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SCIENTIFIC ARTICLE

# Are the osseous and tendinous-cartilaginous tibial tuberosity-trochlear groove distances the same on CT and MRI?

**Betina Bremer Hinckel · Riccardo Gomes Gobbi · Eduardo Noda Kihara Filho · José Ricardo Pécora · Gilberto Luis Camanho · Marcelo Bordalo Rodrigues · Marco Kawamura Demange**

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**Abstract**
*Objective* To verify whether the tibial tuberosity-trochlear groove distance (TT-TG) and the tendinous-cartilaginous TT-TG (the distance between the patellar tendon and trochlear groove: PT-TG) are identical using computed tomography (CT) and magnetic resonance imaging (MRI) techniques.
*Subjects and methods* The TT-TG and PT-TG distances were measured on the same knee samples by three observers (two measurements per observer) using CT and MRI scans collected retrospectively. The reproducibility of the measurements was assessed using the interclass correlation coefficient (ICC). The means and standard deviations of four measurements were calculated for each patient. A paired t-test was used to assess differences between measurements.
*Results* Fifty knee samples (32 with patellar instability and 18 with other conditions) were evaluated. The inter- and intraobserver reliability was excellent for all four measurements (>0.8). On average, the TT-TG distance on MRI was 3.1–3.6 mm smaller than that on CT, and the PT-TG distance on MRI was 1.0–3.4 mm larger than the TT-TG distance on MRI.
*Conclusion* The osseous TT-TG and tendinous-cartilaginous PT-TG distances determined by CT and MRI were not identical.

**Keywords** Patellofemoral joint · Dislocation · Patellar · Risk factor · MRI scan · Computed tomography · Multislice · TTTG

B. B. Hinckel (✉) · R. G. Gobbi · J. R. Pécora · G. L. Camanho · M. K. Demange
Department of Orthopaedics, Institute of Orthopaedics and Traumatology of the Clinical Hospital of the Medical School of the University of São Paulo, São Paulo, Brazil
e-mail: betinahinckel@gmail.com

E. N. K. Filho · M. B. Rodrigues
Department of Musculoskeletal Radiology, Institute of Orthopaedics and Traumatology of the Clinical Hospital of the Medical School of the University of São Paulo, São Paulo, Brazil

## Introduction

Patellar dislocation is responsible for 2–3 % of all knee injuries and is the second leading cause of hemarthrosis [1].

The main predisposing factors for patellar instability are trochlear dysplasia, patellar inclination, patella alta, and an increased quadriceps angle (Q angle) [2–10].

The distance from the tibial tuberosity-trochlear groove (TT-TG) is an estimate of the Q angle [6, 7, 11]. The TT-TG distance is calculated using computed tomography (CT) on extended knees and is considered the gold standard measurement. The determination of the TT-TG distance is essential when examining patients with patellar instability because TT-TG distances >15–20 mm indicate the need for medialization of the tibial tuberosity (TT) [6, 12–15].

Magnetic resonance imaging (MRI) may contribute to the study of the patellofemoral joint, identification of both acute osteochondral and degenerative cartilage lesions, localization of lesions of the medial patellofemoral ligament, identification of dysplasias that cannot be evaluated with conventional radiography, and diagnosis of associated injuries (e.g., meniscal or ligament injuries) [16–27]. Moreover, a better visualization of various structures, including the patellofemoral congruence, trochlear and patellar cartilages, and insertion of the patellar tendon in the TT, allows for the measure of the tendinous-cartilaginous TT-TG distance (the distance from the patellar tendon to the trochlear groove; PT-TG) with increased accuracy. Notably, imaging techniques may help reduce patient exposure to radiation.

The identification of the predisposing factors to patellofemoral instability using MRI may contribute to the integration of studies on this condition.

The TT-TG and PT-TG distances were determined by Schoettle et al. using CT and MRI in a study involving 12 patients with knee instability. The authors found no significant differences between these measurements [28]. However, Staeubli identified a concordance of only 23.3 % between the osteocartilaginous structures and trochlear groove, and the discordance reached 7 mm [29, 30]. Moreover, according to Wilcox et al., the insertion of the patellar tendon is lateral to the most anterior aspects of the TT in 88 % of cases [31]. Therefore, it was essential to conduct a study with a larger number of patients.

The present study aimed to determine the TT-TG and PT-TG distances using both CT and MRI in patients with and without patellar instability.

The null hypotheses are as follows: the TT-TG distance is identical on CT and MRI, the PT-TG distance is identical on CT and MRI, and the TT-TG and PT-TG distances between them are identical on CT and MRI.

