THE EFFECTS OF MEDIALIZATION AND ANTEROMEDIALIZATION OF THE TIBIAL TUBERCLE ON PATELLOFEMORAL MECHANICS AND KINEMATICS IN KNEES WITH PATELLOFEMORAL MALALIGNMENT

Introduction: Patellofemoral malalignment is a major cause of anterior knee pain and patellar instability. It is widely accepted that malalignment causes elevated patellofemoral contact pressures resulting in anterior knee pain and subsequent arthrosis.1,2 Most patients with patellofemoral symptoms improve with non-operative treatment. However, a subset of patients does not respond to these interventions and requires surgery. Surgeons perform medialization and anteromedialization of the tibial tubercle to correct abnormal contact forces and patellar tracking. However, there is little experimental evidence regarding the redistribution of forces and correction of patellar maltracking after realignment procedures. This is particularly problematic because anteromedialization of the tibial tubercle is technically difficult and associated with a risk of postoperative fracture.3

The objective of this study was to evaluate and compare the effects of medialization and anteromedialization of the tibial tubercle on patellofemoral contact mechanics and patella tracking in knees with simulated patellofemoral malalignment.

Materials and Methods: Ten unembalmed human cadaver knee joints (mean age 58.6, range 42 – 86, 6 male, 4 female, 5 right, 5 left) were tested. The tibiae and femora were individually sectioned in the mid-diaphysis. We dissected the specimens to the depth of the joint capsule and isolated the quadriceps tendon. We incised the medial capsule, attached an Iscan digital pressure sensor (Tekscan, Boston, MA) to the retropatellar surface, digitized patellar surface landmarks, and repaired the capsule with suture.

We mounted the knee specimens onto an Oxford rig that simulated a weightbearing squat. Clamping the quadriceps tendon allowed us to vary the quadriceps angle (Q-angle) and to adjust the length of the extensor mechanism to produce knee flexion and extension. We flexed the knee specimens continuously from full extension to 90 degrees of flexion under a vertical hip load of 125 N. Contact force, area, and pressure were measured continuously. A PC Reflex motion analysis system (Qualisys, Glastonbury, CT) collected femoral, tibial, and patellar kinematic data. Patellar tilt, patellar rotation, and the medial-lateral position of the patella were determined. Each knee specimen was tested under the following four conditions: at a physiologic Q-angle; at a Q-angle increased by 7.5 degrees; after medial realignment (1 cm) of the tibial tubercle using a coronal osteotomy in knees with elevated Q-angles; and after anteromedialization (1cm) of the tibial tubercle at the malaligned position in knees with elevated Q-angles. We compared contact pressures, forces, areas and patellar kinematics using a two-way repeated measures ANOVA with multiple contrasts with flexion angle as a trial factor and the condition as the grouping factor.

Results: An increased quadriceps angle significantly altered patellofemoral contact mechanics during the flexion cycle. The mean, maximum, and lateral facet contact pressures were all increased (p<0.0005) as was the percent of total patellofemoral force borne by the lateral facet (p<0.0005). The overall, medial, and lateral facet contact areas were all decreased (p<0.0005).

Medialization of the tibial tubercle significantly decreased the maximum lateral facet contact pressures as well as the percent of total force transmitted by the lateral facet. Anteromedialization was able to significantly decrease the mean, maximum, and lateral facet contact pressures but was unable to decrease the lateral facet force total force (Figure 1). Anteromedialization decreased the mean overall patellofemoral pressure to within normal values (p<0.05), but neither procedure was able to correct the remaining parameters to the normal range (p>0.05). A comparison of the two procedures showed a significant difference only in the ability to correct the percent of total force borne by the lateral facet (p<0.05).

Discussion: Both medialization and anteromedialization decreased elevated patellofemoral contact pressures produced by an increased Q-angle. Neither procedure was clearly superior to the other. Both were able to partially correct the peak pressures produced by malalignment that have been implicated in cartilage injury, and both corrected the lateral translation of the patella. Anteromedialization decreased the patellar mean pressure more effectively than medialization. In contrast, medialization shifted force from the lateral facet more effectively than anteromedialization.

Our study is novel because we acquired dynamic patellofemoral contact measures throughout the flexion cycle while simultaneously obtaining patellar kinematic data. Furthermore, to our knowledge, no study has compared the effects of these two popular realignment procedures on patellofemoral contact mechanics and kinematics. This study confirms previous work demonstrating increased patellofemoral contact pressures secondary to elevated Q-angles. It also shows that an elevated Q-angle shifts the force sensed by the patella to the lateral facet.

Given that a medialization is easier to perform and is associated with a lower postoperative fracture rate, we suggest that it be the procedure of choice in patients requiring realignment for patellar instability.


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![Figure 1. Comparison of the effects of an increased Q-angle, tibial tubercle medialization, and tibial tubercle anteromedialization on patellofemoral contact measures](image-url)