, 4 patients with dysesthesia controlled with medical treatment. Axial pain is present in 1 patient operated for a C2-C3 meningioma with no radiological signs of instability.

Conclusions: Translaminar approach for ventral intradural spinal tumors has been reported to have a 41.6% overall complication rate (25% of postoperative neurological deficit) and 1.5% of mortality (Mehta et al, 2013). MAS facilitates surgical access to ventral and ventrolateral tumors with almost a 180° range of access. Furthermore, implementation of intraoperative image guidance allows customization of surgical trajectory, bone resection and tumor removal thus reducing the risk of neurological complication. In the present series, the rate of overall complication and neurological aggravation is low despite the ventral location of the lesions. Although our experience with these techniques is small, we believe that for ventral and ventrally located spinal tumor, the use of MAS image guided tubular techniques optimizes tumor access and may facilitate a reduction in neurological morbidity. Further experience is needed to confirm this.
Introduction: Atlantoaxial metastases are estimated to occur in less than 1% of all metastatic spinal cases. Surgical management can be aggressive or not, and sporadic only evidence exist in the literature. Hence metastases of the axis are still rendered a clinical challenge. We studied patients surgically treated for C2 metastases, and hereby present the procedures, the clinical outcomes, the complications, and the survival of these patients, aiming to provide insights to the treating physicians.

Materials and methods: Retrospective review of the electronic registry of our institution, for patients admitted and surgically treated for C2 metastases, between December 2010 and December 2015, identified 5 patients, who all underwent stand-alone posterior (occipitocervical or C1-2) instrumentation. Detailed information about patients’ demographics, operative procedures, and histology, as well information about pre- and postoperative clinical status, complications, and patients’ mortality, were available for all patients.

Results: Five patients (4 females, 1 male), with a mean age of 77.2 (range, 67-83) years, presented with severe pain, and radiological signs of spinal instability or impending instability. Surprisingly enough, in 4 of them the primary tumor was not previously diagnosed. Patients’ prognosis was at least 12 weeks. Mean NRS (Numerical Rating Scale) for pain was 7.6 (range, 7-9) preoperatively, and 2 (range, 0-3) postoperatively. No patient presented with neurological deficits either prior to, or after surgery. In only one case pain recurred, and the initial C1-2 posterior fusion (deemed insufficient) was revised to a C0-3 fusion afterwards the patient remained pain free. Median survival was 13.2 (range, 3-27) months, and two patients with lung adenocarcinoma died 3 and 4 months postoperatively.

Discussion: C2 metastases can result into severe pain, disability, and instability, eventually impairing patients’ quality of life. Surgical treatment offers pain palliation and creates a stable environment; however, the surgical procedure remains a matter of debate.

Conclusion: Patients with a prognosis of at least 12 weeks can benefit from palliative surgery for C2 metastases. In neurological intact patients a stand-alone posterior instrumentation without tumor debulking or decompression, can offer satisfying long-term outcomes with acceptable morbidity rates. Major procedures associated with increased morbidity could be hereby safely avoided.
hump $p = 0.043$. Although the rib hump decreased significantly 36.3% after DVR as well $p = 0.023$. There was also significant difference between a rib hump angle after SCRR and DVR ($p = 0.049$).

**Conclusions:** SCRR do not lead to AVD. The true spinal derotation is possible only when DVR systems are used. The decrease of rib hump is achieved both after SCRR and DVR, but the improvement is significantly better after DVR.

**P082**

Biomechanical evaluation of posterior cervical cages as a supplement to the anterior integrated cage and comparison with plated ACDF

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**Introduction:** The most commonly used cervical fusion construct is an anterior interbody graft/cage with anterior plate. The anterior integrated cage (AIC) may provide an alternative technique to anterior cervical discectomy and fusion (ACDF) surgery for treatment of adjacent-level disease. By placing the AIC adjacent to a previous plated fusion, the need for an extensive soft-tissue exposure and hardware removal is obviated.

**Purpose:** To compare the effectiveness of zero profile anterior integrated cage with and without posterior instrumentation and (2) to compare this 360º construct with plated ACDF without posterior instrumentation.

**Materials and methods:** Fourteen specimens (C2-T1) (42.4 ± 6.8 years) were divided in two groups (n = 7/group) and tested in flexion-extension (FE), lateral bending (LB), and axial rotation (AR) to ±1.5 Nm.

**Experimental protocol:** Group 1: Intact, C6-C7 AIC, Supplemental C6-C7 bilateral PC, C3-C5 AIC, Supplemental C3-C5 bilateral PC. Group 2: Intact, C6-C7 plated-ACDF, C3-C5 plated-ACDF.

**Results:** Group I: C6-C7 AIC implantation reduced ROM in all three planes: from 9.3 ± 2.0deg to 5.9 ± 2.9deg in FE ($p = 0.06$), from 7.3 ± 1.6deg to 1.8 ± 1.3deg in LB ($p < 0.01$), and from 5.8 ± 2.0deg to 2.7 ± 2.0deg in AR ($p < 0.01$). Supplemental posterior stabilization reduced ROM: 1.0 ± 0.5deg in flexion-extension ($p < 0.01$), 0.3 ± 0.1deg in LB ($p = 0.03$), and 0.5 ± 0.2deg in AR ($p = 0.04$). The results were similar under two-level fusion (C3-C4 and C4-C5 AIC), with significant reductions in ROM, and then further ROM reduction with addition of bilateral PC. Group I vs. II: The AIC + PC construct was more rigid than the plated-ACDF construct in limiting C6-C7 motion in all three planes of motion. At C6-C7, AIC + PC reduced flexion-extension ROM to 1.0 ± 0.5deg, compared to 2.5 ± 0.8deg after plated-ACDF ($p = 0.01$). In LB, AIC + PC reduced C6-C7 ROM to 0.3 ± 0.1deg, compared to 1.6 ± 0.7deg after plated-ACDF ($p = 0.03$). In AR, AIC + PC reduced C6-C7 ROM to 0.5 ± 0.2deg, compared to 1.7 ± 0.4deg after plated-ACDF ($p = 0.04$). At the upper cervical levels, AIC + PC construct performed similarly or better than plated-ACDF in limiting motion. In flexion-extension there was no significant difference between the AIC + PC construct and plated-ACDF ($p > 0.05$) at C3-C4 and C4-5. In LB and AR, the AIC + PC construct was more effective than plated-ACDF in limiting C4-C5 motion ($p < 0.05$).

**Conclusions:** Supplementation of single- and multilevel AIC using bilateral PC provided a significant increase in stability. The biomechanical effectiveness of bilateral PC supplementing AIC implantation is comparable to plated-ACDF for both single- and two-level fusion constructs. There may be a clinical benefit to using this implant in revision cases.

**P083**

Comparison of surgical outcomes between open-door, double-door laminoplasty, and selective laminectomy with muscle preservation for cervical spondylotic myelopathy – a multicenter study of 881 cases

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**Introduction:** Although there are several posterior decompression surgeries for cervical spondylotic myelopathy (CSM), such as open-door laminoplasty (O group), double-door laminoplasty (D group) and selective laminectomy with muscle preservation (S group), no comparative study of these three methods has previously reported. The aim of this study was to evaluate among three posterior decompression surgeries for CSM.
Methods: Between 2012 and 2014, 881 patients who underwent posterior cervical decompression surgeries for CSM at multi-centers in Japan were enrolled in this series. All subjects were observed with more than 2 years post-surgery. All patients were divided into three groups, O group, D group and S group. Gender, height, body weight, body mass index (BMI), operating time, intra-operating blood loss, Japanese Orthopedic Association (JOA) score, JOA recovery rate and perioperative complications including C5 palsy were evaluated.

Results: Of the 881 participants, 433 were classified as O group, 241 as D group and 256 as S group. Male ratios were 70.4% in O group, 66.8% in D group and 71.9% in S group, respectively. Height/ body weight/ BMI were 161cm/62kg/23.6 in O group, 160cm/63kg/24.7 in D group, 162cm/63kg/23.9 S group. Operating times were 99min in O group, 94min in D group and 142min in S group. Operating time of S group was significantly longer than other groups. Intra-operating blood losses were 76ml in O group, 51ml in D group and 25ml in S group. Intra-operating blood loss of S group is significantly smaller than other groups. The average preoperative JOA scores/ JOA scores at final follow up/ recovery rates were 10.6/13.8/50% in O group, 10.9/13.5/42% in D group, and 11.0/14.0/50% in S group. Incidences of C5 palsy were 12 cases (2.8%) in O group, 4 cases (1.7%) in D group, and 3 cases in S group, respectively. There were no significant differences among three groups.

Conclusions: There are several methods of posterior decompression surgeries for CSM, and each method has both merits and demerits. Although selective laminectomy which use operating microscope take longer operating time than other methods, it could reduce intra-operative blood loss. In all procedures, recovery rates of JOA score were approximately 50% and incidences of C5 palsy were less than 3%, which were not significantly differences. Posterior decompression surgeries would be therefore safe and reliable treatment option for CSM.

P084
Rotatory range of motion of atlanto-occipital joint increases after spontaneous osseous fusion following remodeling therapy for chronic atlantoaxial rotatory fixation
Kazuya Kitamura, Tomohiro Hikata, Nobuyuki Fujita, Mitsuru Yagi, Kota Watanabe, Morio Matsumoto, Masaya Nakamura, Ken Ishii, KSRG members

Introduction: We have previously reported that chronic irreducible and recurrent atlantoaxial rotatory fixation (AARF) can be managed successfully by careful closed manipulation followed by halo fixation (remodeling therapy). Interestingly, we have experienced several cases where rotatory range of motion (ROM) of cervical spine progressively recovered whereas C1C2 or C2C3 had been osseously fused after halo fixation. The purpose of this study was to investigate the dynamic behavior of upper cervical spine during voluntary head rotation after remodeling therapy for chronic AARF.

Methods: Patients who underwent remodeling therapy for chronic AARF from 2009 were reviewed. Following patients were included out of those who underwent CT examination in both right- and left-rotated head positions after remodeling therapy: 3 cases with osseous fusion between C1 and C3 (fusion group: two girls with fusion at C1C2 and one boy with fusion at C2C3) and 6 cases without osseous fusion (non-fusion group: four girls and two boys). The angles made by the occiput (Oc), C1, C2, C3 and C4 with the vertical 0 degrees were recorded (vertebrae angle: Oc—C4 angle) in both head positions. Separation angles between adjacent vertebrae were calculated at each segment and the sum of separation angle in each head position was defined as rotatory range of motion (rotatory ROM: OcC1—C3C4).

Results: There were no significant differences in age (8.0 vs 7.0 years) and period of halo fixation (2.7 vs 2.5 months) between fusion and non-fusion group. Time from onset to initial visit was significantly longer in fusion group (6.4 vs 3.5 months; P=0.04). OcC1 rotatory ROM was significantly larger in fusion group (20.1 vs 9.8 degrees; P=0.002).

Discussions and conclusion: Pang et al reported that OcC1 separation angle is less than 3 degrees to each side in normal children. In our study, OcC1 rotatory ROM was considered to increase to compensate for the affected C1C2 joint in both groups. In fact, significant increase in OcC1 rotatory ROM , not in C3C4, contributed to the recovery of rotatory ROM of cervical spine even when C1C2 or C2C3 are osseously fused after remodeling therapy. (349/350)
P086
The fate of cervicothoracic junction following posterior instrumentation constructs in the cervical spine
Hiroshi Miyamoto, Terumasa Ikeda, Kazuki Hashimoto, Masao Akagi

Introduction: In posterior reconstruction surgery for the cervical spine, the bottom of the construct is occasionally located at the cervicothoracic junction, which is recognized as unique part with transition from the highly mobile and lordotic cervical spine to the relatively stiff and kyphotic thoracic spine. Therefore, there is controversy to decide the level of the distal end of the construct. In the present study, we examined the incidence of distal junctional kyphosis (DJK) occurred at the cervicothoracic junction following this surgery whose bottom of the fixation was at C7, T1, and T2.

Materials and methods: Ninety-four patients (men43, women51, mean age 62 years old) who underwent posterior fixation surgery using screw-rod systems whose bottom of the construct was at the cervicothoracic junction were enrolled. The disease types were; spondylosis 30, rheumatoid arthritis 22, athetoid cerebral palsy 22, tumor 10, trauma 5 and spondylitis 5. The extent of the fixation was a mean of 5.9 vertebrae. The patients were followed up longer than 2 years.

The incidence of DJK at the region, age, gender, disease types, extent of the fixation, and postoperative T1 slope were examined. The risk factors were also analyzed between DJK(+) and DJK(−) using univariate and multivariate analysis.

Results: Eight DJK (8.5%) with the breakage or loosening of the pedicle screws at the region were exhibited. No clinical deterioration were found in these 8 cases, and no additional surgeries have been performed. The univariate analysis showed that the significant risk factor was age (p<0.009). The multivariate analysis showed that age was tended to relate to the incidence (P=0.07, odds ratio 0.91).

Conclusions: DJK are common complications which can occur in patients undergoing spinal instrumentation and fusion surgery. The present study has demonstrated that the incidence of DJK following posterior instrumentation surgeries whose distal end of the constructs located at the cervicothoracic region was 8.5%. From the outcomes of the present study, there is scarce evidence to advocate the requirement of longer fusion extending down to the thoracic spine because no clinical deterioration and following additional surgeries have been indicated with relatively small percentage of the incidence.

P087
Clinical study of the postoperative incident about locking screws used in anterior cervical fixation with dynamic plates
Ryo Kadota, Macond Mochizuki, Atsuomi Aiba

Introduction: To investigate postoperative incidents about locking screws used in anterior cervical fixation with dynamic plate.

Materials and methods: Six-hundred and forty-two patients who underwent anterior cervical fusion with dynamic plate system in our hospital from 2006 to 2016 and followed more than 3mo were enrolled in this study. Their mean age was 64 y/o and 19 hemodialysis cases were included. We investigated 1) the breakage of its locking system without screw displacement and 2) the locking screw displacement. There were 3,000 screws used in total, 784 screws in single-level fixation, 920 in 2-levels, 756 in 3-levels, 522 in 4-lelves and 18 in 5-levels.

Results: There were 11screws in 8 cases (0.4%) which developed postoperative incident about locking screws. There were 1 screw in 1 case of single-level fixation (0.1%) and 2 screws in 1 case of 2-levels (0.2%), both of them were hemodialysis cases. In multilevel fixation more than 3-levels, there were 4 screws in 2 cases of 3-levels fixation (0.5%), 3 screws in 3 cases of 4-lelves (0.8%) and none in 5-levels. In terms of the type of incidents, there were 3 cases of the breakage of locking system and 5 cases of screw displacement. In cases of the breakage of locking system, there were 2 broken screws in 2-levels fixation and 4 screws in 3-levels, and the mean postoperative period of incident was 1 year. Bone union delayed in all cases. In cases of the screw displacement, excluding 1 hemodialysis case in single-level fixation, there were 3 displaced screws in 4-levels hybrid fixation combined with fibula transplantation and the postoperative period incident occurred was 1.3 months. All of the
screws that incident occurred were used in the caudal base vertebra which the fibula transplant was performed. **Discussion:** We thought that the incident occurred in single or 2-levels fixation was caused by poor bone quality or facet instability derived from hemodialysis. We considered the breakage of locking system was caused by metal fatigue in screw-plate interface during bone union delayed. We considered the screw dislocation was caused by the abnormal stress on screws generated by the fibula transplant as it subsided.

**P088**
Locally applied simvastatin as an adjunct to promote cervical fusion
Sravisht Iyer, Matthew E. Cunningham, Robert Frawley, Kelsey Young, George Spaniel, Patrick E. Donnelly

**Introduction:** BMP is contraindicated in ACDF due to seroma formation, swelling and potentially life-threatening respiratory complications. A safer bone anabolic agent would be useful in ACDF, particularly in patients at risk for pseudarthrosis. We sought to examine if simvastatin (SIM) would be able to address this need and assist with spinal fusion.

**Materials and methods:** Blank PLGA (BlankNP) and SIM-loaded PLGA (SimNP) nanoparticles were created by adapting established techniques. SimNP was placed in 15mL of PBS at 37°C with agitation. SIM release was measured for 15d using UV spectrophotometry. In vitro validation was performed using MC3T3-E1 osteoblast precursor cells. A posterior spinal fusion model was utilized in 40 male 12wk old outbred Wistar rats. Rats were treated with BlankNP, SimNP (15 rats each) or SIM drug (10 rats). XR to assess bone formation were obtained at 4wks and 9wks after surgery. Spines were explanted at 9wks and a manual assessment of fusion (MAF) was performed by three blinded observers.

**Results:** SimNP successfully achieved sustained release over two weeks with ~50% occurring in the first day. Release efficiency averaged 74.1%. MC3T3 cells cultured with SimNP had higher expression of osteocalcin and osteopontin and showed more deposition of calcium. Three animals (one from each group) were sacrificed due to complications (paralysis, infection). In the remaining animals, we found no differences between the BlankNP and SIM drug rats in XR scores or MAF. Compared to BlankNP, SimNP treated rats had significantly higher XR scores at 4wks (3.0 vs. 1.9, p=0.010) and 9wks (3.6 vs. 1.8, p<0.001). Compared to SIM drug, SimNP rats had similar XR scores at 4wks but higher scores at 9wks (3.6 vs 2.1, p=0.005). MAF showed that SimNP had a significantly higher fusion rate than BlankNP (42.9% vs. 0%, p=0.006).

**Discussion:** We were able to validate the sustained release of SIM and show that SimNP induces an increase in mineralization and bone formation. Rats treated with SimNP had more bone formation on XR and were significantly more likely to achieve fusion compared to control animals.

**Conclusion:** Our findings suggest simvastatin may be a safe, cost-effective bone anabolic agent for use in cervical fusion surgery.

**P089**
Surgical outcomes after single site selective laminectomy for cervical myelopathy
Masatake Ino, Takachika Shimizu

**Introduction:** Generally, anterior decompression and fusion is performed for one or two level canal stenosis in CSM or disc herniation (DH), and laminoplasty is performed for multi level stenosis. We often have been performed single site selective laminectomy (SSSL) for one or two level canal stenosis in CSM or DH. The aim of this study is to examine the surgical results of SSSL for CSM or DH.

**Materials and methods:** We investigated 12 patients, who underwent SSSL. Seven patients were male and 5 patients were female. Their average age was 55.9 years. Eight patients were CSM and 4 patients were DH. One lamina was resected in 6 cases and 2 laminae in 4 cases. Single level fenestration was performed in 2 cases. We evaluated surgical time, blood loss, post operative complications, pre and post operative JOA score. We also measured pre and postoperative C2–7 angle and “cervical anteversion angle” (CAA; the angle between vertical line and the line through the center of C1 anterior arch and C7 vertebral body) on a lateral cervical radiograph
in the neutral position with horizontal gaze.

**Results:** The average surgical time was 62.8 minutes and the average blood loss was 86.8ml. There was no case of postoperative complications. Average JOA score was significantly improved to postoperative 16.4 points from preoperative 12.4 points (p=0.00015) and the recovery rate was 87%. There were no significant changes in C2-7 angle and CAA pre and postoperatively.

**Conclusion:** Surgical outcomes after single site selective laminectomy for cervical myelopathy with one or two level canal stenosis were satisfactory without any postoperative complications and significant changes of pre and postoperative cervical alignment and cervical balance.

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**P092**

*Lower adjacent segment pathology is a causative factor for the change of cervical alignment after the laminectomy*

*Satoshi Suzuki, Ryoma Aoyama, Ken Ninomiya, Junichi Yamane, Kazuya Kitamura, Satoshi Nori, Hiraku Hotta, Ukei Anazawa, Tateno Shiraishi*

**Introduction:** We have reported that preservation of extension units of spinous processes and those attached muscles were important to maintain post-operative cervical curvature. There has been no study done concerning the impact of extension units on the maintenance of local curvature. The aim of this study is to clarify the influence of extension units for the maintenance of local curvatures.

**Methods:** We investigated 100 consecutive patients who underwent triple laminectomy due to cervical spondylotic myelopathy with minimum 1 year follow-up between 2010 and 2015 at one spine center. All patients underwent muscle-preserving consecutive triple laminectomies between C4 and C6. When performing the laminectomies, we remained extension units above C4 and below C6 and completely preserved all facet joints with those surrounding tissues, therefore sacrificed dynamic stabilizer was only extension units between C4 and C6 in this procedure. We considered C2-7 angle, C2-5 angle, C4-6 angle, C5-7 angle, C2-7 SVA and T1 slope on lateral X-rays. We examined surgical outcomes using Japanese Orthopaedic Association (JOA) score.