## Subjects and methods

After approval by the institutional review board, the medical examination records of patients treated at the Institute of Orthopaedics and Traumatology, Clinical Hospital of the School of Medicine at the University of São Paulo, who underwent CT and MRI of the same knee between 2008 and 2013 were retrospectively collected. All the examination records found in the search were included in the study. We excluded patients with low-quality examinations and/or anatomical abnormalities that precluded the adequate measurement of anatomical structures, such as the deepest point of the trochlea, posterior femoral condyles, TT, and the proximal insertion of the patellar tendon on the tibia.

MRI was performed using the HDxt Signa® 1.5-T system (GE Medical Systems, Milwaukee, WI, USA) equipped with a dedicated knee coil (HDTR Knee, PA). The patients were placed in the supine position with the knee extended at the maximum extension allowed by the dedicated knee coil. For image analysis, sagittal T2 fat and axial T2 fat sequences were used with the following protocol: sagittal T2-weighted fat-saturated images (TR: 3, 400 ms): frequency × phase (320×256), number of acquisitions (Nex): 2, field of view (FOV): 17.0 mm, slice thickness: 3.5 mm, interslice gap: 0.5 mm, echo train length: 12, and bandwidth: 31.25 kHz; axial T2-weighted fat-saturated images (TR: 4,917 ms): frequency × phase (288×224), Nex: 2, FOV: 16.0 mm, slice thickness: 3.0 mm, interslice gap: 0.3 mm, echo train length: 12, and bandwidth: 31.25 kHz.

CT was performed with patients in the supine position with the knee extended and the patella positioned anteriorly or with a slight external rotation, whichever was more comfortable for the patient. Tape was placed on the thigh and distal leg to reduce possible movement artifacts. Helical planes were adopted using the bone window setting (thickness: 1.4–2.0 mm, increment: −1.0 mm, 120 kV, 180–200 mA, FOV: 300–350 cm). The instruments used were Aquilion CXL 128-channel (Toshiba), Brilliance CT 64-channel (Philips), Discovery HD 750 64-channel (GE), and LightSpeed Ultra 8-channel (GE).

The measurements were performed using the 32-bit OsiriX Imaging Software ® (Advanced Open-Source PACS Workstation DICOM Viewer).

The TT-TG and PT-TG distances were measured by landmark selection, as previously described [28, 31–33].

To calculate the TT-TG distance, a line tangential to the posterior medial and lateral condyles (osseous landmark) was drawn from the axial plane where the deepest point of the trochlea could be visualized (where the femur presents as a Roman arch). Subsequently, we drew a second line perpendicular to the posterior condylar line at the intersection with the deepest point of the trochlea (the osseous trochlear landmark). The osseous and osseous trochlear landmarks were transferred to the axial plane, where the most anterior aspect of the TT could be visualized, and a line perpendicular to the landmark at the intersection with the most anterior aspect of the TT was drawn (the TT landmark). The TT-TG distance corresponds to the shortest distance between the osseous trochlea and TT landmarks in mm (Fig. 1).

To calculate the PT-TG distance, in the axial plane where the deepest point of the cartilaginous trochlea was visualized (where the femur presents as a Roman arch), a line tangential to the posterior medial and lateral condyles (the cartilaginous landmark) was drawn. In addition, we drew a second line perpendicular to the posterior condylar line at the intersection with the deepest point of the cartilaginous trochlea (the cartilaginous trochlear landmark). Both the cartilaginous and cartilaginous trochlea landmarks were transferred to the more proximal axial plane where the patellar tendon was completely inserted into the ATT, and a third line was drawn perpendicular to the landmark at the intersection with the median point of insertion of the patellar tendon (patellar tendon landmark). The PT-TG distance corresponds to the shortest distance between the cartilaginous trochlea and patellar tendon landmarks in mm (Fig. 2).

To determine image equivalence (with similar axial cuts and minimal scaling errors between the CT and MRI scans) and decrease bias, the length of the biepicondylar axis (the distance between the medial epicondyle and lateral epicondyle centers in the axial plane) and knee flexion

