Biomechanics of Femoral Osteochondral Defect Repairs following S-Core – A Novel Hybrid Procedure with a Subchondral Implant and Dermal Matrix

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Objectives: To biomechanically characterize the tibiofemoral joint contact characteristics before and after reconstruction of femoral condyle osteochondral fracture defects using a novel hybrid reconstructive procedure. We hypothesized that the reconstruction of osteochondral defects of the femoral condyle will restore the contact characteristics to the intact condition.

Methods: Eight cadaveric knees (mean age 52 ± 11 years; 6 females, 2 males) were dissected to isolate the femur and tibia and then tested with a custom testing system and Tekscan pressure sensors. Tibiofemoral contact areas, contact forces, peak contact pressures, and mean contact pressures were measured with the knee at 30° of flexion for medial defects, and 60° of flexion for lateral defects, with 50, 100 and 150N compressive loads (Figure 1) with the defects created at the center of each respective condyle by drilling. The defects were reconstructed with the S-Core HA Implant (sizes 7 and 9 mm, Subchondral Solutions, Inc. Huntington Beach, CA), a titanium fenestrated threaded implant, countersunk in the subchondral bone, and an acellular dermal matrix allograft. Five conditions were tested for each condyle: Intact, 8-mm defect, 8-mm repair, 10-mm defect, 10-mm repair. Repeated measures analysis of variance was used with statistical significance set at $P < 0.05$.

Results: Representative contact patterns for medial defects are shown in Figure 2.The medial defect significantly decreased tibiofemoral contact force on the medial side and increased force on the lateral side at all loads (Figure 3). Contact force was not restored with repair of larger defect. 10mm medial defects decreased medial contact area which increased with repair even above intact levels. Medial defects increased mean contact pressure on the lateral side at 100 and 150N compared to intact. Medial repairs restored lateral pressure to intact conditions. Medial Peak contact pressure was significantly less than intact for 8 and 10mm repair.

Similarly, the lateral defect significantly decreased tibiofemoral contact force on lateral side and increased contact force on medial side at all loads (Figure 4). Lateral repair restored both medial and lateral contact forces to intact conditions. 10mm lateral defects decreased lateral contact area which increased with repair even above intact levels. Lateral defect significantly decreased tibiofemoral mean contact pressure on lateral side (100, 150N) and increased pressure on medial side (50N). Lateral repair restored both medial and lateral contact pressure to intact conditions at 50 and 100N.

Conclusion: Tibiofemoral joint contact forces are restored to intact conditions after reconstruction of osteochondral fracture defects with dermal allograft matrix and subchondral implants. This was demonstrated for all sizes of lateral defects and for smaller medial defects. In all defect cases there was an off-loading by the contra-lateral compartment, reflected in increase in compartment joint contact forces of the off-loading compartment. After repair, there was a restoration of contact forces of both compartments. Likewise, repair of defects showed normalization of mean contact pressures of the opposite compartment, restoring overall tibiofemoral contact pressure characteristics, and reduction of peak contact pressures after repair in some specimens.

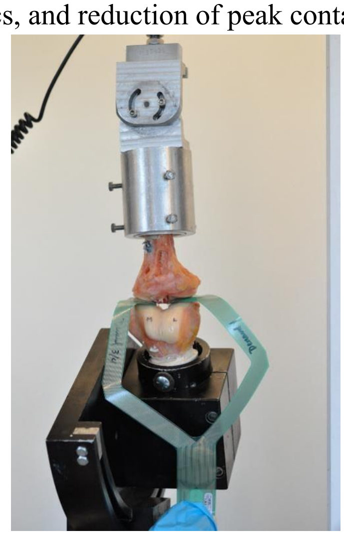

Figure 1. Knee specimen mounted on the Instron material testing system in 30 degrees of flexion.

