The Tibial Tubercle–Trochlear Groove Distance on Axial CT and MRI: Letter to the Editor
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What is This?
Dear Editor:

I have read with the utmost attention a very informative and clearly written article by Camp et al2 entitled “CT and MRI Measurements of Tibial Tubercle–Trochlear Groove Distances Are Not Equivalent in Patients With Patellar Instability.” In this work, the authors conclude that the tibial tubercle–trochlear groove (TT-TG) distance can be measured with excellent interrater reliability on both computed tomography (CT) and magnetic resonance imaging (MRI), although the values obtained should not be interchangeably used because MRI underestimates the value of the TT-TG distance. I hereby sincerely commend the authors for their original as well as practical contribution to the world of musculoskeletal imaging.

The thing that caught my eye here was the excellent interrater reliability. As I gather, the measurements were performed using bony landmarks. If so, the shape of the femoral trochlea on the axial reference cut could have some bearing on the interrater reliability score. If the shape is regular, it resembles a groove. In the course of the measurement, one can visually approximate the deepest point of the groove with ease to draw a vertical TG line passing through it. Yet, if the shape is irregular, as in trochlear dysplasia, it can be very difficult to visually approximate the exact location of the point9 more so if the femoral trochlea is flat. This obvious increase in subjectivity while deciding where to draw the TG line may potentially result in a decrease in the interrater reliability score. In fact, the meta-analysis of Smith et al10 probably the only one published on the radiological assessment of patellar instability until now, showed acceptable(!) intrarater and interrater reliability of the TT-TG distance measurement on axial CT scans, whereas several other authors reported the low interrater reliability of the method6,8,9.

Moreover, as well as unfortunately, trochlear dysplasia is the most common instability factor in patients with patellofemoral instability1 thus posing a very frequent hindrance for measurement of the TT-TG distance in everyday practice. The problem is well known, but there seems to be only 1 published attempt to circumvent it, which is rather outdated and available to connoisseurs of French only.4 Alternatively, one could draw a pericondylar rectangle on the axial reference cut and regard its vertical midline as the TG line.7 There happens to be no statistically significant difference between the positions of the visually approximated TG line (as is usually drawn) and the geometrically approximated TG line (vertical midline of the pericondylar rectangle) in knees without trochlear dysplasia.

Hopefully, in this way, in knees actually exhibiting trochlear dysplasia, the shape of the femoral trochlea on the axial reference cut would become irrelevant for measurement of the TT-TG distance because the TG line would be geometrically approximated where it would have been visually approximated in the first place had the shape of the femoral trochlea been regular in that particular knee. However, this is only the first and modest step on a long and toilsome path toward finding a valid solution. To begin with, one could, for example, compare measurements of the TT-TG distance for interrater reliability using a visually and geometrically approximated TG line.

Be that as it may, and with all of the aforementioned in mind, it would be interesting to know how many patients with trochlear dysplasia were included in the study, perhaps even classified according to Dejour’s classification,3 and how this fact influenced the interrater reliability of both modalities.

Although this was not explicitly stated in the text of the article, and judging from Figure 1 (page 1837), I suppose that the authors were using the single-image technique in the measurement of the TT-TG distance. It is a detail worth mentioning because it has been shown that the interrater reliability of the single-image technique outmatches that of the classic (and still widely utilized) double-image technique.5