**Results:** There were 65 males and 35 females whose average age was 63.5 years old. Average follow up period was 2 years and 8 months. Recovery rate of JOA score averaged 49.6 ± 25. There were no statistically difference between pre- and post-operative values of C2-7 angle, C4-6 angle, C2-7-SVA and T1 slope. C2-5 angle significantly increased from 1.2 ± 10 degrees to 5.6 ± 10 degrees post-operatively. C5-7 angle significantly decreased from 5.7 ± 5.8 degrees to 1.6 ± 7.9 degrees. It is highly likely that lower adjacent segment pathology at C6/7 happened post-surgery because C4-6 angle remained post-surgery, although C5-7 angle decreased post-surgery. Total cervical alignment was unchanged post-surgery because compensatory gain of lordosis between C2 and C5 happened probably owing to the remained extension mechanism.

**Conclusion:** Sacrification of extension units might lead to the lower adjacent segment pathology and deteriorate the local curvature. Total cervical curvature was well maintained after the surgery because the compensatory lordosis happened by the preserved posterior stabilizing structures.

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**P093**

*Risk factors causing horizontal gaze disorder in the cervical kyphosis*

*Kazuki Hashimoto, Hiroshi Miyamoto, Terumasa Ikeda, Masao Akagi*

**Introduction:** Progression of cervical kyphosis can cause difficulty of horizontal gaze. However, its precise mechanism remains unclear. The purpose of the present study was to elucidate the risk factors causing horizontal gaze disorder in the cervical kyphosis.

**Materials and methods:** Fifty-six patients (male 22, female 34, a mean of 72.4 years old) accompanying with cervical kyphosis (13-48, a mean of 23 degrees) were examined in this study. The patients divided into two; group of horizontal gaze possible (G+) and impossible (G-). Disease types were; 30 cervical spondylotic myelopathy, 5 ossification of the posterior longitudinal ligament, and 21 dropped head syndrome. Spinopelvic lateral radiographs in the standing position were taken. Clivo-axial angle (CAA), C0-1 angle, C1-2 angle, C2-7 angle, C2-7 SVA, and T1 slope were measured on the radiographs. The radiologic parameters were compared
between the groups, and risk factors causing horizontal gaze disorder were analyzed using multivariate analysis.

**Results:** The cases classified as G+ were 34, and G- were 22. The radiologic parameters which reached to statistical significance between the groups were; CAA (158.6±8.3° and 183.8±16°, p=0.0004), C0-1 angle (–0.4±7° and 9.2±7.8°, p=0.0001), C1–2 angle (28.9±6.2° and 35.3±9.2°, p=0.006), C2–7 SVA (17.6±9.8mm and 43.9±19.6mm, p=0.0007), and T1 slope (18.2±8.7° and 28.6±13.3°, p=0.0014) in G+ and G- respectively. CAA is the highest in a correlation coefficient for the multiplex logistic-regression analysis with G-. The cut-off value of the CAA at G- was 166° with ROC analysis (p=0.037, OR=1.24, 95%CI: 1.013-1.54).

**Discussion:** Severe cervical kyphosis may be compensated by upward and downward spino-pelvis for maintaining horizontal gaze. The present study has indicated that CAA is one of the most important factors of compensatory mechanism for cervical kyphosis. That is, higher CAA (cut-off value: 166 degree) is a risk factor causing horizontal gaze disorder in the cervical kyphosis.

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**P094**  
Assessment of causative factors related to prolonged postoperative dysphagia after anterior cervical discectomy and fusion  
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**Introduction:** Dysphagia (DG) that occurs after anterior cervical discectomy and fusion (ACDF) is a serious complication. Although most patients’ symptoms improve after a follow-up period, continued DG after discharge results in dissatisfaction and impaired lives. Herein, we examined data on long-term DG persisting for >1 month postoperatively.

**Materials and methods:** Twenty-three patients who underwent ACDF with plate-cage or modified Robinson-Smith procedures between 2005 and 2015 were retrospectively reviewed. Patients were divided into a DG or non-DG (NDG) group using the Bazaz grading system. Our comparison used the following causal factors: C2–7 cobb angles, OC2 angle, C2–7 sagittal vertical axis (SVA), C1–7 SVA, RTSS, RT3–4, and RT5–6 (retropharyngeal thickness at surgical site, C3–4, and C5–6, respectively). Protrusion of plate or grafted bone from the anterior border of vertebra (PRT) was assessed with the standing lateral X-ray at 1 week postoperatively. Operative procedures and time, estimated blood loss, and operation levels were evaluated. P values <0.05 were considered significant.

**Results:** The patients who underwent surgery at C2–7 SVA (31.1/21.3 mm, p = 0.02) and C1–7 SVA (43.0–29.4 mm, p = 0.01) showed statistical differences between groups. However, C2–7 cobb angles (8.9–10.4°), OC2 angle (19.8–17.3°), RTSS (15.9–16.6 mm), RT3–4 (11.2–11.2 mm), RT5–6 (18.1–16.2 mm), PRT (3.6–4.3 mm), operative procedure (plate-cage: 9 cases in both groups), operative time (175.5–172.6 min), and estimated blood loss (56.9–40.3 ml) did not show statistical differences (p > 0.05). C4–5 and C5–6 were the most frequent sites in 5 (45%) and 6 cases (50%) of the DG and NDG groups, respectively (p > 0.05). Eight cases (73%) of the DG group recovered from DG completely after a mean follow-up period of 17.4 months. Although three patients had DG after 37 months’ follow-up, the symptoms were mild and rare.

**Discussion and conclusion:** Early detection and prevention of DG improves treatment results. Significant differences were observed for SVA. Increase of SVA in the early postoperative course suggests that patients compensate the difficulty of swallowing with increasing SVA, indicating pharynx enlargement.

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**P095**  
Cervical fixation in pediatric patient  
Marco Crostelli, Osvaldo Mazza, Massimo Mariani, Dario Mascallo

**Introduction:** Although the indications for internal fixation in management of cervical instability in children are similar to those for adults, accurate pre-surgery study and sharp surgical techniques are necessary because of the small size of patient’s anatomy and the wide spectrum of diseases that require cervical fusion.

**Material and methods:** We operated 40 patients, mean age 8 years 6 months, performing cervical fusion for instability. We performed occipital-cervical fusion in 12 cases, 5 involved stabilization at the cranium–vertebral junction.
We used instrumentation in 17 cases. We used rigid adult instrumentation in five patients under 10 years of age, treated by rod, occipital screws and sub laminar hook instrumentation (9 years old male, affected by os odontoideum in Down syndrome; 7 years and 10 months old male, affected by os odontoideum in Down’s syndrome; 4 years and 6 months old female with occipital-cervical stenosis and C0–C2 instability in Hurler’s syndrome; 26 months old male affected by instability in Klippel Feil syndrome; 9 years 10 month old female with os odontoideum in Down syndrome). We operated on two patients under 3 years of age, using sublaminar wiring with bone precursors and allograft at level C0–C2 (30 months old male with post-traumatic instability C0–C2, and 17 months old male with C0–C2 instability in Larsen syndrome).

**Results:** Mean follow-up is 8 years. Where implants could allow, RMN examination was performed at 1st month after surgery. In the other cases, in which implants do not allow RMN to be performed, CT scan and standard X-rays were carried out, and new X-rays were performed every other year. No patient suffered major complications.

**Discussion:** Despite previous literature indicates that rigid instrumentation should be performed in cases over 10 years of age and sublaminar wiring in cases over 3 years of age, our experience of over ten years of use of adult instrumentation in children reflects in latest literature, showing that these age limits can be lowered.

**Conclusions:** The anatomic size of the patient is the most important factor in determining the use of instrumented arthrodesis to treat pediatric cervical spine instability.

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**P096**

**A 20-year prospective longitudinal study on degeneration of cervical spine using MRI in volunteers**

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**Introduction:** Few studies have illustrated long-term degenerative changes in the cervical spine in detail. The purpose of this longitudinal study was to evaluate degenerative changes of the cervical spine for 20 years in the originally healthy cohorts, and to clarify relationships between the progression of degenerative changes of the cervical spine and the development of clinical symptoms.

**Materials and methods:** Between 1993 and 1996, 497 asymptomatic volunteers underwent MRI to evaluate the prevalence of age-related changes in the cervical spine. 162 subjects (81 males and 81 females, mean age; 56.1 years) from the original cohort were recruited for this 20-year follow-up study. Questionnaires regarding the cervical spine related symptoms were also obtained. Degenerative changes of the cervical spine on MRI were assessed using original numerical grading systems at all intervertebral levels between C2 and T1. The evaluated parameters were 1) Decrease in signal intensity of the intervertebral disc (DSI), 2) Anterior compression of the dura and spinal cord (AC), 3) Posterior disc protrusion (PDP), 4) Disc space narrowing (DSN), and 5) Foraminal stenosis (FS). The progression of degenerative changes and relation with the onset of clinical symptoms were evaluated by logistic regression analysis.

**Results:** The progression of degeneration of cervical spine was found in 81.5% of subjects. The progression of DSI, AC, PDP, DSN and FS was observed in 58.9%, 56.4%, 54.6%, 11.0%, 15.3% of the subjects, respectively. The progression of AC (odds ratio, 2.98; 95% confidence interval [CI], 1.10 to 8.06), PDP (odds ratio, 3.25; 95% CI, 1.21 to 8.74) and DSN (odds ratio, 3.44; 95% CI, 0.84 to 14.2) were related to the onset of neck pain, and the progression of FS (odds ratio, 7.53; 95% CI, 0.87 to 65.3) were related with the onset of upper limb pain.

**Discussion:** This study revealed that the progression of cervical degeneration was found in most of the subjects and suggested that specific morphologic alterations due to degeneration of intervertebral discs might be related to the development of clinical symptoms.

**Conclusion:** The progression of intervertebral disc degeneration for 20 years may be related to onset of neck and upper limb pain.
P097
Long-term outcomes with the use of a carbon fibre cage for anterior cervical corpectomy and fusion in the treatment of cervical spondylotic myelopathy
Takashi Fujishiro, Abdulmajeed Alzakri, Celeste Tavalaro, David Kieser, Louis Boissiere, Ibrahim Obeid, Vincent Pointillard, of Jean Marc Vital, Olivier Gille

Optimal surgical methods for treatment of cervical spondylotic myelopathy (CSM) remain poorly evident. Anterior cage reconstruction may be associated with mechanical complications. Reconstruction with a carbon fibre reinforced polymer cage may provide an appropriate alternative to traditional reconstructive options. Thus this cage was evaluated through clinical and radiographic outcomes at a single centre with multiple surgeons.

Methods: Patient records were assessed. Patients were contacted for clinical and radiographic assessment. Exclusions were for active infection, tumoral pathology and fracture.

Outcomes included: Peri-operative, radiological (Cobb & C2C7 angle, flexion-extension angles (index & adjacent) and Bridwell fusion grade) and clinical (European Myelopathy and Nurick scores and Pain (VAS)).

Results: 100 consecutive patients (30 female & 70 male) with minimum 3-year & mean 6.5-year follow up. Neurological status was normal in 42 patients, with cord dysfunction in 48 (Ranawat grade 2 in 27, 3a in 18 and 3b in 3) and with contributing pathologies affecting clinical assessment in 10.

Mean length of stay was 5.5 days, blood loss 322mls and operative time 98 mins. Corpectomy levels included 10 C4, 14 C5, 44 C6, 1 T2, 7 corpectomies plus discectomy with fusion, 18 two-level and 5 three-level corpectomies, all with an overlying plate. 13 had peri-operative complications including a five dural tears, two respiratory infections, one inferior limb ischaemia, three cervical haematomas and three early cage revisions (two mal-positions and one early migration).

Seven were lost to follow-up. Mean pre-operative pain scores were VAS Neck 4.6 and VAS Arm 5.1 and post-operatively, VAS Neck was 2.6 and VAS Arm was 1.9. Nurick score improved from 1.2 to 0.4/4. Mean EMS was 15.9/18 at follow-up.

48 patients returned for radiographs for the purposes of the study. Flexion-extension angulation differences of >3 were present in 4 patients, all of which displayed fusion of either grade 1 or 2. 6/48 had a kyphotic C2C7 alignment.

Long-term results indicate that the use of a composite carbon fibre cage in corpectomy for CSM is safe, durable and with a low revision rate. Complications were mostly related to malposition on implantation or dural tears due to adhesions.

P098
Comparison of outcomes of open door laminoplasty and muscle preserving selective laminectomy for cervical spondylotic myelopathy in young adults
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Introduction: Efficacy of laminoplasty in elderly patients with cervical spondylotic myelopathy (CSM) has been widely reported. The purpose of this study was to compare surgical outcomes in young adults between open door laminoplasty (O group) and muscle-preserving selective laminectomy using operating microscope (S group).

Methods: This is a retrospective study. Total 1178 patients who received posterior decompression for CSM from 2012 to 2014 in 17 affiliated hospitals were reviewed. After applying inclusion criteria (CSM, age at surgery <45 years and with minimum of 2 years follow-up), 26 patients (25 males and 1 female) were included in O group and 22 patients (15 males and 7 females) in S group. Age at surgery, numbers of decompressed levels, operating time, blood loss, Japanese Orthopedic Association (JOA) score, imaging parameters in plain radiographs and perioperative complications were evaluated.

Results: Age at surgery was 38.2 and 39.1, number of decompressed levels was 3.3 and 3.2, JOA score (preop./final follow up/change/recovery rate) was 10.7/13.9/3.2/56.8% and 12.2/15.0/2.8/60.3% in O and S group respectively. There were no significant differences in these parameters between the two groups. In S group,
Operating time was significantly longer (111 mins vs 128 mins; \( P = 0.03 \)) but blood loss was significantly smaller (98.5 ml vs 14.4 ml; \( P = 0.01 \)). Although there were no significant differences in imaging parameters (preop./final follow up/change) including C2-7 SVA (20.3/20.3/-0.06 vs 20.1/19.4/-0.7), C2-7 lordotic angle (3.4/2.6/-0.7 vs 2.6/5.0/2.4) and C2-7 ROM (43.9/38.1/-5.8 (93.8%) vs 36.0/41.8/5.8 (128.0%)), C2-7 lordotic angle and C2-7 ROM increased postoperatively in S group. C5 palsy was observed in one case in S group, but no case in O group.

**Discussions:** Operative procedure under operating microscope in selective laminectomy could take longer operating time but reduce blood loss. JOA recovery rate, alignment and ROM of cervical spine were well maintained in both groups at minimum of 2 years postoperatively and these techniques would be therefore safe and reliable treatment for CSM in young adults. A larger number of patients and longer follow-up are required to evaluate the result that C2-7 lordotic angle and C2-7 ROM increased postoperatively in S group.

**P099**

**Can the wild bootstrap be tamed for studies with small sample sizes?**

*Georg Zimmermann, Arne C. Bathke, Yvonne Höller, Raffaele Nardone, Eugen Trinka*

**Introduction:** Consider the situation of comparing at least two groups of patients with respect to a univariate outcome of interest, adjusting for one or several covariates. For example, the grouping factor can represent different etiologies of spinal cord injury (SCI), and we could additionally adjust for the age of the patients. If the outcome variable is continuous, the adjusted group means are usually compared by using the traditional analysis of covariance (ANCOVA) approach. However, especially in SCI studies, the group sizes are often small, thus making the assessment of the assumptions underlying the ANCOVA difficult, if not impossible. Therefore, we investigate the performance of the ANCOVA, a heteroskedasticity-consistent variant (HC) and a Wild Bootstrap approach (WB) in an extensive simulation study.

**Materials and methods:** We conduct simulation studies for the three aforementioned statistical tests, with various departures from the classical ANCOVA assumptions of constant variances across the groups and normally distributed observations. We also consider balanced as well as unbalanced group size scenarios. For each setting, we conduct 5000 simulation runs and 5000 bootstrap runs, respectively. The performance of the tests was assessed by comparing the type I error rates (ER) to the pre-specified level of \( \alpha = 0.05 \). Moreover, we illustrate application of those three methods by referring to a therapeutic study in SCI patients.

**Results:** For balanced scenarios, the ERs range from 0.041 to 0.067 for classical ANCOVA, from 0.049 to 0.092 for HC and from 0.035 to 0.055 for WB, respectively. For unbalanced scenarios, the corresponding ER ranges are 0.029 – 0.109 (ANCOVA), 0.058 – 0.196 (HC) and 0.030 – 0.071 (WB), respectively.

**Discussion:** Whereas the poor performance of the classical ANCOVA in unbalanced scenarios has been shown previously, the highly liberal results for the HC method were rather unexpected. Apart from a few instances of slight conservatism, the WB test maintained the pre-specified level of 0.05 very well.

**Conclusion:** Especially when the sizes of the groups are unequal, the WB method should be used instead of the classical ANCOVA test. In future research, the WB approach will be further examined and adapted to multivariate settings, too.

**P101**

**Strategy for correction surgery of dropped head syndrome**

*Kuniyoshi Abumi, Yuichiro Abe, Itaru Oda, Masahiko Takahata*

**Introduction:** Dropped head syndrome (DHS) is relatively rare condition caused by posterior neck muscle insufficiency and/or dysfunction of posterior cervical stabilizers. DHS significantly affects patient’s quality of life. Surgical intervention for DHS caused by neuromuscular disorders had been considered difficult and mostly non-effective. However, sufficient correction can be expected by combined use of multilevel cervical osteotomy and instrumentation for selected patients. Surgeons must consider choice of posterior or combined anterior/posterior osteotomy, the levels of osteotomy and length of instrumentation.
Methods: 12 patients with DHS who underwent surgical correction were reviewed. There were 7 men and 5 women, and their mean age was 65.1 years (range 32-78). Causes of DHS were idiopathic in 6 patients, post-laminectomy and post-laminoplasty in 2, and posttraumatic, ankylosing spondylitis, rheumatoid arthritis and Parkinson disease in each 1. All patients were suffered from horizontal gaze disturbance, and 8 patients had dysphagia preoperatively. 4 patients had cervical myelopathy. Deformity had progressed to chin-on-chest deformity in 6. 9 patients underwent single posterior osteotomy: multi-level Smith-Peterson osteotomy in 8 and pedicle subtraction osteotomy at C7 in 2. Remaining 2 patients underwent combined anterior and posterior osteotomy. Cervical pedicle screw fixation utilized in all. 11 patients underwent cervicothoracic fixation. Occipitothoracic fixation was performed for one patient
Results: Sagittal vertical axis (SVA) on standing lateral projection X-ray picture was preoperatively had shifted to anterior of the sternum in all patients. SVA was transferred by surgical correction to posterior of the sternum in 11 patients. 74 degree of preoperative cervical or cervicothoracic kyphosis in average (range: 46-105) was corrected to 17 degree (range: 5-43). Regarding complication by surgery, transient C5 nerve palsy in 2 patients and loss of correction requiring caudal extension of fusion levels in one were observed.
Discussion and conclusion: For surgical correction of ordinary cervical kyphosis, osteotomy at the apex of deformity is effective. However, osteotomy at the cervicothoracic junction must be considered for correction of DHS considering posterior transposition of anteriorly shifted loading axis and global spinal balance. In addition, spinal cord decompression by anterior or posterior approach must be needed for patients with spinal cord compression.

P102
The effect of prophylactic foraminotomy to C5 palsy in laminoplasty aiming at the largest expansion
Yoshihito Yamasaki, Toru Yokoyama, Kazunari Takeuchi, Takuya Numasawa, Taito Itabashi, Kanichiro Wada, Hitoshi Kudoh

Introduction: There are many reports stating that prophylactic C4/5 foraminotomy is useful for the prevention of C5 palsy after cervical laminoplasty. However, several possibilities such as the position of the gutter, an angle of the expansion lamina and the damage during an operation have been identified as the causes of C5 palsy. We believe that it was necessary to fix these factors to investigate the effect of foraminotomy; we performed laminoplasty aiming at the largest expansion. The purpose of this study was to prospectively investigate the effect of foraminotomy in laminoplasty aiming at the largest expansion.

