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Technical note

Preoperative planning of tibial tubercle medialisation according to the trochlear groove angle

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ABSTRACT

The tibial tubercle-trochlear groove distance (TT-TG) was first described four decades ago. Since then, a considerable body of research has become available on the pathophysiology of chronic patellar instability, whose diagnosis and treatment remain challenging. Tibial tubercle medialisation can correct an abnormal TT-TG. Preoperative planning based on the TT-TG and trochlear angle may avoid both under-correction inducing persistent instability and overcorrection responsible for pain. Preoperative planning should be patient-specific. With appropriate preoperative planning, compensation for moderate trochlear dysplasia can be achieved without any additional procedure.

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1. Introduction

Measurement of the tibial tubercle-trochlear groove distance (TT-TG) (between the anterior tibial tuberosity and the trochlear groove) was first described in the *Revue de Chirurgie Orthopédique* by Goutallier et al., 40 years ago [1]. The TT-TG characterises the amount of valgus of the extensor apparatus at the time of patellar engagement into the trochlear groove. The TT-TG should be measured in the supine position with the knee flexed at 30°. Separate radiographs of each knee should be obtained, with the X-ray beam aligned along the mechanical axis of the femur (i.e., along the line of insertion of the quadriceps muscle) and the lower limb in neutral rotation. In the seminal work [1], 70 surgery-naive knees were studied including 16 normal knees of patients older than 65 years (control group), 30 knees with patello-femoral osteoarthritis, and 24 knees with patellar instability. The TT consistently projected laterally relative to the TG (positive TT-TG). Mean TT-TG was 13 mm (range, 7–17 mm) in the control group, 22 mm (range, 16–31 mm) in the osteoarthritis group, and 22 mm (range, 9–38 mm) in the instability group. The conclusion from these findings was that the TT-TG assessed one of the factors affecting patellar lateralisation when the patella engages the trochlear groove. Consequently, the TT-TG is relevant for planning the amount of TT medialisation. Since this seminal study, the introduction of computed tomography (CT) and magnetic resonance imaging (MRI) has improved the measurement of the TT-TG [2–5]. Several studies have demonstrated that current TT-TG measurement techniques are reliable [6–8], although a mean margin or error of 1.6 mm has been reported [9]. Izadpanah et al. recently emphasised the need for controlling hip rotation and maintaining the knee in 30° of flexion during image acquisition [10].

In patients with patellar instability, a preoperative absolute TT-GT greater than 15 mm was long considered abnormal [11,12]. However, the practice of considering only the preoperative TT-TG value has been challenged recently [13–18]. Thus, it has been suggested that the amount of TT medialisation should be adjusted to the size of the knee [19].

Surgical TT medialisation techniques aim to obtain a postoperative TT-TG of 10 to 12 mm [11,12], i.e., within the reported normal range [1,13]. However, as with the preoperative TT-TG, it may be legitimate to consider the postoperative TT-TG relative to the overall anatomy of the knee, notably to the trochlear dysplasia. An example of this approach consists in factoring the trochlear groove angle into the preoperative planning of TT medialisation, as described in a 1993 report published in a non-surgical journal [20]. A review of the principles and usefulness of this approach seemed timely.

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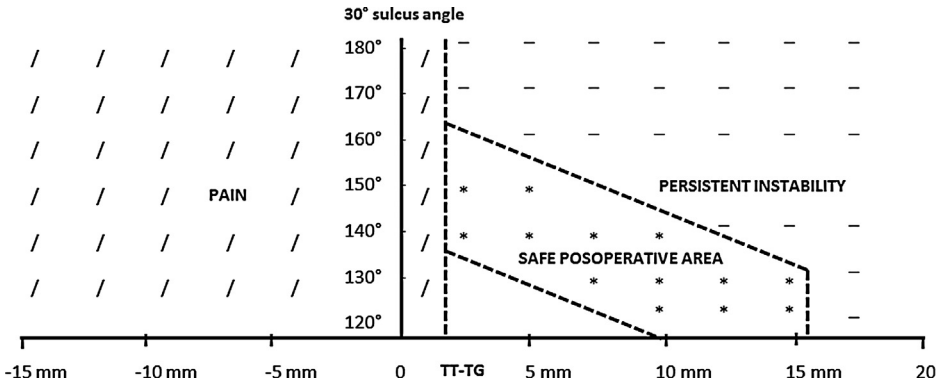

Fig. 1. Diagram for the preoperative planning of tibial tubercle (TT) medialisation, from Goutallier [20]. Pain was consistently present when the postoperative TT-TG value was lower than 3 mm. The patello-femoral instability persisted in the knees with trochlear dysplasia (trochlear groove angle greater than 145°) and insufficient TT medialisation.

2. Technique: quantification of tibial tubercle (TT) medialisation

A diagram is used for preoperative planning (Fig. 1). The diagram was created based on a review of 63 patients seen after surgery for patellar instability documented by at least one episode of patellar dislocation. Mean postoperative follow-up was 8 years (range, 5–14 years). The clinical outcomes of TT medialisation were assessed according to various anatomical factors known to be involved in patello-femoral instability. Severe knee pain with a postoperative TT-TG of less than 3 mm was noted in 8 patients and persistent instability in 6 patients. Persistent instability correlated strongly with the postoperative TT-TG relative to the trochlear groove angle. Based on this correlation, a preoperative planning diagram was developed [20]. It shows that the postoperative TT-TG should tend towards 3 mm as the trochlear groove angle increases (indicating a flat trochlea). For instance, the optimal postoperative TT-TG is about 10 mm if the trochlear groove angle is 135° and 5 mm if the trochlear groove angle is 150° (Fig. 1). The postoperative TT-TG should never be less than 3 mm. Therefore, if the trochlear groove angle is greater than 160° an additional procedure such as trochleoplasty should be considered.

3. Discussion

Patellar instability is often related to a combination of anatomical factors including abnormal patellar height, patellar dysplasia and tilt, trochlear dysplasia, and an abnormal TT-TG [21,22]. Each of these factors should be identified when planning surgical stabilisation, and each should, in theory, be corrected [5]. Patella alta can be corrected by lowering the TT to obtain a satisfactory Caton index value [23]. In patients with abnormal patellar tilt, medial patello-femoral ligament reconstruction deserves consideration [24,25].

Trochlear groove angle measurement with the knee flexed at 30° ensures the detection of dysplasia affecting groove depth, and trochlear groove angles greater than 145° have been described as abnormal [26]. TT-TG measurement has been proven reliable [27,28]. A specific surgical procedure such as trochleoplasty should be considered in patients with major trochlear dysplasia [5,26]. When the dysplasia is moderate, appropriate TT medialisation can ensure effective compensation. Bollier and Fulkerson also reported that compensation for moderate trochlear dysplasia can be obtained by correcting the other factors responsible for instability [29]. To the best of our knowledge, no previous studies have assessed the correlation between the postoperative TT-TG and the trochlear groove angle.

4. Conclusion

TT medialisation, combined with lowering if appropriate, is a simple extra-articular surgical procedure that effectively corrects abnormalities in both the direction of patellar engagement and patellar height. Adjusting TT medialisation to the trochlear groove angle measured with the knee in 30° of flexion can compensate for moderate trochlear dysplasia (trochlear groove angle below 160°), obviating the need for an additional surgical procedure.

Disclosure of interest

The authors declare that they have no competing interest.

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None.

Contribution

S. Zilber: analysed the data and wrote the manuscript.
D. Goutallier: collected and analysed the data.

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