Evolving Trends in Tibial Tubercle Osteotomy With Versus Without Concomitant Medial Patellofemoral Ligament Reconstruction: Patient and Surgeon Factors Impacting Surgical Decisions

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INTRODUCTION: Tibial tubercle osteotomy (TTO) is a procedure to treat patellar disorders that may be performed in conjunction with medial patellofemoral ligament reconstruction (MPFLR). However, the trends in the utilization of concomitant TTO and MPFLR versus isolated TTO remain underexplored. Hence, the current study investigates trends in the use of MPFLR in the TTO population to identify patient and surgeon factors that correlate with the choice of performing versus not performing concomitant MPFLR.

METHODS: Patients undergoing first-time TTO were identified from the 2010-2023Q1 PearlDiver M170 database using Current Procedural Code (CPT). Patients who underwent prior MPFLR were excluded. Each TTO was classified as either isolated (TTO(-)MPFLR) or with concomitant MPFLR (TTO(+)MPFLR). Linear regression models were fit to determine annual trends in number of surgeries, number of surgeons, and average surgeon volume for TTO(+)MPFLR, TTO(-)MPFLR, and all TTOs.

Furthermore, a multivariable logistic regression model was fit to compute adjusted odds ratio for each factor's correlation with selection of TTO(+)MPFLR over TTO(-)MPFLR. Investigated factors included: patient age, sex, medical comorbidities, United States geographic region, insurance plan, TTO indication (patellar instability, patellar chondromalacia), surgeon subspecialty (sports, pediatrics), and annual surgeon volume (low = 1 TTO/year, high ≥ 20 TTO/year). Medical comorbidities included: obesity, hypertension, diabetes, liver disease, and smoking status. The Bonferroni-corrected significance threshold after accounting for 24 multiple hypotheses was $p < 0.0021$.

For each patient or surgeon factor predictive of concomitant MPFLR, linear regression models were fit to determine whether they trended in the concordant direction as TTO(+)MPFLR utilization, thereby potentially explaining the trend in TTO(+)MPFLR utilization. To account for the multiple hypotheses tested by the factor linear regression models (ultimately 10), Bonferroni correction was performed ($p < 0.005$).

RESULTS: From 2010 to 2022, 13,903 TTOs were included (3,311 male patients, 10,592 female patients; average 1070 TTOs/year). Among these, there were 8,462 TTO(-)MPFLR (average 651/year), and 5,441 TTO(+)MPFLR (average 419/year). On average, 667 surgeons performed TTOs each year, yielding an average annual surgeon volume of only 1.6 TTOs/surgeon.

Over the years, there was a stable number of TTOs (slope (m) = -1.1 surgeries/year, $p = 0.83$), number of surgeons performing TTOs (m = -1.6 surgeons/year, $p = 0.58$), and TTO surgeon volume (m = 0.002 surgeries/surgeon/year, $p = 0.58$) (Figure 1-circles). However, there was a linear increase in TTO(+)MPFLR utilization across all domains: number of surgeries (m = 26.5 surgeries/year, $p < 0.001$), number of surgeons (m = 15.1 surgeons/year, $p < 0.001$), and surgeon volume (m = 0.017 surgeries/surgeon/year, $p = 0.007$) (Figure 1-squares). Furthermore, there was a concurrent decrease in TTO(-)MPFLR: number of surgeries (m = -27.5 surgeries/year, $p < 0.001$), number of surgeons (m = -15.1 surgeons/year, $p < 0.001$), surgeon volume (m = -0.012 surgeries/surgeon/year, $p = 0.01$) (Figure 1-triangles).

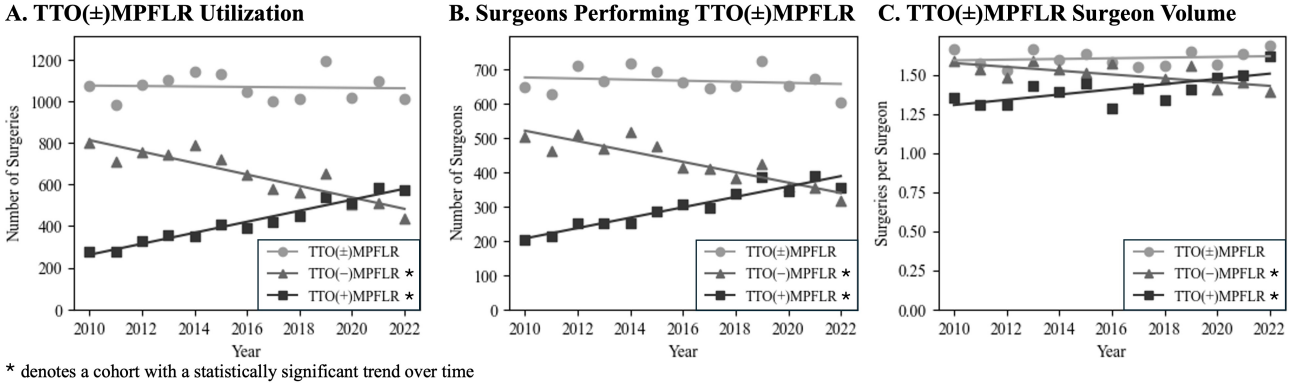
Investigated factors associated with increased odds of having a concomitant MPFLR included: surgical indication of patellar instability (odds ratio [OR]: 3.92, $p < 0.001$), sports-trained surgeons (OR: 1.47, $p < 0.001$), younger patient age (OR: 1.03/yr, $p < 0.001$), and patient male sex (OR: 1.17, $p < 0.001$). Conversely, factors associated with decreased odds of having a concomitant MPFLR included: surgical indication of patellar chondromalacia (OR: 0.62, $p < 0.001$) and Medicaid insurance (OR: 0.81, $p < 0.001$).

Of factors impacting odds of concomitant MPFLR, significant trends over time were observed in the percentage of patients with surgical indication of patellar instability (m = 3.7%/year, $p < 0.001$), percentage of TTOs performed by sports-trained surgeons (m = 1.8%/year, $p = 0.001$), average patient age (m = -0.29 years/year, $p < 0.001$), and percentage of patients on Medicaid (m = 0.6%/year, $p < 0.001$). All these factors trended concordantly with the trend in increasing TTO(+)MPFLR except for Medicaid insurance, which increased over time despite lowering odds of concomitant MPFLR.

DISCUSSION: This study reveals (1) low average annual surgeon volume among surgeons performing TTOs and (2) increasing utilization of concomitant MPFLR with TTO despite stable overall TTO use from 2010 to 2022. Factors associated with concomitant MPFLR included patient factors (patient age, sex, surgical indication) but also non-patient factors (surgeon training, type of insurance). Over the years, factors associated with increasing MPFLR use included increasing patient patellar instability, surgeon sports-subspecialty training, and decreasing patient age. The correlation of procedure with non-patient factors suggests room for further adherence to evidence-based treatment algorithms.

SIGNIFICANCE: The present study reveals the growing role of MPFLR in TTO procedures and the influence of patient and surgeon factors on surgical decisions surrounding concomitant MPFLR, highlighting the need for further investigation into how these factors affect long-term outcomes and the careful selection of personalized treatment strategies for patients with patellar disorders.

IMAGE:
Figure 1. 2010-2022 trends in annual TTO utilization, number of surgeons, and surgeon volume



* denotes a cohort with a statistically significant trend over time