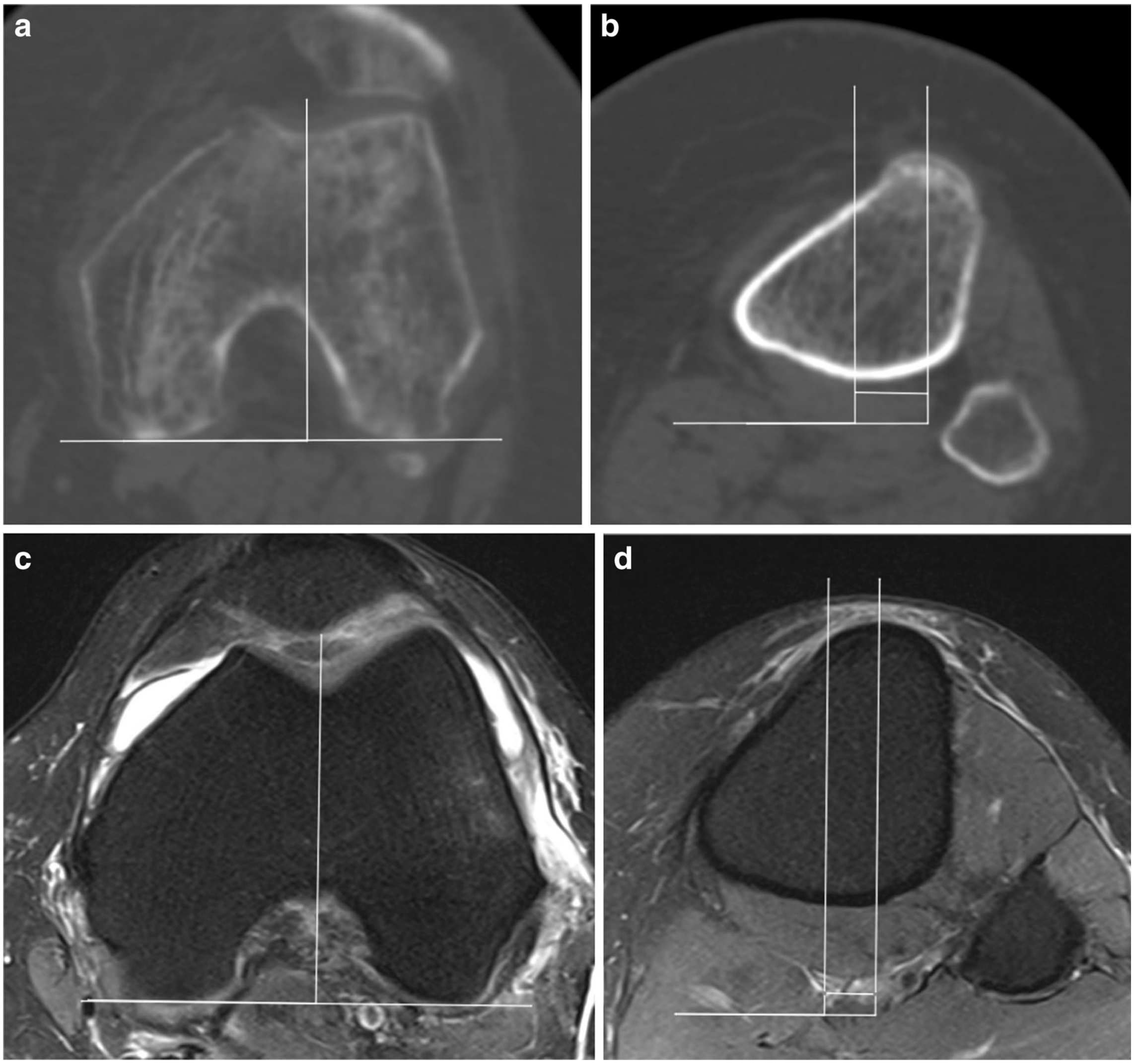


**Fig. 1** TT-TG distance on CT and MRI (images from different patients). *a* Osseous and osseous trochlear landmarks on CT; *b* osseous, osseous trochlear, and TT landmarks and the TT-TG distance determined on CT; *c* osseous and osseous trochlear landmarks on MRI; *d* osseous, osseous trochlear, and TT landmarks and the TT-TG distance determined on MRI. TT-TG = distance between tibial tuberosity and the osseous trochlear groove; TT = tibial tuberosity. CT = computed tomography, MRI = magnetic resonance imaging

angle (the angle between the anatomical axes of the distal femur and proximal tibia in the sagittal section) were measured.

The TT-TG and PT-TG distances were determined on CT and MRI by three observers (two orthopedists specialized in knee surgery and one radiologist specialized in musculoskeletal radiology) independently with no exchange of information during this part of the study. The four measurements (TT-TG–CT, TT-TG–MRI, PT-TG–CT, and PT-TG–MRI) were determined twice with an interval of at least 2 weeks between each measurement.

The biepicondylar length and knee flexion angle were determined on CT and MRI only once by one of the observers.

