INTRODUCTION
Degenerative disc disease has been characterized by changes in compositional, structural, and functional changes to the whole intervertebral disc (IVD) [1]. However, investigations of altered mechanics of the anulus fibrosus are relatively few, especially in degenerated IVDs. The purpose of this study was to determine the mechanical changes that occur in the anulus following induced degeneration in a rabbit model and as a result of natural degeneration in human IVDs.

METHODS

Induced Degeneration:
Twelve New Zealand white rabbits (9 months old) were used for the induced degeneration portion of this study. Eight of the 12 rabbits underwent spinal surgery (experimental group) and the additional four served as age-matched control animals. In the experimental group, disc degeneration was induced in two IVDs (L2/3 and L4/5) via anular puncture [2]. Specifically, an antero-lateral approach was taken to expose the IVD that was to be punctured. Once exposed, an 18G needle was used to puncture the IVD. Animals resumed normal activity post surgery and disc height was assessed biweekly via x-ray. Four rabbits were sacrificed one month post-puncture and the other four at three months post-puncture. Following sacrifice, T2-weighted MR imaging was used to confirm degeneration development in the punctured IVDs (Figure 1). Four IVDs from each rabbit were excised (two non-punctured controls and two punctured IVDs). Two anulus samples were dissected from each IVD. Peel tests in a 180° "T" configuration (Figure 2) were conducted on multi-layered anular samples to assess strength and in particular, resistance to delamination.

Natural Degeneration (human tissue):
Preliminary data have been collected (similar 180° “T” peel tests) from human lumbar IVDs. The degeneration grades [3] of the IVDs were determined independently by two medical doctors in order to compare healthy IVDs with degenerative IVDs. Future work will include further examination of additional lumbar spines in order to determine if findings are similar to those observed in the rabbit model.

RESULTS

Induced Degeneration:
Disc height, obtained from x-ray imaging, decreased by up to 23% 12 week post-surgery indicating degeneration in the IVD. Further, T2 MRI values in the nucleus of the IVD were lower in the punctured discs compared to non-punctured (p=0.002), indicating reduced hydration and the presence of degeneration. Peel strength was also found to be 26% lower in anular samples from punctured IVDs compared to control IVDs from the same rabbit (p=0.01) and 30% lower than samples obtained from the non-operated control rabbits (p=0.02).

DISCUSSION & CONCLUSIONS
The IVD puncture resulted in decreased IVD height and decreased water content as shown by the X-ray and MR images. These are typical changes observed in naturally degenerated IVDs. Further, degeneration also decreased the peel strength, and thus the resistance to delamination in the anulus. This was to be expected as delamination and cleft formation are also often observed in degenerated IVDs [1]. Preliminary results from cadaveric tissues with natural degeneration have shown a similar trend of decreased peel strength as that seen in the rabbit anular puncture model.

REFERENCES