Intestinal Suture

manual for foreign students

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The manual is intended to the main aspects of the main expeditious reception in abdominal surgery – to an intestinal Suture. Information and illustrative material is presented according to demands of competence-based approach to a vocational education.

The manual is intended for the students who are trained on specialties of the higher education Medical business, Pediatrics.

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**Introduction**

«Reading about different devices, invented with a purpose of performing an intestinal suture, it makes one smile to think how much time was wasted by many authors who created tools of little use. Lembert suture is one of a few true evidences of progress in the art of medicine».

N. I. Pirogov

«There is no story more fascinating, than the history of evolvement of intestinal suture».

Hans Kehr

The intestinal suture is the basic surgical approach in abdominal surgery. Intestinal injury heals the same way as any other surgical injury, though with a difference—in presence of massive bacterial contamination and physiological intestinal motion.

Intestinal suture is a suture on hollow viscera of the abdominal cavity, which structural pattern comprises of outer peritoneal sheet, muscular layer, and submucosa and mucosa being the most inner structure. Anatomic and physiological features of these organs allow the inner layers (submucosa and mucosa) to slide over the outer ones (peritoneum and muscular layer). Alimentary tract is ultimately exposed to external environment, consequently its lumen is infected, which is why the major requirement for the proper intestinal suture is its tightness providing structural integrity and sterility in the abdomen.

**History of Evolution of Intestinal Suture**

The beginning of the technique is traced back to the times of hoary antiquity. The first citations are found in the Indian books of Veda dated back to ca. 5000 BC. Healers of ancient Hindu civilization were evolved enough to perform abdominal dissection and manually push an obstructing fecal concretion or remove an arrowhead and sew the wound. The latter procedure was conducted using big black ants (scaristesgygas), which were set onto the wound so their pincers would put two opposite edges together and seal the opening, after that their body was separated from the head, leaving it with pincers closed.

In year 20 AD the very first description of the actual suture was given by Celsus. Though he insisted that intestinal injury is ultimately lethal, he admitted that in case of colon injury there is some sense in attempting to overcast the intestinal suture.
In the II century Claudius Galen, basing in experimental results, conceded suturing of stomach and rectum. In the XI century Al-Zahrawi was suturing wounds using special threads, made from elastic elements of the intestinal wall of animals. In the XII century surgeons from Salerno inserted an elder tube or animal trachea or dried section of gut in the intestinal lumen. However vast number of attempts was doomed to fail without any success. Medical science was helpless fighting with purulence and infection. In the XVI century Paracelsus recommended the ostomy as the only solution for patients with intestinal injury.

In 2016 it is the 190th anniversary of Lembert’s idea of suture pattern of the same name, which became the fundamental principle of abdominal surgery. N. I. Pirogov characterized it as the true evidence of progress in the art of medicine.

Interrupted Lembert suture is still an irrefragable approach to the present day. Based on physiological properties of peritoneum – its known ability to adhere to itself – this suture with numerous modifications dictated existence of great number of remarkable surgical tractates.

Next stage of the technique advancement took place in the last quarter of the XIX century. In no small it depended on implementation of aseptics and antiseptics principles and inhalation anesthesia. At this time surgical catgut was introduced and widely spread as dissolvable stitches. In 1880 Cherny suggested the suturing pattern, as a modification of the Lembert suture, for suturing mucosa aimed at prevention of intestinal contents permeating through Lembert suture, and by doing so improve the healing process. This was the first time in history of abdominal surgery when double-row suture became widely recognized. Performing the Cherny suture requires inserting needle on the inner side of the intestinal wall, going through submucosa and muscle layer, then crossing the wound and exiting in reversed order. This suture pattern may be interrupted or continuous, although its primary purpose is to induce hemostasis, however additional integrity is also brought about by including submucosa in the suture.

Albert’s suture (1981) has the same function as Cherny suture, but insert and exit is performed in submucosal layer. This suture is through, double-row with a first row knot placed outside of intestinal lumen. It is followed by the second row of sutures going through serosa and muscle layers. Miculicz in his turn used through stitches as a first row suture, placing knots inside the seromuscular Lembert suture.
Intestinal anastomosis with performing Cherny, Albert and Miculiczsutures is not only of historical interest. Some practicing surgeons prefer to use Cherny and Miculicz sutures configuring posterior lip and Albert suture for anterior lip of anastomosis.

In 1911 Schmieden suggested the through continuous suture to form an anterior lip of anastomosis, which is being widely used to the present date. Synonyms for Schmieden suture are: inverting suture, glover’s suture, catch stitch, buried suture. The technique comprises of the following steps: the sequence of layers for one edge “mucosa-submucosa-muscular layer-serosa” is the same as for the other. (Fig. 8)

The differences in modern multiplerows sutures is due to seeking to achieve more precise communication between two portions of intestine. In 1964 I. D. Kirpatovskiy proposed the double-rowsuture, in which the inner row apposes only submucosal layers, and the outer one does serosa and muscular layer (Fig. 5). Needless to say, in this manner it can be used only for the anterior lip of anastomosis.