Measurement reliability was determined using the intraclass correlation coefficient (ICC), and a 95 % confidence interval (CI) was used to determine the inter- and intraobserver reliability. A subgroup with and without patellar instability was examined to determine whether patellar instability was a confounding factor.

The means and standard deviations of four measurements were calculated, and a paired t-test was performed to assess significant differences between measurements ($p<0.05$). Pairing was performed by calculating the following distances measured by each observer: the TT-TG distance on CT compared with the TT-TG distance on MRI, the PT-TG distance on CT compared with the PT-TG distance on MRI, the TT-TG distance on CT compared with the PT-TG distance on CT, and the TT-TG distance on MRI compared with the PT-TG distance on MRI. To compare the TT-TG distance on CT with the TT-TG distance on MRI and the TT-TG distance on MRI with the PT-TG distance on MRI, Bland-Altmann plots were constructed.

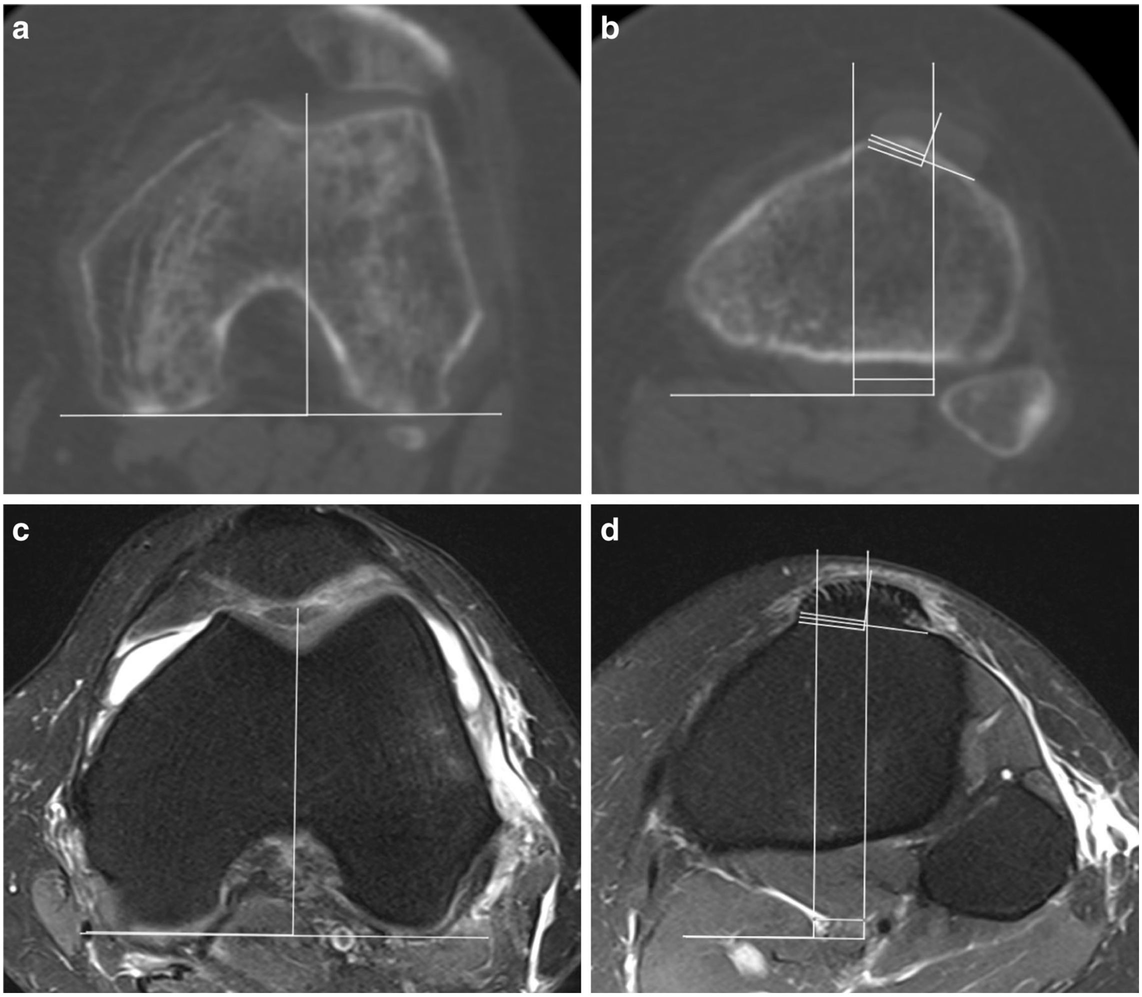


**Fig. 2** PT-TG on CT and PT-TG on MRI (images from different patients). **a** Cartilaginous and cartilaginous trochlear landmarks on CT; **b**: cartilaginous, cartilaginous trochlear, and patellar tendon landmarks and the PT-TG distance on CT; **c**: cartilaginous and cartilaginous trochlear landmarks on MRI; **d**: cartilaginous, cartilaginous trochlear, and patellar tendon landmarks and the PT-TG distance on MRI. PT-TG = distance between patellar tendon and the cartilaginous trochlear groove; PT = patellar tendon. CT = computed tomography, MRI = magnetic resonance imaging

