

The Course of Macroscopic Degeneration in The Human Lumbar Intervertebral Disc

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INTRODUCTION: Previous studies predominantly addressed macroscopic alterations of the intervertebral disc during aging and degeneration in a descriptive, qualitative manner¹⁻⁵. So far, quantitative data on age-related macroscopic alteration is still sparse. The objective of this study therefore was: 1) to provide a semi-quantitative description of the temporal course of macroscopic features of age-related disc changes. 2) Explore the relation and sequence of different features such as clefts and tears. 3) To provide a conceptual morphological framework of disc aging and degeneration.

METHODS: A total of 248 mid-/parasagittal sections of lumbar motion segments originating from 41 routine autopsies (7mt-88y; asymptomatic back) were analyzed semi-quantitatively for macroscopic changes of intervertebral discs, endplates and adjacent vertebrae. An array of macroscopic markers based on Thompson's grading was graded for every motion segment and correlated with the respective age of the donor.

RESULTS: Nuclear fibrous transformation, anular disorganization as well as endplate and vertebral body alterations process predominantly in the first two and in the 5th to the 7th decades. In the 3rd and 4th decade only little progression of the alterations is apparent. Cleft formations in the nucleus pulposus and anulus tears show a delayed appearance mostly starting in the 2nd decade of life. In general, nuclear clefts precede anular tear formations. Within the anular tears, radial and concentric tears demonstrate a similar course over time while rim lesions mostly develop after the 6th decade and independently from the others. Significant differences are observed between the upper and lower lumbar spine with lower segments exhibiting more extensive alterations in several parameters.

DISCUSSION & CONCLUSIONS: This study semi-quantitatively demonstrates that nuclear fibrous transformation and anular disorganization in the motion segment precede the formation of tears and clefts in the intervertebral disc. This strongly indicates cleft formation as a consequence of these alterations during aging and/or degeneration. The temporal sequence suggests a strong correlation of cleft and tears formation starting with nuclear clefts. Rim lesions appear independently and substantially later in life. Our results support the concept that disc degeneration starts in the nucleus. Finally, it emphasizes that the extent of macroscopic alterations already being apparent in the second decade of life is a challenge to any tissue engineering and repair attempt.

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