Materials and methods: Thirty-six patients who consecutively underwent cervical posterior surgery were enrolled (23 male and 13 female; 20 spondylosis and 16 OPLL; average age, 64.7 years). There were 20 patients with double door laminoplasty and 16 with laminoplasty and fusion from C2 to T1. To get the largest expansion, the position of the gutter was made an edge outside the spinal canal and the angle of the opened lamina was kept as large as possible. Sixteen patients (10 laminoplasty and 6 laminoplasty and fusion) underwent foraminotomy (foraminotomy group, FG), and other 20 patients (10 laminoplasty and 10 laminoplasty and fusion) did not undergo foraminotomy (non-foraminotomy group, NFG). The incidence and severity of C5 palsy, the spinal cord shift on MRI on the next day of operation and the anteroposterior diameter of C4/5 foramen at the preoperative computed tomography scan were investigated. The statistical significance level was set at 0.05.

Results: One patient who was suspected of having an intraoperative injury was excluded. C5 palsy occurred in 10 patients (28.5%): 6 of 15 patients (40%) in FG, and 4 of 20 patients (20%) in NFG. The number of severe patients for which MMT was less than 3 was 4 of 15 patients (26.7%) in FG, and 2 of 20 (10%) patients in NFG. The incidence and severity were high in FG, but there were no significant differences. Moreover there were no significant differences in other evaluations.

Conclusion: Prophylactic foraminotomy is not effective for postoperative C5 palsy in laminoplasty aiming at the largest expansion.
A clinical and radiographic study of patients undergoing posterior decompression surgery for cervical spondylotic myelopathy associated with anterior spondylolisthesis: Retrospective multicenter study of 867 cases

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Background: There have been fewer studies on cervical spondylolisthesis than on lumbar spondylolisthesis. This study aimed to investigate the clinical and radiographic features of patients undergoing posterior decompression surgery for CSM associated with anterior cervical spondylolisthesis.

Methods: Totally, 867 patients diagnosed with CSM who underwent posterior decompression surgery with a minimum follow-up of 2 years in 17 hospitals were included. There were 582 males and 285 females; their mean age was 67.4 ± 11.8 (range, 27–93) years.

Cervical anterior spondylolisthesis was defined as anterior slippage of >2 mm on performing a standing cervical X-ray in the neutral position. Radiographic and clinical features related to spondylolisthesis were compared initially and at the final follow-up between patients with cervical anterior spondylolisthesis (group S) and those without cervical anterior spondylolisthesis (group N). Student’s t test was performed, and p < 0.05 was considered to be significant.

Results: Preoperatively, 68 patients (7.8%) had cervical spondylolisthesis: C2 level, 3 patients; C3, 11; C4, 31; C5, 12; C6, 3; and C7, 8. The following clinical and radiographic features showed significant differences (group S vs group N): average age at surgery (74.0 vs. 66.8 years), height (155 vs. 160 cm), body weight (55.2 vs. 61.1 kg), preoperative C2–C7 SVA (27.8 vs. 22.5 mm), postoperative C2–C7 SVA (29.4 vs. 24.0 mm), preoperative JOA score (9.8 vs 10.8 pts), and JOA recovery rate (53.9 vs. 41.6%).

Because of posterior decompression surgery, the progression of anterior spondylolisthesis in groups S and N was observed in 5 (7.4%) and 19 (2.4%) patients, respectively.

Conclusions: The incidence of anterior spondylolisthesis with anterior slippage of >2 mm preoperatively was observed in 7.8% of the patients who had undergone posterior decompression surgery. The most common level of anterior spondylolisthesis was at C4, and anterior spondylolisthesis was more frequently seen in females. Although group S showed significantly lower preoperative JOA scores, their satisfactory JOA recovery rates implies that posterior decompression surgery is an effective surgical method for patients having anterior cervical spondylolisthesis. The presence of a significantly larger SVA in group S suggested that anterior spondylolisthesis is associated with sagittal malalignment.

Radiographic and clinical analysis of cervical coronal balance in patients with cervical spondylotic myelopathy

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Background: Compared with lumbar coronal balance, cervical coronal balance has received comparatively little attention. The aim of this study was to demonstrate the impact of cervical coronal balance in patients with CSM.

Methods: This study included patients with CSM who underwent posterior decompression surgery at our hospital from 2008 to 2013. Patients were excluded if they had a history of previous cervical surgery, rheumatoid arthritis, or hemodialysis. The mean follow-up period was 44.9 ± 18.6 months (range, 24–97). We included 122 males and 68 females; the mean age was 63.4 ± 12.2 years (range, 29–89). Cervical scoliosis (CS) was defined as the Cobb angle exceeding 10º. The neurologically dominant side (right or left) was determined when at least one of the following four conditions was confirmed: 1) dominant side of pain or numbness in extremities, 2) different scores in the grip-and-release test during 10 s on more than five occasions, 3) different powers of grip for weights more than 10 kg, and 4) different muscle strength with more than one grade of MMT. Furthermore, we investigated the prevalence and progression of CS and its association with other radiologic and clinical parameters.

Results: The prevalence of CS was 28.9% (n = 55). Radiographic factors showing significant differences (CS
group vs non-CS group, p value) included vertebral rotation (7.2° vs 4.6°, p < 0.01), C2–C7 angle (16.8° vs 12.4°, p = 0.03), and T1 slope (25.1° vs 23.9°; p = 0.01). Through posterior decompression surgery, progressions of the Cobb angle by more than 5° were observed in eight patients at the final follow-up period (n = 2, 3.6% in the CS group vs n = 6, 4.4% in the non-CS group). Twenty-three patients (41.8%) had dominant symptom sides in the CS group. Of these, 17 patients (73.9%) had symptoms on the concave side, whereas 6 had symptoms on the convex side (p < 0.01).

Conclusions: Patients with CS had a significantly larger vertebral rotation, C2–C7 angle, and T1 slope, but they did not exhibit worse clinical results. Patients with CS had symptoms more frequently on the concave side.

P107
Does pelvic tilt affect cervical spondylolisthesis? A prospective study of 155 cases of cervical spondylotic myelopathy
Ken Ninomiya, Ryoma Aoyama, Satoshi Suzuki, Satoshi Nori, Junichi Yamane, Kazuya Kitamura, Itsuo Watanabe, Kensuke Ochi, Hiraku Hotta, Seiji Ueda, Ukei Anazawa, Tateru Shiraishi

Background: Although there have been some reports of a relationship between cervical spondylotic myelopathy (CSM) and pelvic parameters, in most studies, subjects were associated with severe spinal deformity. We aimed to investigate the relationship between detailed cervical radiographic and clinical features and pelvic parameters in patients with a chief complaint of cervical myelopathy

Methods: Since 2013, we obtained clinical records and radiographic data, including preoperative cervical and whole spine x-rays and MRIs, from 155 CSM patients. Patients were excluded if they had OPLL, rheumatoid arthritis, hemodialysis, or a history of spine surgery. In total, 110 males and 45 females were included; the mean age was 63.5 ± 13.3 years (range, 25–87 years). Radiographic findings of the cervical, thoracic, and lumbar spine and pelvic parameters and clinical aspects were compared between patients with PT less than 20° (group A, n = 89) and more than 20° (group P, n = 66). Cervical spondylolisthesis was defined as more than 2 mm anterior or posterior slippage on a standing cervical x-ray in the neutral position. Student’s t-test was used, and p < 0.05 was considered significantly different.

Results: Radiographic and clinical factors showing a difference (group A vs. group P; p value) were the average age during surgery (60.9 years vs. 67.0 years; 0.004), body weight (65.4 kg vs. 60.5 kg; 0.04), C2–C7 angle (11.2° vs. 17.1°; 0.008), SVA (18.1 mm vs. 38.2 mm; 0.003), SS (30.7° vs. 27.8°; 0.03), PI (44.8° vs. 53.5°; < 0.001), LL (31.7° vs. 27.7°; 0.07), PI–LL (13.0° vs. 25.8°; < 0.001), presence of posterior spondylolisthesis (14.6% vs. 25.8%; 0.03), and preoperative JOA score (11.8 pts vs. 11.1pts; 0.12).

Conclusions: Larger PT correlates with larger SVA for CSM patients without severe spinal deformity. A smaller LL and larger C2–C7 angle may compensate for the spinal global imbalance on the sagittal plain because of pelvic retroversion. A significantly higher ratio of cervical posterior spondylolisthesis suggests a possible compensation mechanism for sagittal imbalance. Sagittal spinal imbalance may affect lower preoperative JOA scores in group P.

P108
Anterior approaches with zero-profile devices for 3- and 4-level disease: analysis of clinical outcome and sagittal alignment
Giuseppe M. V. Barbagallo, Massimiliano Maione, Francesco Certo

Introduction: In multilevel diseases posterior approaches are often preferred; however, anterior approaches provide comparable clinical results and better alignment. Anterior plating increases interbody fusion rates and stability, maintains or improves sagittal alignment and prevents graft dislocation or subsidence. However, it entails higher rates of soft tissue injuries and dysphagia, particularly in multilevel cases. A zero-profile, stand-alone device for ACDF may reduce morbidity associated with traditional anterior plates, while maintaining the benefits.
We analyze the prospectively collected data of a series of patients treated with three- or four-level ACDF with zero-profile device, focusing on clinical outcome, sagittal alignment and complications.

**Materials and methods:** 24 patients were enrolled. Nurick scale was used to assess myelopathy. Neck Disability Index (NDI) and visual analogue scale (VAS) scores for neck and arm pain; Short Form (SF) 36 for functional status. Preoperatively, x-rays with flexion/extension views, CT and MRI were obtained.

14 patients (58.3%), mean age 55.9 years, underwent three-level surgery; 10 (41.7%), mean age 61.7 years, underwent four-level surgery. Postoperative X-rays and CT were performed to assess fusion rate and implant-associated complications. Cervical alignment was measured by pre- and post-operative segmental and C2-C7 lordosis. Post-operative dysphagia was recorded according to Bazaz dysphagia index.

Mean clinical follow-up is 39 months (range 24 – 72).

**Results:** Implant-associated complications were not reported. Fusion was achieved in 49% of spaces at last CT scan. Mean neck and arm pain VAS score decreased from 6.7 to 1.6 (p<0.01) and from 5.9 to 0.9 (p<0.01), respectively. Significant improvements (p<0.01) in SF36 and NDI were also documented. 18 of 24 (75%) patients had pre-operative lordotic curvature; 3 (12.5%) had a straight cervical spine and 3 (12.5%) a kyphotic one. C2–C7 lordosis angle varied from 11.9° to 18.2°. At last follow-up it was 14.9°. The slight loss in lordosis during the follow-up period was not associated with worsening of clinical parameters. Five patients complained of mild dysphagia (20.8%). No cases of long-term dysphagia (> 6 months) were observed.

**Conclusions:** Three- and four-level ACDF with zero-profile devices is safe and effective. It restores segmental and global cervical lordosis and achieves a short and long-term satisfactory clinical outcome.

**P109**

Clinical and radiographic outcomes of patients with cervical deformity secondary to thoracolumbar proximal junctional kyphosis


**Introduction:** Cervical deformity (CD) development secondary to proximal junctional kyphosis (PJK) has recently been documented in adult spinal deformity (ASD) patients after surgical correction for thoracolumbar ASD. This study aims to analyze surgical management of patients with CD secondary to PJK versus patients with primary CD.

**Materials and methods:** Retrospective review of prospective, multicenter CD database. CD was defined as at least one of the following: C2-C7 Cobb>10°, CL>10°, cSVA>4cm, CBVA>25°. Patients were grouped into those who had PJK (UIV+2 < -10°) prior to cervical surgery versus whose who did not (Non-PJK).

**Results:** Of 123 eligible cervical deformity patients, 26 (21.1%) had radiographic PJK prior to cervical surgery. There were no significant differences in age, gender, BMI, Charlson Comorbidity Index, history of prior cervical surgery, or baseline HRQLs (p > 0.05). PJK patients had significantly greater T2-T12 thoracic kyphosis (58.78° vs 45.04°, p=0.002), cSVA (49.07mm vs 38.86mm, p=0.020), T1 Slope (42.64° vs 28.41°, p=0.001), TS-CL (44.08° vs 35.64°, p=0.048), C2-T3 SVA (98.82mm vs 75.75mm, p=0.015), C2 Slope (45.40° vs 36.04°, p=0.043), C2-S1 (p=0.033) and CTPA (p=0.005). The PJK group had significantly more levels fused (10.68 vs 7.42 levels, p=0.01) and their average posterior LIV was more caudal (T6 versus T4, p=0.004).

There were significantly more posterior column osteotomies performed in the PJK group (38.5% vs 16.5%, p=0.018). There was significantly greater blood loss in patients with PJK (1158.08±1062.65cc vs 678.27±760.39cc, p=0.028); operative time, surgical approach, and BMP-2 use did not differ between the two groups (all p>0.005).

PJK patients experienced higher rates of complications 30 and 90 days postoperatively (23.1% vs. 5.2%, p=0.004; 30.8% vs. 19.6%, p=0.026), and had higher instrumentation failure 30 days postoperatively (7.8% vs. 1.03%, p=0.004). However, there were no differences in HRQLs between PJK and Non-PJK patients at 3M, 6M, or 1Y (all p>0.05).
Conclusion: The prevalence of pre-operative PJK was 21.1% among CD cases. Patients with cervical deformity secondary to PJK had worse baseline cervical deformity, despite no differences in HRQL or demographics. Surgical correction of CD associated with PJK required more invasive surgery and had higher complication rates than Non-PJK patients, despite achieving similar outcomes.

P111
Drivers of cervical deformity have a strong influence on achieving optimal radiographic and clinical outcomes at 1 year following cervical deformity surgery

Introduction: Cervical deformities have variable structural causes. Recent findings show that the primary driver (PD) of malalignment, most frequently the apex of the curve, is important in characterizing cervical deformity (CD) treatment and outcomes.

Materials and methods: Retrospective review of a prospectively collected CD database. Inclusion: radiographically defined CD, >18 years, 1Y follow-up. PD apex was classified based on spinal region: cervical, cervicothoracic junction (CTJ), thoracic, or spino-pelvic. Primary analysis evaluated PD groups meeting alignment (Ames modifiers cSVA, TS-CL, CBVA, mJOA) and HRQL (EQ5D, NDI, mJOA) goals using t-tests. Secondary analysis grouped interventions according to fusion constructs including PD apex based on lowest instrumented vertebra: cervical LIV≤C7, CTJ LIV≤T3, thoracic LIV≤T12.

Results: 73 patients (62yrs, 60%F) were evaluated with the following PDs of their CD: cervical 50.6%, CTJ 27.3%, thoracic 13.0%, and spino-pelvic 2.6%. They were corrected with average 7.6 levels fused, 21.9% including three-column osteotomy. Primary analysis comparing PD groups showed cervical drivers (n=39) had the greatest 1Y post-op cervical and global alignment changes (improvement in T1S, CL, cSVA, C1S). Thoracic drivers were more likely to have persistent severe TS-CL modifier grade at 1Y (0=20.0%, + =0.0%, ++=80.0%, p=0.031). Secondary analysis compared fusion constructs between 68% of patients whose fusion included PD apex to those who didn’t. Patients whose surgery included the PD apex met quality of life MCID at similar rates: EQ5D (Included:12% vs. not:9%, p=0.373), mJOA (Included:8% vs not:11%, p=0.404, and NDI (Included:23% vs not:32%, p=0.556).

However, CD modifiers were relieved from ‘severe’ more frequently in patients whose construct included PD apex: cSVA (Included:64% vs not:40.4%, p=0.006) and Horizontal gaze (Included:44% vs not:21.2%, p=0.006). Thoracic and Spino-pelvic PD apex patients did not significantly improve in any HRQLs when PD apex was not treated.

Conclusion: Structural drivers of cervical deformities have an important effect on treatment rendered and 1 year outcomes following correction. Importantly, patients with thoracic or spino-pelvic drivers not included in the construct result in residual deformity and inferior HRQLs.

P113
Cervical deformity surgeries meet cost-utility benchmarks using one-year outcome analysis

Introduction: Cost-utility analysis, a special case of cost-effectiveness analysis, estimates the ratio between the cost of an intervention to the benefit it produces in number of quality-adjusted life years. Cervical deformity correction has not been evaluated in terms of cost-utility and in the context of value-based health care.

Methods: Included were patients with 1-year follow-up after surgical correction for cervical deformity, defined as one of the following: kyphosis (C2-7 >10°), cervical scoliosis (>10°), positive cervical sagittal imbalance (cSVA >4cm), or horizontal gaze impairment (chin-brow vertical angle >25°). Quality of care was calculated by comparing pre-operative to 1-year post-operative EuroQol 5D (EQ5D) quality of life measure to the cost of
surgery. Costs were assigned using US Medicare 30- day average reimbursement. Reoperations and deaths were added to cost and subtracted from utility respectively. Primary analysis considered cost per QALY with one year post-op benefit. A secondary analysis measured QALY gained to life expectancy using a standard 3% discount (women: 81.6 years, men: 76.9 years).

Results: 84 patients (average age: 61.9 years, 58.3% female, BMI: 29.3) were analyzed after cervical deformity correction (average levels fused: 7.2, osteotomy used: 50%). Costs associated with index procedures were: 9+ level posterior fusion (PF) ($55,205), 4-8 level PF ($27,145), 4-8 level PF with anterior fusion (AF; $54,272), 2-3 level PF with AF ($26,970), 4-8 level AF ($20,001) and 4-8 level posterior refusion ($35,371). Average 30-day cost of surgery was $38,704, and $41,670 at 1-year with 12 revisions and 4 deaths accounted for. Cost per QALY gained to 1-year follow-up was $489,299. If sustained to life expectancy (average 18.7 years in this population), average QALYs gained was 1.24 per patient--$33,680 per QALY.

Conclusions: 30-day Medicare average costs applied to clinical data collected in a multi-center surgeon-run database described cervical deformity surgeries costing $41,670. This yielded a cost of $489,299 for first QALY, $33,680 per QALY if patients meet reach expectancy. Longer follow-up is needed for a more definitive cost-analysis, but this data is an important first step in justifying cost-utility ratio for cervical deformity correction.

P114
Effects on sagittal balance in treatment of cervical degenerative disc disease with anterior approach
Mauro Costaglioli, Pierluigi Sannais, Carla Pani

Introduction: The cervical arthrodesis with anterior approach (ACDF) is one of the most commonly performed for the treatment of cervical degenerative pathologies procedures. This technique can also improve the contour of the spine on the sagittal plane deformity in which the cervical kyphosis, which may result in significant effects on symptoms and quality of life of patients as they often cause neck pain and other associated symptoms. With this study it is aimed to assess, according to our survey, the possible correlation between improved balance sagittal cervical and out as the best of the patients clinically.

Materials and methods: were evaluated retrospectively in 27 cases treated with ACDF (ACDF a single-level and two-level ACDF) using 7.5 ° cervical lordotic cages in the last three years with a minimum follow-up of one year. Radiological studies examined are plain radiographs preoperatively, at 12 weeks and 1 year postoperatively. The measured radiographic parameters will be the focal lordosis, disc height, lordosis C2-C7, lordosis C1-C7 and the vertical axis sagittal (SVA) C2-C7. Patients the Neck Disability Index questionnaire (NDI) was administered before surgery, after three months after surgery and after one year. The coefficient resulted from individual questionnaires will be crosswise with their assigned post-operative radiological parameters.

Results: It was detected an improvement of the sagittal profile in almost all cases. Preliminary data show a correlation between the reduction of lordosis is focal that total with a worse clinical outcome measured by the NDI. Conversely an improvement in post-operative cervical sagittal balance of parameters seems to be correlated with a marked clinical improvement.

Conclusions: In the study population, the improvement of focal lordosis seems significantly correlated with an improvement of the general lordosis (C1-C7 and C2-C7). An improvement of cervical balance parameters, seems to be associated with a good postoperative outcome with a reduction of NDI. Further studies with expansion of the series are still required to establish accurate statistically significant results correlations.
Acupuncture for pain management in evidence-based medicine
Taqee Ansari Mohammed, Mohammed Al Bassir Rahamani

Pain is an enormous and prevalent problem that troubles people of all ages worldwide. The effectiveness of acupuncture for pain management has been strongly verified by large randomized controlled trials (RCTs) and meta-analyses. Increasing numbers of patients with pain have accepted acupuncture treatment worldwide. However, some challenges exist in establishing evidence for the efficacy of acupuncture. A more applicable and innovative research methodology that can reflect the effect of acupuncture in the settings of daily clinical practice needs to be developed.

