

Radio-anatomic position for the lateral radiographic view of the human patello-femoral joint

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Summary. Recent clinical and epidemiological studies have emphasised the importance of the patello-femoral joint (P-FJ) in osteoarthritis. X-ray examination of this joint for joint space width (JSW) assessment using the standard medio-lateral view is difficult. In 26 femora, the mean angle of inclination between the medial and lateral condyles measured at their inferior and anterior surfaces, relative to a line passing between the medial and lateral femoral epicondyles, was used to define the optimum alignment of the x-ray tube. The results showed that for medio-lateral radiography of the P-FJ, the central ray of the x-ray beam should be directed cranially, in an upward projection by 5° and then anteriorly by 4°, resulting in superimposition of the inferior and anterior condylar surfaces respectively. The value of these angles was confirmed by radiographs of the 26 femora and 10 post mortem joints. The margins for joint space width measurement were identified by embedding lead balls, within the cartilage of the cadaveric knees, and were defined as the median vertical ridge of the patella and the middle of the patella groove on the femur.

Une position radio-anatomique pour la radiographie de profil de l'articulation fémoro-patellaire humaine

Résumé. De récentes études cliniques et épidémiologiques ont souligné l'importance de l'articulation fémoro-patellaire (AFP) dans l'arthrose du genou. L'examen radiographique de cette articulation, notamment pour l'appréciation de l'épaisseur de l'interligne articulaire en incidence médio-latérale de routine, est difficile. Sur 26 fémurs, l'angle moyen d'inclinaison des surfaces inférieure et antérieure des condyles latéral et médial par rapport à une ligne unissant les deux épicondyles a été utilisé pour définir l'alignement optimal du tube radiogène. Les résultats ont montré que pour une radiographie médio-latérale de l'AFP, le faisceau central de rayons X devait être dirigé crânialement de 5°, et antérieurement de 4°, permettant ainsi d'obtenir la superposition des deux condyles. La validité de ces angles a été confirmée par les radiographies de 26 fémurs et de 10 articulations cadavériques. Les repères pour la mesure de l'épaisseur de l'interligne articulaire, identifiés par l'insertion de billes de plomb dans le cartilage des articulations cadavériques, ont été définis comme étant la crête verticale médiane de la patella et le milieu de la gorge patellaire du fémur.

Key words: Knee — Patello-femoral joint — Radiography

Recent epidemiological and clinical studies have highlighted the importance of the patello-femoral joint (P-FJ) in evaluating osteoarthritis of the knee [4, 8, 9], indeed approximately 50% of all OA patients have either patello-femoral or both patello-femoral and medial tibio-femoral compartment involvement [4, 8]. However, assessment of radiographic features recorded in a lateral view of the P-FJ have greater observer variability than those of tibio-femoral compartment [3]. In the latter joint, recent radiographic studies have shown that precise measurements of joint space width, both within and between patients, can be achieved by standardising the radiographic procedures [2, 6]. The present variability in the lateral radiographic view of the P-FJ is due not only to non-standardisation of the radiographic procedure for joint positioning but also to the difficulty in defining precisely the radio-anatomic margins of the joint space [7, 10, 11].

Since a method for precise repositioning of the P-FJ in the lateral view would require superimposition of the femoral condyles to delineate clearly the margins of the joint space, we undertook a study of the anatomical configuration of the femur and patello-

femoral joint to define these angles of projection and further identify accurately the radio-anatomical landmarks of the inter-bone distance for joint space width measurements.

Materials and methods

The materials studied comprised 26 adult femora from different subjects; 10 (5 male and 5 female) non-diseased post mortem human knee joints with a mean standard deviation (SD) age at death of 75.3 (11.7) years. To obtain superimposition of both femoral articular condyles, in a lateral view of the P-FJ, the extent to which the profile of the lateral condyle differed from the medial was defined with respect to a fixed anatomical plane identified as the line extending between the medial and lateral epicondylar ridges (Fig. 1). Two angles were identified which defined 1) the degree to which the inferior surface of the lateral condyle was proximal to the medial (Fig. 1a) and 2) the extent to which the anterior surface of the lateral projected beyond the medial condyle (Fig. 1b). These angles were measured on the femora, with a goniometer, in the para-coronal and horizontal anatomical planes respectively (Fig. 1 a and b). The coefficient of variation for repeat measurements of these angles was 10 and 11% respectively.

