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Histological Features of the Degenerating Intervertebral Disc in the Goat Disc-injury Model

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Background: Human disc regeneration therapies have long been sought. Although small animal (rodents, rabbit) models are useful, their intervertebral disc (IVD) dimensions limit the ability to study regeneration strategies requiring the injection of therapeutics or implantation of tissue-engineered constructs.

Purpose: Our aims were to first optimize a minimally invasive, rapidly responsive (within two months), large animal (goat) model of moderate to severe IVD degeneration and, second, to establish a numeric histological grading scale for injury-induced IVD degeneration in large animals.

Methods: Six adult goats were used with Institutional Animal Care and Use Committee approval. Under general anesthesia, various instruments and techniques were used to create an injury to the right lateral aspect of goat discs at various lumbar levels. Two months post-injury, the goats were euthanized and the spines were harvested for histology. The IVDs were dissected with adjacent endplates, decalcified, and stained using Alcian blue with H&E counterstaining. A numeric grading scale for large animal discs was developed, based on the rabbit histological scale developed by Masuda et al. and histological features of human IVDs described by Boos et al.

Results: Injuries produced by a 4.5mm drill bit inserted into IVDs to a depth of 15mm resulted in the highest degree of IVD degeneration and the highest histological scores, both significantly higher than the uninjured controls ($p=0.0139$). Inserting a number 15 blade twice in cruciate fashion or number 10 blade once parallel to the endplate did not result in statistically significant changes in histological scores.

Conclusion: We have developed a minimally invasive, injury-induced goat model of IVD degeneration and a histological scale to categorize the degree of IVD degeneration in large animals. Among the various injuries inflicted, a 4.5mm drill bit, which disrupts the interchelating annulus fibers, resulted in the most significant histological changes at the two-month time point.