Introduction: Pain is “an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage. The previous experience of acupuncture research studies are invaluable for researchers to recognize the limitations and challenges of research designs and would help to move the field forward in future research. For example, the design of an adequate sham control, involvement of skilled and experienced acupuncturists, adequate outcome measures in the clinical trials, and the discovery of physiological effects of acupuncture in basic science are all important tasks for acupuncture researchers to address and solve. Acupuncture is a complex intervention and focuses on individualized treatment. Other challenges also exist in the clinical research of acupuncture. One challenge is the involvement of the acupuncturist. Challenges and future directions of acupuncture research for pain conditions in EBM.

High-quality RCTs and meta-analysis have increasingly produced robust evidence of the effectiveness of acupuncture for pain conditions, although nonspecific physiologic response to the needle insertion and the nature of holistic character of acupuncture treatment lead to many challenges in the research designs that reflect the daily clinical acupuncture practice.

Individual patient data meta-analysis and large RCTs of acupuncture for pain conditions. In recent years, studies have increasingly provided some evidence for using acupuncture for pain management. In 2012, an individual patient data meta-analysis was conducted by Andrew et al to evaluate the effectiveness of acupuncture for four types of chronic pain: back and neck pain, osteoarthritis, chronic headache, and shoulder pain. The result reflects that acupuncture was superior to sham acupuncture controls and to the usual care controls in all four chronic pain conditions.

Discussion: As the newest revolution in the field of medical science, EBM has converted the classic authoritarian expert-based medicine and become the fundamental basis for clinical practice.

Conclusion: In recent years, large RCTs and meta-analysis of the effectiveness of acupuncture have greatly advanced our knowledge of acupuncture. Increasingly more patients worldwide now accept acupuncture treatment. Challenges remain in the course of establishing evidence on acupuncture, and have no conflicts of interest and no financial interests related to the material of this manuscript.

Keywords: acupuncture; evidence-based medicine; pain management; research methodology

P117
Intraoperative dexamethasone administration impairs wound healing, but not the clinical outcome in dorsal cervical instrumentation in patients with cervical myelopathy
Christian Blume, Henrich Wiederhold, Hans Clusmann, Christian Andreas Mueller

Objectives: Cervical spondylotic myelopathy (CSM) is a progressive disease and the most common cause of chronic and slowly progressive spinal cord injury. Glucocorticoids have obvious anti-inflammatory effects, are able to reduce pain and spinal cord edema. However, there are no clinical data, whether patients with CSM undergoing dorsal decompression and instrumentation have a clinical benefit from intraoperative dexamethasone bolus. The aim of this study was to investigate the influence of dexamethasone administration on wound healing, infection, and clinical outcome in patients with posterior cervical decompression and fusion for multilevel CSM.
Methods: Retrospective study on postoperative results in 49 patients with CSM undergoing dorsal instrumentation and decompression of the cervical spine in our department between 2008 to 2013. Administration of dexamethasone (40 mg) during surgery depended on the senior surgeons decision. Patients were divided in two groups: Dexamethasone-Group (DG) (n=25) and non-DG (nDG) (n=24). All patients were monitored for preoperative neurological symptoms and postoperative neurological status. Clinical follow up was evaluated through questionnaires including NDI and mJOA Score.

Results: From 2008 to 2013 dorsal instrumentation and decompression was performed in 49 patients with CSM (17 female). Mean age was 68.12±12.22 (p=0.302). DG and nDG showed no significant statistically differences in terms of pre-operative findings. The intraoperative findings showed a significant difference in terms of blood loss (DG 900ml ± 469.35 versus nDG 650ml ± 692.52, p=0.025). Five patients of the DG had wound healing complications compared to patients (n=0) in the nDG group (p=0.021). Apart from that we did not observe any significant differences between the two groups regarding complications. The postoperative outcome, as assessed by the postoperative NDI and mJOA score (median follow up 29 months) showed no statistically significant difference between the two groups (DG vs. nDG).

Discussion: Intraoperative Dexamethasone administration had no influence on the postoperative neurological status and the follow up outcome. However, there was a statistically significant higher rate of wound infections in the DG. This data supports the hypothesis of a missing clinical benefit of dexamethasone bolus application intraoperatively.

Conclusion: These results should be verified in larger prospective randomized trial.

P118
Endogenous angiogenic response in cervical spondylotic myelopathy – a pilot series
Christian Blume, Hans Clusmann, Maximilian Schmeisser, Lars Brandenburg, Christian Andreas Mueller

Objective: The aim of this prospective study was to evaluate the levels of angiogenic mediators in cerebrospinal fluid (CSF) and blood serum (BS) in patients with cervical spondylotic myelopathy (CSM).

Methods: Patients with CSM who underwent lumbar myelography CSF and BS were sampled. Patients were monitored for neurological symptoms including NDI and mJOA. Clinical follow up with examination and questionnaires were performed preoperatively (preop), 5 days, 6 weeks and every 3 months (up to 18 months) postop. A control group with preop CSF and BS samples was formed from patients with abdominal aortic aneurysm surgery (AAA-group), who had a lumbar drain for intradural pressure monitoring. The control group was monitored to exclude neurological signs of CSM (mJOA). The samples were evaluated with ELISA. The angiogenic protein-concentrations were measured in CSF and BS in pg/ml: PDGF-BB (Platelet-derived growth factor), Endoglin, Angiopoietin-2, Endothelin-1, VEGF-A, C, D (Vascular Endothelial Growth Factor), FGF-1 and 2 (Fibroblast Growth Factor), EGF (Epidermal Growth Factor).

Results: Overall 26 patients were included. CSM-group 14 patients (mean age 64 years), AAA-group 12 patients (mean age 58 years (p=0.178)). Mean preop scores: mJOA CSM-group 9.2, AAA-group 17.0 (p= <0.001); NDI CSM-group 49.7, AAA-group 1.2 (p= <0.001). We identified significant differences in the CSF preop: Angiopoietin-2 CSM-group 243.6 vs AAA-group 388.2 (p=0.019); VEGF-A CSM-group 12.3 vs AAA-group 5.0 (p=0.019). In BS, only Endoglin was different in CSM-group 1526.9 vs AAA-group 975.4 (p=0.024). In the clinical follow up examinations of the CSM-group mJOA and NDI showed significant improvement from the third month postop.

Discussion: The groups are clearly distinguished regarding the clinical signs of myelopathy. Increased levels of angiogenic factors in the CSF are associated with the diagnosis of CSM. From a variety of tested items, only Endoglin was different in BS. Thus, angiogenic factors could contribute to an increased induction of angiogenesis (VEGF-A, Endoglin) and a dysregulation of microvascular permeability (Angiopoietin-2) in patients with CSM. A limitation is the non-availability of postoperative CSF, in general.

Conclusion: These factors may serve as tools for further research on prognosis and pathophysiology. At first, the relevant factors may be tested in respective animal models with CSM.
Factors relating successful ventilator weaning in cervical spinal cord-injured patients

Torphong Bunnaprasert, Kanlaya Chunja

**Introduction:** Respiratory complications are the catastrophic problem in Spinal Cord Injured (SCI) patients, leading to death. In cases of Cervical SCI, they usually end up with using the mechanical ventilator if the patients are not able to control their respiratory muscles. The weaning program should be performed early as possible to prevent the difficulty for weaning-off. Objective is to study the predicting factors that effect of the success in SCI ventilator weaning.

**Materials and methods:** Forty-two SCI patients with ventilator were included in this retrospective study. Data were collected from 2013 to 2016, by using hospital database. Univariate analysis was used to identify the factors related to weaning success. Multivariate analysis was used to investigate the independent factors providing significant association with weaning successful.

**Results:** Among 42 Spinal Cord Injury patients with ventilator, there were 38 cases (90.47%) achieving successful weaning. Level of consciousness (OR=11.1 95%CI 3.4,59.5), normal chest-film (OR=5.8 95%CI 1.2,59.4), normal vital sign (OR=25.5 95%CI 1.42,137.5), and normal hemoglobin/hematocrit (OR=19.8 95%CI 1.17,106.8) were the factors related to successful rate of ventilator weaning.

**Discussion:** There are several factors that associate with the success rate of ventilator weaning in Cervical Spinal Cord-Injured (SCI) patients. By using 3 steps of the weaning protocols including preparation of the readiness to wean, weaning process and extubation process, we found that 38 of 42 SCI patients had successful weaning with 4 important factors.

**Conclusion:** The success rate of ventilator weaning of this study is 90.47%. In our practice, the patients’ conscious level, vital signs, chest film and hemoglobin/hematocrit should be evaluated or concerned before and between the weaning processes.

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Lateral olfactory tract usher substance enhanced axonal regeneration and functional recovery after spinal cord injury in adult mice

Shuhei Ito, Narihito Nagoshi, Osahiko Tsujii, Shinsuke Shibata, Munehisa Shionzaki, Morio Matsumoto, Kohtaro Takei, Hideyuki Okano, Masaya Nakamura

**Introduction:** Lateral olfactory tract usher substance (LOTUS) is a membrane and secreted protein that functions as a molecule for neuronal circuit formation, and combines with the Nogo receptor 1 to antagonize several axonal growth inhibitors. LOTUS also promotes axonal process extension. It has been reported that in LOTUS knockout mice, motor function recovery after spinal cord injury (SCI) significantly deteriorated as compared with wild-type mice. The purpose of this study is to evaluate axonal regeneration and motor function recovery after SCI in LOTUS-overexpressing mice.

**Materials and methods:** Contusive SCI was induced at the Th10 level in LOTUS-overexpressing mice (LOTUS group; n=22) and wild-type mice (control group; n=16) as reported previously, and hindlimb motor function was evaluated until six weeks after SCI using BMS score, DigiGate system and rotarod test. Six weeks after SCI, biotinylated dextran amine (BDA) was injected into the primary motor cortex in both groups to trace corticospinal tract (CST). Two weeks after injection, electrophysiological analysis using spinal cord-evoked potential was conducted. After the mice were sacrificed, histological analyses were performed.

**Results:** In the LOTUS group, the BMS score showed significant better functional recovery compared with that in the control group at a week after SCI and thereafter. In the LOTUS group, DigiGate analysis revealed significant longer stride length, and rotarod test showed significant longer total run time at 6 weeks after SCI. Electrophysiological analysis revealed significant shorter latency in the LOTUS group 8 weeks after SCI. Histological analyses revealed that the CST axons labeled with BDA significantly increased at the rostral sites in the LOTUS group compared to the control group. Furthermore, the areas of 5-HT positive serotonergic fibers and p-GAP43...
positive regenerating fibers significantly increased at the caudal sites in the LOTUS group. In the LOTUS group, the transverse areas of spinal cord and LFB positive myelination area significantly increased at the epicenter.

**Conclusion:** Taken together, LOTUS showed beneficial effects for functional recovery in SCI by promoting axonal regeneration and neuronal protection. In the future, we will evaluate the efficacy of LOTUS overexpressing neural stem cell transplantation in the injured spinal cord.

**P123**

**Pretreatment with a gamma-secretase inhibitor prevents tumor-like overgrowth in human iPSC-derived transplants for spinal cord injury**

*Toshiki Okubo, Narihito Nagoshi, Jun Kohyama, Osahiko Tuji, Morio Matsumoto, Hideyuki Okano, Masaya Nakamura*

**Introduction:** We previously reported that transplantation of certain neural stem/progenitor cells derived from human iPS cells (hiPSC-NS/PCs) into the injured spinal cord resulted in tumor-like overgrowth and subsequent deterioration of motor function. Control of tumor-like overgrowth is critical in clinical applications of iPSC-based transplantation therapy for spinal cord injury (SCI). Remnant immature NS/PCs must be removed or induced into more mature cell types, which may avoid tumor-like overgrowth following transplantation. Meanwhile, Notch signaling controls the neuronal differentiation of NS/PCs, and inhibition of this signaling with gamma-secretase inhibitor (GSI) induces NS/PCs to differentiate into more mature neuronal cells with limited proliferation. The purpose of the present study was to elucidate the effects of GSI on tumorigenic hiPSC-NS/PCs.

**Materials and methods:** hiPSC-NS/PCs, a potentially tumor-like overgrowth cell line, were cultured with GSI. We induced contusive SCI in mice and transplanted hiPSC-NS/PCs with or without GSI pretreatment 9 days after SCI. The growth/survival and histological analyses of transplanted cells were examined with bioluminescence imaging (BLI) and immunohistochemistry. Behavioral analyses were also performed by BMS score.

**Results:** BLI analyses revealed that the photon counts of transplanted cells increased more than 10-fold from their initial values, suggesting tumor-like overgrowth in the non-GSI pretreatment group, in accordance with the motor functional deterioration. However, in the GSI pretreatment group, the photon counts of transplanted cells reached a plateau around 4 weeks after transplantation, which resulted in no tumor-like overgrowth through inhibition of cell proliferation and long-lasting motor functional recovery. In the GSI pretreatment group, the proportion of pan-ELAVL+ mature neuron increased significantly, which were further integrated with the reconstruction of the host neuronal network and form synapses. To examine neurotransmitter phenotype of transplant-derived mature neurons, in the GSI pretreatment group, the proportion of glutamic acid decarboxylase 67 + GABAergic neuron was also significantly increased compared with the non-GSI pretreatment group.

**Discussion and conclusion:** We confirm that GSI pretreatment of hiPSC-NS/PCs prevent tumor-like overgrowth of transplanted cells by inhibiting cell proliferation, resulting in safe and long-lasting functional recovery. Pretreatment of hiPSC-NS/PCs with GSI prior to transplantation can improve their safety in clinical setting.

**P124**

**Transplanted human iPS cell-derived neuronal precursor cells promote motor functional recovery after chronic spinal cord injury**

*Toshiki Okubo, Narihito Nagoshi, Jun Kohyama, Osahiko Tuji, Morio Matsumoto, Hideyuki Okano, Masaya Nakamura*

**Introduction:** Previously we have reported that neural stem/progenitor cells derived from human iPS cells (hiPSC-NS/PCs) pretreated with gamma-secretase inhibitor (GSI), which called human iPS cell-derived neuronal precursor cells (hiPSC-NeuPCs), promoted more neuronal differentiation and maturation in vitro. And in vivo, transplantation of these cells differentiated into more mature neurons without tumorigenicity and maintained greater functional recovery at sub-acute spinal cord injury (SCI). The purpose of the present study was to elucidate the effectiveness of transplanted these cells for chronic SCI in mice.

**Materials and methods:** To obtain hiPSC-NeuPCs, safe hiPSC (201B7)-NS/PCs were pretreated with GSI for 1 day before transplantation. We induced contusive SCI at T10 level, and transplanted hiPSC-NeuPCs (NeuPCs) to the injured spinal cord.
group), hiPSC-NS/PCs (Control group) or PBS (PBS group) at 42 days after injury.

Results: At 89 days after transplantation, immunohistochemical findings revealed that the transplanted cells survived and did not cause tumor-like overgrowth. The proportion of pan-ELAVL positive mature neuron was significantly increased in the NeuPC group, and more growth-associated protein 43-positive fibers were observed, indicating that the axonal regrowth was promoted. Quantitative analysis revealed that the transverse area of the spinal cord at lesion epi-center and +4mm caudal were significantly decreased in the other groups compared with the NeuPC group, suggesting that the NeuPC group transplantation prevented atrophy of the injured spinal cord. Luxol fast blue staining also revealed a greater preservation of myelinated areas in the NeuPC group compared with the other groups. The functional recovery was enhanced at 56 days after transplantation and maintained thereafter in the NeuPC group compared with the other groups.

Discussion and conclusion: These results indicate that only transplantation of hiPSC-NeuPCs differentiated into more mature neurons and maintained functional recovery even at chronic SCI. However, the degree of functional recovery was smaller at chronic phase compared with sub-acute phase. Therefore, we will evaluate efficacy of hiPSC-NeuPC transplantation combined with rehabilitation therapy to enhance greater functional recovery even at chronic SCI.

P125
Medullary lesions in odontoid fractures
Anton Kathrein, Ingrid Sitte

Introduction: Odontoid fractures afflicted with a traumatic lesion of the spinal cord are rare but very critical pathologies. Little is known about the prevalence, evidence based treatment concepts and prognosis of those injuries. In a retrospective study we evaluated our patients clinically and by MRI follow up. We also tried to define prognostic factors.

Materials and methods: Within a 20 year period 234 patients with an odontoid fracture were diagnosed and treated. Out of these 234 patients 31 patients (13%) sustained also a medullary lesion. Pathomorphologically we detected medullary contusions with edemas and / or intramedullary hemorrhages, in one case even a complete transsection of the spinal cord could be proved. In 16 patients initial MRI evaluation could be performed.

Results: We lost 24 of these 31 patients within the first days more often than not by respiratory insufficiency. 7 patients survived and could be followed up clinically, neurologically and by MRI. 6 of these patients presented with an oedema of the cord at the fracture level and only one with an additional hemorrhage. Clinically 4 of 7 patients recovered completely to normal, structural lesions remained in 5 of 7 patients. Gliotic changes could be detected in 5 of 7 patients.

Discussion: In the early stage the prognosis of these severe injuries is very critical, High grad instability can lead to additional iatrogenic trauma and nursing of those patients is always challenging. Therefore early surgical stabilization in order to increase prognosis and to prevent further complications is rational.

Conclusion: The individual course of a patient usually can not be expected in advance. Early pre- or postop MRI can be of prognostic value as patients with edema have much better prognosis than patients with intramedulary embleedings.

P126
Treatment in traumatic central cord syndrome – Neurologic recovery and complications

Introduction: Traumatic central cord syndrome (TCCS) is an infrequent injury (9% of SCI), and the role of surgery in neurologic recovery has not been clarified yet. Our aim was to assess neurologic improvement and complications associated with the different kinds of treatments for TCCS.

Materials and methods: Retrospective analysis. Inclusion criteria: >60 years old; TCCS. Exclusion: fracture and/ or unstable ligament injury.
Results: 214 patients with cervical SCI were admitted to our center between 2010 and 2015. 23 (mean age 70.4, 78.3% men) patients met the inclusion criteria. 14 patients underwent surgical treatment (ST) and 9 nonsurgical (nST). 42.9% ST patients and just one nST patient had an ASIA C at admission. Mean time from admission to surgery was 7.6 days. Mean follow-up was 26.2 months (1-6; 76.2% >12m). 8 patients suffered some kind of in-hospital major complication; the most frequent were respiratory complications (3 pneumonia cases, 1 re-intubation). 6 ST and 2 nST suffered in-hospital major complications, without being statistically significant. 2 patients (8.7%) died during hospitalization (1 ST, 1 nST). Patients >70 years of age and those with a Charlson Comorbidity Index (CCI) score > 3 had significantly more risk of suffering from major complications (OR = 12 (IC 95% = 1.77-98) and 14 (IC 95% = 1.4-73.91) respectively. 3 patients (ST) improved their ASIA scale score on discharge, and 3 (1 ST, 2 nST) at the end of follow-up. No significant differences between the two groups regarding neurologic improvement or any other variable were found.

Conclusion: 34.8% of > 60 years old patients treated for TCCS will suffer some kind of major complications. In our series age (>70) and comborbidities (CCI>3) seem to be related with a higher risk of major complications. No differences regarding neurologic improvement between the two kinds of treatment were found. Surgery does not seem to increase the risk of in-hospital major complications in our sample. Randomized prospective studies without selection bias and an appropriate sample size are necessary to elucidate what is the best treatment for patients with TCCS.

P127
Analysis of the parameters of the cervical spine sagittal balance in patients with cervical spine kyphosis
Vladimir Sergeevich Klimov, Vladimir Germanovich Letyagin, Alexey Vladimirovich Evsyukov, Vitaly Vasilevich Stepanenko

Objective: To describe the surgical strategy in correction of marked cervical kyphotic deformity in 12 cases which were caused by various etiologies. Other aims are to report the possibility of complications and to demonstrate our technique of multilevel cervical surgery in providing optimal lordotic neck and the role of the sagittal balance of the cervical spine.

Materials and methods: 12 patients with cervical imbalance underwent surgery. 7 male and 5 females. 7 patients after tumor resections, 5 of them with post-laminectomy syndrome and 2 patients were anterior surgery and fusion; 4 patients with trauma, 3 of them failed cervical trauma surgery and 1 patient with fibrous dysplasia of the cervical spine. Cervical sagittal balance parameters include: angular alignment (C2–C7 SVA, thoracic inlet angle - TIA, T1 slope, C2–C7 Cobb angles. With consideration of surgical management, combined 360° anterior posterior or 540° surgery were done in 6. In 4 cases were performed anterior cervical surgery, in 2 - posterior cervical surgery.