Categorical data analysis of the TT-TG and PT-TG distances, either normal or altered, with 15-mm and 20-mm sections was performed.

A paired t-test was used to evaluate the significant difference ($p<0.05$) between the biepicondylar length and knee flexion angle using both CT and MRI. A Pearson correlation test was performed to determine the association between the increase in the variation of the knee flexion angle measured on CT and MRI and the increase in the TT-TG variation measured on CT and MRI.

## Results

Initially, 79 knees from 72 patients were studied. Of these 72 knee samples, 29 were excluded because they exhibited anatomical changes (fractures, tumors, arthritis, or previous surgeries), thereby reducing the sample size to 50 knees from 43 patients.

The mean age was 28.7±13.1 years (range: 14–70 years). Sixteen knee samples were obtained from male subjects, and 34 samples were obtained from female subjects. Among these 50 samples, 20 were from the right leg, and 30 were from the left leg. In addition, 32 samples came from patients with patellar instability, and 18 came from patients without patellar instability.

The inter- and intraobserver reliability was >0.80 for all four measurements (Table 1).

The examination of the subgroups with and without patellar instability indicated no significant differences in the ICC among the measures evaluated.

On average, the TT-TG distance on CT was larger than that on MRI for all observers (Table 2 and Fig. 3). The absolute differences varied between 7.96 mm, with the CT measurement being smaller than that on MRI, and 12.76 mm, with the

**Table 1** Intraclass correlation coefficients

| Measurement | Osseous landmark (TT-TG) | Tendinous-cartilaginous landmark (PT-TG) |
|---|---|---|
| Interobserver CT | 0.971 (CI 95 %, 0.953–0.982) | 0.901 (CI 95 %, 0.841–0.941) |
| Interobserver MRI | 0.969 (CI 95 %, 0.950–0.981) | 0.983 (CI 95 %, 0.972–0.990) |
| Intraobserver CT | 0.944 (CI 95 %, 0.904–0.968) | 0.895 (CI 95 %, 0.823–0.939) |
| Intraobserver MRI | 0.900 (CI 95 %, 0.831–0.942) | 0.932 (CI 95 %, 0.883–0.961) |

ICC with 95 % CI; ICC: intraclass correlation coefficient; CI: confidence interval

TT-TG=distance between the anterior tibial tuberosity and the osseous trochlear groove; PT-TG=distance between the patellar tendon and the cartilaginous trochlear groove; CT=computed tomography; MRI=magnetic resonance imaging

CT measurement being larger than that on MRI. This cumulative difference was >5 mm in 30 % of the cases, >8 mm in 10 % of the cases, and >10 mm in 2 % of the cases.

The TT-TG distance was significantly smaller than the PT-TG distance on both CT and MRI (Table 3 and Fig. 3). The absolute differences ranged from 2.75 mm, with PT-TG being smaller than TT-TG, to 9.13 mm, with PT-TG being larger than TT-TG.

The PT-TG distance was larger on CT than on MRI for the three observers. This difference ranged from 3.3 mm to 4.1 mm.

The categorical analysis and increased TT-TG or PT-TG distances among the patients with and without patellar instability are shown in Table 4.

The length of the biepicondylar axis was 0.5 mm smaller on CT ($p<0.05$).

