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Paper #30

Functional Biomechanical Performance of a Novel Anatomically Shaped Polycarbonate Urethane Total Meniscus Replacement

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Summary:
This cadaver knee joint study demonstrates the biomechanical potential of a novel meniscal replacement as an alternative to meniscal allografts.

Abstract:
INTRODUCTION
Limitations related to the availability and sizing of meniscal allografts combined with post-implantation tissue shrinkage and remodeling hamper the widespread application of meniscal allograft transplantation. An anatomically shaped polycarbonate urethane (PCU) total meniscus implant was developed to overcome these limitations. The purpose of this study was to evaluate functional biomechanical performance of the novel implant and to compare its functioning with the native meniscus, a meniscal allograft and the knee after total meniscectomy.

METHODS
In a knee loading rig, five human cadaveric knees were flexed between 0° and 90° while being subjected to compressive loads mimicking a squat movement. In addition, anteroposterior (AP) laxity tests were performed in 30° and 90° flexion. Meniscal kinematics and knee (AP and rotational) laxity were quantified using roentgen stereophotogrametric analysis. Peak contact pressure, mean contact pressure and contact area on the tibial cartilage were determined in 90° flexion. The measurements were repeated for the following conditions: (1) intact medial meniscus, (2) PCU implant, (3) total medial meniscectomy and (4) meniscal allograft transplantation.

RESULTS
The implant and allograft both displayed increased posterior (implant: +1.46 mm ($p<0.001$) and allograft: +1.40 mm ($p<0.001$)) and medial (implant: +1.08 mm ($p<0.001$) and allograft +0.72 mm ($p=0.001$)) displacements compared to the native meniscus. The differences in displacement between the implant and allograft were non-significant. Compared to the native knee, AP laxity was increased for the implant (+1.33 mm), meniscectomy (+1.61 mm) and allograft (+1.51 mm) conditions in 30° flexion (for all: $p<0.001$). However in 90° flexion, laxity differences between the implant and native meniscus (+0.87 mm) were non-significant. The implant reduced the mean contact pressure compared to total meniscectomy (-0.39 MPa, $p=0.018$), but was not able to further reduce contact pressures to native meniscus levels. Also peak contact pressure and contact area were significantly increased for the implant compared to the native meniscus (+2.20 MPa, -265 mm2, both $p<0.001$). Contact mechanics between the implant and allograft was never statistically different.

CONCLUSIONS
Biomechanical performance was similar for the implant and the allograft. However, both meniscal replacements could not restore outcomes to native meniscus levels or sufficiently improve outcomes after meniscectomy. This was

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presumably caused by the freedom of motion allowed by the suture-only fixation of the horns.

CLINICAL RELEVANCE

This study demonstrates the biomechanical potential of a novel meniscal replacement as an alternative to meniscal allografts.