



Measurement of the knee joint line in Turkish population

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Objective: The aim of the present study was to determine the knee joint line level by its distance to the adductor tubercle and the apex of the fibular head in the Turkish population.

Methods: The study included 117 knees of 108 patients (63 males, 45 females; mean age: 31.3 years, range: 16 to 82 years). Femoral width and the distance from the apex of the fibular head to the joint line as well as the distance from the adductor tubercle to the joint line were measured on anteroposterior radiographs.

Results: Mean femoral width was 87.2 mm. The average distance from the adductor tubercle to the joint line was 47.9 mm and from the fibular head to the joint line was 20.5 mm. A linear correlation was found between the distance from the adductor tubercle to the joint line and femoral width, with a ratio of 0.55. There was no significant correlation between the distance from the fibular head to the joint line and femoral width.

Conclusion: There was a linear correlation between the femoral width and the adductor tubercle-joint line distance irrespective of any factors such as age, gender and height. Therefore, the adductor tubercle can be used as a reliable landmark to determine the joint line level for easy evaluation and measurement during surgery.

Key words: Anatomical determinants of the knee joint line; knee joint line; revision knee prosthesis surgery; total knee prosthesis surgery.

Determination of the knee joint line position is critical in total knee prosthesis surgery, particularly in revision knee prosthesis surgery. Complications such as decreased strength of the extensor mechanism, compression on the patella, anterior knee pain, and decreased range of motion of knee joint may arise in cases in which the level of the joint line is not properly determined.^[1,2] However, there is no standard method for the measurement of the

joint line position. The epicondyle, adductor tubercle, fibular head and patella are among the most widely used anatomical determinants.^[3-6] Proper position of the joint line is determined through measurement of the distances between these anatomic points. Recently, ratios between these distances have become increasingly preferred as they may be affected by factors such as age, gender, body mass index, and race.^[3,5,7]

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The aim of this study was to measure these distances and ratios in the Turkish population and to compare them with those reported in the literature.

Patients and Methods

Radiographic images of patients who presented to our emergency service and outpatient clinic for trauma and knee pain and underwent radiography were retrospectively evaluated. Patients with evidence of a fracture around the knee, with history of a prior fracture, and those who underwent surgery for fracture around the knee were excluded. A total of 117 knees from 108 patients (63 males, 45 females; mean age: 31.3 years, range: 16 to 82 years) were included.

Radiographs were obtained with the patient in the supine position and the knee in full extension. Radiological data included anteroposterior radiographs performed with the centered patella showing the knee joint. Using anteroposterior (AP) radiographs, the line which connects the most distal points of medial and lateral femoral condyles was defined as 'the joint line' (JL) (Fig. 1a). The line which connected the most prominent parts of the medial and lateral epicondyles was defined as 'the femoral width' (FW) (Fig. 1b), and the distance measured by the perpendicular distance from the adductor tubercle to the joint line as 'the adductor tubercle to the joint line distance' (AJD) (Fig. 1c). The perpendicular distance from the superior pole of the fibular head to the joint line was defined as 'the fibular head to the joint line distance' (FJD) (Fig. 1d). All measurements were performed in an electronic

format using the NeoRad SimpliCT navigation and a picture archiving and communication system (PACS). The PACS electronically correlates the magnification and measurements. Two independent observers measured the JL, FW, AJD and FJD. These data were used to assess interobserver reliability. To assess intraobserver reliability, an additional observer repeated the measurements one week later using the same radiographs in a random order.

The correlation between the FW and the AJD and FW and FJD were assessed using the Pearson correlation test, along with a linear regression analysis to determine the ratios between them.

To determine inter observer and intraobserver reliability, intraclass correlation coefficients were calculated with a confidence interval of 95%. Level of significance was set at $p < 0.05$.

Results

Mean FW was 87.2 ± 10.8 mm. The average AJD was 47.9 ± 6.2 mm and the average FJD was 20.5 ± 4.0 mm. A strong positive correlation was found between the AJD and FW ($p < 0.05$) (Fig. 2). The ratio between the FW and AJD was 0.55 as assessed by linear regression analysis. There was a weak correlation between the FJD and FW (Fig. 3).

Intraclass correlation coefficients for the FW, AJD and FJD were 0.99, 0.97, and 0.99, respectively, for the intraobserver measurements and 0.99, 0.98, and 0.99, respectively, for the interobserver measurements.