N. I. Pirogov used single-row sero-muscular-submucosal interrupted suture, where knots were placed on the outer side (Fig. 6). Its hemostatic and sealing features exceed those of regular seromuscular suture.

After V. P. Mateshuk had published his research papers in 40-50ss single-row suture became rather popular in Russia. This suture, in which knots are placed inside the lumen, was named “inner knot suture”. It requires inserting the needle between submucous and muscular layers and exiting 2-4 mm from the edge (Fig. 7). On the other edge the procedure is conducted in reversed order.

The current trend in intestinal surgery is performing continuous locking stitch, which doesn’t penetrate the mucous layer. This method is called “Russian suture” (Fig. 9). The needle is to be inserted in serosa and exits near the bottom of mucosa, not penetrating it on one side. On the other the needle is inserted in submucous towards serosa. Firsts the sutures are tightened on the inner side, which leads to edges to be inversed and close communication with serosa to occur. Serous layers are tightened on the outer side, which causes the edges to appose firmly without mucosa being inversed. This suture features a tight and strong seal, but also requires using atraumatic needle and suture.
Classification of Intestinal Suture Patterns

There are ca. 500 suturing techniques known to date. All of them can be grouped as follows:

I. By suture structure:
   - interrupted
   - continuous

II. By intestinal layers involved:
   - sero-serous
   - sero-muscular
   - seromusculo-submucosal
   - seromusculosubmucoso-mucosal

III. By a knot placement:
   - intraluminal
   - extraluminal

IV. By wound edges apposing method:
   - inverted
   - averted

V. By number of rows:
   - Single row
   - Double-row
   - Triple-row

VI. By suture performance:
   - manual
   - mechanical

VII. By suture material:
   - dissolving
   - non-dissolving

Basic Requirements

As a result of collaborative experience of many practicing surgeons, who founded practical and theoretical basis for intestinal suture, the following requirements were defined:

1) tightness of suture;
2) ability to preserve aseptic environment;
3) ability to provide hemostasis;
4) proper endurance;
5) uniformity of the procedure.

Tightness is mainly provided by sterility of the suture, which induces mechanism of biological fusion of living tissues.
(fibrination and serous layers adhesion) and secondarily – by flawless adaptation of the intestinal wall structures.

Sterility is achieved by performing of sero-muscular suture. Hemostasis could be achieved by proper bleeding blood vessels occlusion, which is determined by actual operative technique and could be improved with use of additional bleeding termination techniques.

Endurance is provided by involvement in the suture natural anatomic supportive structure – submucosa.

Uniformity is formed by establishing technical procedures algorithms, separate stages unification, parameters definition and integration, including tools, instruments and suture material selection. Thus during practices sessions one should use straight round shaped needle while performing intestinal suture in a way to receive tactile feedback, which is impossible while using a needle driver with a reflexive needle. Non-routinemethods could be used in case of extraordinary situations such as spontaneous bleeding, infiltrated tissue eruption etc.

As for two other intestinal suture patterns, continuous and interrupted, each has its own strengths and shortcomings. Thus, continuous suture overcast technique is more simple and takes less time to perform, however in case of the knot failure there might be consequent anastomotic dehiscence over the whole suture length. While in case of the knot failure in interrupted suture, dehiscence could be prevented by other knots sealing the wound. Also interrupted suture provide a little bit more equal tension distribution, which contributes to better blood supply and vermicular movement of affected portion of intestine. Interrupted sutures tend to constrict and distort lumen in the place of anastomosis in less extent, whereas the continuous suture is associated with a denser, more rigid adhesion limiting effectiveness of anastomosis. On the other hand, this suture also could provide stronger communication, which lessens chance of mucous prolapse between two layers of serosa, induces hemostasis and, again, takes less time to perform.

The difference of the intestinal suture consists in an immense variety of approaches, which could be explained by attempts of many authors to enhance its structural integrity. For a long time double- and triple-row sutures has deemed to be top priority for achieving this purpose. However multiplicity of rows scarcely can assure inability of microorganisms to penetrate through the suture or a ligature canal. There is a paradoxical direct correlation between biological permeability of a suture and number of row of stitches. Apparently this happens because of coinciding deterioration of blood supply caused by excessive squeezing of tissues. Besides absorbency may play a certain role in this process. Along with redundant traumatization
of intestines by suturing, these factors are the main cause of the suture failure. As experience shows, the decent single-row suture is better than poor double-row one. The second-row brings along a higher chance of complications, and subsequently less reliability.

At present in surgical practice the preference is given to dissolvable single-row seromusculo-submucosal suture.

Advantages of the single-row suture:
1) performance speed;
2) lesser traumatization;
3) lesser amount of foreign tissue;
4) better intestinal wall layers cohesion;
5) smaller tissue adhesion area;
6) lesser extent of lumen distortion;
7) lesser extent of blood and lymph circulation compromise;
8) faster tissue regeneration;
9) faster and better scar formation;
10) lesser extent of tissue infiltration;
11) lesser chance of microabscess formation;
12) faster immune suture rejection;
13) more adequate anastomosis;
14) lesser suture failure rate.

