Use of Tibialis Anterior Tendon as Distal Landmark for Extramedullary Tibial Alignment in Total Knee Arthroplasty: An Anatomical Study

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Abstract

We studied the accuracy of using the tibialis anterior tendon (TAT) as a distal landmark for extramedullary alignment in total knee arthroplasty. Forty-five consecutive ankle magnetic resonance imaging scans were reviewed. On the computerized images, a digital ruler was used to measure the distance from the midpoint of the distal tibia (point M) to the TAT. Mean distance was 1.89 mm; range was 0 to 4.5 mm (95% confidence interval, 1.45-2.33). For 7 (15.6%) of the 45 scans, the distance was 0 mm. On 38 scans (84.4%), the TAT was within 2 mm of point M. The TAT is an easily palpable fixed anatomical structure that corresponds very closely to the midpoint of the distal tibia.

Appropriate alignment of total knee arthroplasty (TKA) has been well documented as a major contributor to the longevity and success of the procedure. As early as 1977, Lotke and Ecker[1] found a significant correlation between favorable clinical outcome and radiographic alignment. Several authors have since confirmed this correlation.[2-6]

One result of this correlation is several new TKA designs, some of which include special jigs to obtain correct alignment. Intramedullary alignment has been considered superior to extramedullary alignment for making the femoral cut and arriving at an accurate and reproducible placement of the respective component.[4,7,8] However, there is still much controversy about which guide provides better reliability and reproducibility of the proximal tibial cut. Most knees are amenable to either technique, but extramedullary jigs are unreliable in patients with abnormal anatomy of the ankle and an excess of soft tissue, and intramedullary systems are inappropriate when there is excessive tibial bowing, previous fracture, or retained hardware.[9,10] Intramedullary instrumentation also carries the proposed risk for thromboembolic phenomena, postoperative hypoxia, increased blood loss, and intraoperative complications.[11,12] Therefore, extramedullary instrumentation is commonly used to align the tibial cut.

Proponents of extramedullary jigs argue that the tibial tubercle, tibial crest, and ankle joint are easily palpable during surgery and therefore facilitate jig placement.[6,12,13] The device is commonly aligned parallel to the axis of the tibia and centered on the midpoint of the talus, 3 mm medial to the center of the ankle joint.[14] The midpoint of the talus or center of the distal tibia is used as the distal landmark and is often estimated by palpating the ankle joint and the medial and lateral malleoli. The estimate of the midpoint is highly surgeon-dependent, and there is much interobserver variability. The second metatarsal has also been used as a distal landmark, but its reliability is questionable because of the ease of rotation of the foot.

We searched the literature and found no reports of anatomical studies encouraging use of the tibialis anterior tendon (TAT) as a distal landmark in extramedullary alignment in TKA. In the present anatomical study, magnetic resonance imaging (MRI) helped us to evaluate the accu-

Figure 1. The tibialis anterior tendon is easily visible and palpable at the level of the tibial plafond.

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Figure 2. The tibialis anterior tendon (purple line) can reproducibly be identified and palpated during surgery.

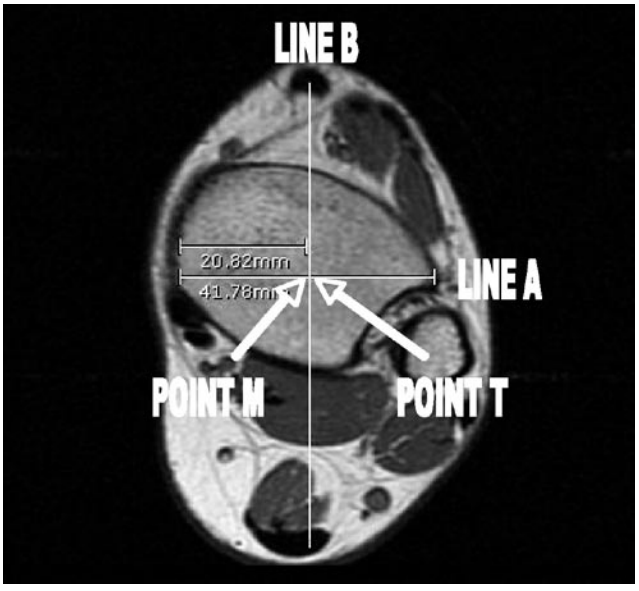

Figure 3. Magnetic resonance imaging of distal tibia just above plafond. Line A is drawn through the widest aspect of the distal tibia in the coronal plane. Line B is a perpendicular line drawn in the sagittal plane from the center of the tibialis anterior tendon. Point M is the midpoint of line A. Point T is the point of intersection between lines A and B, representing the tibialis anterior tendon. The distance between points M and T is measured. There is almost no difference between points M and T.

racy of using the TAT (Figure 1) as a fixed, easily palpable (Figure 2) distal landmark for reliable and reproducible identification of the appropriate distal landmark (midpoint of the distal tibia).