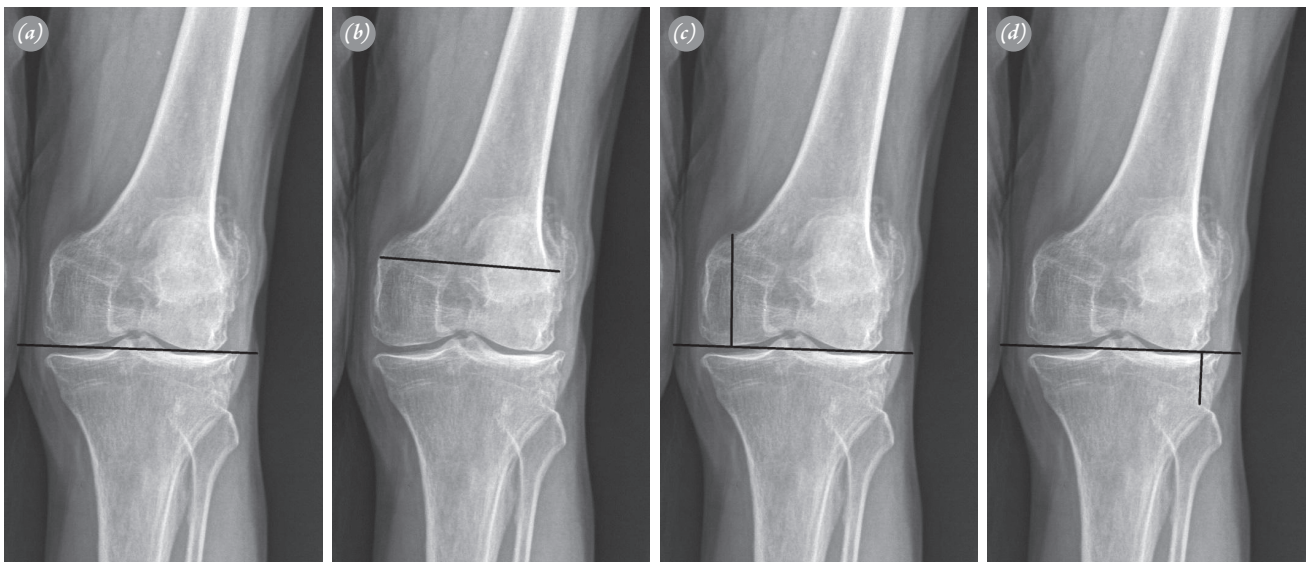


Fig. 1. (a) Radiograph showing the joint line (JL). (b) Radiograph showing the femoral width (FW). (c) Radiograph showing the distance from the adductor tubercle to the joint line (AJD). (d) Radiograph showing the distance from the fibular head to the joint line (FJD).

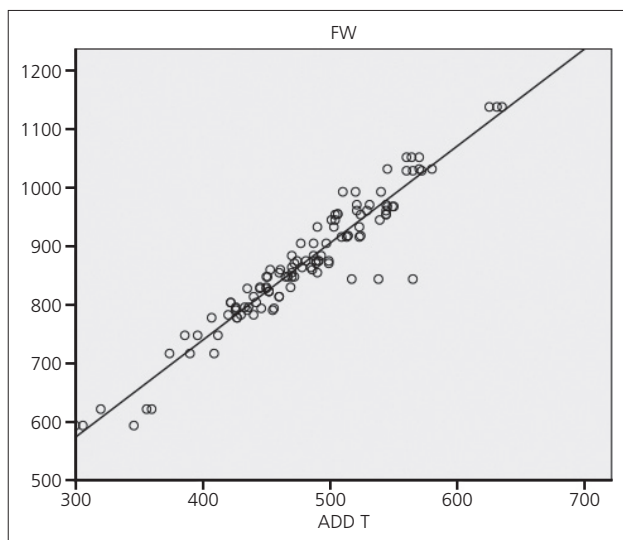


Fig. 2. Graph showing the correlation between the femoral width (FW) and the distance from the adductor tubercle to the joint line (AJD).

