Can Tibial Tubercle – Trochlear Groove (TT-TG) Distance be Measured Clinically?

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BACKGROUND

Several patho-anatomic entities are associated with patella instability. Excessive tibial tubercle to trochlear groove distance (TT-TG) is known to be a common feature of patella instability due to the lateral force vector acting on the patella.

The tibial tubercle to trochlear groove (TT-TG) distance is a measurement used in deciding the necessity of a tibial tubercle osteotomy and transfer for management of recurrent patella instability.

The standard technique in measuring the TT-TG distance is the use of computed tomography where the two images - deepest central portion of the trochlear groove and the peak of the tibial tubercle - are superimposed on top of each other and the horizontal distance between these two anatomic regions measured¹.

Clinical TT-TG measurement using a string technique has been previously reported².

We wanted to investigate a different clinical technique for measuring the TT-TG distance. With the knee flexed at 90 degrees, the inferior patella pole is collinear with the central trochlea in the sagittal plane.

Since the inferior patella pole and the tibial tubercle are easily identifiable surface landmarks, we attempted to develop a TT-TG measurement technique that can be readily used in a clinic/office based setting.

MATERIALS AND METHODS

Clinical TT-TG measurement method

Three fellowship-trained orthopaedic surgeons used the following standardized technique:

1. Patient sitting on the examination table with knee flexed at 90 degrees over the edge of the table.
2. Surface anatomy delineated as follows: the medial and lateral edges of the patella are identified along with the center of the patella. The inferior pole of the patella is next identified and marked.
3. A plumb line from the inferior patella pole is then extended distally to the horizontal level of the tibial tubercle. A level is used to ensure the plumb line is collinear all the way distally starting from the inferior patella pole.
4. The horizontal distance between the plumb line and tibial tubercle is then measured, providing the clinical TT-TG distance.

CT measurement method ¹,³,⁴

Two fellowship-trained MSK radiologists used the following standardized technique:

1. Patient sitting on the examination table with knee flexed at 90 degrees over the edge of the table.
2. Scans are taken from proximal to the patella to distal to the tibial tubercle.
3. Axial images are used to identify the deepest portion of the trochlear groove and apex of the tibial tubercle.
4. These two images are then superimposed on each other and the horizontal TT-TG distance between these two anatomic landmarks is measured as the TT-TG distance/interval.

STATISTISTICAL ANALYSIS

Bland-Altman analysis⁵:

1. A one-sample t-test was used to assess the presence of fixed bias. This assesses whether the clinical measurement resulted in consistently higher or lower values than the CT measurements.
2. A Bland-Altman plot with 95% limits of agreement was used to determine if the clinical and CT methods could be used interchangeably. The plot consists of the differences between each patient’s clinical and CT measurements on the Y axis versus the average of the measurements on the X axis.
3. A regression analysis was performed to determine whether the differences between clinical and CT measurements were associated with the magnitude of the actual TT-TG distance.

RESULTS

1. The fixed bias value was -2.075 mm which indicated that on average, CT TT-TG distance was greater by 2.075 mm compared with clinical measurement. However, the result of the one sample t-test (p=0.06) was not statistically significant, providing no evidence of a fixed bias at the traditional 5% two-sided level.

The upper and lower limits of the differences between the two methods were 9.155 mm and -14.565 mm. This suggests that 95% of the time, differences between clinical and CT measurements will fall between these limits. The plot also indicated that it is feasible for clinical measurements to overestimate TT-TG distance by as much as 9.155 mm and to underestimate the difference by as much as 14.565 mm.

3. The linear regression analysis (p = 0.43) did not indicate that the magnitude of TT-TG distance played a role in inter-method agreement.

CONCLUSION

1. Clinical measurement can be used to estimate TT-TG distance but clinicians should be aware of its limitations.
2. Based on the results of this study, clinical TT-TG measurement can both overestimate and underestimate the value when compared to CT scan. Therefore, clinical measurement cannot replace CT measurement.
3. Furthermore, CT continues to provide additional useful information for treatment decision making; for example, identifying trochlear morphology and osteochondral fracture.

REFERENCES