Biomechanical Forces of the Lateral Knee Joint Following Complete Meniscectomy and Subsequent Meniscal Transplant in Pediatric Cadavers

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Background: Meniscus transplant successfully treats symptomatic meniscal deficiency in children. While clinical outcomes are well characterized, biomechanical lateral joint forces in the meniscus-deficient and transplant states are unknown.

Hypothesis / Purpose: We hypothesize that meniscectomy will substantially increase contact pressures and decrease contact area. Transplant will partially restore contact biomechanics of contact pressure and contact area towards normal intact state.

Study Design: This descriptive laboratory study characterizes contact pressures on lateral tibial plateau during the intact meniscal state, meniscectomy, and meniscal transplant. Cadaver size appropriate pressure load equivalents was applied by a robot at degrees of flexion: 0, 30, 60.

Methods: Eight cadaver knees (ages 8-12) underwent contact pressure testing of the lateral meniscus at robot-controlled degrees of flexion: 0, 30, 60. Tekscan pressure mapping sensors were inserted underneath the lateral meniscus. Meniscus transplant was anchored with transosseous suture fixation and sutured to the joint capsule with horizontal mattresses. Multiple comparisons analysis was performed and Tukey-adjusted p-values are reported.

Results: Contact area of the intact state was significantly greater than meniscectomy state at 0 degrees ($p<0.001$) and 60 degrees ($p=0.059$). At 0 degrees, contact area of the intact state was greater than the transplant state ($p=0.002$) and the transplant state was greater than the meniscectomy state ($p=0.026$). Compared to the meniscectomy state, the transplant state at 30 and 60 degrees improved towards normal, but were non-significant.

Mean and peak pressures of the intact state were significantly less than meniscectomy state at every degree of flexion. Transplant improved mean contact pressures with full restoration of native pressures at 0 degrees and partial restoration at 30 degrees. While transplant did partially improve peak contact pressures at 0 degrees, there were no observed improvements at 30 or 60 degrees. Peak pressures of the transplant state were significantly greater than intact state at 30 degrees ($p=0.054$) and 60 degrees ($p=0.006$).

Conclusion: Meniscus transplantation following meniscectomy partially improves contact biomechanics towards normal. Most optimally, contact pressures are improved at acute degrees of flexion. Peak and mean pressures both improve at 0 degrees, whereas mean pressure also improves at 30 degrees. Contact area improves at 0 and 60 degrees.

Clinical Relevance: Characterizing contact biomechanics helps surgeons identify optimized meniscal transplantation approaches.

Key Terms:
Meniscectomy, Transplant, Lateral Meniscus, Biomechanical Testing