Also, Saudan and Fritschy9 write, “Nos résultats mettent ainsi en doute la précision supposée de la mesure de la TA-GT par des radiologues non spécialistes de l’appareil moteur” (“Our results thus question the assumed accuracy of the TA-GT measurement by the radiologists that are not specialists for the locomotor system”). In the Camp et al2 article, 2 fellowship-trained musculoskeletal radiologists performed the measurements. In that regard, it could have been useful to analyze the difference in the interrater reliability between the TT-TG distance measurements performed by the musculoskeletal radiologists and radiologists without any specific training in musculoskeletal imaging.
What follows is an aside on terminology. There appears to be a growing number of synonyms for the lines drawn during measurement of the TT-TG distance. In the article by Camp et al.,\textsuperscript{2} the terms “posterior condylar line” and “trochlear line” are used. Albeit largely a matter of linguistic preference, the terms “posterior intercondylar line” and “TG line” may be semantically more transparent: the former because the line is drawn from one to another (Latin: inter-) posterior part of the femoral condyles and the latter because it is more precise. Even the traditional acronym TT-TG could be reversed into TG-TT, especially when using the single-image technique because one first draws the TG line and then the TT line and not vice versa, although this is probably hard to expect because of the historical background of the acronym. At any rate, it might not be a bad idea to try to establish some sort of terminological standardization to avoid possible misinterpretations in professional and scientific texts when figures are not available.

In the end, I wish the authors the best of luck in their private and professional lives as well as many crucial discoveries in years to come.

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Authors’ Response:

Thank you for your thoughtful review of the recently published study entitled “CT and MRI Measurements of Tibial Tubercle–Trochlear Groove Distances Are Not Equivalent in Patients With Patellar Instability.”\textsuperscript{1} You are correct that the TT-TG distance measurements taken in this study utilized bony landmarks on both CT and MRI. We would have hypothesized that CT, which tends to provide a better assessment of bony geometry, would have produced slightly higher interrater reliability results compared with MRI. Although the interrater reliability was excellent for both CT and MRI, the interrater reliability of MRI (0.84) was slightly higher than that of CT (0.78).

We also agree that the ability of our radiologists to accurately determine the deepest portion of the TG, a critical step in TT-TG distance calculation, is affected by the degree of trochlear dysplasia. As the groove flattens, the center becomes increasingly difficult to locate, which may account for some of the slight variability in measurements observed between our radiologists in the study. In the 59 knees in our study, trochlear dysplasia was present as follows: grade A, 30 knees (51%); grade B, 6 knees (10%); grade C, 19 knees (32%); and grade D, 4 knees (7%) based on the classification of Dejour.\textsuperscript{4} Despite the significant number of trochlear dysplasia in this cohort, the interrater reliability remained high. As you suggest, this may be in part because the radiologists are both experienced and fellowship trained in musculoskeletal radiology. We used these specific radiologists to maximize the reliability of the study, but as you point out, the reliability of non–musculoskeletal trained radiologists may not be as high. We did not study this specifically, however.

To date, there have been a few attempts to overcome the obstacle of trochlear dysplasia in assessing extensor mechanism malalignment,\textsuperscript{2,3} and we applaud your efforts in creating a vertical midline of the pericondylar rectangle as a rather accurate estimation of the deepest portion of the TG.\textsuperscript{5} In a similar effort, Seiltlinger et al\textsuperscript{3} studied the TT–posterior cruciate ligament distance and determined that this was increased in patients with patellar instability compared to controls. Both studies highlight the possibility that, once fully validated clinically, there may be an alternative radiological method for assessment of the distal vector of the extensor mechanism that does not rely on the often dysplastic anatomy of the trochlea. Further investigation into the subject is certainly warranted.

When considering interobserver reliability, attention is appropriately focused on the challenging TG landmarks,
but it is also important not to neglect the difficulty of accurately defining the lateralized TT. In this distal measurement, MRI may also have some advantages over CT, which assisted our radiologists in their excellent interrater reliability. As Wilcox et al have demonstrated, using the soft tissue landmark of the patellar tendon on MRI provides a more reliable distal measurement than the TT on CT, with improved limits of agreement between observers in their study.

Regarding terminology of the TT-TG distance and the radiographic lines used to calculate it, we decided to use the terms “TT-TG,” “posterior condylar line,” and “trochlear line” because these phrases represent the more commonly used terminology in the current literature. Your suggestions also seem to be appropriate descriptors; however, as you mention, terminology is often difficult to change because of robust historical precedence. Thank you for your kind thoughts and interest.

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