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Measurement of Anteriorization Following Tibial Tubercle Osteotomy Can Be Performed Accurately on Lateral Knee Radiographs

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Faculty Disclosure Information

- Our disclosure(s) are:
- A.H.G. has received speaking fees from Bio-ventus and Organogenesis; research support from Cartiheal, JRF, Moximed, Organogenesis, and Vericel; consulting fees from JRF, Moximed, Smith & Nephew, Flexion Therapeutics, and Vericel; nonconsulting fees from Linvatec and Pacira Pharmaceuticals; honoraria from Fidia Pharma; and royalties from Organogensis; he also holds stock or stock options in Engage and Stryker.

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Introduction

- ***Background:*** There is growing interest in sagittal plane malalignment as a risk factor for patellofemoral chondral wear and a correspondingly important measure to correct when performing certain tibial tubercle osteotomy (TTO) procedures.
- ***Goal:*** Develop and validate a radiographic method of measuring anteriorization following TTO.

Methods

- ***Design***: All TTOs from two surgeons from 2015-2023 that had both pre- and postoperative XRs and MRI
- ***Surgeries***: Anteromedializing TTO, straight distalization TTO, or anteromedializing TTO with distalization
  - ~10mm anteriorization target for anteriorizing TTOs
- ***Measurements:*** Two methods to assess anteriorization developed, using the pre-post difference in distance between the anterior-most aspect of the tibial tubercle and either:
  - The center of the tibial shaft (**Figure 1**) or the anterior tibial plateau (**Figure 2**)
- ***Validation****:* Agreement calculated between each method of XR measurement and the gold standard MRI measurement (pre-post difference in sagittal tibial tubercle-trochlear groove distance) using intraclass correlation coefficients (ICCs)
- ***Secondary:*** Anteriorization amounts between techniques compared with One-Way Analysis of Variance tests

Discussion / Conclusions

- Anteriorization following TTO can be measured using routine pre- and postoperative radiographs.
- The amount of anteriorization achieved with modern anteriorizing TTO techniques was than is traditionally aimed for.
- Moving forward, surgeons can assess the amount of anteriorization achieved during TTO on standard radiographs, while researchers may investigate the potential role of anteriorization on postoperative outcomes.

Measurement Techniques

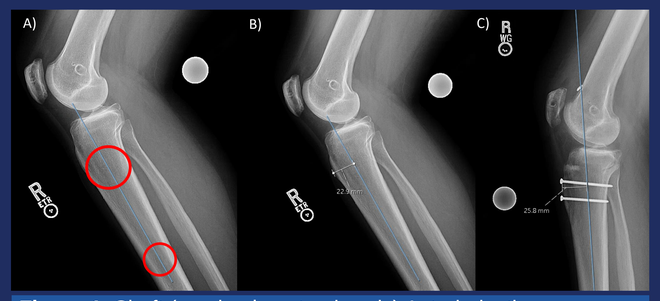

Figure 1. Shaft (proximal anatomic axis) Anteriorization Measurement: A) Two circles, one at 5 cm from the tibial plateau and one 15 cm from the tibial plateau are drawn. A line that bisects the two circles is then used as the reference point. B) The anterior distance is measured as the distance from the line drawn in part A to the most anterior aspect of the tibial tubercle (22.9 mm preoperatively. C) Utilizing the methods explained in A and B (25.8 mm postoperatively), the anteriorization amount for this example is 25.8 – 22.9 = 2.9 mm.

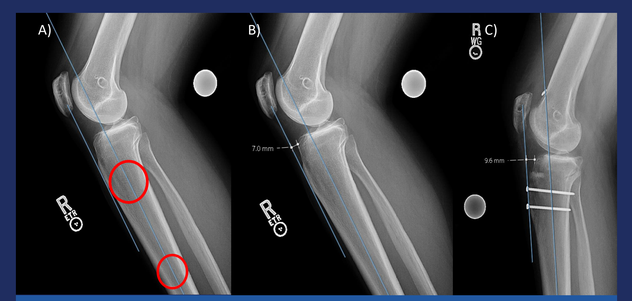

Figure 2. Anterior Plateau Anteriorization Measurement: A) A line is drawn tangential to the anterior most aspect of the tibial tubercle, ensuring the line runs parallel to the anatomic axis of the proximal tibia. B) The distance from the anterior aspect of the tibial plateau to the tangential line is measured as 7.0 mm preoperatively. C) Utilizing the methods explained in A and B (9.6 mm postoperatively), the anteriorization amount for this example is 9.6 – 7.0 = 2.6 mm.

Results

- 70 patients (52 [74%] women), mean age 31.5 ± 9.2 years
- Mean anteriorization among the 57 anteriorizing TTOs (p=0.35):
  - XR shaft technique: 4.9 ± 2.5 mm
  - XR plateau technique: 4.6 ± 2.6 mm
  - MRI: 5.3 ± 2.7 mm
- Mean anteriorization among the 13 straight distalization TTOs (p=0.66):
  - XR shaft technique: 0.1 ± 2.5 mm
  - XR plateau technique: -0.3 ± 2.2 mm
  - MRI: 0.6 ± 2.6 mm
- **Excellent** agreement with MRI for both the **XR shaft** (ICC 0.89) and **XR plateau** (ICC 0.82) technique (**Table 1**)
- **Interrater** (ICC=0.94-0.95) and **intra-rater** (0.97-0.98) reliability was **excellent** for both techniques (**Table 2**)

Table 1. ICCs and Pearson correlation coefficients (*R*) for the agreement in measurement between the imaging modalities.

Comparison	ICC	
Shaft XR-MRI	0.89	
Plateau XR-MRI	0.82	
Shaft XR-Plateau XR	0.91	
Comparison	***R***	***p***
Shaft XR-MRI	0.90	<.0001
Plateau XR-MRI	0.84	<.0001
Shaft XR-Plateau XR	0.91	<.0001

ICC scores ≥0.75 are considered excellent agreement, 0.6-0.74 good, 0.4-0.59 fair, and <0.4 poor.

Table 2. ICCs for the agreement between (i.e., interrater reliability) and within (i.e., intra-rater reliability) raters for the various measurement techniques.

Measurement Modality	Interrater	Intra-rater
Shaft XR	0.950	0.989
Plateau XR	0.939	0.975
MRI	0.942	0.973

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