Knots located inside the lumen of intestine facilitate their rejection and removal via the intestinal tract. When dissolvable suture is used knot’s position is inessential.
Schematic image of intestinal suture

Fig. 1. Lembert suture (Karnushina A.V., 2015)

Fig. 2. Cherny suture in a combination of with Lembert suture for a back labium of an anastomosis: 1 – Cherny suture, 2 – Lembert suture (Nikolaev A.V., 2009)
Fig. 3. Albertsuture in a combination of with Lembert suture for a back labium of an anastomosis: 1 – Albertsuture, 2 – Lembert suture (Karnushina A.V., 2015)

Fig. 4. Miculicz suture in a combination of with Lembert suture for a back labium of an anastomosis: 1 – Miculicz suture, 2 – Lembert suture (Karnushina A.V., 2015)
Fig. 5. Kirpatovsky suture: 1 – internal submucosal interrupted suture; 2 – external serosa and muscular interrupted suture (Karnushina A.V., 2015)

Fig. 6. Pirogov suture (Karnushina A.V., 2015)
Fig. 7. Mateshuk suture (Karnushina A.V., 2015)

Fig. 8. Continuous through suture of Schmieden.(Sergiyenko V.I., Petrosyan E.A., Frauchi I. V., 2002)
**Suturing Penetrating Wound of Intestine**

<table>
<thead>
<tr>
<th>Operating Sequence</th>
<th>Specification</th>
<th>Check-up indication</th>
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</thead>
<tbody>
<tr>
<td>Initial surgical debridement of the intestinal wound</td>
<td>Excise necrotic and abrupt tissue on the edges using a sharp lancet, the excess of mucosa can also be dissected.</td>
<td>Wound edges are clean and congruent</td>
</tr>
<tr>
<td>Wound (2x3cm or smaller) closure using through (contaminated) interrupted suture pattern</td>
<td>Capture the wound edges using traction suture, placed on corners of the wound. The through interrupted suture is performed with catgut threads. Thread length should be ca. 17 cm. Insert the needle and exit 3-5 mm from the edge. Insert the needle in serosa of the opposite edge, cross the wound and exit toward serosa. Place a knot on the outer side and cut off the excess of the thread. Overcast the second row of the seromuscular Lembert suture upon the first row.</td>
<td>Performing the suture keep checking intestinal wall layers apposition is correct, which is crucial for tissue regeneration.</td>
</tr>
<tr>
<td><strong>Longitudinal-transversal wound transformation</strong></td>
<td><strong>Longitudinal (parallel to intestinal axis) wound should be transformed into transverse to prevent the lumen constriction. Place traction sutures on sero-muscular layers of intestine in the middle of the wound 4-5 mm from the edge. perform traction and start the intestinal suture.</strong></td>
<td><strong>The lumen is not constricted preventing passage obstruction.</strong></td>
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<tr>
<td><strong>Aseptic interrupted sero-muscular Lembert suture</strong></td>
<td><strong>Suture material - silk or synthetic thread. Aseptic interrupted sero-muscular suture is overcasted upon the initial suture. It includes two steps: 1) Insert the needle through serosa and muscular layer 7 mm from the initial suture. Exit at the same level 2-3 mm from the suture. Stitch length should not exceed 4-5 mm. The needle with thread should be stretched through the intestinal wall all the way up to the middle of the thread; 2) on the other side at the same level insert the needle and exit 4-5 mm and 8-10 mm form the edge of the first suture respectively. Thus there should be two stitches placed on both sides of the first suture. The interrupted sero-muscular suture stitches should be at least 5 mm apart from each other. At the moment of tighteningsero-muscular folds are formed and serosa sheets are tightly apposed to each other. When determining the stitch interval length one should consider the major factor of adhesion - tight serosa sheets apposition.</strong></td>
<td><strong>The needle must not penetrate the intestinal wall. For proper control use the following criteria: the needle exiting the intestinal wall must be barely seen (&quot;not buried&quot;) and outlined through serosa; 2) when the needle passes only through serosa it is clearly seen, and it may cause eruption of serosa; 3) when inserted correctly the needle's outline can be perceived. Serosa sheets are apposed tightly.</strong></td>
</tr>
</tbody>
</table>
Every stitch should be tightened and a knot to be placed right after finishing the stitch, and excess of thread to be cut off, leaving 2-3 mm tails. The first suture threads can be used as traction stitches.

