INTRODUCTION: Many investigators are studying tissue engineering approaches to generate constructs, with properties similar to articular cartilage, for implantation into focal articular defects. Previous studies have shown that chondrocytes seeded onto a degradable polymer scaffold deposit matrix initially in the peripheral region and then towards the center. Further matrix inhomogeneity is caused as nutrient and gas transfer to the center of the construct are diffusionally limited by peripheral matrix deposition and increased construct thickness. While complex hydrodynamic conditions (including convection) in the growth environment are necessary to generate uniform tissue engineered cartilage constructs, with properties similar to articular cartilage, this environment is very difficult to control experimentally. Therefore, perfusion may be useful in generating more homogenous tissue engineered cartilage constructs, with properties similar to articular cartilage.

METHODS: Formation of constructs: Cartilage was aseptically harvested from the patellofemoral groove of ~3 wk old calves. Chondrocytes were isolated by digestion with collagenase and resuspended in culture medium (DMEM containing 10% fetal bovine serum, 50 µg/ml ascorbate, and antibiotics). Disks of polyglycolic acid felt (97% porosity, 45 mg/cm² density, 10 mm × 4 mm thick) were pre-wet in medium and seeded with chondrocytes (125 × 10⁶ cells/cm²) felt for 8 hr. All cell-laden scaffolds were pre-cultured for 3 or 10 d under free-swelling conditions. Growth conditions: Some constructs were cultured under free-swelling conditions for an additional 10 days (FS group). Constructs to be perfused were aseptically placed in the designed bioreactor chamber, which was connected in series with a peristaltic pump (Cole-Palmer Masterflex: Model 9770-50) via silicone tubing, with flow directed into the confining tunnel and out the piston. The chamber was then placed in series with a peristaltic pump (platen side first) was then slipped into the confining tunnel. The piston (platen side first) was then slipped into the confining tunnel. The movable piston (platen side first) was then slipped into the confining tunnel. The movable piston (platen side first) was then slipped into the confining tunnel.

RESULTS: A bioreactor system was designed that perfuses medium through tissue engineered constructs during growth, and 2) determine the effect of perfusion on the spatial distribution and composition of matrix components in tissue engineered cartilage.

COLL content did not depend on pre-culture duration (p=0.4), but varied significantly based on growth condition (p<0.001). Overall, perfusion at both 0.034 and 0.100 ml/min increased COLL content by approximately 1.7X compared to FS controls. However, the relative effects of flowrate depended on the pre-culture duration (p<0.001). Therefore, the effect of perfusion flowrate on tissue engineered cartilage constructs depends on construct properties.


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