Results: 12 patients showed good outcome. Optimal alignment was presented in 10, in 2 - suboptimal alignment. We have not seen the growth of neurological deficits in any case. Unfortunately, despite reduction of the curvature of the rods, only incomplete improvement of neurological deficit was demonstrated. Analyses revealed significant correlations between C2–7 angle and C2-C7 SVA in patients with kyphotic deformity and can allow good clinical and neurological results.

Conclusion: Significant analysis of the parameters of the cervical spine sagittal balance and addition to corrected surgery can allow good outcome.

P128
Surgical planning for severe cervical deformity using a 3D Model
Juan Barges-Coll, Juan Barges-Coll, Rodolfo Maduri

Introduction: Cervical deformities are among the most challenging problems for spinal surgeons and can cause disability and pain. Disability, in the form of myelopathy. In these challenging cases, osteotomies are necessary to mobilize the rigid spine and to obtain the desired correction, but they can be associated with increased risk of complications. Careful preoperative planning and a complete understanding of the anatomic variations allow patient-tailored approaches with and case specific techniques for the optimal and safe treatment. 3D modeling has been
introduced into the surgical arena as a tool for better understanding the complex underlying anatomy.

**Material and methods:** We present three cases with diagnosed mild cervical myelopathy associated with a fixed cervical kyphotic deformity for which surgical decompression and deformity correction. The cervical CT images of the 3 patients were imported into the Mimics Innovation Suite (Materialise NV, Belgium), a certified medical imaging manipulation software suite. The algorithm interpolates all 2D masks to generate a 3D model of the cervical spine. This model is then “edited” to include only the specific region of interest, to make it suitable for 3D printing. Analysis of the 3D model clearly shows the location ankylosis, in addition to other details. Osteotomies for deformity correction were planned using the fine detail of the 3D model.

**Discussion:** Planning is a critical step for correct decision making. Attempts have been made to understand the pathologies and complex anatomical structure. As a modern concept, we can now compare the current practice that depends on MRI and CT imaging with 3D printed models to augment surgical planning and education. The complex 3D anatomy and pathology of the spine remains difficult with 2D imaging, (CT MRI), eventhough it remains the standard for the pre- and postoperative evaluation of the spine patient.

**Conclusion:** Preoperatively, 3D models can be used to improve understanding of related pathology. With much current attention focused on the importance of sagittal balance in spinal reconstruction, such tools can also enhance 3D interpretation and surgical planning. As 3D printing technology evolves and costs decrease, patient-specific 3D printing may become more widespread and even routine for both clinical and educational uses.

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**P129**

**MR diffusion tensor imaging and fiber tracking in spinal cord lesions**

**Stefan Leis, Fritz Klausner, Eugen Trinka, Mark R. McCoy, Stefan Golaszewski**

**Introduction:** Magnetic resonance diffusion tensor imaging (MR DTI) can be used to visualize neural pathways within white matter (tractography or fiber tracking). While fiber tracking is of increasing importance in the assessment of brain lesions like space-occupying tumors, experience with spinal cord lesions is limited primarily due to technical limitations.

**Objective:** To evaluate the feasibility of MR fiber tracking to detect spinal cord lesions.

**Patients and methods:** From September 2012 to January 2017 MR-DTI was performed in 31 patients (59.5 +/- 15.9 y.o., 6 female) on a Philips Achieva 3T MRI scanner. All but one patients had spinal cord lesions of different aetiologies (traumatic compressive myelopathy, n=18; ischemia, n=8; myelitis, n=4; and psychogenic paraparesis, n=1). Level of injury was cervical spine in 17 and thoracic spine in 13 patients. The extent of motor and sensory impairment was classified using the International Standards for Neurological Classification of Spinal Cord Injury (ISNCSCI). Somatosensory and motor evoked potentials were done whenever possible.

**Results:** In 16 patients fiber tracking showed rarefaction or disconnection of fibers at the level of injury. MR DTI data could not be analysed due to movement and susceptibility artefacts in 7 patients. No discontinuity of fibers was found in the patient with psychogenic paraparesis.

**Conclusion:** MR DTI fiber tracking is capable to detect lesions of different origin in spinal white matter. Quantification of lesion extent and correlation with clinical and electrophysiological data is part of ongoing studies.

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**P130**

**A non-surgical technique for minimally-invasive complete spinal cord lesion in minipigs**

**Elena Esra Foditsch, Reinhold R. Zimmermann, Ludwig L. Aigner, Karin K. Roeder, Ioan I. Hutu, Günter G. Janetschek, Gratian G. Miclaus**

**Introduction:** Spinal Cord Injury (SCI) is a devastating medical problem associated with severe disability and co-morbidities. Current porcine SCI models require an open surgery for laminectomy and various SCI models exist. The inherent surgical risks are mainly the potential blood loss, CSF leakage and the recovery from a medium to large surgery. The aim of this study was to develop a minimally invasive method for controlled complete SCI lesion in minipigs.
Materials and methods: Ten female, adult Göttingen minipigs were included. All steps during the procedure followed by CT scans. In general anesthesia, an initial CT scan of the spinal cord was made and the angle for needle guidance to the intervertebral space Th13/L1 assessed. After skin incision, the spinal channel was punctured. The needle was introduced into the epidural fat tissue. A hydrophilic guide wire was inserted into the extradural space until level Th8. After dilatation of the insertion site, a kyphoplasty balloon catheter was inserted to level Th12 and inflated to 2 atm. Balloon filling was maintained and controlled by a manometer for 30 minutes. After completion and removal of the balloon catheter, a final CT scan was made.

Results: The procedure was highly standardized and reproducible. Duration was about 60 minutes. Only minor skin bleeding was seen. Piercing of the dura was excluded by CT. The lesion level could be clearly defined. Balloon pressure was maintained without losses and led to a complete compression of the spinal cord, clearly shown by CT scans. No intradural bleeding was observed. SCI recovery was fast and body balance restored immediately after SCI.

Discussion: All risks of the open surgery may be excluded by this technique. Standardization and completeness can be easily proven by CT images. The CT-SCI lesion technique is smart as it avoids a long surgery and a big trauma.

Conclusion: We could establish a new, minimally invasive, highly standardized, CT-guided SCI procedure for large animal models. This technique can be further adapted for incomplete SCI due to the controlled approach. We assume it may completely replace open surgery for experimental compression SCI in large animals in the future.

P131
Surgical treatment of spondylotic multilevel cervical myelopathy. Comparative study of 4 anterior reconstruction techniques
Rafael Gonzalez Diaz, Enrique Peces Garcia, Rosa Maria Egea Gamez, Jose Isaac Losada Vidal

Introduction: Surgery for spondylotic cervical myelopathy allows several types of anterior reconstruction after decompression.

Objective: To compare results and complications with 4 different anterior reconstruction techniques, including hybrid reconstruction. The techniques were: Discectomy and fusion with iliac crest bonegraft (1), discectomy and fusion with local graft and cages (2), corpectomy of two or more levels and fusion with mesh cages (3) and hybrid reconstruction (corpectomy combined with discectomy) (4).

Materials and methods: Comparative retrospective cohort study of patients with anterior or posterior spondylotic cervical myelopathy of three or four levels using four different anterior reconstruction techniques. We analyzed 130 patients who underwent these criteria from 2000 to 2013. Patients were divided into the 4 groups previously described. In all cases a type of semi-rigid plate was used. The choice between techniques 1-2 and 3-4 depended on the presence of stenosis behind the vertebral body.

Radiological findings (fusion, lordosis, implant sinking, complications, changes in adjacent levels) and clinical assessments (Neck disability index (NDI), Nurick scale and Japanese Orthopedic Scale (JOAS) were analyzed.

Results: The sample was homogeneous in all groups. There were no significant differences in clinical parameters evaluated in the different groups. We found greater mechanical complications in the corpectomy group (3), which required surgical revision (mesh cagedislocation, subsidence, and increased loss of cervical lordosis). No significant differences were found in any groups regarding changes in adjacent levels (osteophytes, degeneration). There were no significant differences in the two discectomy groups, although the postoperative stay was increased in one day when the iliac bonegraft was taken (group 1) and a lower (non-significant) fusion rate in the patients in group 2. The technique of hybrid reconstruction (4) was correlated with better outcome in the final lordosis (significant), lower implant subsidence without any mechanical complication.

Conclusions: The hybrid reconstruction technique, when it is necessary to perform such technique, comparing with other anterior reconstruction techniques, seems an effective alternative with a lower rate of complications and similar clinical results.
P132
Long-term outcome of a cervical spine implant
Kerstin Schwenker, Albert Eckert, Martin A. Krombholz, Alexander B. Kunz, Martin Seidl, Wolfgang P. Piotrowski, Raffaele Nardone, Eugen Trinka, Stefan M. Golaszewski

Introduction: This case study examines long-term biomechanical changes caused by a total disc replacement in a 34-year old female patient after traumatic incomplete spinal cord injury (SCI) with incomplete transverse section C5/C6 and cervical myelopathy, AIS D sub C5.

Materials and methods: 11-years follow-ups are reported. First MRI was done prior to surgery. Clinical, radiological (X-rays, CT, MRI, myelography of the spine) and electrophysiological examinations (Somatosensory and Motor Evoked Potentials SSEPs/MEPs, NLG, EMG) were acquired yearly because of fluctuating neurological symptoms.

Results: After implant the patient showed slight problems with bladder function and hypoesthesia in the complete left leg. 9 months later intermittent pain in the cervical spine and a worsening of bladder function occurred. CT scans, X-rays and myelography proved an osteophyte level C5/6. Slight protrusions within the presurgical MRI in the level C4/C5, C6/C7 became more prominent. In the further course heterotopic ossification in the level of implant and disc protrusions were progressive and were finally diagnosed as disc bulging in 7-years follow-up report for MRI. SSEPs were normal, MEPs showed a slight increase of the resting motor threshold of the left leg. NLG/EMG was regular. The 11-years follow-up report showed further aggravation of the clinical parameters.

Discussion: Heterotopic ossification in the level of implant and disc herniation in the adjacent spine segments were detected at least 9 months post implantation with progression in the further time course. Altered biomechanical stress due to the implant could be responsible to these secondary changes of the cervical spine beyond age-related degenerative alterations of the cervical spine, already beginning within the first year after surgery and with worsening of clinical symptoms.

Conclusion: Therefore, long-term biomechanical effects of implantation should be taken into consideration and thus should lead to further research implant improvement with regard to material and biomechanics.

P133
Marked cervical kyphotic deformity – report of 22 cases with special reference to multilevel subaxial cervical posterior osteotomy
Abolfazl Rahimizadeh

Introduction: Surgical management of the cervical kyphosis is rarely described in the literature. Herein we will describe our surgical strategy in correction of the cervical kyphotic deformity in 22 cases which were caused by a various etiologyos. Other aims are to report the possibility of complications and to demonstrate our technique of multilevel cervical osteotomy which is necessary for optimal lordotic neck. Osteotomy also might be helpful in prevention of segmental roots complications.

Method: 22 patients including 12 male and 10 females are presented with consideration of surgical management, combined 360 degree anterior posterior or 540 degree surgeries were done in 20. In 6 cases posterior cervical osteotomy was done.

Result: 21 patients showed good recovery. Optimal alignment was observe in 18, in 2 suboptimal alignment and in one it failed which was achieved later with extension of the construct. In one with good alignment delayed deterioration of neurological status which forced us to remove the rod. Unfortunately, despite reduction of the curvature of the rods, only some improvement of neurological deficit was demonstrated.

Conclusion: Management of the cervical spine kyphosis in particular severe ones pose a challenge to the surgeon. This means that precise preoperative decision making is necessary for correction of this deformity. Segmental root injuries which are due to severe foraminal stenosis and traction of the subaxial cervical roots remain the most frequent postoperative complication of excessive correction of the cervical kyphosis. However, multilevel cervical osteotomy described above might prevent this kind of complication. Furthermore, although, one stage surgery was done in majority of the cases, neurological deficit which was observed in only one case, result in that we believe two stage
surgery might permit the spinal cord and the corresponding roots to accommodate with new curvature with time.

Materials and methods: In this retrospective single-center study, 90 patients with cervical myelopathy (based on their medical history, physical examination and radiological investigation (such as MRI) underwent single or multi-level anterior cervical discectomy and fusion (ACDF), anterior cervical corpectomy and fusion (ACCF) or posterior laminectomy and fusion from 2011 to 2015. We utilized the SF-36, VAS, NDI and Nurick grade in our patients preoperatively and again 6 weeks, 3, 6 and 12 month post-operatively to assessed the outcome of surgery.

Results: The study group consisted of 56 male (62.2%) and 34 female patients (37.8%) and the age of patients ranged between 27 to 87 years. Comparison of preoperative Analyzing the obtained VAS, Nurick, SF-36 parameters and NDI scores showed significant improvement. (p value < 0.001) Also our analysis showed that the female’s VAS scores improved more significantly than men’s VAS score during the follows up. (p-value<0.05) But age and different kinds of surgery didn’t significantly effect on the improvement of none of VAS, Nurick, NDI and all parameters of SF-36. (p-value > 0.05)

Conclusion: Cervical surgeries in patients with different severity of CSM, beyonds their motor and sensory functional improvement can improve different aspects of their quality of life after one year follow up.

Keywords: cervical spondylotic myelopathy, surgical outcome, quality of life

Symptomatic adjacent segment disease after anterior cervical discectomy for one-level degenerative disc disease
Roland D. Donk, Wim I. M. Verhagen, André Verbeek, Allard Hosman, Ronald Bartels

Study design: A prospective cohort of 142 patients underwent either anterior cervical discectomy alone, anterior cervical discectomy with fusion by cage standalone or anterior cervical discectomy with arthroplasty. We then followed up on their condition a mean of 9.1 ± 1.9 years (5.6–12.2 years) later.

Objective: We aimed to evaluate the annual rate of clinically symptomatic adjacent segment disease (ASD) and to analyze predictive factors.

Summary of background data: Until recent, ASD has been predominantly evaluated radiologically. It is not known whether all patients had complaints. A frequent cited annual rate of ASD is 2.9%, but a growing number of studies report a lower annual rate. Furthermore, maintaining motion to prevent ASD is one reason for implanting a cervical disc prosthesis. However, the results of studies contradict one another.

Anterior cervical pseudarthrosis – revision with bilateral posterior cervical cages
Jeffrey D. Coe, William Smith, Gillespy Mark, Jason Huffman, Bruce M. McCormack

Introduction: Pseudarthrosis after anterior cervical discectomy and fusion (ACDF) may result in persistent pain and disability. Posterior revision surgery results in higher healing rates, but is more extensive compared to anterior surgery. The objective of this study is to evaluate a novel minimally disruptive, tissue sparing posterior fusion using posterior cages and bone graft placed between the facet joints as treatment for symptomatic ACDF pseudarthrosis.

Materials and methods: A retrospective, multi-center, medical chart review was performed of 26 patients with symptomatic pseudarthrosis after ACDF treated with posterior cervical cages. Visual analog scale (VAS) for neck and arm pain, Neck Disability Index (NDI) and perioperative metrics were collected. Fusion at one year was determined via assessment of dynamic radiographs in all 26 patients and by CT scan in 17 patients.

Results: Mean OR time was 101.5 minutes, mean EBL was 85.2 mL and mean hospitalization was 1.4 days. Mean follow-up was 18.3 months. VAS neck and arm scores at latest follow-up improved significantly from 7.9 +/- 1.5 to 3.8 +/- 2.3 and 7.2 +/- 2.2 to 3.1 +/- 2.5, respectively; NDI scores decreased from 65.0 +/- 20.3 to 30.0 +/- 17.9. Fusion at one year was confirmed by CT in 17 patients and by dynamic radiographs in all 26 patients.

Discussion: ACDF pseudarthrosis revision using a tissue sparing posterior approach to place posterior cages between the facet joints is an effective surgical strategy in select patients. Along with positive clinical and
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radiologic outcomes, the procedure is associated with less blood loss, shorter operating times, and briefer hospital stays as compared to revision with lateral mass fixation or interspinous wiring.

Conclusion: This novel minimally disruptive, tissue sparing posterior technique using cages placed bilaterally between the facet joints is safe and effective for the treatment of symptomatic pseudarthrosis after ACDF.

P137
Reoperation rate of microscope-assisted and non-microscope anterior Cervical Discectomy and Fusion (ACDF) for treatment of degenerative cervical myeloradiculopathy
Torphong Bunnaprasert, Boonserm Pakdeenit

Introduction: It has been known that microscope-assisted ACDF provides various advantages, for instance, better magnification and superior illumination through its coaxial light source for safer, faster, and more extensive decompression. However, using routine microscope-assisted surgery takes longer operative time, higher costs and more technically demanding. There are no studies to compare the reoperation rate between non-microscope and microscope-assist surgery. Objective is to demonstrate whether microscope-assisted ACDF can decrease reoperation rate, increase postoperative fusion rate and decrease complications.

Materials and methods: It was retrospective descriptive study. We collected the patients with cervical spondylotic myelopathy or radiculopathy underwent ACDF with anterior cervical plating in our institution since 2006-2016 by single experienced spine surgeon. In microscope-assisted group, it had been brought into the operative field during meticulous decompression of the neural elements, endplate preparation, fusion and instrumentation. Demographic data radiographic study and clinical outcome were reviewed.

Results: From our study, 23 of 1,082 ACDF cases (2.12%) were reoperated; 20 non-microscope ACDF (86.96%) and 3 microscope ACDF (13.04%). Mean time-to-reoperation was 33.04 months (SD = 36.27). Most common cause of reoperation in both groups were adjacent segmental diseases (52.17% non-microscope group, 8.69% microscope-assisted group), following by residual disc protrusion or remnant of osteophyte in non-microscope ACDF (3 cases, 13.04%). No wound complication and similar fusion rate presented in both groups.

Discussion: Reopeation rate of 86.96% and 13.04% is found in patients who underwent non-microscope ACDF and microscope-assisted ACDF for treatment of degenerative cervical myeloradiculopathy respectively. Adjacent segment disease is still the most common cause of reoperation in patients who had previous ACDF surgery in both groups. Residual neural compression is infrequently found, however, there is one case that microscope ACDF (4.35%) has residual disc remaining which may cause from early introduction of microscopic surgery.

Conclusion: Microscope-assisted ACDF can help surgeon improve illumination, magnification, more extensive safer decompression. It may improve surgical outcome by decrease reoperation rate. However, non-microscope ACDF still provides favorable results and outcomes in majority of the patients in this study.

P138
Are unconstrained cervical artificial discs susceptible to migration? – an in vivo study
Hoon Choi, Naryan Yoganandan, Jamie Baisden

Introduction: Cervical arthroplasty is an area of active research due to the potential advantages of motion preservation and reduction of adjacent segment degeneration. This led to the introduction of a number of cervical artificial disc implants by companies, largely divided into constrained, semi-constrained, and unconstrained types. However, there have been independent reports of anterior migration and, sometimes disintegration, of non-constrained artificial discs. In vivo studies investigating the potential migration of the artificial disc are lacking.

Materials and methods: We performed cervical arthroplasty at C3-C4 with commercial cervical artificial disc implants in healthy female adult Alpine goats (45-60 kg) under general anesthesia. Twelve goats were equally divided into three groups of four: Group A received a constrained; Group B received a semi-constrained; and Group C received an unconstrained artificial disc. Intra- and post-operative radiographs were performed to confirm the position of the hardware. Goats received standard post-operative care, including analgesia, antibiotic prophylaxis,
regular diet, and ambulation. Goats were monitored in a veterinary unit for six months with radiography at regular intervals to confirm the position of the hardware.

**Results:** All twelve goats tolerated cervical arthroplasty well. All had satisfactory placement of the artificial disc implant on intra-operative radiography. All tolerated regular diet immediately after surgery. There was no change in behavior after surgery. There was no migration of the implants in Groups A and B. Complete anterior extrusion of the inferior plate out of the disc space and disintegration of the implant occurred within one week after surgery in three goats (75%) in Group C.

**Discussion:** Goat maintains the axial loading pattern similar to the human, and therefore, is an appropriate experimental model for longitudinal cervical spine studies. Unconstrained artificial disc implants rely on axial loading and limited range of motion of the disc segment to preserve integrity.