Precision of this new radiographic projection was validated by radiography of the 26 femora and in 10 post mortem knees with 30-40° flexion, with a film to focus distance of one metre. Following the procedure described below for defining the margins of the joint space, the JSW measurements on these films were performed at the mid-patellar articular surface (Fig. 2b) using a vernier calliper. The inter-bone distance was measured to the nearest 0.1 mm. Both inter (n = 10) and intra-observer (n = 2) errors for JSW measurements were determined by calculating the coefficient of variation [1].

The radio-anatomical landmarks for joint space width (JSW) measurements were defined by placing lead balls in the mid-sagittal plane of the articular cartilage of the patella and femur in the

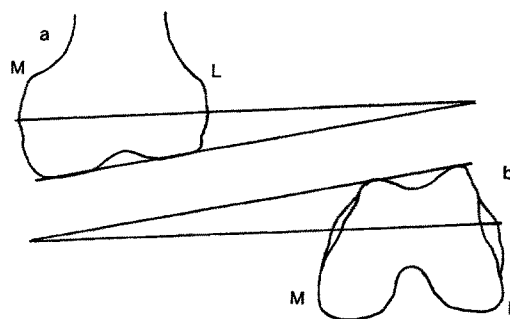


Fig. 1a, b

Diagram of the measurements taken from the human post-mortem femora: **a** anterior surface of the femur, showing the angle measured between the inferior surface of the condyles and the line projected out from the medial and lateral epicondyles; **b** inferior surface of the femur, showing the angle subtended between the anterior condylar surfaces and the projected line from the epicondyles

Schéma des mesures effectuées sur les fémurs humains secs : **a** vue antérieure du fémur montrant l'angle mesuré entre la surface articulaire inférieure des condyles et la ligne joignant les épicondyles latéral et médial **b** vue inférieure du fémur représentant l'angle défini par cette même ligne et la surface articulaire antérieure

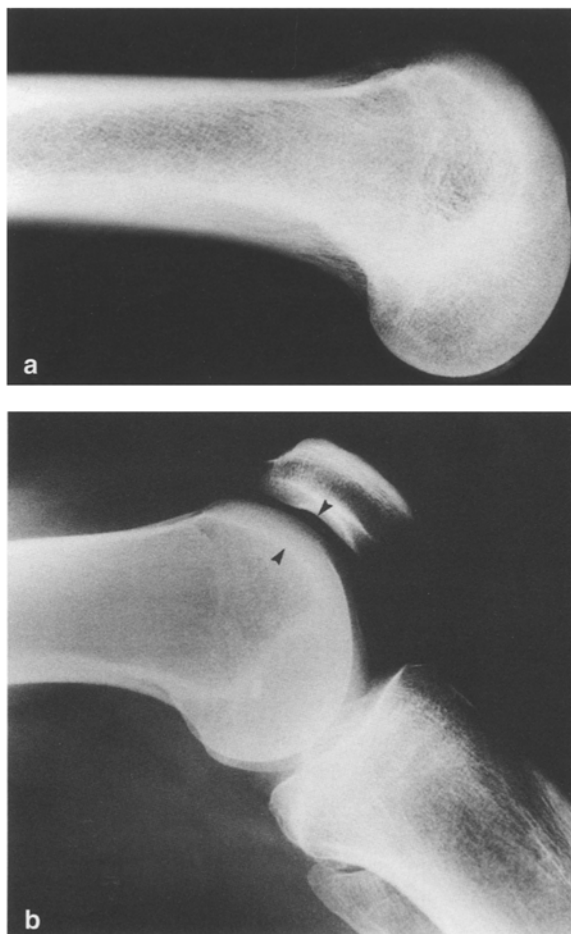


Fig. 2a, b

Lateral view radiograph of **a** a femur with the angle of projection of the central ray of the x-ray beam defined by the measurements illustrated in Figure 1; both anterior and inferior surfaces of the both condyles are superimposed and **b** of the patello-femoral joint of the knee. The arrows identify the site for joint space measurement

Radiographie en incidence latérale **a** d'un fémur, avec un angle de projection du faisceau principal de rayons X déterminé par les mesures illustrées sur la fig. 1 ; superposition des surfaces articulaires antérieure et inférieure des deux condyles et **b** de l'articulation fémoro-patellaire. Les flèches montrent les repères utilisés pour la mesure de l'épaisseur de l'interligne articulaire

10 cadaveric knees and re-radiographed in the manner described above.

