Correct component rotation affects the functional outcome after total knee arthroplasty. Rotation errors of the femoral component are held responsible for occurrences such as instability in flexion and midflexion, patellar maltracking, and arthrofibrosis following total knee arthroplasty. However, in many cases, the epicondylar axis cannot be reliably identified due to bone defects or metal artifacts on computed tomography, so alternative landmarks are necessary to evaluate the femoral component rotation. The current study sought to determine the relationship of the posterior cortical bone and the anterior cortical bone in relation to the epicondylar axis. In this retrospective study, 398 consecutive patients who had undergone magnetic resonance imaging of the knee joint were included. The average angle between the posterior cortical bone and the epicondylar axis was 7.3°±3.3°. When the posterior cortical bone was used as the reference, the average absolute error was 2.6°±2.1°. In comparison, the average angle between the anterior cortical bone and epicondylar axis was 10.4°±4.5°. When this reference was used, the average absolute error was 3.6°±2.8°. The posterior cortical bone is a more consistent landmark than the anterior cortical bone is for intra- or postoperative approximation of the epicondylar axis. This appears to be due to the flat geometry of the posterior cortical bone compared with the elliptical form of the anterior cortical bone of the distal femur. In practice, an external rotation of the femoral component of 7° in relation to the posterior cortical bone is to be recommended. [Orthopedics. 2017; 40(3):188-190.]
In the postoperative evaluation of component rotation by computed tomography, neither the Whiteside line nor the posterior condylar axis are available as references, so the epicondylar axis has to be determined directly. Depending on the computed tomography scanner and the implant material, artifacts limit the determination of the epicondylar axis, especially in the case of implants with a femoral box (posterior stabilized, varus valgus constrained, or hinged implants).

Given this, Talbot and Bartlett evaluated the anterior cortical bone of the distal femur as an alternative landmark and a sufficiently reproducible position in relation to the epicondylar axis was found. However, Watanabe et al. pointed out the limited practicability of this landmark because the epicondylar axis considerably deviates from a surface in one-third of the cases, and therefore limits the definition of a tangent.

In contrast to the anterior cortical bone, the posterior cortical bone of the distal femur appears to be regular, without relevant curvature. Therefore, in the current study, the objective was to determine whether the posterior cortical bone is a more precise landmark than the anterior cortical bone for determining the rotation of the femoral component.

**Materials and Methods**

In this retrospective study, 398 consecutive patients who had undergone magnetic resonance imaging (MRI) of the knee joint were included. Before the start of the study, approval from the local ethics committee was obtained. Age and sex of the patients were taken from the MRI meta-data.

Two planes were located in the MRIs and the relevant osseous landmarks were determined: one section in which both epicondyles were imaged and one section with the best possible tangents to the anterior cortical bone, as well as the posterior cortical bone slightly above the trochlea (Figure 1). The lateral epicondyly was defined as the highest osseous point of the femoral lateral collateral ligament attachment; the medial epicondyly was localized in the sulcus between the 2 attachments of the deep and superficial medial collateral ligament so the surgical epicondylar axis could be defined. The posterior condylar axis was determined as a line connecting the most posterior points of the osseous condyles.

Angles between the tangent to the anterior cortical bone and the epicondylar axis, between the posterior cortical bone and the epicondylar axis, and between the posterior cortical bone and the posterior condylar axis were calculated from the data. All angles were tested for age and sex dependency using the Pearson’s correlation test and the Mann-Whitney U test at a significance level of $P<.05$.

**Results**

Average patient age was $52.3\pm14.5$ years (range, 11-81 years) (men, 185; women, 213). The average angle between the posterior cortical bone and the epicondylar axis was $7.3^\circ\pm3.3^\circ$ (range, $-4.3^\circ$ to $16.1^\circ$) (Figure 2). Thus, in the case of computed tomographic evaluation, a parallel alignment of the femoral component to the epicondylar axis can be assumed if it is positioned $7.3^\circ$ externally rotated to the posterior cortical bone. If this reference were used, the average absolute error would be $2.6^\circ\pm2.1^\circ$ (range, 0$^\circ$ to 11.6$^\circ$).