<table>
<thead>
<tr>
<th>Overcast of the Albert double-row suture</th>
<th>The first row of the interrupted suture should be formed with catgut thread. The knots are placed on the outer side. The second row of interrupted sero-muscular suture should be formed with silk or synthetic thread. The seromuscular row should overlap the first row at least for 5-8 mm on each side.</th>
<th>The lumen is not constricted, serosa sheets are tightly appose to each other.</th>
</tr>
</thead>
</table>

Wound closure with continuous sero-muscular sutures:
1 - purse-string suture
2 - Z-shaped suture

1. Suture material - silk or synthetic thread № 1-2, length 25-30 cm. At the end of placing a purse-string suture around a small wound (3-5 mm) the edges of the wound should be buried in intestine and serosa sheets should tightly appose. In this regard stitches must be placed not closer than 8-10 mm from the edges. The interval between them should be no less than 5 mm (5-8 mm). Every time accomplishing a stitch it is required to tighten it to avoid tightening multiple stitches at once later, which may damage intestinal tissue. While performing suture around the wound the needle in the needle-driver needs to be repositioned ("push" and "pull" suturing). At the moment of accomplishing the circumference both ends should not be tightened though a not should be placed. Tightening and burying of the suture should be performed simultaneously: using a dissecting forceps grab the intestinal wall

a) when the purse-string suture is overcasted correctly the wound edges are completely buried in the intestinal wall, and serosa sheet form folds and tightly appose to each other. While in case of incorrect suturing there might be parts of mucosa appear between the serosa sheets.

b) When the Z-shaped suture is overcasted correctly the wound edges are completely buried in the intestinal wall, and serosa sheet form folds and tightly appose to each other.
inside the suture near the edge and push it inside the wound while tightening the suture (while threads are pulled through a gauze sponge they should be parallel and placed at the level of the suture). The purse-string suture is tightened conclusively only after removal of the forceps. Finally place a double knot finishing the suture.

2. Z-shaped suture can be placed upon the purse-string suture or used to close a smaller wound. Insert the needle 8-10 mm from the edge, make two stitches, then cross the wound and make two more stitches 8-10 mm form the edge on the other side, so that the suture becomes Z-shaped. Tighten the thread and place the first knot, making sure that the edges bury in the intestinal wall, and then place the final second knot (just as for the purse-string suture).

<table>
<thead>
<tr>
<th>Penetrating wound closure</th>
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<tbody>
<tr>
<td>1. Penetrating wound closure should be performed using interrupted suture, which may cross all 3 or just 1 mucosal layer of the intestinal wall.</td>
</tr>
<tr>
<td>2. Overcast double-row sero-muscular suture upon the interrupted suture, sequentially burying the previous suture in the lumen (when suturing intestinumtenue place only single-row suture)</td>
</tr>
</tbody>
</table>
### End-to-End Intestinal Anastomosis