Results

Mean (SD) of the angle measured in the coronal plane between the inferior femoral articular surfaces and the line

passing between the medial and lateral epicondyles of the femur was 5.0° (0.5°) (Fig. 1a). Mean (SD) of the angle measured in the horizontal plane between the anterior femoral articular surfaces and the line passing between the medial and lateral epicondyles of the femur was 4.2° (0.5°)(Fig. 1b).

Superimposition of the lateral and medial femoral condyles in the latero-medial view of the joint, was obtained in the 26 femora and 10 post mortem knees, by rotating the x-ray tube inferiorly in the coronal plane by 5° and posteriorly in the horizontal plane by 4° respectively, relative to a line projected between the medial and lateral femoral epicondyles (Fig. 2 a and b).

The radio-anatomical landmarks for JSW measurements in the mid-sagittal plane of the P-FJ, identified by the lead balls in the cartilage, were:

Patella - the articular surface of the cortex on the median vertical ridge.

Femur - the bright radiodense band of the subchondral cortex in the mid-patella groove of the femur, inferior to the profile of both femoral condyles (Fig. 2b).

Mean (SD) JSW measurements for the post mortem knees was 6.7 (0.2) mm, with an intra- and inter observer variation of 2.4 and 2.9% respectively.

Discussion

Simple anatomical observation of the configuration of the distal end of the femur and radiographic examination of the P-FJ in post-mortem knees identified the radiographic angles of projection required to obtain superimposition of the femoral condyles in a standing lateral view of the joint. In the latero-medial projection used in this study, superimposition of the inferior surface of the femoral condyles was achieved by rotating the tube head in the vertical plane so that the central ray of the x-ray beam is directed caudally or in a downward projection by 5°. Similarly, to obtain superimposition of the anterior surfaces of the femoral condyles, the tube head was rotated in the horizontal plane so that the central ray projected posteriorly by 4°. Thus, for the medio-lateral view of the joint usually employed in radiographic examinations of this joint, the angles would be reversed so that the central ray was directed cranial or in an upward direction by 5° and anteriorly by 4° respectively. The

angle of 5° used in displacing the tube head in the vertical plane, has been confirmed from an independent study of a consistent method for lateral tibio-femoral compartment knee radiography [7]. Here, the angle selected had been based upon radiographic experience in positioning the joint rather than from an anatomical study.

The radiographic angle of projection described in this study is different from the standardised lateral view of the knee [5], with the posterior borders of the two condyles superimposed, used to assess trochlear dysplasia [5]. The central ray of the x-ray beam in our investigation was directed along the anterior margin of the condyles to obtain their superimposition. Whereas, in Galland et al's study [5] the central ray was aligned with the posterior surfaces of the condyles better to define the femoral trochlea and its shape.

Embedding lead balls within the articular cartilage helped to define accurately the bony margins of the P-FJ space, from which it was possible to make precise measurements of the joint space. In the semi-flexed knee the JSW measurement were taken at the middle third of the patellar articular surface, since the superior and inferior thirds are in contact with the femur when the joint is in either full flexion or extension.

The precision of this new radiographic view was confirmed by the low coefficient of variation for measurement of JSW obtained from the post mortem knees. Preliminary observations from our patients indicate that in those instances where fluoroscopy is not available, there are difficulties in identifying, by palpation, the surface markings of the femoral epicondyles and patella in those who are overweight and with either mild varus or valgus deformities. Such difficulties can be overcome with the use of fluoroscopy.

The relevance of this new lateral view for evaluating anatomical changes in the knee joints of patients with osteoarthritis has yet to be fully assessed. The measurement of the patello-femoral JSW in this view could be interesting if osteoarthritis always led to

an axial joint space narrowing. However, since lateral or medial loss of joint space occurs even at early stages of the disease with either focal articular destruction or subluxations, it is clear that both the lateral and the axial or skyline views are necessary to obtain a proper assessment of the changes in this joint. Indeed, a comparative study of the contribution of these two views to assessing disease related changes would contribute to our understanding of OA and its progression in the patello-femoral joint.

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