Biomechanical comparison of menisci from different species and artificial constructs.

Loss of meniscal tissue is correlated with early osteoarthritis but few data exist regarding detailed biomechanical properties (e.g. viscoelastic behavior) of menisci in different species commonly used as animal models. The purpose of the current study was to biomechanically characterize bovine, ovine, and porcine menisci (each n = 6, midpart of the medial meniscus) and compare their properties to that of normal and degenerated human menisci (n = 6) and two commercially available artificial scaffolds (each n = 3). Samples were tested in a cyclic, minimally constraint compression-relaxation test with a universal testing machine allowing the characterization of the viscoelastic properties including stiffness, residual force and relative sample compression. T-tests were used to compare the biomechanical parameters of all samples. Significance level was set at p < 0.05. Throughout cyclic testing stiffness, residual force and relative sample compression increased significantly (p < 0.05) in all tested meniscus samples. From the tested animal meniscus samples the ovine menisci showed the highest biomechanical similarity to human menisci in terms of stiffness (human: 8.54 N/mm +/- 1.87, cycle 1; ovine: 11.24 N/mm +/- 2.36, cycle 1, p =
0.0528), residual force (human: 2.99 N +/- 0.63, cycle 1 vs. ovine 3.24 N +/- 0.13, cycle 1, p = 0.364)
and relative sample compression (human 19.92% +/- 0.63, cycle 1 vs. 18.72% +/- 1.84 in ovine
samples at cycle 1, p = 0.162). The artificial constructs -as hypothesized- revealed statistically
significant inferior biomechanical properties. For future research the use of ovine meniscus would be
desirable showing the highest biomechanical similarities to human meniscus tissue. The significantly
different biomechanical properties of the artificial scaffolds highlight the necessity of cellular ingrowth
and formation of extracellular matrix to gain viscoelastic properties. As a consequence, a period of
unloading (at least partial weight bearing) is necessary, until the remodeling process in the scaffold is
sufficient to withstand forces during weight bearing.

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