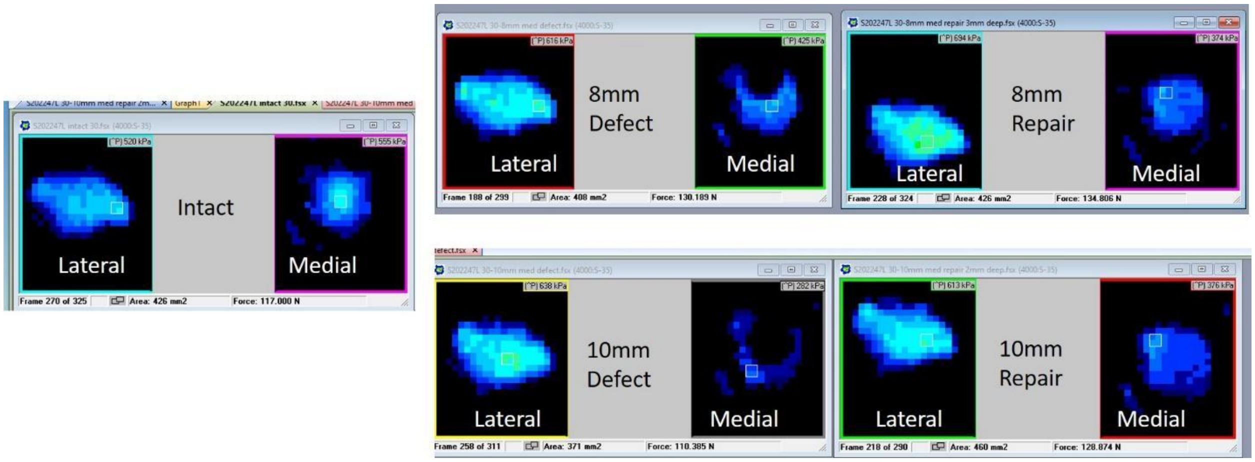

Figure 2. Representative Tekscan contact patterns for medial side defects.

