

Research Article

Influence of Tibial Tuberosity Distalization on Patellofemoral Tracking and Contact Pressures: A Dynamic Computational Simulation Study

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Multibody dynamic simulation of function for knees with recurrent instability were utilized to characterize the influence of patellar distalization, with and without patellar tendon tenodesis, on patellar tracking and pressure applied to cartilage.

INTRODUCTION: The current study is based on the hypothesis that patella tendon distalization will reduce lateral maltracking during knee flexion and will not elevate patellofemoral contact pressures. Multibody dynamic simulation of function for knees with recurrent instability were utilized to characterize the influence of patellar distalization, with and without patellar tendon tenodesis, on patellar tracking and pressure applied to cartilage.

METHODS: Multibody dynamic simulation models were created to represent seven knees with patella alta (Caton-Deschamps index ≥ 1.3) being treated for patellar instability. Dynamic knee squatting was simulated for each knee in the pre-operative condition, following distalization of the attachment points for the patellar tendon on the tibia (Caton-Deschamps index = 1.0), and following distalization combined with patellar tendon tenodesis. The simulated motions were used to characterize the bisect offset index (percentage of the patella lateral to the deepest part of the trochlear groove) and the patellofemoral contact pressure distribution (based on discrete element analysis). Friedman tests with post-hoc Student-Newman-Keuls tests were used to identify significant ($p < 0.05$) differences between the pre-operative to post-operative data.

RESULTS: Tibial tuberosity distalization significantly reduced lateral patellar maltracking at 5°, 10° and 20° of knee

flexion. Tuberosity distalization significantly decreased the maximum pressure applied to cartilage from 20° to 35° of flexion, with each change approximately a 25% decrease. The pressure centroid was located more superiorly on the patella following distalization, and more medially at low flexion angles. The superior position was significantly larger for the distalization conditions through the full range of knee flexion from 0 to 90°, with a maximum difference of 5 mm at 15°. Distalization produced a significantly more lateral pressure centroid at 25° and 30° of flexion, with a change larger than 1 mm. Distalization also significantly increased contact area from 15° to 40° of flexion. Tenodesis overall had a relatively small influence on the kinematics and pressure, compared to distalization.

CONCLUSIONS: Based on the current simulations of dynamic knee squatting, tibial tuberosity distalization consistently decreases patellar lateral maltracking, with the largest changes occurring at low flexion angles. Tibial tuberosity distalization generally produces a decrease patellofemoral contact pressures but also increases medial contact pressures. Distalization was also shown to move the centroid of contact pressure proximal and lateral. The possibility of elevated contact pressures beyond 90° of flexion warrants further investigation.



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