**Table 2** TT-TG and difference between TT-TG distances measured on CT and MRI[a]

| Observer | Measurement | TT-TG±SD | TT-TG on CT and MRI±SD |
|---|---|---|---|
| 1 | CT | 12.73±4.25 | 3.43±3.87* |
| | MRI | 9.30±3.75 | (CI 95 %, 2:33–4:53) |
| 2 | CT | 12.63±3.87 | 3.62±3.73* |
| | MRI | 9.01±3.42 | (CI 95 %, 2.56–4.67) |
| 3 | CT | 13.67±4.12 | 3.14±3.86* |
| | MRI | 10.53±3.54 | (CI 95 %, 2.04–4.23) |

[a] in mm

*$p<0.001$

CI: confidence interval; SD: standard deviation; TT-TG = distance between the anterior tibial tuberosity and the osseous trochlear groove; PT-TG = distance between the patellar tendon and the cartilagenous trochlear groove; CT = computed tomography; MRI = magnetic resonance imaging

The knee flexion angle was 7.46±11.6° larger on MRI than on CT ($p<0.0001$). The mean flexion angle was 3.68° and 11.14° on CT and MRI, respectively. No significant correlation was observed between differences in the TT-TG distance and differences in the knee flexion angle on CT and MRI ($p=0.051$).

## Discussion

An increased Q angle is a major predisposing factor for patellar instability [5]. The gold standard method used is the calculation of the TT-TG distance on CT with the extended knee. This is an adaptation of Dejour et al. for the measurement originally described by Goutallier and Bernageau in 1978 on axial radiographs measured at 30° [7]. A TT-TG distance larger than 15–20 mm is considered pathological and indicates TT medialization [6, 12–15]. However, the osteotomy procedure for TT medialization can cause changes in both the patellofemoral and tibiofemoral joints, including increased pressure in the medial patellar facet and tibiofemoral joint, which may be deleterious in the long term [15, 34, 35]. Therefore, the TT-TG distance should be determined and interpreted with caution. This study presents differences between the TT-TG and PT-TG distances on CT and MRI and possible explanations for these findings.

The inter- and intraobserver reliability values ranged from 0.901 to 0.983 and 0.895 to 0.944, respectively, corroborating the reliability of the measurements performed. These values are consistent with those of previous studies [19, 28, 31, 33, 36–39]. In addition, the patellar instability was not a confounding factor for reliability.

The only studies that evaluated whether the TT-TG distances on CT and MRI were identical were those of Schoettle et al. and Camp et al., who found conflicting results [28, 33]. Schoettle et al. studied 12 knees (10 with patellar instability and 2 with patellofemoral pain) and found that the mean values for the TT-TG distances on CT and MRI were 14.4 mm and 13.9 mm, respectively, and were not statistically different. Camp et al. studied 59 knees of patients with patellar instability and found that the TT-TG distance on CT was 2.23 mm larger ($p<0.001$) than that on MRI in these patients, with a mean of 16.9 mm on CT and 14.7 mm on MRI [1, 33]. In that study, it was observed that in the subgroup of patients with a TT-TG distance >20 mm, the difference increased to 3.8 mm [33] and was significant. Our results showed that the TT-TG distance on CT was 3.1–3.6 mm larger than that on MRI, reaching 7.3 mm and supporting the findings by Camp et al. [33]. Moreover, the TT-TG differences between patients with patellar instability and controls vary between 1.6 mm and 7.1 mm and are clinically relevant, as reported in the literature. Considering the absolute values, this difference was >8 mm in 10 % of the cases, and the maximum difference was