<table>
<thead>
<tr>
<th><strong>Resection volume assessment</strong></th>
<th>Assess the intestine and select an intestinal loop appropriate for resection, assuming the injury and determining indications for procedure. Slightly stretch and spread the part of intestine to be resected and its corresponding mesenterium so vascular arches and straight vessels could be visualized.</th>
<th>Mesenterialtortion should be ruled out and arterial arches and straight arteria outlines should be clearly visualized.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Separation of the resected part using crushing forceps</strong></td>
<td>Part of the intestine to be resected (15-20 cm) should be resected should be separated with two crushing forceps (intestinal or vascular Bilrot modification). Forceps are placed on the intestine parallel to straight vessels at the place where no blood vessels are visualized.</td>
<td>Check that forceps are placed correctly – their handles are open, and the jaws are closed</td>
</tr>
<tr>
<td><strong>Mobilization of the resected part of the intestine</strong></td>
<td>Mobilization is procedure of separation the part of the intestine from mesenterium. Make a hole in a vessel-free area of mesenterium right near the edge of the intestine (using closed forceps). Insert hemostatic forceps in the hole and place it parallel to intestinal axis, then grip the mesenterium 2-2.5 cm from the intestinal edge (grasping 2-3 straight vessels). Then insert the second forceps in the hole, closer to the mesenteric root, keeping it parallel to the first forceps. Dissect the part of mesenterium, between the forceps and secure its distal (closer to the intestine) part with silk thread; also secure and suture the proximal part. Thus sequentially separate the intestine from its mesenterium.</td>
<td>The part of intestine is separated from its mesenterium; Both distal and proximal parts of mesenterium are secured and sutured, including blood vessels.</td>
</tr>
<tr>
<td>Section</td>
<td>Description</td>
<td></td>
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<tr>
<td>Separation of parts of the intestine at the level of future anastomosis using smooth tissue forceps.</td>
<td>Place smooth tissue forceps 2.5-3 cm outwards from smashing forceps (placed on the intestinal loop to be resected) keeping them in parallel. Note that suggested anastomosis area should include a few straight arteries. The smooth tissue forceps are placed aslant (handles are open, jaws are closed). Straight arteries outlines are visualized on the suggested anastomosis area on the mesenterium.</td>
<td></td>
</tr>
<tr>
<td>Mobilized intestine dissection</td>
<td>Dissect the intestine at the place between smashing and smooth tissue forceps on each side using a sharp lancet. There are 2.5-3 cm long parts of intestine left inwards from each smooth tissue forceps, which will be used for establishing the anastomosis.</td>
<td></td>
</tr>
<tr>
<td>Intestinal ends apposition</td>
<td>Two parts of the intestine should be properly apposed, so the dissected ends (ones both of the intestine and the mesenterium) are congruent and could be apposed. To do so bring together the ends of the intestines, edges of the mesenterium and the side surfaces of intestinal forceps touch each other and are on the same level. The intestinal lumen appears slit-like on both ends, anterior and posterior (touching each other) edges and two corners (mesenterial and loose) could now be distinguished. Anastomosing ends are brought together and clamped by intestinal forceps.</td>
<td></td>
</tr>
<tr>
<td>Expanding the lumen of anastomosing ends</td>
<td>When the lumen is too narrow, the incision should be a little bit skewed, thus appropriate blood supply is assured. To avoid the constriction of the intestine the loose ends could be dissected lengthwise (1.5-2 cm long) and sharp edges be smoothed</td>
<td>The lumen size is adequate to the anastomosis.</td>
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<td>----------------------------------------</td>
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</tbody>
</table>
| Suturing stages                         | 1. Visualize serosa of posterior edges turning forceps handles in opposite directions. Place pars nuda in the middle between the loose and mesenterial corners.  
2. Perform interrupted sero-muscular suture on the posterior edge 4-5 mm from the edge using silk thread. Cut off the excess od thread at each knot except the first and the last ones, since they can be used as traction sutures. The distance between neighbor knots should be 3-5 mm. Perform single-row mattress suture in the middle of posterior edge, where serosa is not presented.  
3. Perform interrupted suture with catgut thread on the posterior edge. | If sero-muscular suture knots are located too close to each other the needle can get into the lumen and infect the suture, and it can cause a lack of space for the subsequent suture too. The stitches should not grasp the previous sero-muscular suture. Reverden suture is used to fasten a vulnerable spot, which manifests itself after the forceps had been removed. Control the tension when performing the twisted suture, as it may cause the lumen distortion. |
<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Perform both corner stitches first, at the exact corners, inserting the needle in the inner side on one edge and in the outer side on the other, placing knots in the lumen. In the middle of the suture row where the mesenterium attaches to the intestine perform the interrupted mattress suture (Fig. 11). Keep the same 5 mm interval between the knots. After finishing this, the double-row suture on the posterior wall is considered accomplished.</td>
</tr>
<tr>
<td>4.</td>
<td>The anterior interrupted suture is performed with catgut thread. It begins from one of the corners, from inside outwards on one side, and vice versa on the other. Knots are placed inside the lumen. After two or three stitches, the suture starts on the other corner. Keep suturing until there is only a small area in between the corners. This area is closed by performing the z-shaped suture or by placing a knot with threads from last two knots from each side (both last stitches are made from inside outwards) (Fig. 13).</td>
</tr>
<tr>
<td>5.</td>
<td>The anterior sero-muscular suture should not be too distant from the previous, to avoid the lumen distortion (Fig. 14).</td>
</tr>
<tr>
<td>6.</td>
<td>When suturing the mesenterial edge of the intestine, note that serosa sheets can contract by 4-5 mm, uncovering the muscular layer and thus serosa can be not captured in the suture.</td>
</tr>
</tbody>
</table>
perform the interrupted suture on the mesenterium to avoid intestinal strangulation. It is recommended to peritonize and elaborately appose serosa sheets on both sides (Fig. 15), which helps to prevent post-op complications, such as adhesion. Before abdominal wall closure assure that there is no obstruction in the anastomosis (Fig. 16)

<table>
<thead>
<tr>
<th>Mesenterial gap closure</th>
<th>Perform the interrupted suture with silk thread to close the mesenterial gap.</th>
<th>Serosa sheets are tightly apposed, there is no visible gap, and the straight vessels are intact.</th>
</tr>
</thead>
</table>

**Obstruction check**

1. Carefully displace the anterior suture against the posterior.
2. Perform slight introsusception of an afferent limb in the efferent.
3. Using two fingers bring the walls of the afferent and efferent limbs together until they touch each other inside the lumen.

In case of obstruction none of these techniques would be performable.
## Side-to-Side Intestinal Anastomosis

<table>
<thead>
<tr>
<th>Operating sequence</th>
<th>Important! After mobilizing the intestinal loop, place smashing forceps both on residual and resected ends of the intestine. Leave the interval between the forceps equal to 1-1.5 cm.</th>
</tr>
</thead>
</table>
| Afferent and efferent residual limb closure | There are a few methods of residual limb closure:
1) Ligate the intestine with catgut thread after the forceps removal and then dissect it from the part to be resected. The limb is closed with the z-shaped or purse-string suture.  
2) In case of a larger lumen diameter use the double-row Albert suture.  
3) The stiff forceps is kept on the limb. Using a sharp lancet dissect the intestinal limb on the inner edge of the forceps. Then suture the limb using continuous suture with catgut thread, including the forceps (do not tighten the first stitch). Do not overtight other knots. When the suture is accomplished slightly open jaws of the forceps and carefully remove from under the stitches. Tighten the knots by stretching the catgut thread and close the residual limb. Then knot the ends of thread, gathering the stitches into one knot. Perform the purse-string or z-shaped suture upon the previous suture. |
| Afferent and efferent residual limbs apposition | The limbs should be apposed on the basis of peristalsis movement, mesenterial and loose edges should be apposed to homonymous structure. The limbs length is determined by 1) The residual limb is buried in the purse-string suture, serosa folds are tightly apposed.  
2) Serosa sheets are tightly apposed in the suture.  
3) The encircling stitches are tied up and tightly appose to each other. The residual limb is buried in the purse-string suture. |
the size of the anastomosis, which should be twice as large as the lumen diameter. The corners should be 2-3 cm far from the basis of the limbs. Dissection lines should be 5 mm far from the loose edge of the intestines, so when suturing the mesenterium is not involved in the operation are.