Discussion

Accurate knowledge of the normal value for the knee JL is essential in planning knee arthroplasty, and revision surgery in particular, as any shift in the JL may disrupt biomechanics of the knee, resulting in complications such as decrease in strength of the extensor mechanism, compression on the patella, anterior knee pain, and decreased range of motion of the knee joint.^[1,2,8]

Many studies have focused on determining the JL position through measurements between anatomical points.^[4] Reference points used include the inferior end of the patella, the superior end of the tibia, the tibial tuberosity, fibular head, femoral epicondyles and adductor tubercle. Recently, the use of these ratios have become more commonly preferred since the distances may be affected by factors such as age, gender, body mass index, and race.^[3,5,7] Computed tomography (CT), magnetic resonance imaging (MRI) and plain radiography are useful in identifying the position of the JL^[9,10] although MRI and CT are more expensive than plain radiographs and the inserted implant may produce artefacts in images, particularly in planning revision surgery. Herzog et al.^[11] and Sarmah et al.^[12] found no difference between direct radiographic and MRI and CT measurements. As plain radiography is a routine procedure in preoperative surgery, plain radiographs are mostly commonly used for determination of the JL level.

Reference points can be readily measured on a plain radiograph before any primary total knee prosthesis; however, they may not be detected during a revision surgery of bone defects. Therefore, the use of a reference

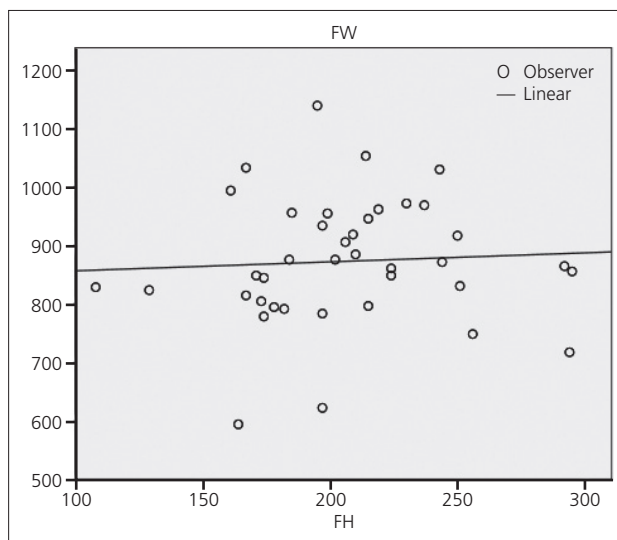


Fig. 3. Graph showing the correlation between the femoral width (FW) and the distance from the fibular head to the joint line (FJD).

point which can be determined before the revision surgery and even during the surgery would be more practical. The adductor tubercle is an appropriate landmark to determine the JL since it can be easily identified and measured both on the preoperative plain radiographs and during surgery.

Mean FWs of 89.7 mm have been reported by Iacono et al.,^[3] 79.9 mm by Romero et al.,^[5] 81.7 mm by Servien et al.,^[4] 75 mm by Lee et al.,^[13] and 77.2 mm by Seedhom et al.^[14] In the present study, the FW was measured as 87.2 mm. While we found that the average AJD was 47.9 mm, it was 48.7 mm in the study by Iacono et al.^[3] The FJD was 20.5 mm in average as our reference point for the JL was the line drawn tangent to the most distal points of the medial and lateral femoral condyles. The average FJD was 14.1 mm in the study by Servien et al., who measured the distance from the most superior point of the fibular head to the line connecting the tibial plateau.^[4] Iacono et al. considered the JL as the line connecting the most distal points of medial and lateral femoral condyles and reported an average FJD of 16.7 mm.^[3]

Since measurement results may vary due to factors such as gender, age, body mass index and race as already shown above, the ratios of these distances must be preferred. We evaluated the presence of any correlation between these distances. Iacono et al.^[3] found a linear correlation between the FW and AJD and reported a ratio of 0.543. In the same study, the authors also found a correlation between the FW and the distance from the medial epicondyle to JL with a ratio of 0.343. Romero et al. found a linear correlation between the FW and the

distance from the medial and lateral epicondyles to the JL.^[5] In line with the literature, the present study also found a strong linear correlation between the FW and AJD, with a ratio of 0.55. The ratio is not influenced by any factors such as gender, age or weight. There was a weak correlation between the FJD and FW.

In conclusion, there was a linear correlation between the femoral width and the distance of the adductor tubercle to the joint line in the Turkish population. The adductor tubercle appears to be a reliable landmark for the determination of the joint line level in primary total knee prosthesis and revision knee prosthesis surgeries.

Conflicts of Interest: No conflicts declared.

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