**Conclusion:** Unconstrained artificial disc implants are not recommended in individuals with a hypermobile neck and/or occupations involving head supported mass/helmets (in some civilian and military environments) resulting in additional axial loads and repetitive motions of the cervical spinal column.

An emergent magnetic resonance imaging (MRI) was performed and in boths cases revealed an anterior spinal epidural compressive hematoma extending from the surgical level to superior thoracic levels.

**Definition of case specific challenges**

Anterior cervical SEH extending to thoracic spine with emergent need of decompression

**Treatment:**

Case 1: 3 hours after the symptoms onset patient was submited to a an anterior approach through the previous one and drainage of hematoma of attempted with removal of a cage and aspiration. Drainage was unsuccessful so a posterior approach was performed. An extensive laminectomy C4-T2 was done and hematoma was successfully drained.

Case 2: 2 hours after symptoms onset patient was submited to an anterior approach through the previous one. Corpectomy of C6 was performed and a thin elastic urinary catheter was used to hematoma drainage. Reconstruction of done with tricortical iliac bone graft at the corpectomy site and fusion with plate.

**Complications and management:** Neurological recovery was obtained 12 to 24 hours after procedure and a year after surgery boths patients were neurologically asymptomatic.

The patient submited to posterior laminectomy complains of cervical pain with progressive cervical kyphosis whereas patients submited to corpectomy is asymptomatic.

**Conclusion:** Emergent SEH drainage is mandatory to obtain full neurological recovery. In boths cases presented full neurological recovery was obtained though with diferent mid-term and long-term consequences.

**P142**

Surgical results of posterior cervical fusion using O-arm based navigation system and new techniques with new devices

Keiji Wada, Ryo Tamaki, Hideaki Murata

**Objective:** To evaluate the surgical results of posterior cervical fusion using O-arm based navigation system and show the new techniques with new devices.

**Methods:** 22 patients were included in this study. All patients underwent posterior cervical fusion using O-arm based navigation system. 121 screws were inserted: 11 for C1 lateral mass (LM), 23 for C2 pedicle, 5 for C2 lamina, 4 for Magerl, 52 for lower cervical pedicle, and 26 for lower cervical LM. All screws were evaluated with postoperative CT. Perforation of the screws was evaluated with Neo’s classification. Complications regarding screw perforation were also investigated.

**Results:** A total of three screws were perforated. All three screws were lower cervical pedicle screws and were grade 1 perforation. No complications were observed regarding screw perforation.

**Discussion:** Posterior cervical fusion using O-arm based navigation system has been reported safe procedure. However, there have been some cases of screw perforation reported. This was due to vertebral rotation during the step of screw insertion. We recently used a new reference frame and new tapping devices and screw drivers.
with navigation. These devices helped screw insertion more accurately.

**Conclusion:** Posterior cervical fusion using O-arm based navigation system become more accurate with new navigation devices.

**P144**

**Cervical spine injuries in ankylosing spondylitis and dish – Are they different?**

Francesco C. Tamburrelli, Maurizio Genitiempo

**Introduction:** Frequently gathered in the same group due to the abnormal ossification of the cervical spine, Ankylosing Spondylitis (AS) and Diffuse Idiopathic Skeletal Hyperostosis (DISH) are quite different in terms of pathologic and radiologic features. These aspects seem to influence directly the behavior of the spine in case of trauma and influence the choice of the best treatment of the lesion. The objective of the presentation is to refer of a study made to investigate the clinical and radiologic aspects that differentiate the two very similar diseases, discuss surgical indications and the results of a case series with an minimum 1-year follow-up.

**Materials and methods**: Twenty-eight (12 AS and 16 DISH) consecutive fractures of the cervical spine were studied. Clinical history and neurologic status were recorded, radiologic aspects, the type of operation, the long-term follow-up at minimum 1 year were investigated. All patients except two were operated on.

**Results:** Two AS patients died for incoming complications before the operation while 10 were operated on by posterior stabilization. All patients of the DISH group were operated on, (6 anterior - 10 posterior). All the patients treated surgically survived at minimum 1-year follow-up. Two patients with preoperative neurologic compromise, ASIA B (one AS and one DISH), showed no significant improvement after the operation.

**Conclusions:** Typically in the DISH group the injury of the spine occurred preferentially at the disc level involving soft tissues and causing a very unstable lesion that requires frequently an anterior approach. In AS group the fracture happens in a completely ossified spine and typically runs through the disc, disc and bone and, less frequently, trough the bone. In AS fractures the risk of catastrophic neurologic damage is high in case of displacement although it is unlikely to occur and frequent is a delayed diagnosis. The fractures are difficult to reduce but generous to heal so in our case we carried out a posterior stabilization only without insisting in achieving a perfect reduction of the fracture. Although the above reported differences, the final outcome was the same in both the groups.

**P146**

**Assessment of causative factors related to prolonged postoperative dysphagia after anterior cervical discectomy and fusion**

Yoshinori Ishikawa, Naohisa Miyakoshi, Michio Hongo, Yuji Kasukawa, Daisuke Kudo, Yoichi Shimada

**Introduction:** Dysphagia (DG) that occurs after anterior cervical discectomy and fusion (ACDF) is a serious complication. Although most patients’ symptoms improve after a follow-up period, continued DG after discharge results in dissatisfaction and impaired lives. Herein, we examined data on long-term DG persisting for >1 month postoperatively.

**Materials and methods:** Twenty-three patients who underwent ACDF with plate-cage or modified Robinson-Smith procedures between 2005 and 2015 were retrospectively reviewed. Patients were divided into a DG or non-DG (NDG) group using the Bazaz grading system. Our comparison used the following causal factors: C2–7 cobb angles, OC2 angle, C2–7 sagittal vertical axis (SVA), C1–7 SVA, RTSS, RT3–4, and RT5–6 (retropharyngeal thickness at surgical site, C3–4, and C5–6, respectively). Protrusion of plate or grafted bone from the anterior border of vertebra (PRT) was assessed with the standing lateral X-ray at 1 week postoperatively. Operative procedures and time, estimated blood loss, and operation levels were evaluated. P values <0.05 were considered significant.

**Results:** The patients who underwent surgery at C2–7 SVA (31.1/21.3 mm, p = 0.02) and C1–7 SVA (43.0–29.4 mm, p = 0.01) showed statistical differences between groups. However, C2–7 cobb angles (8.9–10.4°), OC2 angle (19.8–17.3°), RTSS (15.9–16.6 mm), RT3–4 (11.2–11.2 mm), RT5–6 (18.1–16.2 mm), PRT (3.6–4.3
mm), operative procedure (plate-cage: 9 cases in both groups), operative time (175.5–172.6 min), and estimated blood loss (56.9–40.3 ml) did not show statistical differences (p > 0.05). C4–5 and C5–6 were the most frequent sites in 5 (45%) and 6 cases (50%) of the DG and NDG groups, respectively (p > 0.05). Eight cases (73%) of the DG group recovered from DG completely after a mean follow-up period of 17.4 months. Although three patients had DG after 37 months' follow-up, the symptoms were mild and rare.

Conclusion: Early detection and prevention of DG improves treatment results. Significant differences were observed for SVA. Increase of SVA in the early postoperative course suggests that patients compensate the difficulty of swallowing with increasing

**Figure (1a)** persistent drainage from the surgical wound (1b) lateral C-spine X-ray (1c) sagittal MRI after primary anterior cervical spine surgery

**Figure (2a)** Debridement, implant removal & esophageal defect repair (2b) Follow-up 18 months lateral C-spine X-ray after posterior spine surgery (2c) Clinical improvement

**P148**

**Fixation of Unstable C1-C2 Fracture-Dislocation without Neurologic Deficit**

**Torphong Bunnaprasert, Boonserm Pakdeenit**

**Background:** Due to the relatively wide spinal canal at the upper cervical spine, severely-displaced fracture or dislocated C1-C2 joints may have neurologically intact. However, unstable fracture and ligamentous injuries still require secure operative fixation and fusion.

**Introduction and material:** A 38-year-old business woman had severe neck, upper thoracic and right shoulder pain for 30 minutes after car accident. Examination showed marked tenderness at upper cervical and thoracic spine. Motor and sensory examination was intact. Plain X-rays demonstrated severely-displaced fracture at waist of odontoid process extended to C2 body with significant angulation (Anderson and D’Alonso type III). CT scan showed total C1 posterior dislocation form C2, marked lateral displacement and severe rotation (Fielding type IV). She also had T3 compression fracture and middle 1/3 of right clavicle fracture.

**Definition of case specific challenges:** severe displaced C1-C2 fracture without neurologic deficit

**Treatment:** She was placed in prone position. Realignment was done indirectly by using simple manipulation and
padding. Image-guided fluoroscopy was used until obtaining the optimal reduction. Posterior midline approach was done subperiosteally to identify the posterior elements of C1–C2. Severe ligamentous injury was found at C1–C2 junction. Careful hemostasis was used to verify the proper C1 screw entry points. Insertion of C1 lateral mass screws in this severe ligamentous-injured patient was quite unstable, thus, bicortical C1 lateral mass screws were inserted by free-hand technique. C2 pedicle screws were placed, later. Direct reduction of the dislocated C1–C2 facet joints was done using meticulous joint leverage by Penfield 4. In addition, rod contouring was done to assist reduction. Finally, rotational correction was achieved and posterior fusion with autologous bone graft was applied. **Complications and management:** none  
**Conclusion:** Postural fracture reduction was occurred during anesthesia and positioning even in case of significant displacement. Fixation in the unstable fracture and dislocation must be done carefully.

**Legend to the figure:**

1a 1b 1c
Figure (1a) Preoperative lateral X-rays (1b) Coronal CT image before surgery (1c) Postoperative coronal CT image (1 week after operative C1–C2 fixation and fusion)

2a 2b
Figure (2a) AP X-ray (2b) Lateral X-ray after operative C1–C2 fixation and fusion 12 months
P149
**Infective endocarditis with chief complaint of neck pain – two case reports**
Akiko Yamamoto, Tsuyoshi Kato, Shoji Tomizawa, Toshitaka Yoshii

**Introduction:** Infective endocarditis (IE) shows variable symptoms and it is reported that 1% of IE patients visited orthopedics department on the first contact. On the other hand, pyogenic spondylitis (PSD) also shows variable symptoms and PSD in cervical spine is rarely reported comparing to other parts. Because of such variable symptoms, it is difficult to diagnose both diseases in early stages. In this paper, we report the rare two PSD with IE cases with chief complaint of neck pain.

**Case 1:** 74-year-old man who visited our department with a chief complaint of neck pain and diagnosed as C5/6 PSD from MRI. Neck pain had gradually disappeared by using antibiotics, but his inflammatory reaction remained for 8 months. We considered that PSD flared up again, but MRI showed no sign for PSD. His blood culture was positive of Enterococcus faecalis, and his heart exam revealed systole murmur. The echocardiography revealed mitral vegetation and severe MR, so he was finally diagnosed as IE. After that, mitral valve replacement surgery was performed and his complaint disappeared.

**Case 2:** 79-year-old male on chronic hemodialysis presented to the emergency department with neck pain for lasting 2 weeks and numbness of both arms with a sudden onset. He had numbness and paresis of bilateral upper extremity and his blood examination showed severe elevation of inflammatory makers. MRI showed C3/4, C5/6 stenosis and high intensity at anterior of vertebra. His neurological findings had gradually got worse, on the other hand, blood culture and echocardiography revealed vegetation attached to the aortic valve. It has not been so long until the diagnosis of both diseases, but we could not decide immediately to perform cervical operation because of the vegetation and general risk. Finally, he underwent both operations and got better and better with no general complications.

**Discussion:** It is previously reported that IE and PSD is coexist in 9-30%, and most patients with IE and PSD are diagnosed as PSD at first. Spine surgery in the prone position for patients with IE has never been reported. It is still controversial whether or not we should perform spine surgery in prone position in a hurry.

**Conclusion:** We have experienced two cases of IE with chief complaint of neck pain. We should consider the association of IE in the treatment of PSD.

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P150
**Odontoid synchondrosis fracture in children 2 report of 6 cases with special reference to partial odontoidectomy via posterior only approach in an irreducible atlantoaxial dislocation**
Abolfazl Rahimizadeh

**Purpose:** To report 6 new cases of synchondrosis odontoid fracture with displacement where four were diagnosed early and two with delay. The fracture could be reduced with hyperextension with traction in four and open reduction in the other two.

**Background history:** Fractures of the odontoid process are among the most common cervical injuries in preschool children, occurring at an average age of 4 years. However, these injuries are infrequently reported in the literature. The reports are mostly confined to one or two cases. These are actually physeal injuries of the basilar synchondrosis between the odontoid process and the body of the axis. However, the odontoid process is angulated anteriorly in majority. Reduction by hyperextension or by cranial traction followed by rigid immobilization results in a high rate of union. In a minority, either suffering irreducible atlantoaxial dislocation, in those with severely angulated odontoid malunion, and in missed cases surgery is warranted.

**Material and method:** 3 boys and three girls at the age of 3 to 6 years with odontoid synchondrosis fracture are presented. Four were admitted shortly after injury and the other two, around 4 months after injury. Three of the acute cases were managed with immobilization in halo after reduction. The other acute one, a non-compliant child, underwent primary C1-C2 fixation. Both neglected ones were associated with irreducible atlantoaxial
One of these two, with odontoid non-union was reduced with facet releasing followed by a new reduction maneuver with polyester bands. The last one with malunited odontoid fracture could be reduced only after partial odontoidectomy via posterior only approach. Followed by C1-C2 fixation.

Result: All 6 patients recovered and fusion could be achieved

Conclusion: Where majority of acute synchondrosis odontoid fractures heal with external immobilization. Primary surgery has been advocated by some to obviate the need for long-term immobilization. The real challenge is in neglected one with account a small proportion of the fractures with fracture angulation more than 30 degree or significant odontoid displacement which require posterior C1-C2 fixation after alignment. In addition, neglected ones with chronic IAAD require more challenging surgery. From facet release, odontoidectomy and atlantoaxial stabilization. We will describe a new formulation protocol for management of irreducible atlantoaxial dislocation which will facilitate decision making. Furthermore, we will show demonstrative odontoidectomy via posterior only approach which is not done before.

P151
Posterior screw fixation for the treatment of the cervical spine injury
Alexander Vladimirovich Burtsev, Alexander Vadimovich Gubin, Olga Mikhailovna Pavlova

Introduction: The goal of this study is to determine indications for the posterior screw fixation for the treatment of the cervical spine injury.

Materials and methods: A retrospective analysis of 101 patients with cervical spine injury, were treated in Ilizarov Center from 2010 to 2014. We identified 2 groups of patients: patient with craniocervical junction injury (24 patients) and patient with subaxial cervical spine injury (77 patients). All patients were studied by A-P and lateral X-ray, CT, MRI. We used various types of spondylodesis: anterior, posterior or combined (anterior and posterior) cervical instrumental fixation.

Results: Anterior fixation was performed in 45 patients (44.5%), posterior screw fixation in 46 patients (45.5%) and combined fixation in 10 patients (10%). Among 24 patients with craniocervical junction injury 14 patients had «hangman» and miscellaneous axis fractures, 8 patients had odontoid fractures (II and III types), two patients had transverse atlantal ligament ruptures. In all these cases we used posterior screw fixation. From 77 patients with subaxial cervical spine injury 22 patients (28.6%) had posterior surgery, 45 patients had anterior fixation (58/4%) and 10 patients (13%) had combined surgery.

Discussion: Posterior screw fixation only is used in the cases of isolated posterior supporting complex injuries (posterior ligaments, lateral masses, lamina and spinous processes). When two or three-column injuries, such as vertebral dislocation or traumatic spondylolisthesis, is required a combined (at 360°) stabilization. Anterior fixation only is performed in cases of isolated anterior column injury (intravertebral disc, vertebral body).

Conclusions: Posterior screw fixation is the method of choice for unstable craniocervical junction injuries. Subaxial cervical spine injury, accompanied by damage of the posterior supporting complex, require posterior instrumental spondylodesis (needed in 40% of cases of subaxial cervical spine injury).

P152
Spinal navigation for posterior instrumentation of C1-C2 instability using a mobile intraoperative CT scanner
Julien Haemmerli, Marcus Czabanka, Peter Vajkoczy

Objective: Spinal navigation techniques for surgical fixation of unstable C1/2 pathologies are challenged by complex osseous and neurovascular anatomy, instability of the pathology and unreliable preoperative registration techniques. Intraoperative CT-scanner with autoregistration of C1/C2 promises adequate accuracy of spinal navigation without requiring further registration procedures. The aim of this study was to analyze accuracy and reliability of posterior C1/C2 fixation using intraoperative mobile-CT-scanner guided navigation.
Methods: From July 2014 to February 2016, 10 patients with instability of C1/C2 received posterior fixation using C2-pedicule and C1-lateral mass screws, and two patients received a posterior fixation from C1 to C3. Spinal navigation was performed using intraoperative mobile CT. Following navigated screw insertion in C1 and C2 intraoperative CT was repeated to check for accuracy of screw placement. Accuracy of screw positioning was retrospectively analyzed and graded by an independent observer.

Results: A total of 12 subjects were retrospectively analyzed, ten females and 2 males (mean age 80.7; range: 42–90). Instable pathologies (verified by fracture dislocation or by flexion/extension x-ray) included: 8 Anderson type II fractures, 1 instable Anderson type III fracture, 1 Hangman fracture Levine Effendi Ia, 1 complex Hangman-Anderson III and 1 destructive rheumatoid arthritis of C1-C2. In 4 patients, critical anatomy was observed: high riding vertebral artery (3 patients) and arthritis-induced partial osseous destruction of C1 lateral mass (1 patient). A total number of 52 screws were placed. Correct screw positioning was observed in 51 screws (98.1%). Minor pedicle breach was observed in 1 screw (1.9%). No screw displacement occurred (accuracy rate 98.1%).

Conclusion: Spinal navigation using intraoperative mobile CT scanning is reliable and safe for posterior fixation in instable C1/C2 pathologies with high accuracy in this patient series.

P153
Tactics and results of surgical treatment of non-united odontoid fractures
Alexander Vladimirovich Burtcev

Introduction: Non-union of odontoid fractures is a relatively common and dreaded complication. Surgical stabilization of non-united odontoid fractures is usually required for patients with atlanto-axial instability and progressive neurologic deficits.

Aim: To clarify the surgery strategy and to evaluate the results of surgical treatment of non-united odontoid fractures.

Materials and methods: For 24 months 6 patients aged 28 to 60 (the average age being 46) with odontoid fractures underwent posterior screw fixation. According to Anderson and D’Alonzo’s classification, there were 5 cases of fractures of Type II, and 1 case of Type III. The average time from injury to surgery was 55 days. All the patients underwent the cervical MRI to identify the transverse ligament disruption. Also, 3D-CT-angiography of the cervical spine was produced for planning the type of fixation. 5 patients underwent posterior screw fixation C1-C2, and in 1 case occipitospondylodesis was performed due to the location of the intersegmental vertebral artery which is the C1 arch below. The transverse ligament disrupted (n=2), was done posterior screw fixation with bone graft fusion. In case the transverse ligament was not disrupted (n=4), was done applied temporary screw fixation without bone graft. After 6–9 months of healing, the screws were removed (n=2). All the patients underwent the CT and functional x-ray examination in 6-9 months.

Results: In all cases we observed solid bone fusion and absence of instability in the C1-C2 segment.

Conclusion: Posterior screw fixation is an effective method of surgical treatment for non-united odontoid fractures. Using the preoperative 3D-CT-angiography, it is possible to precisely identify an anomalous of vertebral artery (VA) and significantly reduce the risk of VA injury. The preoperative MRI performed to identify the disruption of the transverse atlantal ligament facilitates the choice of the type of fixation.

P156
Acute combination fractures of the atlas and axis in elderly patients
Hiroshi Kato, Toshiya Tachibana, Keishi Maruo, Fumihiro Arizumi, Kazuki Kusuyama, Kazuya Kishima, Shinichi Yoshiya

Introduction: Odontoid fractures in elderly patients have recently been increasing in our experience. The objective of this study was to evaluate three elderly patients with acute C1-2 combination fractures.

