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ORIGINAL ARTICLE

Is radiographic measurement of distal femoral torsion reliable?

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Total knee arthroplasty;
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Summary
Background: Distal femur torsion (DFT) is a crucial parameter in knee replacement surgery. The reference standard for measuring DFT is posterior condylar angle (PCA) measurement using computed tomography (CT). The objective of this study was to assess the feasibility and reliability of a radiographic PCA measurement method.
Materials and methods: We studied 125 osteoarthritic knees in 79 patients (42 women and 37 men) with a mean age of 71.6 ± 8.8 years (range 47 to 86 years); 32 knees were aligned, 85 in varus, and eight in valgus. DFT was measured on an antero-posterior (AP) radiograph of the knee in 90° of flexion (known as the seated AP view). The PCA was defined as the angle subtended by the tangent to the posterior condyles and the transepicondylar axis (anatomic PCA [aPCA]) or the line connecting the lateral epicondyle to the medial sulcus (surgical PCA [sPCA]). The PCA was conventionally recorded as positive in the event of external torsion and negative in the event of internal torsion. PCA measurements were performed three times by each of five observers to allow assessments of inter-observer and test-retest reliabilities.
Results: aPCA was consistently negative (mean, −6.1 ± 1.6°) (range, 0 to −10°); inter-observer and test-retest reliability were satisfactory (0.54 < rw 0.80). sPCA was positive in 41 knees and negative in 84 knees) (mean, −0.3 ± 1.4°) (range, −5° to +2°); inter-observer and test-retest reliabilities were poor (0.28 < r < 0.69). A weak but significant correlation was found between aPCA and coronal alignment, with a trend towards greater internal torsion in the group of valgus knees.
Conclusion: Radiographic measurement of DFT is simple and non-invasive. Measurement reproducibility was satisfactory for aPCA but not for sPCA. aPCA showed marked inter-individual variability and tended to increase when the knee was in valgus. Mean aPCA values were comparable to those reported using CT. In contrast to CT, radiographic DFT measurement can easily be

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incorporated into the pre- and postoperative work-ups for knee replacement surgery, provided the patient can achieve 90° of knee flexion.
Level of evidence: Level IV, prospective cohort study.

Distal femoral torsion (DFT) is a crucial parameter for knee replacement surgery as it governs knee kinematics, most notably patellar tracking, as well as ligament balance in flexion [1—10]. Therefore, rotational malposition of the femoral component might result in failure of total knee arthroplasty (TKA) [11,12]. DFT was first evaluated in the 1990s, using computed tomography (CT) [13,14]. In 1987, Yoshioka et al. [15] defined DFT as the condylar twist angle or posterior condylar angle (PCA) formed by the tangent line to the posterior condyles and the transepicondylar axis. In 1993, Berger et al. [16] distinguished the anatomic PCA (aPCA) described above and the surgical PCA (sPCA) for which the medial landmark was the medial sulcus of the medial epicondyle, which they felt was easier to identify. Although CT is now the reference standard for DFT [11,13—16], routine CT may not be feasible given radiation exposure considerations, the limited availability of CT machines, and difficulties with bony landmark identification in some patients [11,14,17]. These limitations have prompted studies of radiographic methods for DFT measurement [18,19]. Using original methods based on antero-posterior (AP) radiographs of the knee in flexion, Takai et al. [18] in 2003 then Kanekasu et al. [19] in 2005 found DFT values similar to those obtained using CT. These simple and reproducible methods have not gained widespread acceptance and, to our knowledge, have not been evaluated in independent studies.

The objective of this study was to assess the inter-observer and test-retest reliability of a standardised radiographic method for measuring DFT. We evaluated this method in a consecutive series of osteoarthritic knees.

Material and method

We prospectively evaluated 125 osteoarthritic knees for which TKA was performed between January and November 2010, in 79 patients (42 women and 37 men) with a mean age of 71.6 ± 8.8 years (range, 47 to 86 years). The osteoarthritis was primary in 108 knees, post-traumatic in seven (sequelae of epiphyseal fractures were excluded), and secondary to inflammatory joint disease in 10. In the coronal plane, 32 knees were aligned, 85 were in varus, and eight were in valgus. Mean preoperative mechanical tibio-femoral axis (hip-knee-ankle [HKA] angle) was 175 ± 5° (range, 164°to 192°).

DFT was measured on an AP radiograph of the knee in the seated position (known as the AP seated view), i.e., with the knee flexed to 90°, according to a method derived from those described by Takai et al. [18] and Kanekasu et al. [19] (Fig. 1). The patient was seated on a radiotransparent table with the legs hanging over the edge. The axis of the femur was strictly perpendicular to the film, which was in direct contact with the anterior aspect of the knee. Neutral rotation was ensured by the weight of the leg. The X-ray source was behind the patient, 1 m from the film, and centred on the popliteal fossa. The X-ray beam was angled upwards 15° from the horizontal. X-ray-beam constants were adapted to patient build and soft-tissue thickness. The AP seated radiograph was considered properly performed if it showed the Roman arch-shaped intercondylar notch, medial and lateral epicondyles, medial sulcus, and posterior edges of both condyles (Fig. 2). These bony landmarks were used to define two angles (in°) determining DFT:

Figure 1 Antero-posterior (AP) seated radiograph of the knee: the patient is seated with the legs hanging down and the knee in contact with the film. The source is behind the patient and the X-ray beam has 15° of upwards obliquity.

- the aPCA between the tangent line to the posterior condyles and the transepicondylar axis;
- and the sPCA between the tangent line to the posterior condyles and the line connecting the lateral epicondyle to the medial sulcus of the medial epicondyle.

When the tip of the angle pointed laterally, the distal femur was twisted internally and the PCA was arbitrarily reported as negative (anti-clockwise direction for the left knee). When the tip of the angle pointed medially, the distal femur was twisted externally and the angle was positive (clockwise direction for the left knee) (Fig. 2).

To allow an assessment of inter-observer and test-retest reliabilities, each of five observers (three junior and two senior orthopaedic surgeons) each measured the angles three times at intervals of 1 month.