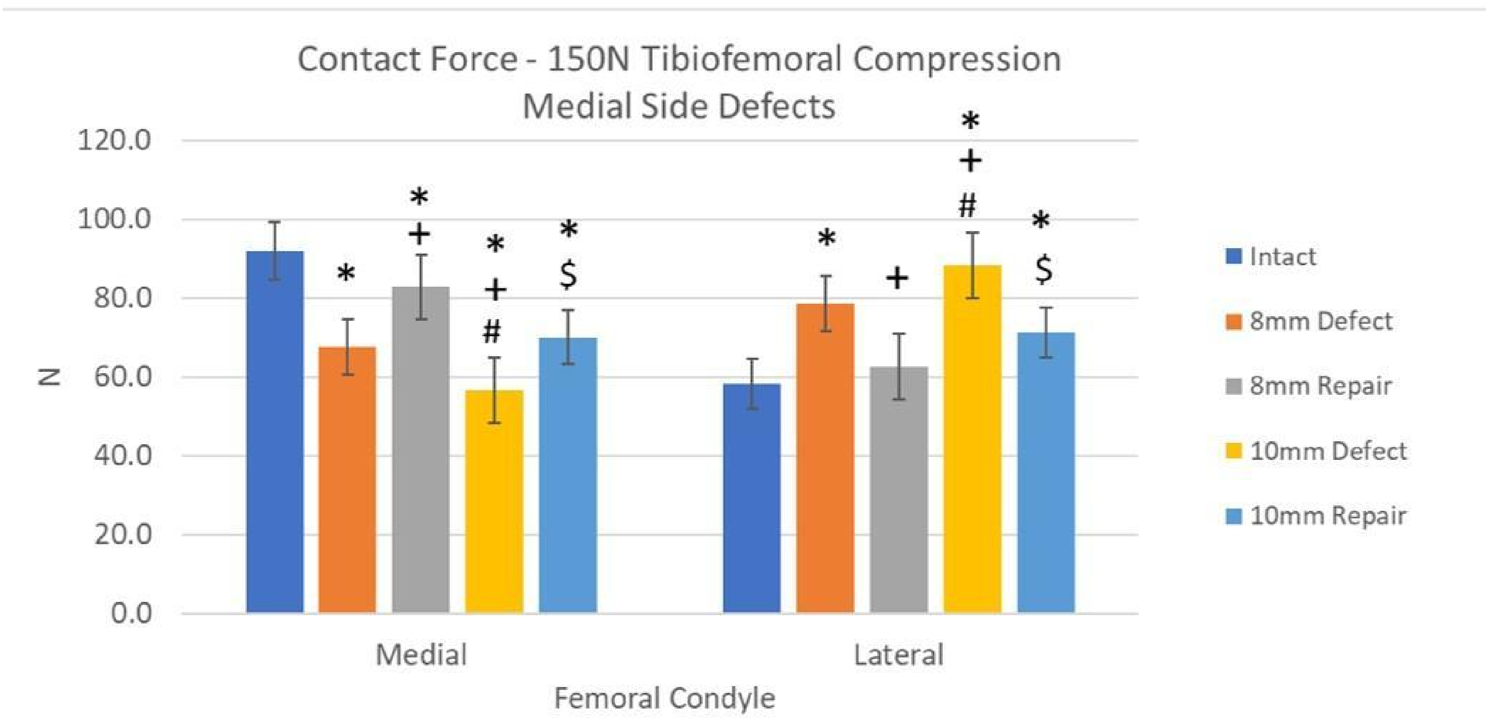

Figure 3. Tibiofemoral contact force for medial side defects and 150N compressive loads. ($P < 0.05$; * vs Intact, + vs. 8mm defect, # vs. 8mm repair, $ vs. 10mm defect).

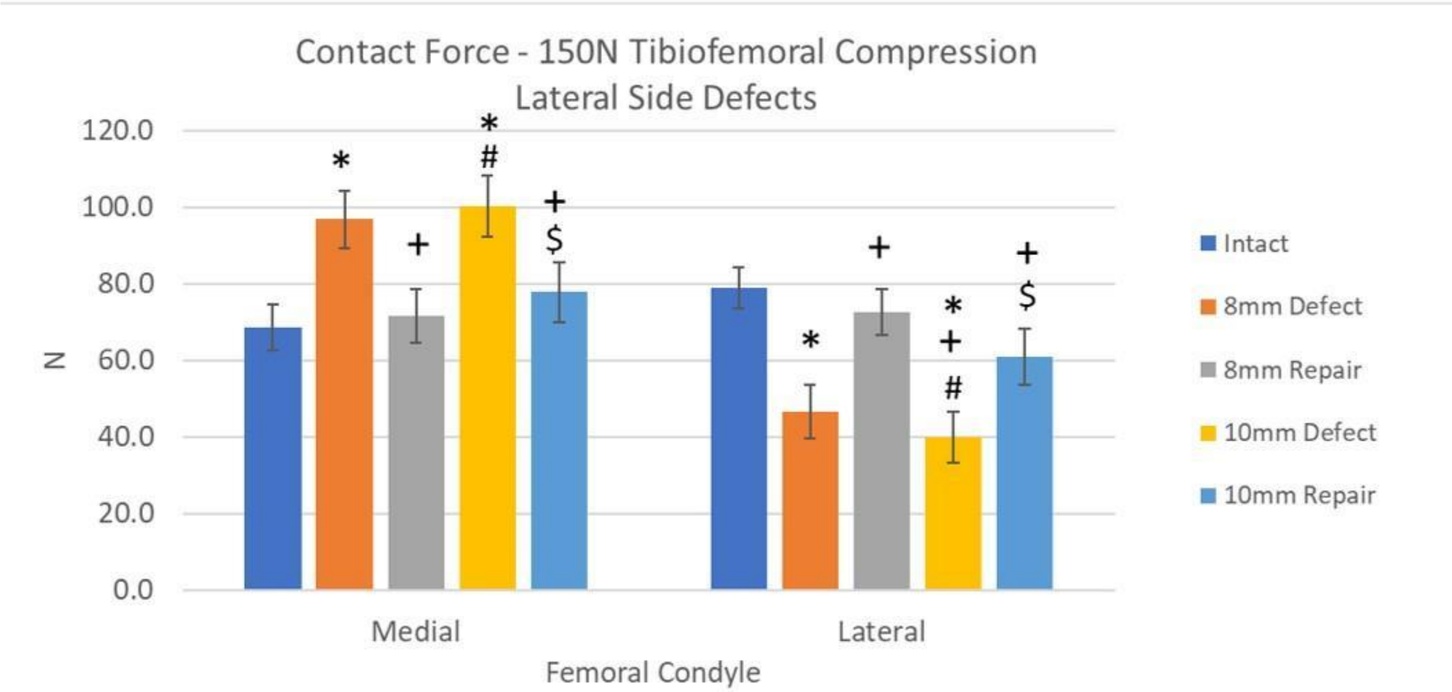

Figure 4. Tibiofemoral contact force for lateral side defects and 150N compressive loads. ($P < 0.05$; * vs Intact, + vs. 8mm defect, # vs. 8mm repair, $ vs. 10mm defect).