Materials and methods: Three consecutive patients with acute C1-2 combination fractures who were treated in our hospital were included in this study. Medical records were evaluated retrospectively. The follow-up period was more than 6 months in all patients, and the evaluated factors were as follows: mechanism of injury, ASIA impaired scale (AIS), type of fracture, treatments and bony fusion.
Results: The age of patients ranged from 78 years old to 87 years old. All patients were females. The mechanism of injury was falling down in all of 3 patients. AIS E was in all patients. C2 fracture was type II odontoid fracture in all patients, while C1 fracture was anterior arch and posterior arch fracture in two patients and posterior arch fracture in one patient. Two patients with displaced type II odontoid fracture (atlantodental distance [ADI] was 7mm or 13mm) received occipitocervical fusion (OCF). One patient with non-displaced type II odontoid fracture received immobilization with a hard collar for 3 months. Bony fusion was achieved in all of three patients.

Discussion: C1-type II odontoid combination fractures with ADI ≥ 5mm should be considered for surgical stabilization and fusion. We performed surgical fusion for 2 patients with displaced C1-type II odontoid combination fractures. We chose OCF in several surgical options, because it may be difficult to apply an anchor such a wire into the fractured C1.

Conclusions: Two elderly patients with displaced C1-type II odontoid fracture and one elderly patient with non-displaced C1-type II odontoid fracture were treated successfully by OCF and immobilization, respectively.

P158
Fatal cervical spine injuries in traumatic cardiac arrest – diagnosed by post mortem computed tomography
Keitaro Tada, Takamitsu Tokioka

Introduction: Cervical spine injuries are sometimes misdiagnosed in polytrauma, since injuries are not seen from the surface. Post Mortem Computed Tomography (PMCT) is useful for detecting hidden injury and cause of the death in trauma. Retrospectively, cause of death and spinal findings were rechecked by PMCT.

Materials and method: From March 2005 to December 2016, 120 traumatic cardiac arrest patients were transported to the emergency room, and 114 patients underwent PMCT (78 male and 36 female; age range 2-99 years old; mean age, 59.7 years old). Analysis were performed in mechanism of injury, cause of death and cervical spine injury.
Results: In total 114 patients, 64 were injured by traffic accidents and 31 were fall or downfall accidents. Since most of cases were polytrauma, traumatic shock was the 71.9% in cause of death. Cervical spine injuries were detected in 28 patients (24.6%). In those 28 patients, 10 upper cervical spine injuries (8.8%) were thought to be fatal and could be the cause of death.

Conclusion: Upper cervical spine injury may lead instant death. PMCT can reveal fatal cervical spine injury in traumatic cardiac arrest. Fatal cervical spine injuries detected in 8.8% of traumatic cardiac arrest.

P159
Percutaneous transarticular C1/C2 screw fixation without spondylodesis as primary treatment of odontoid fractures type Anderson II and III
Florian Brakopp, Florian Wuthe, Philipp Schenk, Thomas Mendel, Gunther Olaf Hofmann, Bernhard Ullrich

Introduction: The treatment of odontoid fractures type Anderson II and III is still a great surgical challenge. The mainly geriatric patients are afflicted with a considerable comorbidity. According to literature, the most commonly used operative technique using ventral odontoid screw fixation frequently results in implant failure or pseudoarthrosis. Another established technique is the dorsal C1/2 screw fixation including spondylodesis with an iliac crest bone graft according to Magerl. Here we applied a percutaneous transarticular C1/2 screw fixation without spondylodesis. This technique intends to avoid the spinal fusion and retains the option to release the segments C1/2 by screw removal after consolidation. Moreover, it reduces the invasiveness of the intervention due to the percutaneous approach. Here we present a prospective follow-up examination to evaluate the clinical and radiological long term results for patients with percutaneous transarticular C1/C2 screw fixation without spondylodesis.

Materials and methods: In the frame of a therapy-accompanying observational study, we report on the transarticular C1/C2 screw fixation using a modified technique as primary therapy for the treatment of odontoid fractures type Anderson II and III.

Between January 2014 and January 2016 22 patients (10 male, 12 female) suffering from odontoid fractures type Anderson II (19 patients) and Anderson III (3 patients) have been treated. Six patients additionally suffered from an atlas fracture and one patient initially developed an incomplete paraplegia sub C2. Up to now 12 patients could be reexamined by CT. For half of these patients SF-12-health survey, the range of motion and the neck disability index could be determined.

Results: The average operation time was 32±19 minutes including an X-ray inspection of 3±1 minutes. The average age of the patients was 80 (range 45-99) and the average time in hospital was 11±10 days. No neurological, vascular and infect-associated complications have been observed. All patients currently reexamined by CT exhibit a fracture consolidation.

Conclusions: The transarticular atlantoaxial screw fixation according to Magerl represents an established technique. However, the described percutaneous, minimal invasive treatment of odontoid fracture type II and III without iliac crest bone graft represents a save alternative operation technique with high success rate.

P160
The effectiveness of infrared thermography in patients with whiplash injury
Sunghwa Paeng

Introduction: This study aims to visualize the subjective symptoms before and after the treatment of whiplash injury using infrared (IR) thermography.

Materials and methods: IR thermography was performed for 42 patients who were diagnosed with whiplash injury. There were 19 male and 23 female patients. The mean age was 43.12 years. Thermal differences (ΔT) in the neck and shoulder and changes in the thermal differences (ΔdT) before and after treatment were analyzed. Pain after injury was evaluated using visual analogue scale (VAS) before and after treatment (ΔVAS). The correlations between ΔdT and ΔVAS results before and after the treatment were examined. We used Digital Infrared Thermal Imaging equipment for IR thermography.
Results: The skin temperature of the neck and shoulder immediately after injury showed 1–2°C hyperthermia than normal. After two weeks, the skin temperature was normal range. ΔT after immediately injury was higher than normal value, but it was gradually near the normal value after two weeks. ΔdT before and after treatment were statistically significant (p<0.05). VAS of the neck and shoulder significantly reduced after 2 week (p=0.001). Also, there was significant correlation between ΔdT and reduced ΔVAS (the neck; r=0.412, p<0.007) (the shoulder; r=0.648, p<0.000).

Conclusion: The skin temperature of sites with whiplash injury is immediately hyperthermia and gradually decreased after two weeks, finally it got close to normal temperature. These were highly correlated with reduced VAS. IR thermography can be a reliable tool to visualize the symptoms of whiplash injury and the effectiveness of treatment in clinical settings.

Keywords: Whiplash injury, Infrared thermography, Visual analogue scale, Thermal difference, Pain

P161
Relationship between the timing of reduction of cervical spine dislocations and neurological recovery.
Keisuke Kintaka

Introduction: Although many studies have reported that it is desirable to perform reductions for cervical spine dislocation injuries as early as possible, the ideal timing remains unclear. We investigated the relationship between the interval from injury to reduction (referred to as “reduction time”) and the neurological prognosis.

Methods: Of the 179 consecutive patients with cervical spinal cord injury treated at our hospital between 2007 and 2016, there were 47 patients with distractive flexion according to the Allen classification (37 males, 10 females; average age, 58.9 years) where the Asia Impairment scale (AIS) grade at the time of transportation from the sites of injury to the medical facilities ranged from A to D. We evaluated the reduction time and change in paralysis at one month after the injury.

Results: The AIS grade distribution at the time of injury was as follows: A, 21 cases; B, 10 cases; C, 8 cases; and D, 8 cases. The median reduction time was 7.0 hours (range, 2.0 hours to 21 days). Reduction was completed within the determined cut-off value of 6 hours in 21 of 47 patients (44.7%), which consisted of 9 of 21 AIS A patients, 4 of 10 B patients, 4 of 8 C patients and 4 of 8 D patients. Among these 21 patients, all 12 patients with an initial AIS B to D improved significantly by one or more AIS grade. On the other hand, in 14 AIS B to D patients where the reduction time was over 6 hours, only 7 patients (50.0%) showed improvement by one or more AIS grade.

Discussion and conclusions: In our case series, in patients with an AIS grade between B and D, more neurological improvement was observed when the reduction time (affected by transportation time) was less than 6 hours. These results provide a target for reduction and transportation times during the acute phase of treatment. Diagnosis and reduction of the dislocation, or transferring the patient to a medical facility that can perform reduction, should be conducted as early as possible.
P162
The clinical influence of cervical spinal cord compression on the neurological outcome after traumatic cervical spinal cord injury without major fracture or dislocation
Tsuneaki Takao, Itaru Yugue, Takeshi Maeda, Takayoshi Ueta, Keiichiro Shiba

Introduction: The biomechanical etiology of traumatic cervical spinal cord injury (CSCI) remains under discussion, and its relationship with cervical spinal cord compression is one of the most controversial issues in the clinical management of traumatic CSCI. The aim of the current study was to clarify the influence of cervical spinal cord compression on neurological functional recovery after traumatic CSCI without major fracture or dislocation.

Materials and methods: Patients non-surgically treated for an acute CSCI without major fracture or dislocation were selected. We analyzed 160 subjects with traumatic CSCI using T2-weighted mid-sagittal magnetic resonance imaging. The sagittal diameter of cervical spinal cord, degree of spinal cord compression, and neurologic outcomes in motor function, including improvement rate, were assessed.

Results: There were no significant relationships between degree of cervical spinal cord compression and their American Spinal Injury Association motor scores at both admission and discharge. Moreover, no significant relationships were observed between degree of cervical spinal cord compression and their neurological recovery during the following period.

Discussion and Conclusion. Our results showed no relationships between pre-existing cervical spinal cord compression and neurological outcomes after traumatic CSCI. These results suggested that decompression surgery might not be recommended for traumatic CSCI without major fracture or dislocation despite pre-existing cervical spinal cord compression.

Keywords: cervical spinal cord compression; cervical spinal cord injury without major fracture or dislocation; MRI; neurological outcome

P163
Relationship between the timing of reduction of cervical spine dislocations and neurological recovery
Kazunari Takeda, Shuhei Osaki, Takeshi Kikuchi, Yasuo Ito

Introduction: Although many studies have reported that it is desirable to perform reductions for cervical spine dislocation injuries as early as possible, the ideal timing remains unclear. We investigated the relationship between the interval from injury to reduction (referred to as “reduction time”) and the neurological prognosis.

Methods: Of the 179 consecutive patients with cervical spinal cord injury treated at our hospital between 2007 and 2016, there were 47 patients with distractive flexion according to the Allen classification (37 males, 10 females; average age, 58.9 years) where the ASIA Impairment scale (AIS) grade at the time of transportation from the sites of injury to the medical facilities ranged from A to D. We evaluated the reduction time and change in paralysis at one month after the injury.

Results: The AIS grade distribution at the time of injury was as follows: A, 21 cases; B, 10 cases; C, 8 cases; and D, 8 cases. The median reduction time was 7.0 hours (range, 2.0 hours to 21 days). Reduction was completed within the determined cut-off value of 6 hours in 21 of 47 patients (44.7%), which consisted of 9 of 21 AIS A patients, 4 of 10 B patients, 4 of 8 C patients and 4 of 8 D patients. Among these 21 patients, all 12 patients with an initial AIS B to D improved significantly by one or more AIS grade. On the other hand, in 14 AIS B to D patients where the reduction time was over 6 hours, only 7 patients (50.0%) showed improvement by one or more AIS grade.

Discussions and conclusions: In our case series, in patients with the AIS grade between B and D, more neurological improvement was observed when the reduction time (affected by transportation time) was less than 6 hours. These results provide a target for reduction and transportation times during the acute phase of treatment. Diagnosis and reduction of the dislocation, or transferring the patient to a medical facility that can perform reduction, should be conducted as early as possible.
Introduction: Magnetic resonance imaging is a well accepted modality in the diagnostic evaluation of traumatic spinal disorders. Some even consider MRI as the most sensitive and most valuable tool in this field. In a post mortem cadaver study the posttraumatic findings in MRI and the „golden standard“ of serial cryosections have been correlated.

Materials and methods: In twelve trauma victims specimens oft he cervical spine – occiput to C7- could be harvested post mortem during autopsy for serial cryosection using a Rotational Cryotom which has been invented by the author. About 70 sections in the sagittal plane were performed and documented in each specimen. Patients intra-vital or post mortem MRI documents were evaluated by two experienced radiologists independantly. The two results were matched and correlated.

Results: Only 4 of 15 fractures (26%), 5 out of 10 ligament ruptures (33%), 3 of 21 disc lesions (14%), 13 out of 90 embleeded zygapophyseal joints (14%), none oft he 5 spinal nerve lesions (0%) but 5 out of 5 medullary lesions (100%) could be detected on MRI scans.

Discussion: Serial cryosections of specimens present the „golden standard“ of anatomy and pathomorphology and can be used to prove the power of cross sectional diagnostic methods. MRI in fresh harvested specimens of the cervicale spine were considered comparable to MRI scans in living individuals by the radiologists.

Conclusion: MRI is a highly accepted and recommanded methode in the diagnostic evaluation of traumatic disorders oft he cervical spine. Numberous posttraumatic findings in or cryosections could not be detected by MR imaging. Especially small element lesions could not be diagnosted. The absence of pathological findings does not exclude there presence. X-ray, functional evaluation, multislice CT and MRI in combination has to be recommanded for highest possible accuracy in the diagnosis of cervical spine trauma.

Introduction: C2 fractures are the most common cervical fractures in the geriatric population. There are different strategies for treatment in the elderly, but there are no consensus guidelines for a standardized treatment. Objective: to describe the results of conservative treatment with non-rigid immobilizations in C2 fractures in patients older than 75 years.

Materials and methods: Retrospective analysis of eleven patients with a mean age of 85.6 years. The average follow-up is 1 year and 1 month. All had subaxial cervical osteoarthritis, six of the nine patients had pulmonary or coronary heart disease, three had moderate dementia, and two had severe osteoporosis. Six patients had other osseus or cranioencephalic lesions at the time of the trauma. Eight patients had C2 nondisplacement fractures, 2 patients had fractures with a displacement of less than 2 mm, and 1 patient displaced fracture with a C1–C2 rotational dislocation. Four patients were treated with a semi-rigid collar from the beginning, three were treated with a soft collar from the beginning because short neck and obesity, one was treated with soft collar with tracheostomy orifice for prolonged intubation, one patient who was treated with a semi-rigid collar presented decubitus ulcer and switched to soft collar, and two patients were placed on Sternal–Occipital–Mandibular Immobilizer collar, but were switched to semi-rigid collar at two weeks for intolerance and dysphagia. Clinical evaluation (EVA scale and mobility) and radiological evaluation (simple X-ray and computed tomography) were performed.

Results: At the end of the follow-up, all patients were asymptomatic and had good functional capacity, despite the fact that 3 of them presented pseudoarthrosis.

Discussion: Many published odontoid fractures studies describe the elderly patient as being older than 65 years, which includes a population that may not have comorbidities. It has been shown in several studies that
in octogenarians odontoid pseudoarthrosis does not generate functional deficit and that some patients present pseudoarthrosis of odontoid diagnoses by chance in imaging tests.

**Conclusions:** Conservative treatment in geriatric patients is a valid option, with minimal complications in mildly displaced C2 fractures. Odontoid pseudoarthrosis in patients with low functional demand does not appear to have clinical repercussions.

**P167**  
**Minimally invasive percutaneous screw fixation of craniocervical junction fractures**  
*Stanisław Adamski, Wojciech Kloc, Piotr Murawski, Witold Libionka, Rafał Pankowski, Marek Rocławski*

**Introduction:** Despite that most cases of craniocervical junction fractures can be treated nonoperatively with reduction and subsequent immobilization in a rigid cervical collar or halo, in some instances, operative management is necessary and can be accomplished by using either anterior or posterior fusion techniques. Open posterior procedures can result in significant blood loss, pain, and limited cervical range of motion. Also variability of C2 anatomy can make instrumentation challenging and prone to potentially severe complications. We want to show a minimally invasive, navigation-guided technique for surgical treatment of Levine Type II, Effendi Type Ila traumatic spondylolisthesis of C2 and Type IIIa Atlas fractures.

**Material and Methods:** For 8 patients: 4 with Levine Type II, 2 with Effendi Type Ila traumatic spondylolisthesis of C2 and 2 with Type IIIa Atlas fractures percutaneous screw fixation was performed: 6 directly through the fracture site and 2 C1-C2 transarticular fixation. This technique was facilitated by the use of intraoperative CT O-arm scan and StealthStation S7 Surgical Navigation System.

**Results:** Of the 8 patients, 2 were women, 6 were men, age range was 33–69 years. No intraoperative or postoperative complications occurred. All patients were obtained flexion-extension radiographs the day after surgery and at 6 weeks. For all patients, dynamic imaging demonstrated a stable construct.

**Conclusion:** Craniocervical junction fractures can be safely repaired with the use of percutaneous minimally invasive surgical technique. This technique may be appropriate, depending on circumstances, for Levine Type II, Effendi Type Ila traumatic spondylolisthesis of C2 and Type IIIa Atlas fractures; however, the degree of associated ligament injury and disc disruption must be checked.

**P168**  
**Analysis of results with minimum 4 years follow-up corpectomy and expandable cage implantation for A2 subaxial cervical spine injury**  
*Andrei A. Kalinin*

**Background:** Segment stabilization is a priority in the surgical treatment of most traumatic injuries of the lower cervical spine in the presence of posttraumatic instability. Optimal stabilization procedure is still disputable.

**Objective:** to assess outcomes of corpectomy and telescopic expandable cage implantation with cervical plate fixation in patients with the uncomplicated A2 subaxial cervical spine injury.

**Material and methods:** Authors reviewed charts and films of 105 patients (63 males, 42 females) mean age 32.5 years (range: 28-57 years) operated in acute period (1-11 days) of trauma within 2009-2013 years, that were available at least 4 year follow-up after surgery.

All patients had traumatic instability of the cervical spine (5 or more points on modified White and Panjabi criteria) and ASIA E type injury (ASIA/ISCSCI). All patients had osteoligamentous lesion in anterior column (type A2) caused by motor vehicle accidents and diving. Electromyography showed minimal (n=74, 70.5 %) and moderate (n=31, 29.5 %) changes of f-wave and M-response in upper extremities before operation. MRI showed no signs of traumatic spinal cord injuries in all cases. Visual Analogue pain Scale (VAS), Macnab and Nurick scales were used to assess the pretreatment status and clinical outcomes. Functional X-rays and CT images were used to assess the fusion.
Results: One level corpectomy was performed in 61 (58 %), two levels in 34 (32 %), three levels in 10 (10 %) patients. Significant decrease of preoperative pain in cervical spine and in upper extremities was revealed after surgery was achieved at 4 years follow-up (mean VAS decreased from 71 to 11, \( p=0.016 \); and from 54 to 8, \( p=0.022 \) consequently). According to the Nurick scale 4 years after surgery full regress of symptoms was achieved in 90 (86 %), 15 (14 %) patients improved, no patient remained unchanged or get worse. Macnab results were excellent in 81 (77 %), good in 24 (23 %), no fair and poor cases. Fusion was achieved at 1 year follow-up in 84 (80 %) cases, at 2 years – in 92 (87 %), at 3 years – in 71 (91 %), at 4 years – in 100 (95 %) patients. Electromyography showed improvement of f-wave and M-response in upper extremities in 96 (91 %) patients. There were no complications associated with corpectomy or implant itself but 6 postoperative surface wound infections and 4 hematomas which were successfully treated conservatively.

Conclusion: This retrospective review showed efficacy of anterior decompression and expandable cages implantation for the treatment of the patients with A2 uncomplicated subaxial cervical spine injury. The robust postoperative fixation allowed early rehabilitation without significant postoperative complications and 95 % fusion rate at 4 years follow-up.

P170
Complete cervical dislocation C6-C7 due to discoligamentous distraction with spinal cord injury associated with rotational dislocation C1-C2
Cristina Igualada Blazquez, Tania Quevedo Narciso, Edmundo Vicente Herrera, Luis Esparragoza Cabrera

Introduction: Cervical dislocations due to disruption of the anterior and posterior discoligamentous complex without facet block are uncommon. We present a patient with a lesion of this type associated with dislocation C1-C2, a combination that has never been described before.

Material and methods: 41-year-old male precipitated from 12 meters. In the initial CT scan, we observed a C1-C2 rotational dislocation, a chance fracture in T7, burst fracture with a 50% of canal occupation in L1, multiple costal fractures and pelvic fracture. There is also a 3 mm distraction between the body and facets of C6-C7 that not being discard that it is an CT scan artifact. When the patient is stabilized, a new CT scan is performed confirming C6-C7 disc space distraction with retrolisthesis and C6-C7 facet distraction. Magnetic resonance imaging confirms disruption of the anterior and posterior longitudinal ligament, widening of the disc space, disruption of joint capsules and posterior ligament complex, and spinal contusion at the C6-C7 level. The patient has a paralysis and numbness in the lower limbs.