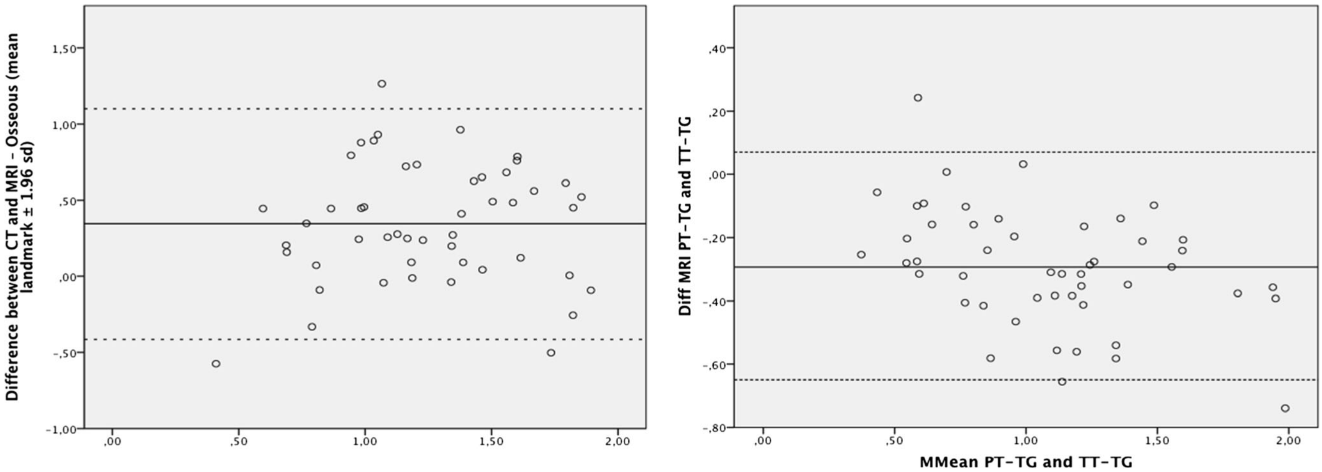


**Fig. 3** Bland-Altmann plots of the difference between the TT-TG distance on CT and TT-TG distance on MRI and the difference between the TT-TG distance on MRI and PT-TG distance on MRI. TT-TG = distance between the anterior tibial tuberosity and the osseous trochlear groove; PT-TG = distance between the patellar tendon and the cartilaginous trochlear groove; CT = computed tomography, MRI = magnetic resonance imaging

12.76 mm. The clinical importance of this difference can be observed in Table 4 where the choices of measurements, methods, and limits of normality substantially changed the percentage of patients assigned below the limit of normality. By considering the different combinations of these parameters, the proportion of patients requiring TT osteotomy varied from 0 to 71.8 %.

We observed that the PT-TG distance exhibited the best interobserver reliability value (0.983) on MRI. The TT-TG distance on MRI was smaller than the PT-TG distance on MRI (varying between 1.05 mm and 2.93 mm). In absolute terms, this difference was 9.13 mm. In an MRI study involving patients without patellar instability, Wilcox et al. found similar results using MRI: the PT-TG distance had the best interobserver reliability (0.977), the TT-TG distance was 1.37 mm smaller than the PT-TG distance, and the largest difference between these measurements was 4.18 mm [31]. In our study, we also found the TT-TG distance on CT to be smaller than the PT-TG distance on CT. Therefore, the TT-TG distance underestimates the PT-TG distance.

**Table 3** Absolute differences between TT-TG and PT-TG*

| Observer | Measurement | Mean±SD [a] |
|---|---|---|
| 1 | MRI | 2.93±1.86 (CI 95 %, 2.40–3.47) |
| 2 | MRI | 2.25±1.24 (CI 95 %, 1.89–2.60) |
| 3 | MRI | 1.05±1.54 (CI 95 %, 0.61–1.49) |
| 1 | CT | 3.46±1.95 (CI 95 %, 2.90–4.01) |
| 2 | CT | 2.61±1.52 (CI 95 %, 2.18–3.04) |
| 3 | CT | 1.26±3.61 (CI 95 %, 0.22–2.29) |

[a] in mm

*$p<0.01$

CI: confidence interval; SD: standard deviation; TT-TG = distance between the anterior tibial tuberosity and the osseous trochlear groove; PT-TG = distance between the patellar tendon and the cartilaginous trochlear groove; CT = computed tomography; MRI = magnetic resonance imaging; PT-TG larger than TT-TG

Our study addressed two potential causes of the differences between CT and MRI measures not previously investigated: MRI distortion and knee flexion. MRI distortion has been reported to be small [40, 41]. The difference between the length of the biepicondylar axis on CT and MRI was 0.5 mm and was not clinically significant. Therefore, we concluded that the imaging methods and axial cuts used were clinically identical. The knee flexion angle was approximately 7° greater on MRI than on CT. It is known that, through knee flexion, the internal rotation of the tibia with subsequent TT medialization decreases the Q angle. However, the extent to which this occurs has not been fully elucidated. Yamada et al. reported that the TT medialization was very small [42]. Dejour et al. initially performed CT analyses with the knee extended and at 15° of flexion. After considering that these measurements were not significantly different, the measurement for zero degrees of knee flexion was standardized [43]. Dietrich et al., contrary to these studies, showed a ±5-mm decrease in the TT-TG distance with 15 degrees of flexion and ±7 mm with 30 degrees of flexion. The flexion angle issue between CT and MRI was also cited by Camp et al., although this was not further investigated [33]. These measures can be influenced by changes in the reference marks between the images due to the change in the obliquity of the axial image acquisition for different degrees of flexion angles. We are not aware

**Table 4** Proportion of TT-TG distances larger than the limit of normality

| | Instability | Without instability | Instability | Without instability |
|---|---|---|---|---|
| Method/measurement | >15 mm | >15 mm | >20 mm | >20 mm |
| TT-TG on CT | 14 (43.7 %) | 3 (16.6 %) | 2 (6.25 %) | 1 (5.55 %) |
| PT-TG on CT | 23 (71.8 %) | 11 (61.1 %) | 12 (37.5 %) | 2 (11.11 %) |
| TT-TG on MRI | 6 (18.75 %) | 1 (5.5 %) | 0 | 0 |
| PT-TG on MRI | 9 (28.1 %) | 2 (11.1 %) | 4 (12.5 %) | 0 |

