

Proteoglycan Breakdown of Meniscal Explants Following Dynamic Compression Using a Novel Bioreactor

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Abstract

Motivated by our interest in examining meniscal mechanotransduction processes, we report on the validation of a new tissue engineering bioreactor. This paper describes the design and performance capabilities of a tissue engineering bioreactor for cyclic compression of meniscal explants. We showed that the system maintains a tissue culture environment equivalent to that provided by conventional incubators and that its strain output was uniform and reproducible. The system incorporates a linear actuator and load cell aligned together in a frame that is contained within an incubator and allows for large loads and small displacements. A plunger with six Teflon-filled Delrin compression rods is attached to the actuator compressing up to six tissue explants simultaneously and with even pressure. The bioreactor system was used to study proteoglycan (PG) breakdown in porcine meniscal explants following various input loading tests (0–20% strain, 0–0.1 MPa). The greatest PG breakdown was measured following 20% compressive strain. These strain and stress levels have been shown to correspond to partial meniscectomy. Thus, these data suggest that removing 30–60% of meniscal tissue will result in the breakdown of meniscal tissue proteoglycans.