Results: The patient is operated making a anterior and posterior fixation C6-C7. The patient could not be operated on the other vertebral injuries due to hemodynamic instability. The patient continued with cervical collar during his stay in intensive care unit to control the C1-C2 ligamentous lesion. After 54 days in intensive care unit the patient is derived to a rehabilitation center and is able to make wheelchair transfers.

Discussion: In the case of a patient with a partial medullary section due to ligamentous distraction injury, traction maneuvers are not indicated as in facet dislocations. The treatment of choice is the realization of posterior and anterior arthrodesis knowing that spinal cord injury is usually irreversible due to the primary spinal cord injury, with no signs of spinal cord compression that may benefit from urgent decompression surgery.

Conclusion: Pure cervical dislocations are a rar epatology, which sometimes goes unnoticed. When we have a patient with neurological symptoms, magnetic resonance imaging should be performed to discard injuries of this type and injuries to other levels.
Clinical Features of the extension teardrop fracture of the axis – review of 15 cases
Masahiko Watanabe, Masahiro Tanaka

Introduction: Extension teardrop fracture (ETF) of the axis is an extremely rare injury. ETF of the axis is avulsed by the intact anterior longitudinal ligament during the hyperextension of the head and upper cervical spine. The classical clinical features of this fracture have mainly been described, by radiologists rather than spine surgeons, include its occurrence in elderly osteoporotic patients, as associated with minimal or no prevertebral soft-tissue swelling, and with no associated neurological deficit. However, recent case studies indicate notable exceptions to these clinical features, although few studies have investigated osteoporosis in these patients. The purpose of this study was to clarify the clinical features of ETF of the axis.

Methods: We reviewed 15 patients retrospectively with regard to their injury etiology, neurological deficit, treatment and outcome, and imaging findings (size and displacement of the fragment, C2/3 subluxation, disc injury, and osteoporosis of the axis).

Results: ETF of the axis constituted 12.0% of upper cervical spinal injuries at our institute. The mean age of the patients was 53.3 years and distinct osteoporosis was identified in only one patient. Nine patients sustained ETF of the axis in traffic accidents, four patients from falls from greater than standing height, and two patients from falls from standing height. C2/3 subluxation was observed in two patients, in whom the displacement of the fragment was significant, although its size did not appear to have an effect. MRI that was examined in nine patients within 48 hours after injury, showed no disc injuries. One patient died from brain injury. Two of the other 14 patients (patients 8 and 11) showed the minor neurological deficit classified as D in Frankel’s classification. Only one patient underwent surgery for the presenting symptoms of dysphagia. The other patients underwent conservative treatment using halo vest or orthosis. They showed bony fusion but did not complain of neck pain, except one patient (patient 11) with traumatic spondylolisthesis.

Conclusions: Based on our case study, osteopenia and older age should not be considered risk factors. Most patients with ETF of the axis can be treated conservatively, and surgical intervention may only be indicated for specific cases. Because we found no differences between the outcomes of the patients treated with halo vest and cervical orthosis, immobilization with orthosis could be indicated in most patients.

Table 1: Clinical Data

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P172
Preliminary results of the influence of trauma and degeneration on the presence of SPARC and ultrastructure of cervical intervertebral disc cells and tissues

Ingrid Sitte, Miranda Klosterhuber, Ilja Vietor, Sieghart Sopper, Heidelinde Fiegl, Sabrina B. Neururer, Richard A. Lindtner, Anton Kathrein, Sally Roberts

Introduction: SPARC (Secreted Protein, Acidic and Rich in Cysteine, also known as Osteonectin) is a multifunctional glycoprotein reported to be diminished in aged and degenerate intervertebral discs (IVDs). Disc cells with a ‘balloon cell’ morphology have been described in degenerate cervical discs. Balloon cells were found in some human IVDs after compression-fracture and induced in vitro in bovine loaded discs within a distinct range of absorbed energy. The homogeneous nucleus (euchromatin) indicates these cells to be highly transcriptionally active. Here we examine the presence of SPARC and morphology of disc cells in different pathologies and culture conditions.

Materials and methods: Discs were obtained from young adult bovine tails (n = 4) and from patients undergoing surgery for degeneration (herniation (degenerate grade (DG)III-III: n = 4); protrusion (DGIV-V; n = 6) or trauma (DGII-III) (compression-fracture: n = 7; rotation-fracture: n = 3). Cells were isolated enzymatically and cultured in monolayer, with or without 20% fetal calf serum (FCS). Cell viability and morphology were observed via light and electron microscopy. The presence of SPARC was demonstrated via immunohistochemistry and FACS analysis. Cell culture supernatants were screened (ELISA) for pro-apoptotic and inflammatory proteins.

Results: Balloon cells were found in all degenerate cultured discs (DGII-V: 69±12% of cells) and compression-fractures (37±28%). Cell size was smaller in degenerated cultured cells (DGIV+V) and when cultured without FCS. Discs with rotation-fractures most resembled healthy bovine discs with little evidence of balloon cells. Comparing the trauma and the degeneration groups, degenerate discs contained significantly less healthy (p=0.019) but more balloon cells (p=0.002). Bovine and rotation-fractured discs stained heavily for SPARC, whereas there was less in degenerate discs (DGII-V) and those from patients with compression-fracture. A significant difference was found for the degeneration group comparing both culture conditions, having significantly more necrosis (p= 0.032) without FCS. IL-6, IL-8 and TGF-β were found up-regulated in all human pathologies.

Discussion: Decreased SPARC, which regulates cell proliferation, migration and interacts with TGF-β, appears to be associated with disc degeneration and compression-fractures. Both pathologies revealed high numbers of balloon cells and decreased SPARC levels compared to healthy bovine and rotation-fractured discs.

Conclusion: These preliminary findings indicated that different etiologies regulated different pathways.

P173
Morphological response of the intervertebral disc and its cells to post-traumatic clinical instability in the cervical spine

Ingrid Sitte, Miranda Klosterhuber, Richard A. Lindtner, Sabrina B. Neururer, Martin C. Freund, Kristian Pfaller, Anton Kathrein

Introduction: The healthy intervertebral disc (IVD) guarantees functionality of the spine. The cells within maintain the extra-cellular matrix. Post-traumatic clinical instability is defined as painful loss of ability to resist under physiological load, progressive dislocation, pain, additional neurological deficit and deformity. The aim of the study was to assess morphological changes related to instability over a time period of up to one year.

Material and methods: Anterior portions of unstable segments (middle/lower cervical spine) of IVDs (n=55) were studied. The group was investigated with regard to the main parameters of clinical instability by White & Panjabi. Fractures were classified radiologically according to Magerl’s classification. Two groups were formed with either compression (A: B1,2) or less compression load (B3:C).

Disc architecture was studied histologically and cell/matrix morphology by electron microscopy. According to ultrastructural observations, two time-groups (up to 6 days vs later) were established. Statistical analyses were carried out between time-groups.

Results: Cell death up to 100% was seen in the first days in both groups. After day 6 histological changes were evident with cell proliferation in the outer annulus fibrosus (oAF). Compression groups revealed a significant
proliferation in the oAF (p=0.030) and the nucleus pulposus (p=0.022), but no significant differences was found in less compression fractures. Matrix and cell damage was partially restored with time post-trauma. Some healthy cells were surrounded by a blank lacuna which indicated inability to synthesize fibrils. Even though cell-death slightly decreased, cell-death remained high (mean 55%).

**Discussion:** The pathomorphological substrate of injury is fracture and/or dislocation combined with clinical symptoms. These are evident shortly after trauma, as well as cell death and matrix disruptions. Post-traumatic clinical instability is the consequence of injury to the different anatomical structures which have been injured. The findings of a high incidence of cell death after day 6 and blank lacunas demonstrate decreased ability to synthesize fibrils for maintenance and restoration of the matrix.

**Conclusion:** Even so some remodeling was obvious this study was able to detect ongoing damage by clinical instability. If stabilization without fusion will restore the injured IVD must be evaluated in further clinical long-term studies.

P174

A survey of the use of traction by specialists for the reduction of cervical dislocations

*Nicholas A. Kruger, Mathew Workman*

**Introduction:** There is an increasing body of literature supporting early decompression of spinal cord injuries especially in low energy cervical dislocations. Closed cervical reduction is a safe and rapid mechanism to achieve this however its use and acceptance amongst specialists is poorly described.

This study aimed to assess the training, experience and decision making of trainees and surgeons who manage cervical spine dislocations with the goal of implementing further training and refresher courses as necessary.

**Methods:** Orthopaedic and neurosurgery registrars and specialists in South Africa were emailed a questionnaire consisting of 13 questions related to their training, experience and management of cervical dislocations. Data was analysed using descriptive statistics. We reported categorical data in tables with frequencies and percentages. Normality of the data was tested qualitatively and responses were compared.

**Results:** 79% of surgeons were taught closed reduction during specialist training. Of the neurosurgeons, 92% covered spine trauma compared to 66% of orthopaedic surgeons. Of those surgeons who provide trauma cover, 64% are comfortable performing closed cervical reduction but 36% would refer to a colleague accepting a 2 hour delay in treatment. 60% of respondents feel confident in completing closed cervical reduction in under 4 hours. 38% of neurosurgeons vs of 3% orthopaedic surgeons preferred MRI prior to closed reduction. 51% of surgeons thought that the risk of worsening neurology during traction was up to 25% but 69% of surgeons felt ER doctors could safely perform closed cervical reduction with training. 81% of surgeons do not think surgical reduction is routinely possible in under 4 hours.

**Conclusion:** There are some misconceptions around cervical traction which may affect clinical practice and optimum management. It is a safe procedure that does not require prior MRI and carries an extremely low risk of worsening a patient’s condition. Closed cervical traction reduction is the most rapid, safe mechanism to reduce cervical dislocations and requires education of undergraduates, emergency doctors, and specialists to increase awareness of the reduction process.

P175

Minimally invasive cervical pedicle screw fixation by a posterolateral approach for cervical fractures

*Takamitsu Tokioka, Takahiro Hayashi*

**Purpose:** A new method for minimally invasive cervical pedicle screw (MICEPS) fixation by a posterolateral approach was developed not only to avoid lateral misplacement of cervical pedicle screws but also to allow direct reduction of dislocated facet joints. Our initial experiences with this fixation for trauma cases were reviewed.

**Methods:** This study included 56 consecutive patients who received surgery for cervical fractures between 2009 and 2014. Average waiting time between presentation and surgery was 36 hours (range, 1–240). Using the American
Spinal Injury Association impairment scale, at admission there were 14 patients in grade A, 4 in grade B, 4 in grade C, 14 in grade D, and 20 in grade E. The facet joint was exposed with blunt dissection using a finger between the levator scapulae muscle and splenius muscle, and a self-retaining tubular retractor with illumination was applied between the split muscle fibers. Reduction of locked facet was enabled by partial facetectomy. K-wire (1.4mm) was inserted using a navigated guide tube and rigid drill driver. A drill, tap, and cannulated pedicle screw were sequentially inserted over the K-wire. Facet fusion via bone grafting can be performed at this point. The rod was placed to the screw head. We inserted a total of 203 cervical pedicle screws. Nineteen patients were treated by conventional methods Thirty-seven patients were treated by MICEPS fixation.

Results: The average surgical time was 217 minutes with the conventional pedicle screw fixation and 165 minutes with the MICEPS fixation(p=0.0014). 3 cases of irreducible facet dislocation were reduced by direct release of locked facet joint, and disc herniation was removed by facetectomy in one case. The average intraoperative bleeding was 560ml in the conventional fixation and 140ml in the MICEPS fixation(p<0.0001). Clinically significant screw deviation was significantly lower in the MICEPS fixation group (2%) than in the conventional cervical pedicle screw group (12%).

Conclusions: This posterolateral approach allows for direct exposure of facet joint and horizontal pedicle screw insertion. Neither of the misplaced screws was laterally deviated in the MICEPS group by this approach.

P176
Therapy results of the conservative treatment of upper cervical fractures with the halovest immobilisation
Bernhard W. Ullrich, Gunther O. Holmann, Martin Bäumlein, Thomas Mendel, Florian Brakopp

Introduction: The treatment of upper cervical fractures with Halovest Immobilisation (HVI) is controversially discussed in literature. For odontoid fractures type II and III (Anderson/D’Alonzo) there is a strong tendency towards surgical treatment. Also in our clinic those fractures were treated mainly with ventral or dorsal stabilisation. In literature on the one hand there is a high mortality of 40% and on the other hand pin-associated complications from 20% to more than 40% within HVI. Objective is to show our experience, treatment results and possible predictor for complications of conservative treatment with HVI.

Materials and methods: In the period of 9/2004-12/2013 54 patients with upper cervical fractures were treated with HVI. Retrospectively obtained patient data of treatment, complications and follow-up care were evaluated. For characterisation of general condition the Charlson Comorbidity Index (CCI) was calculated. The bony consolidation was evaluated with CT scans. Nonunion results were examined concerning stability with functional images.

Results: The mean duration of HVI was 81.5 (±27.8) days. The most frequent fracture was in 24 (44.4%) cases an isolated odontoid fracture type III, which healed in 22 cases (91.7%) as bony union. From overall 9 cases of odontoid fractures type II, 4 patients (44.4%) required further surgical treatment after HVI. There were 7 isolated atlas fractures, which healed in 6 cases (85.7%) as bony union and in 1 case (14.3%) as fibrous nonunion without instability.

The elderly (≥65 years) had in more cases bony nonunion than the younger patients (11 vs. 2; 37.9% vs. 8%, p<0.05). A CCI ≥4 points was correlated with higher rate of pin-associated complications (6 vs. 2; 21.4% vs. 7.7%, p<0.05). None of the patients had cardiopulmonary complications. The mortality was 0%.

Discussion: On the whole good results were shown by odontoid fracture type III and atlas fractures. The fusion rate of odontoid fracture type II was lower. This correlates with the literature. In contrast to literature the mortality of our patients was lower.

Conclusion: On the basis of our evaluated data we see the HVI for odontoid fracture type III and atlas fracture as an alternative for treatment with acceptable complications.
**P177**
Low bone mineral density as a risk factor for odontoid fractures in the elderly
Yu-Mi Ryang, Anna C. Rienmüller, Johannes Kaesmacher, Claudia Schweizer, Alexander Valentinitisch, Jan Kirschke, Bernhard Meyer

**Introduction:** Traumatic odontoid fractures (TOF) are the most common injuries in the c-spine of the elderly. Degenerative changes of the cervical spine including the upper cervical level and cervical bone loss have been identified as important risk factors for fractures. So far no detailed information on segment specific BMD and risk of TOF is available.

**Material and methods:** We retrospectively analysed 5303 patients above 60 years admitted to a level I trauma centre between 01/2008 und 01/2016, who received CT imaging of the cervical spine. We identified 92 patients with TOF and 81 with other cervical spine fracture (OCSF). BMD of the c-spine was determined on CT scans for every segment and compared to age- and sex matched patients within our database.

**Results:** Out of 91 patients with TOF we found 74 type II and 18 type II fractures to Anderson and D’Alonzo. Significantly higher degrees of cystic degeneration were found in types II. Patients with OSCF were significantly younger then TOF (mean 76 versus 82 years), had a significantly higher cervical BMD (223.1mg/ml vs 184.1mg/ml) and significantly lower degenerative changes (p<0.05). In a multivariate logistic regression model, we found BMD as the major significant predictor of TOF (adjusted OR 0.992, 95%-CI 0.987-0.997 for 1mg/ml).

**Discussion:** The present data supports the statement, that odontoid fractures of the elderly should be considered as caused by loss of bone mineral density. Considering the impact of this fracture type we advocate including TOF in the category of major osteoporotic fractures.

**Conclusion:** Low BMD was found as the major risk factor for TOF but not for OCSF in the elderly.

**P178**
Neurologic deficit due to disc rupture after operation for c3-4 fracture-dislocation
Jaewan Soh

**Background:** Cervical bilateral facet fracture-dislocation is unstable, it is ncessary for reduction and fixation by operative treatment.

**Introduction and material:** A 65-year-old male patient was admitted after falling down from 3m. Despite of serious neck pain, but there were no neurologic symptoms. In simple radiographs and CT images, bilateral facet fracture-dislocation at C3-4 were occurred.

**Definition of case specific challenges:** In this case, there was no initial neurologic deficit despite of cervical fracture-dislocation. However, after the reduction surgery, neurologic deficit was developed by injured intervertebral disc herniation.

**Treatment:** We tried reduction of dislocation using skeletal traction. Howevere, that didn’t work. The patient was operated for reduction of dislocation and fixation by posterior approach.

**Complications and management:** Right after the operation, the patient complained of severe pain in the left upper and lower extremity. Then, sensory and motor functions of the left upper and lower extremity disappeared. In MRI findings, ruptured intervertebral disc at C3-4 compressed the spinal cord on left side. Therefore, we determined emergency operation, ruptured intervertebral disc was removed by anterior approach. After surgery, the patient’s neurologic symptoms were improved and sensory and motor functions were returned to be normal after 2 months. The patient was followed up for 1 and a half year postoperatively.

**Conclusion:** When cervical bilateral facet fracture-dislocation is occurred, injured intervertebral disc may be intrude into the neural canal during reduction of dislocation, resulting in neurologic abnormalities.
Legend to the figure: 1a, 1b Initial anteroposterior and lateral radiographs show widening of interspinous space at C3-4 and anterior translation of C3 body.
2a, 2b CT images show bilateral facet dislocation at C3-4.
3a, 3b Postoperative anteroposterior and lateral radiographs show reduction of dislocation at C3-4 with fixation of lateral mass screws.
4a, 4b, 4c, 4d Postoperative T2 weighted MR sagittal and axial images show compression of dural sac at C3-4 by ruptured intervertebral disc.
5c, 5d Secondary postoperative anteroposterior and lateral radiographs show anterior discectomy and fixation using plate at C3-4.
6a, 6b, 6c, 6d One and a half year followed up anteroposterior, lateral, flexion and extension radiographs show solid fusion at C3-4 and no instability.

P179
Detailed analysis and consequent treatment in revision cases can turn into amazing clinical success months after index surgery
 Bastian Storzer

Introduction and material: Diagnostic and treatment in cervical revision surgery can have a lot of pitfalls. Especially in patients with multiple operations and long construct. We present a 74-years-old rheumatoid patient with polyarthrosis who had surgery for multilevel degenerative disease and stenosis before (C2-T2 ventro-dorsal) (Fig.1a-b). Postop the patient developed a C5 palsy left-sided which was improved after 3 months. 6 months later the patient suffered from recurrent cervicobrachialgia on the left side, dysphagia, occipitocervical neck pain and pain in the shoulder with reduced abduction (<70°). He had history of shoulder arthroplasty left-side.
Definition of case specific challenges: CT scan showed atlantoaxial arthrosis, neuroforamenstenosis C4/5 and C5/6 on the left but no Implantat dislocation or loosening, non-union was present at C7/Th1 (still in progress) (Fig.2a-d). MRI showed no spinal cord compression (Fig.3a). In the scintigraphy pseudoarthrosis was not definitely confirmed (Fig.4a).

Treatment: We performed posterior revision surgery months after the first operation with changing of implant, lengthening of the implant from C1-T3 and a dorsal spondylodesis with autogen and allogen Spongiosa (Fig.5a-b).

Complications and management: Neuroforamenstenosis C4-6 was adressed with decompression and fascial dehiscence with plastic muscle coverage. Non-union was confirmed and treated with fusion C7-T1 and 3-rod construct. Postoperative, the patient showed immediately an improvement of his symptoms.

Conclusion: C5 symptoms can be misinterpreted as omarthrosis. Dehiscence of fascia can also lead to neckpain. Pseudoarthrosis can be a difficult diagnosis even when you have a scintigraphy. Detailed analysis of all pain sources is necessary for correct treatment.

Legend to the figures: 1a X-ray lateral, 1b X-ray ap, 2a CT sagittal, 2b CT C1/2, 2c CT C4/5, 2d CT C5/6, 3a MRI, 4a szintigraphy, 5a X-ray lateral, 5b X-ray ap
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