Materials and Methods

We reviewed 45 consecutive MRI scans of the ankle/lower leg with intact ankle mortise. Of the 43 patients, 21 were women, and 22 were men. Mean age was 30.4 years (range, 8-70 years). The Synapse system (FujiFilm Medical Systems, Stamford, Conn) was used for radiologic imaging and analysis. Axial T_1-weighted images just above the articular surface of the tibial plafond were selected for analysis. Measurements were made with a digital ruler that accounts for magnification. Line A (tibial width) was drawn in the coronal plane through the widest point of the distal tibia from the medial cortex to the lateral cortex. Line B was a perpendicular line drawn in the sagittal plane from the center of the TAT. The midpoint of line A (point M) was marked corresponding to the midpoint of the distal tibia. The point of intersection (point T) between lines A and B was marked, and the distance between points M and T was measured. This distance represents the distance between the midpoint of the distal tibia and the TAT (Figure 3).

Figure 4. We use the tibialis anterior tendon (purple line) as the distal landmark for extramedullary alignment in total knee arthroplasty.

Results

In 41 (91.1%) of the 45 ankle scans, point T was medial to point M; in the other 4 scans (8.9%), point T was lateral to point M. Mean distance was 1.85 mm (range, 0-4.5 mm) for the medial group, 2.38 mm (range, 1.5-3.5 mm) for the lateral group, and 1.89 mm (range, 0-4.5 mm) for both groups (95% confidence interval, 1.45-2.33). For 7 (15.6%) of the 45 scans, the distance was 0 mm. On 38 scans (84.4%), the TAT was within 2 mm of point M.

Discussion

The significance of alignment in the success and longevity of TKA has been repeatedly emphasized.[1-6] Lotke and Ecker,[1] who found that clinical results of TKA were positively correlated with radiographic alignment ($P<.05$), created a radiographic index to assess overall TKA alignment. Fifty percent of this score was contributed by the tibial component alone.

Bargren and colleagues[2] and Gibbs and colleagues,[3] in a combined series, showed that varus-, neutral-, and valgus-aligned TKAs had 67%, 29%, and 6% failure rates, respectively. Moreland[14] described the mechanisms of failure in TKA and emphasized that malalignment leads to loosening and instability. Vince and colleagues[15] noted that all their tibial-loosening cases were aligned in varus, and 80% of their knees with varus tibial alignment needed revision.

Dennis and colleagues[16] emphasized the importance of centering an extramedullary alignment guide distally over the

center of the talus 3 to 5 mm medial to the midpoint of the ankle to avoid making varus cuts. Teter and colleagues[17] corroborated this view. Similarly, Ishii and colleagues[8] emphasized the same principle using the midpoint of the distal tibia as the distal landmark. On the basis of their experience, they claimed that, on the tibial side, the extramedullary guide could be just as reliable and reproducible because it is easy to palpate and observe the tibial shaft superficially. However, they noted that it can easily be affected by tibial and ankle conditions, such as obesity, rotation, and deformity.

In the present study, we sought to identify a fixed, anatomical landmark that would reliably and reproducibly help identify the appropriate distal landmark (midpoint of the distal tibia). The TAT is an easily palpable anatomical structure that corresponds very closely to the midpoint of the distal tibia. In this series, mean distance from the TAT to the midpoint was 1.89 mm. On 38 (84.4%) of the 45 scans, the TAT was within 2 mm of point M. Therefore, we feel that the TAT can be used reliably as the distal landmark for extramedullary alignment for the tibial cut in TKA. Using this landmark will eliminate the need for surgeons to make their own estimates, which has been common practice. As already mentioned, the midpoint of the talus or center of the distal tibia is used as the distal landmark and is often estimated by palpating the ankle joint and the medial and lateral malleoli. The estimate of the midpoint is highly surgeon-dependent, and there is much interobserver variability. The second metatarsal has also been used as a distal landmark, but its reliability is questionable because of the ease of rotation of the foot. Using the TAT as the distal landmark eliminates any interobserver variability by providing an easily palpable fixed anatomical structure.

This study may have more clinical significance with the surge in popularity of minimally invasive TKA techniques, in which extramedullary alignment is more appropriate.

At our institution, we have been using the TAT as the distal landmark in TKA (Figure 4). Further clinical and radiographic study needs to be performed to evaluate results.

Authors' Disclosure Statement

The authors report no actual or potential conflict of interest in relation to this article.

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This paper will be judged for the Resident Writer's Award.