Utility and Feasibility of Apparent Diffusion Coefficient Maps for the Assessment of Intervertebral Disk Tissue State and Degeneration
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Introduction: Intervertebral disk (IVD) degeneration is one of the common issues of the modern society. Avascularity and nutrient deprivation is a major etiological factor for IVD degeneration. Diffusion imaging of the intervertebral disk is a new approach for functional assessment of molecular transport and studying pathophysiological mechanisms behind the disk degeneration. The aim of this study is to assess the utility of apparent diffusion coefficient (ADC) MRI maps in the assessment of degenerative lumbar spine disease and describe characteristic features of ADC maps in various degenerative lumbar spinal conditions.

Materials and Methods: 1.5T MRI imaging of 100 consecutive patients (452 IVDs total) admitted to the spinal surgery service were assessed in T1, T2 and diffusion weighted images (DWI) sequences. ADC maps were generated from DWI images using Osyrix software. The ADC values and characteristic ADC maps were assessed in the regions of interest drawn over the different pathological entities.

Results and Discussion: Characteristic ADC map features were identified for protrusion, extrusion and sequester types of lumbar IVD herniations, spondylolisthesis, reactive Modic endplate changes, Pfirrmann grades of IVD degeneration, and compromised spinal nerves. ADC maps overlaid onto T2WI provided additional contrast and information about the diffusivity of different types and locations of disk herniations. ADC maps were able to differentiate two types of reactive bone-marrow changes from the normal bone in the adjacent vertebrae (p<0.01). Quantitative ADC values correlated with the clinically used qualitative T2 Pfirrmann scores for the assessment of the degree of IVD degeneration (Figure 1). However, quantitative ADC values showed that herniated IVDs have significantly higher diffusion than the non-herniated IVDs of the similar degeneration grade, suggesting different mechanisms for the IVD degeneration in these entities. ADC inhomogeneity was significantly higher in herniated than in non-herniated IVDs (p<0.01). We believe that quantitative ADC may be more accurate in the assessment of the functional state and degree of tissue degeneration in the IVD. This may be important for selection of donors or recipients of IVD cell transplants. We are conducting further histological studies confirm these findings. Additionally, the study found that ADC values were significantly higher in compromised nerve roots compared to the adjacent nerve roots in the cases of IVD-radicular conflicts (p<0.01), which may have diagnostic clinical implications.

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