

Apparent Diffusion Coefficient in Human Intervertebral Discs in Healthy Young Volunteers

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Introduction

Intervertebral disc has important functions in spine and therefore its well-being is essential. Normal nucleus pulposus is avascular throughout its life, so diffusion is the mechanism which will mainly care the metabolism of disc (2, 3).

According to our knowledge so far the wholly noninvasive method for diffusion process of intervertebral disc has not been available. MR Imaging is the only method available for imaging the molecular process in vivo in a noninvasive fashion (1).

The aim of this study was to determine ADC-values of nucleus pulposus of intervertebral discs in healthy young volunteers and to investigate if there is alteration of these values in thoracic or lumbar area.

Methods

The imaging was carried out using 1.5 T GE Signa EchoSpeed MR scanner (GE Medical Systems, Milwaukee WI). The diffusion measurements were made using a non-phased array general purpose receive only flexible coil (GPFLEX) which contained two electronically summed surface coils. The coil could be wrapped around the patient's lower back, producing a relatively uniform signal throughout the region of interest.

The diffusion weighted images were obtained using a spin echo, single-shot EPI sequence (effective TE about 73 ms, TR 5000 ms, slice thickness 5 mm, spacing 5 mm, Fov 40x20 cm, matrix size 128x128, 1 NEX).

The sensitizing gradients were applied sequentially in x-, y- and z-directions (z is in the direction of the main magnetic field) using diffusion weighting factors (b-values) of 250 and 500 s/mm². The ADC values were determined in all three orthogonal directions (ADC-x, ADC-y and ADC-z). An average ADC could then be calculated from the three ADC-values.

Subjects

Seventeen healthy young volunteers underwent MR studies. These volunteers had no history of traumatic events to back or previous back pain. Mean age was 15 years (range; 8-21 yrs). T2-weighted sagittal SE images were obtained before diffusion imaging to evaluate visually possible disc pathologies like degeneration or bulging. Thirteen of these 17 healthy volunteers had normal spine finding. Diffusion imaging was performed only in discs which were considered normal.

Results

The mean ADC of the intervertebral discs was 1,59E-03 in z-direction, 1,49E-03 in x-direction and 1,32E-03 in y-direction. The ADC values were lowest in upper thoracic area and highest in lower lumbar area, and this disc level dependance was most evident in diffusion along z-direction. (Figure 1).

Conclusion

We have described variation of ADC-values of healthy intervertebral discs in thoracolumbar spine with use of echo-planar imaging readout. The variation of these values most likely reflects the variation of the hydrostatic pressure inside intervertebral discs, which is the basic mechanism preserving the nutrition of these structures. The method may be used in assessing disc degeneration in clinical and epidemiological studies.

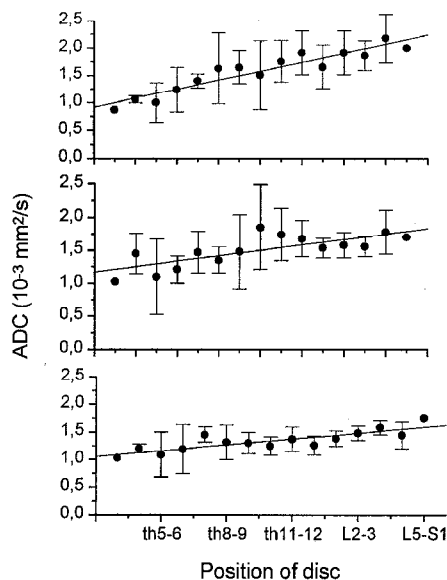


Figure 1. The ADC-values of intervertebral discs in healthy young volunteers. The uppermost figure describes ADC-values in z-direction, the middlemost in y-direction and the undermost in x-direction.

References

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