To determine dissection zone one can palpate the limbs through the intestinal wall and assess their size.

| Intestinal anastomosis suturing | 1. Perform the first row of interrupted sero-muscular suture 5-8 mm from the dissection line before cutting the intestine open.  
2. Determine the length of the first row. Allow the diameter to be 2 cm, then anastomosis lumen diameter should be twice as big, i.e. 4 cm. The first row must overlap the dissection line by 1 cm. Thus the first row suture length is 6 cm. Perform 2 stitches on the edge positions of these 6 cm, which will be used as traction sutures.  
To keep the suture lines straight use “division by 2” method. Stitches interval should be 3-4 mm.  
3. Cutting the limbs open. Using a sharp lancet carefully dissect serosa and muscular layer in parallel to the sero-mucular suture 5-8 mm from it. The length of the incision should be 2 cm less than the first sero-muscular suture (1 cm from each edge) | The mesenterial edges are at the same level. Serosa sheets are tightly apposed to each other. |
<table>
<thead>
<tr>
<th>Then using dissection forceps pull submucosal and mucosal layers into the wound and dissect them with scissors, leaving intact 3 mm from dissected seromuscular layer on each side.</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Perform the second row of continuous encircling suture 4-5 from the dissection line after cutting the intestine open (form the posterior edge of the anastomosis). One can start the suture by the dissection line (dissection corners), or at the point between a proximal third and distal two-thirds of the incision. After the first stitch place a reef knot, leaving one thread 2-3 cm long. The other long end is being used for suturing in following order: mucosa-serosa in the affecting limb and serosa-mucosa in the effecting limb until the opposite end of the incision. Handling the corners of the wound is the most important stage of the intervention. Perform three pairs of catch-stitches: 1st pair – on the inner edges of the corner, 2nd pair – on the top of the corner, 3rd pair – on the outward edges of the corner. Using the same thread suture the third row of “infected” continuous suture (glover’s suture, inverting suture, catch stitch, Schmiden suture). In this suture the needle is always inserted on the inner side of the intestinal wall. Thus, suturing sequence on the afferent as well as efferent limb is going to be “mucosa-serosa”, “mucosa-serosa”.</td>
</tr>
</tbody>
</table>
When inserting the needle in the afferent limb using the dissection forceps invert the mucosa of the efferent limb in the lumen of the anastomosis and vice versa. The thread must be stretched all the time, which is why particular concurrence of an assistant and a surgeon has to take place. Suture until the corner, where continuous encircling suture started. When the third row is accomplished, place a knot and cut off the excess of thread. To finish anastomosis place the 4th row of interrupted seromuscular suture, overlapping by 1 cm from each edge of the third row. Then cut off the threads of the traction sutures.

<table>
<thead>
<tr>
<th>Mesenterial gap closure</th>
<th>Since mesenterial sheets communicate along the whole anastomosis, they should be sutured using interrupted suture on both sides on the edges of dissected mesenterial sheets.</th>
<th>Mesenterial sheets tightly appose to each other with no gap between them.</th>
</tr>
</thead>
</table>
| Obstruction check       | 1. Carefully displace the anterior suture against the posterior.  
2. Perform slight introsusception of an afferent limb in the efferent.  
3. Using two fingers bring the walls of the afferent and efferent limbs together until they touch each other inside the lumen. | In case of obstruction none of these techniques would be performable. |
Stages of applying of an interintestinal anastomosis in the way "End-to-End"

*Рис. 9.* Beginning of a back row of sero-muscular suture. The third back interrupted mattress suture especially carefully covers the intestine sites deprived of a seroza (parsnuda).

*Рис. 10.* The back row of sero-muscular sutures is finished.
Рис. 11. Back row of the interrupted sutures.

Рис. 12. Back row of the interrupted sutures is finished.
Рис. 13. The anterior interrupted suture with setting of the single sutures rolled in a lumen is finished. This area is closed by performing the z-shaped suture. The first seam of the anterior sero-muscular suture is imposed.

Рис. 14. The anterior interrupted suture
Рис. 15. Applying of an anastomosis is finished. The opening in a mesentery is sewn up with the interrupted rolled sero-muscular suture.

