Tibial Tuberosity Medialization Reduces Pressure Applied to Patellofemoral Cartilage with Lesions

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INTRODUCTION
Patellofemoral pain is commonly attributed to lateral malalignment and subsequent overloading of patellofemoral cartilage. Chronic overloading of lateral cartilage can lead to areas of cartilage degeneration, or lesions. Underloading or lateral dislocation can lead to development of medial lesions on the patella. Medialization and anteromedialization of the tibial tuberosity are performed to improve alignment by altering the orientation of the patella tendon. The procedures are typically reserved for patients with malalignment combined with cartilage lesions. The current study was performed to characterize the influence of tibial tuberosity medialization and anteromedialization on patellofemoral kinematics and the patellofemoral pressure distribution for knees with lateral and medial cartilage lesions.

METHODS
Ten cadaveric knees were secured to a testing frame at 40°, 60° and 80° of flexion (Fig. 1). Loads were distributed among the quadriceps muscles in a pattern that simulated vastus medialis obliquus weakness with a total quadriceps force of 586 N [1]. A hamstrings load of 200 N was split between the medial and lateral hamstrings. Loading cables connected to weights over pulleys were clamped to the muscles at their insertion sites. The tibial tuberosity was osteotomized and secured back on the tibia at multiple positions using a fixation plate. To simulate anteromedialization, the tuberosity was anteriorized 10 mm from the medial position. To simulate tibial tuberosity medialization, the tuberosity was medialized 10 mm from the pre-operative position. To simulate anteromedialization, the tuberosity was anteriorized 10 mm from the medial position with shims. Knees were tested with the cartilage intact, with a 12 mm diameter lesion at the center of the lateral facet, and with a similar lesion on the medial facet. For the medial lesion case, the lateral lesion was filled with silicone to reduce pressure concentrations surrounding the lesion.

Patellofemoral translations and rotations and the patellofemoral pressure distribution were measured for each test. A sensor from a magnetic tracking system (trakSTAR, Ascension Technology) was used to digitize landmarks to establish reference axes for the femur and patella. Sensors were also attached to the femur and patella to track the motion of the reference axes during testing. Patellofemoral translations and rotations were quantified using the floating axis coordinate system [2]. Maximum lateral and medial pressures were measured with a calibrated sensor (I-Scan, Tekscan), which was inserted into the joint. The position of the patella ridge was identified by palpating the sensor during testing. At each flexion angle, for each cartilage condition, a repeated measures ANOVA with a post-hoc Student-Newman-Keuls test was performed to determine if the position of the tibial tuberosity significantly (p < 0.05) influenced the data generated.

RESULTS
Tibial tuberosity medialization decreased the patellofemoral lateral translation, while anteromedialization also decreased patellofemoral flexion. For the intact cartilage, medialization decreased the average lateral shift by 1 mm or less, with the difference significant at 40° and 80° of flexion (Fig. 2A). The average patella flexion was approximately 4° smaller for the anteromedial tuberosity than for the medial tuberosity, with the difference significant at each flexion angle (Fig. 2B).

Tibial tuberosity medialization decreased the maximum lateral pressure, but had less influence on the maximum medial pressure. For intact cartilage and cartilage with a lateral lesion, medializing the tuberosity significantly decreased the maximum lateral pressure at 60° and 80°, with a decrease of 15% (Fig. 3). Medialization of the tuberosity tended to increase the maximum medial pressure, but the increase was only significant for intact cartilage at 80° (Fig. 4). The maximum medial and lateral pressure tended to be lower for the anteromedial case than the medial case, but no significant differences were identified.

DISCUSSION
Medialization of the tibial tuberosity improved patellofemoral alignment and reduced the pressure applied to cartilage surrounding a lateral lesion. Medialization tended to increase the pressure applied to medial cartilage, but the medial pressure typically did not exceed the lateral pressure, even with a medial lesion present. Peak pressures were not consistently smaller for anteromedialization than medialization, although a benefit could still occur in vivo if the increased moment arm of the patella tendon due to anteriorization of the tuberosity decreases the quadriceps force needed to extend the knee.

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REFERENCES