Biological and biomechanical effects of fibrin injection into porcine intervertebral discs

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STUDY DESIGN
Surgically denucleated porcine intervertebral discs (IVD) were injected with BIOSTAT BIOLOGX Fibrin Sealant (FS), and the in vivo effects were assessed over time by histological, biochemical, and mechanical criteria.

OBJECTIVE
The objectives were to test whether the intradiscal injection of FS stimulates disc healing.

SUMMARY OF BACKGROUND DATA
Disc avascularity prevents the deposition of a provisional fibrin scaffold that typically facilitates soft tissue repair. Poor disc wound healing leads to disc damage accumulation and chronic inflammation characterized by overproduction of proinflammatory cytokines and proteolytic enzymes.

METHODS
Four lumbar IVDs from each of 31 Yucatan minipigs were randomized to untreated controls; degenerative injury (nucleotomy); and nucleotomy plus FS injection. Animals were killed at 1, 2, 3, 6, and 12 weeks postsurgery. IVDs were harvested to quantify (1) architecture using morphological and histological grading; (2) proteoglycan composition using DMMB assay; (3) cytokine content using ELISA; and (4) mechanical properties using quantitative pressure/volume testing.

RESULTS
There was progressive invasion of annular tissue into the nucleus of nucleotomy discs and concomitant reduction in proteoglycan content. By contrast, FS supplementation inhibited nuclear fibrosis and facilitated proteoglycan content recovery over time. FS discs synthesized significantly less TNF-α than degenerate discs (66% vs. 226%, P < 0.05) and had upregulation of IL-4 (310% vs. 166%) and TGF-β (400% vs. 117%) at 2 to 3 weeks posttreatment. At the third week postsurgery, the denucleated discs were less stiff than controls (pressure modulus 779.9 psi vs. 2754.8 psi; P < 0.05) and failed at lower pressures (250.5 psi vs. 492.5 psi; P < 0.05). The stiffness and
leakage pressure of the FS-treated discs recovered to control values after 6 and 12 weeks, respectively.

CONCLUSION
FS facilitated structural, compositional, and mechanical repair of the surgically damaged IVD. These FS-derived benefits are likely due to its conductive scaffold properties and metabolically active constituents such as thrombin, factor XIII, and aprotinin acetate.

type          journal paper/review (English)
date of publishing  15-8-2011
journal title     Spine (36/18)
ISSN electronic   1528-1159
pages            E1201-9