Рис. 16. The lumen of an anastomosis is checked by two fingers.
Comparative Evaluation of Intestinal Anastomosis Techniques

The operation of choice is end-to-end entero-enteroanastomosis, (enteroenteroanastomosistermino-terminalis), since it is the most adequate and physiological in terms of both anatomy and function. Its limitation is determined by the absence of serosa cover on the so called pars nuda which is 2-4 mm long (Fig. 9). That is why it is absolutely critical to peritonize this area. For another thing, hemostasis is impeded since the whole circumference of the intestine is involved in the anastomosis, including the major blood vessels, which are located in the mesenterium.

The other techniques of intestinal anastomosis (enteroenteroanastomosis latero-terminalis and enterocholoanastomosis) are always available for surgeons, because they are irreplaceable in a number of situations (e.g. Braun entero-enteroanastomosis on a long loop or jejunocoloanastomosis etc.) Strengths of the side-to-side technique include the absence of a problem of special peritonization of the pars nuda zone, which is a great challenge when performing the end-to-end anastomosis. Also, since the surgeon is not limited by the intestinal diameter restrictions, the rate of obstruction is relatively low. It is possible to determine the diameter of the anastomosis lumen prior to the intervention. Hemostasis maneuvers are easier to perform, on account of the incision is made on the antimesenteric border, where the density of blood vessels is lower and their bore is significantly smaller. The limitations of the method include a “wasteful” manner, when the limbs formation and the anastomosis itself form intestinal reduplication. Also parts of the intestine excluded from the participation in intestinal transit form so called “close pockets”.

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Test

Choose one correct answer.

1. THE DOUBLE – ROW SUTURE IS
   1) Beer suture
   2) Lambert suture
   3) Mikulicz suture
   4) Mateshuka suture

2. CHOOSE THE SINGLE – KNOT SUTURE FROM GIVEN OPTIONS
   1) Jolie suture
   2) “Russian” suture
   3) Schmieden suture
   4) Kirpatovsky suture

3. CHOOSE THE OUT - MUCOUS SUTURE FROM GIVEN OPTIONS
   1) Albert suture
   2) Pirogov suture
   3) Chernie suture
   4) Mikulicz suture

4. CHOOSE FROM GIVEN OPTIONS ONE, THAT DOES NOT MATCH WITH THE MAIN REQUIREMENTS FOR INTESTINAL SEAM
   1) Hemostatition
   2) Impermeability
   3) Durability
   4) Evertiruemost
5. PRIORITY OF DISCOVERY THE FIRST RELIABLE SUTURE METHOD BELONGS TO
1) Riverden
2) Mikulicz
3) Lambert
4) Billroth

6. LAMBERT DESCRIBED HIS REVOLUTIONARY INTESTINAL SUTURE METHOD AT
1) 1826
2) 1882
3) 1901
4) 1911

7. THE ADVANTAGE OF LAMBERT SUTURE ARE ALL OPTIONS EXCEPT
1) Speed of accomplishment
2) Low trauma
3) Minimal amount of foreign material in tissues
4) Good hemostatic internals

8. SUTURAL MATERIAL MOST LIKELY USE FOR THE FIRST SUTURE LINE
1) Absorbable
2) Nonabsorbable
3) Monofilament
4) With polymer coating
9. TISSUE MOST PROVIDING STABILITY OF INTESTINAL STEAM
1) Serous
2) Muscular
3) Submucosal
4) Mucous

10. TISSUE WHICH BY CROSSLINKING REACHES A MAXIMUM HEMOSTATITION
1) Serous
2) Muscular
3) Submucosal
4) Mucous

11. CHOOSE CORRECT STATEMENT
1) According to the nature of the wound edges matching there are 2 types of intestinal steams: intraluminal and extraluminal
2) According to the localization of the node and the end of ligature there are 2 types of intestinal steam: inverted and averted
3) According to the nature of the wound edges marching there are 2 types of intestinal steams: continuous and nodular
4) According to the localization of the node and the end of ligature there are 2 types of intestinal steam: intraluminal and extraluminal

12. AS A FIRST LINE OF SUTURES MIKULIZH USED
1) Perforating intraluminal suture
2) Perforating extraluminal suture
3) Submucoso-submucosal suture
4) Perforating encircling suture
13. AS A SECOND LINE OF SUITURES MIKULIZH USED

1) Perforating intraluminal suture
2) Perforating extraluminal suture
3) Serouso-muscular suture
4) Serouso-musculo-submucosal suture

14. RUSSIAN SUITURE IS

1) Continuous U-shape mattress suture
2) Nodular three-lane colon suture
3) Continuous encircling out-mucous suture
4) Continuous encircling perforating tie-suture

15. CHERNIE SUITURE IS

1) One-lane nodular suture
2) Two-lane nodular suture
3) Continuous suture
4) Three-lane nodular suture

16. FIRST REFERENCE OF INTESTINAL STEAM IS IN THE

1) Indian Vedas
2) Works of Claudius Galen
3) Canon of Avicenna
4) Works of Hippocrates