A significant, but in practice negligible, difference was found between men ($6.8^\circ\pm3.4^\circ$, range, $-4.3^\circ$ to $15.4^\circ$) and women ($7.7^\circ\pm3.2^\circ$, range, $-2.9^\circ$ to $16.1^\circ$; $P=.008$). The average angle between the posterior cortical bone and the posterior condylar axis was $8.2^\circ\pm3.3^\circ$ (range, $-2.8^\circ$ to 17.4$^\circ$). Compared with the posterior cortical bone, the anterior cortical bone of the femur was less reliable in determining the epicondylar axis. Here, the average angle was $10.4^\circ\pm4.5^\circ$ (range, $-3.5^\circ$ to 24.8$^\circ$). If the calculated $10.4^\circ$ were used as a reference, an average absolute error of $3.6^\circ\pm2.8^\circ$ (range, 0$^\circ$ to 14.4$^\circ$) would result. A sex dependency was not found. None of the angles calculated showed age dependency.

**Discussion**

The main finding of the current study is that the posterior cortical bone is a better landmark than the anterior cortical bone of the distal femur for indirectly determining the surgical epicondylar axis. Its flat geometry explains why the posterior cortical bone is a more reproducible landmark than the anterior cortical bone for both intra- and postoperative approximation of the classical epicondylar axis. In the most widely used measured resection technique, a rotation of the femoral component parallel to the epicondylar axis is aimed for. This is achieved intraoperatively by direct palpation of the epicondyles and by indirect determination via the posterior condylar axis or the Whiteside line. A standardized computed tomography protocol has been established in the postoperative control of femoral rotation after the measured resection technique. However,
in many cases the epicondyles cannot be reliably imaged as a result of considerable metal artifacts, so alternative osseous landmarks are necessary.18

Talbot and Bartlett13 were able to show that the anterior cortical bone has a close correlation to the epicondylar axis and thus, for the first time, they established an alternative to the direct visualization of the epicondylar axis.

However, the current data show that the anterior cortical bone has a greater variance in relation to the epicondylar axis than the posterior cortical bone. This is attributable to the greater variability of the geometry of the distal femur in the anterior aspect compared with the posterior aspect. Although the posterior distal femur is practically level 10 cm cranially of the joint line, the anterior cortical bone shows a flattened elliptical form here, which makes the definition of a tangent unreliable. Because the posterior cortical bone can always be reliably visualized, even in the case of metal artifacts, it can serve as a control of rotation of the femoral component in all cases.

The biomechanical and clinical impact of a femoral component position in reference to the posterior cortical bone is yet unclear. Currently, the posterior cortical bone can only serve as a landmark to approximate the epicondylar axis. Further studies including the evaluation of the femoral component position in reference to the posterior cortical bone will reveal the biomechanical and clinical significance of this new landmark.

Beside postoperative control, the posterior cortical bone can also be used to determine the intraoperative rotation of the femoral component in the case of extensive bone defects (eg, distal femoral replacement). On the basis of the data shown here, an externally rotated positioning of the component by approximately 7° is to be the aim.

Despite the low average spread between posterior cortical bone and epicondylar axis, with a standard deviation of 3°, there are outliers that produce errors of up to 11° in individual cases. Therefore, the posterior cortical bone is only useful as an additional landmark if established landmarks (posterior condylar axis, epicondylar axis, Whiteside line) can no longer be determined due to bone defects or artifacts in intra- or postoperative imaging.

**CONCLUSION**

The posterior cortical bone should be taken into account in every case it is accessible without additional soft tissue trauma, aiming for an external femoral component rotation of 7°.

**REFERENCES**


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