TT-TG = distance between the anterior tibial tuberosity and the osseous trochlear groove; PT-TG = distance between the patellar tendon and the cartilaginous trochlear groove; CT = computed tomography; MRI = magnetic resonance imaging

of studies that directly measured changes by tracking the movement of reference marks during flexion. In our study, the correlation between the increase in flexion angle and decrease in TT-TG distance reached $p$=0.051, a level that may be related to an inadequate sample size for this secondary analysis. Therefore, we acknowledge that the minor increase in the flexion angle may have influenced the differences between CT and MRI. However, the minor increase in the flexion angle most likely was not the only factor responsible for the measurement differences, which reached 12.76 mm. To perform MRI, patients are positioned with knees slightly flexed for better comfort and better adjustment of the knee coil [23]. Thus, potential bias may have occurred in all the studies involving MRI [23, 33]. Therefore, we suggest that the TT-TG distances close to the limit of normality should be evaluated with caution, considering the extent of knee flexion.

Considering that the TT-TG and PT-TG distances on both CT and MRI were not identical, each measurement should be used considering their specific corresponding limits of normality, most likely between 15 and 20 mm for both imaging techniques according to current evidence [6, 12, 14, 15, 23]. The study by Pandit et al. defined the range for normal male and female subjects to be 10.1 mm [44]. In this respect, we believe that a case-control study of the PT-TG distance using MRI is in demand. The results of case-control studies conducted on CT and MRI are shown in Table 5.

One of the limitations of the present study was that the CT and MRI images were not acquired using the same imaging device. However, considering that we followed the same protocol and obtained reproducible images corroborated by the length of the biepicondylar axis analysis and considering the observations of Dejour et al. and other studies [33, 43], we

**Table 5** Results of previous case-control studies

| Study | Measurement | TT-TG | Study | Control | Study - control |
|---|---|---|---|---|---|
| Dejour et al. [6] | CT | Osseous | N: 143 | N: 94 | |
| | | | 19.8 mm | 12.7 mm | 7.1 mm |
| | | | >20 mm: 56 % | >20 mm: 3.5 % | |
| Balcarek et al. [38] | MRI | Osseous (M) | N: 47 | N: 83 | |
| | | | 12.6 mm | 11 mm | 1.6 mm |
| Balcarek et al. [38] | MRI | Osseous (F) | N: 53 | N: 74 | |
| | | | 14.1 mm | 10 mm | 4.1 mm |
| Balcarek et al. [38] | MRI | Osseous (M+F) | N: 101 | N: 157 | |
| | | | >20 mm: 6 %<br>>15 mm: 36 % | >20 mm: 1.3 %<br>>15 mm: 14 % | |
| Balcarek et al. [46] | MRI | Osseous | N: 109 | N: 136 | |
| | | | 14.6 mm | 10.6 mm | 4 mm |
| | | | >20 mm: 11 %<br>>15 mm: 35 % | >20 mm: 2.2 %<br>>15 mm: 10.3 % | |
| Köhlitz et al. [23] | MRI | Osseous | 186 | 186 | |
| | | | 14.7 mm | 9.9 mm | 4.8 mm |
| | | | >20 mm: 15.3 %<br>>15 mm: 26.3 % | >20 mm: 1.6 %<br>>15 mm: 7.5 % | |

CT = computed tomography; study = patellar instability; control = no patellar instability; M = male subjects; F = female subjects believe that this limitation has not compromised our results. The difference between the CT and MRI protocols and the slight increase in knee flexion found on MRI may have influenced the results to some extent. Furthermore, the differences between the CT and MRI protocols are inherent to the imaging method and most likely have occurred in other studies comparing them. Recent studies have suggested decreasing the inter- and intraobserver correlation for the measurement of the TT-TG distance on MRI with increasing severity of trochlear dysplasia [45]. Therefore, the fact that we did not classify the trochlea dysplasia may be a limitation. However, verifying that there was no significant difference in ICC values between the patients with patellar instability and those without most likely indicated that it did not influence the results appreciably.

In conclusion, osseous and tendinous-cartilaginous measures of the TT-TG distance are not the same on CT and MRI. Thus, until data of normal and abnormal values of the PT-TG distance on MRI are available, these measures should not be used interchangeably.

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**Conflict of interest** The authors declare that they have no conflict of interest.

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