17. PIROGOV SUITURE IS

1) Extraluminal
2) Intraluminal
3) Multilevel
4) Continuous

18. PIROGOV SUTURE HAS ALL INTERNALS EXCEPT
1) High mechanical reliability of suture
2) Seizure of the mucous tissue in the seam
3) Good hemostatic effect
4) Precise comparison of intestinal tissues

19. CHOOSE THE CLASSIC TYPE OF LAMBERT SUTURE
1) Serouso-muscular
2) Serouso-serous
3) Serouso-muscolo-submucosal
4) Serouso-muscular-submucoso-mucosal

20. IN THE INTESTINAL STEAM’S CLASSIFICATION ACCORDING TO NODE AND STRANDS ENDING LOCALIZATION EMPHASIZING
1) Absorbable
2) Interluminal
3) One-lane
4) Hand suture

21. IN THE INTESTINAL STEAM’S CLASSIFICATION ACCORDING TO THE NATURE EMPHASIZING
1) Hand suture
2) Absorbable
3) One-lane
4) Extraluminal
22. IN THE INTESTINAL STEAM’S CLASSIFICATION ACCORDING TO THE STRUCTURE EMPHASIZING

1) Interluminal
2) One-lane
3) Hand suture
4) Discontinuous

23. CHOOSE TWO-LANE INTESTINAL STEAM

1) Pirogov suture
2) Schmieden suture
3) Lambert suture
4) Albert suture

24. SPECIFY WHICH PART OF ANASTOMOSIS IS ADVISABLE TO USE ALBERT SUTURE

1) Front lip suture
2) Rear lip suture
3) Superposition of the Z-shaped suture
4) “pars nuda” suture

25. SPECIFY THE METHOD OF INTESTINAL STEAM WHICH INCLUDES 4 INTESTINAL TISSUES

1) Kirpatovsky suture
2) Beer suture
3) Pirogov suture
4) Chernie suture
26. SPECIFY THE METHOD OF INTESTINAL STEAM WHICH INCLUDES
3 INTESTINAL TISSUES
1) Lambert suture
2) Pirogov suture
3) Chernie suture
4) Beer suture

27. SPECIFY THE METHOD OF INTESTINAL STEAM WHICH INCLUDES
2 INTESTINAL TISSUES
1) Mateshuk suture
2) Pirogov suture
3) Mukilizh suture
4) Albert suture

29. SPECIFY THE TYPE OF INTESTINAL ANASTOMOSIS WHICH HAVE
TO BE CHOSEN
1) “end-to-end”
2) “side-to-side”
3) “side-to-end”
4) “end-to-side”

30. SPECIFY THE LENGTH BETWEEN “DIRTY” AND “CLEAN” SUTURES
IN THE TWO-LANE STEAM
1) 0,5 cm-0,8 cm
2) 0,8cm-1.0 cm
3) 1.0cm-1.2cm
4) 1.2cm-1.4cm
Case Study

Case 1. A patient present with trauma was taken to the operating room. Emergency exploratory laparoscopy reveals intestinal injury and mesenterial hemorrhage. What technique would you use to perform temporary and permanent hemostasis?

Case 2. Intraoperative findings of a patient include a penetrating wound 2x2 cm 50 cm distal of flexuraduodeojejunalis. Mucosal folds extrude from the wound in the lips-like manner. Explain this occurrence.

Case 3. Hemorrhage develops during dissection of smashed edges of an intestinal wound. In what layer of the intestinal wall the blood vessels are situated?

Case 4. Thread cuts serosa in multiple loci while surgeon is placing a knot of the purse-string suture. What technical mistake did lead to this complication?

Case 5. Bowel obstruction develops in a patient, who earlier received an intervention of single-row end-to-end anastomosis formation, which led to the lumen constriction. What surgical techniques would you use to prevent this complication?

Case 6. During suturing a stab wound a surgeon notices folds of mucosa between the stitches of the purse-string suture. What could cause this event?
Case Studies Answer Key

1. Temporary hemostasis is performed by using hemostatic forceps. Permanent hemostasis is achieved by ligating the blood vessels clamped by the forceps. Ligate the central end of the blood vessel and suture adjacent tissue.

2. Mucosa extrusion happens because of the inner and outer intestinal layers uneven displacement.

3. The most developed blood vessels system (which probably caused the hemorrhage) is located in the submucosal layer.

4. Probably the stitch did not include a muscular layer, which created excessive pressure on serosa, which caused its eruption.

5. Perform more slanting incision on the anastomosing intestines or widen their lumen with longitudinal incision on the antimesenterial border, smoothing sharp edges to prevent distortion and contraction of the lumen during end-to-end anastomosis.

6. 1) Mismatch of the purse-stringsuture and the limbsize; 2) Non-synchronous tightening and burying of the suture (the suture was tightened before the limb was buried; 3) the purse-string suture stitches cut through and caused failure of the suture.

The list of the recommended literature
Main literature


Additional literature

Educational edition

Songolov Gennady
Ignatyeich, Galeyeva Olga
Pavlova, Redkov Sergey
Nikolaevich

Intestinal suture

Manual for foreign students