Intraoperative Tibial Tubercle Medialization vs. Radiologic Change in Tibial Tubercle-Trochlear Groove Distance after Tibial Tubercle Osteotomy: How Much Are We Really Medializing?

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INTRODUCTION: The tibial tubercle-trochlear groove distance (TT-TG), which reflects the lateralization of the tibial tubercle relative to the trochlear groove, is used in diagnosis of patellar instability and maltracking, as well as in pre-operative planning for tibial tubercle osteotomy (TTO). A higher TT-TG indicates a stronger lateral force vector in the patellofemoral compartment, contributing to maltracking and patellar instability. During TTO, the tibial tubercle is medialized by an amount which is typically planned based on the pre-operative TT-TG distance. However, the extent to which the intraoperatively measured tubercle medialization (TM) reflects the true change in TT-TG (ΔTT-TG) after TTO is not well understood. A discrepancy between TM and ΔTT-TG would reveal either (a) a systematic disagreement between physical and radiologic measurements, or (b) the existence of additional dynamic anatomic factors influencing TT-TG after TTO. One such additional contributor may be increased external rotation of the tibia relative to the femur during supine MR or CT imaging. The purpose of the present study was to radiologically quantify the ΔTT-TG after TTO and to determine if this value was consistent with intraoperatively measured TM. The hypothesis was that ΔTT-TG would be less than TM and that this difference would correspond with an increase in the post-operative external rotation of the tibia relative to the femur.

METHODS: Patients who underwent anteromedializing TTO for a diagnosis of patellar instability during January 2011 – December 2024 were retrospectively identified and those with pre- and post-operative knee MRIs available were included. The TT-TG distance and relative external tibial rotation (rETR) were measured pre- and post-operatively. Intraoperatively measured TM was obtained from the operative report. Paired t-tests were used to compare (1) pre- and post-operative measures, and (2) ΔTT-TG and TM. Linear regression was used to assess the association between the quantities (TM - ΔTT-TG) and ΔrETR.

RESULTS: A total of 39 patients (29 females, 10 males) met inclusion criteria with a mean age of 28.0 ± 9.2 years and BMI of 28.3 ± 7.6 kg.m2. From pre- to post-operatively, the TT-TG distance decreased by a mean of 5.6 mm (18.0 ± 4.7 mm vs. 12.4 ± 4.8 mm; $p < 0.001$) and the rETR decreased by a mean of 1.5 degrees (5.9 ± 4.7 vs. 4.4 ± 5.7; $p = 0.020$). The ΔTT-TG was found to be 4.5 mm (44.5%) less than the measured intraoperative TM (5.6 ± 4.2 mm vs. 10.1 ± 1.9 mm; $p < 0.001$). The disparity between intraoperative TM and ΔTT-TG (TM - ΔTT-TG) was found to positively correlate with the change in rETR ($\beta = +0.358$; $p = 0.025$).

DISCUSSION AND CONCLUSION: The main finding of the present study was that ΔTT-TG after TTO was significantly less than intraoperatively measured TM. This disparity may reflect a systematic disagreement between physical and radiologic measurements or an inability to accurately quantify tubercle medialization intraoperatively. Additionally, this discrepancy suggests the possibility that the TT-TG distance is not a pure static metric of the lateral position of the tibial tubercle and that it may instead be influenced by dynamic factors that are also altered during TTO. Although the current study found the tibia to be significantly more internally rotated relative to the femur on average post-operatively, the quantity (ΔTT-TG – TM) was found to positively correlate with rETR. This finding suggests that the discrepancy between ΔTT-TG and TM may be partially attributable to a compensatory post-operative external rotation of the tibia relative to the femur in some patients on supine MRI after TTO, which depresses the change in TT-TG relative to true TM. The current study suggests that the TT-TG distance may be an imperfect tool for diagnosis and operative planning in patellar instability.