High density collagen gel

Currently, the only methods available for annulus fibrosus repair involve mechanical closure of defect, which does little to address biological healing in the damaged tissue. Collagen hydrogels are injectable and have been used to repair annulus defects in vivo. In this study, high-density collagen hydrogels at 5, 10, and 15 mg/mL were used to repair defects made to intact rat caudal intervertebral discs in vitro. A group of gels at 15 mg/mL were also cross-linked with riboflavin at 0.03 mM, 0.07 mM, or 0.10 mM. These cross-linked, high-density collagen gels maintained their presence in the defect under loading and contributed positively to the mechanical response of damaged discs. Discs exhibited increases to 95% of undamaged effective equilibrium and instantaneous moduli as well as up to fourfold decreases in effective hydraulic permeability from the damaged discs. These data suggest that high-density collagen gels may be effective at restoring mechanical function of injured discs as well as potential vehicles for the delivery of biological agents such as cells or growth factors that may aid in the repair of the annulus fibrosus [1)].

Open annular defects compromise the ability of the annulus fibrosus to contain nuclear tissue in the disc space, and therefore lead to disc herniation with subsequent degenerative changes to the entire intervertebral disc. This study reports the use of riboflavin crosslinked high-density collagen gel for the repair of annular defects in a needle-punctured rat-tail model. High-density collagen has increased stiffness and greater hydraulic permeability than conventional low-density gels; riboflavin crosslinking further increases these properties. This study found that treating annular defects with crosslinked high-density collagen inhibited the progression of disc degeneration over 18 weeks compared to untreated control discs. Histological sections of FITC-labeled collagen gel revealed an early tight attachment to host annular tissue. The gel was subsequently infiltrated by host fibroblasts which remodeled it into a fibrous cap that bridged the outer disrupted annular fibers and partially repaired the defect. This repair tissue enhanced retention of nucleus pulposus tissue, maintained physiological disc hydration, and preserved hydraulic permeability, according to MRI, histological, and mechanical assessments. Degenerative changes were partially reversed in treated discs, as indicated by an increase in nucleus pulposus size and hydration between weeks 5 and 18. The collagen gel appeared to work as an instant sealant and by enhancing the intrinsic healing capabilities of the host tissue [2)].

Yu Moriguchi et al., demonstrated that riboflavin crosslinked high-density collagen gels (HDC) can facilitate Annulus Fibrosus repair in vivo.

42 rats, tail disc punctured with an 18-gauge needle, were divided into 3 groups: untreated (n=6), injected with crosslinked HDC (n=18), and injected with Annulus Fibrosus cell-laden crosslinked HDC (n=18). Ovine AF cells were mixed with HDC gels prior to injection. X-rays and MRIs were conducted over 5 weeks, determining disc height index (DHI), nucleus pulposus (NP) size, and hydration. Histological assessments evaluated the viability of implanted cells and degree of annular repair.

Although average DHIs of both HDC gel groups were higher than those of the puncture control group at 5 weeks, the retention of disc height, NP size and hydration at 1 and 5 weeks was significant for the cellular group compared to the punctured, and at 5 weeks to the acellular group. Histological assessment indicated that AF cell-laden HDC gels have accelerated reparative sealing compared to

acellular HDC gels.

AF cell-laden HDC gels have the ability of better repairing annular defects than acellular gels after needle puncture.

This project addresses the compelling demand of a sufficient treatment strategy for degenerative disc disease (DDD) perpetuated by annulus fibrosus (AF) injury, a major cause of morbidity and burden to health care systems.

The study is designed to answer the question of whether injectable, photo-crosslinked, high density collagen gels can seal defects in the annulus fibrosus of rats and prevent disc degeneration. Furthermore, they investigated whether the healing of AF defects will be enhanced by the delivery of AF cells (fibrochondrocytes) to these defects. The use of cell-laden collagen gels in spine surgery holds promise for a wide array of applications, from current discectomy procedures to future nucleus pulposus reparative therapies [3].

1)
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