There have been many reports which suggest that in patients with tibiofemoral osteoarthritis, a reduction in joint space is demonstrated better on weight-bearing radiographs taken with the knee in semi-flexion than in full extension. The reduction has been attributed to the loss of articular cartilage in the contact area in a semiflexed arthritic knee. None of these studies have, however, included normal knees. We have therefore undertaken a prospective, double-blind, randomised study in order to evaluate the difference in the joint-space of arthroscopically-proven normal tibiofemoral joints as seen on weight-bearing full-extension and 30˚ flexion posteroanterior radiographs. Twenty-two knees were evaluated and the results showed that there may be a difference of up to 2 mm in the two views. This difference could be attributed to the inherent differential thickness of the articular cartilage in different areas of the femoral and tibial condyles and a change in the areas of contact between them.

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Since the discovery of X-rays by Roentgen in 1895 the techniques for performing a radiographic examination of the knee have been modified considerably in order to increase the amount of information which can be obtained from different positions for different parts of the knee. Before the 1960s non-weight-bearing radiographs in anteroposterior, lateral and axial projections were taken as standard views. However, after the work by Ahlback in 1968 on arthritic knees, the taking of weight-bearing anteroposterior and lateral views became common practice for evaluating the tibiofemoral joint. Recently, there have been many reports which have supported the use of weight-bearing views in some flexion (30˚ to 45˚) compared with conventional views in full extension. It has been suggested that the flexed position shows the more functional weight-bearing area on the radiographs and a decrease in the joint space is more marked in this position as compared with full extension. These studies have all been performed on arthritic knees. We have found no study in the English literature which has compared full-extension and semiflexed views in non-arthritic knees in which the joint space would be expected to be normal. It can be argued that the reduction in joint space which is seen in semiflexed views is not a true reflection of the wear of the articular cartilage, but actually depicts the inherent differential thickness of the articular cartilage in different parts of the femoral and tibial condyles. Our study was designed in order to assess the difference in height of the tibiofemoral joint space in weight-bearing full-extension and 30˚ flexion radiographs of arthroscopically-proven normal knees.

 Patients and Methods

We performed this prospective, randomised, double-blind study between January 2001 and February 2002. The protocol had ethical approval and informed consent was obtained from all patients included in the study. The number of patients in the study was calculated to be 13 to achieve a power of 80% in order to detect a difference in the tibiofemoral joint space on the two radiographic projections.

The criteria for inclusion in the study were age < 50 years and suspected pathology in the knee other than osteoarthritis. The patients were chosen randomly. All needed arthroscopic assessment and treatment. Those who were included initially, but who were later found to have osteoarthritic changes in the articular cartilage at arthroscopy, were excluded.

There were initially 50 patients, although 28 were later excluded since osteoarthritic changes in the tibiofemoral compartments were found at arthroscopy. There were therefore 22 patients in the study. This increased the power of the
study further and decreased the chance of bias. Their mean age was 34.1 years (18 to 48). There were 16 men and six women with 14 right and eight left knees.

All patients underwent pre-operative weight-bearing posterioranterior radiography of the knee in full extension and 30° of flexion according to a standard protocol (Figs 1 and 2). Only one knee was examined at each exposure. The full-extension radiograph was taken first followed by the 30° flexion view. The leg was held vertical with the patella just touching the plate for both views. The position of the foot was unchanged between the two views. The distance between the X-ray tube, the plate and the knee was also kept constant between the two views. Patients could grasp a support in order to bend the knee to 30° by moving the pelvis backwards while keeping the foot and leg still. The flexion angle was measured using a goniometer. All the radiographic examinations were carried out without difficulty.

Each patient underwent an arthroscopic evaluation and any osteoarthritic changes of the tibial and femoral condyles were noted. The operating surgeon was unaware of the radiographic findings regarding the joint space.

All the radiographs taken for the study were randomly mixed with other radiographs of arthritic and normal knees, which were not included in the study, and the minimum joint space height, the radiolucent area between the radiopaque sclerotic margins of the medial and lateral tibiofemoral joints was measured in millimetres. The radiographic assessment was undertaken by an orthopaedic consultant, a specialist registrar and a senior house officer, who were unaware of the identity of the patients or the arthroscopic findings at the time of assessment.

Statistical analysis using Wilcoxon signed rank test was undertaken with the help of a qualified statistician.

Results

Our results showed that 80% of the measurements performed by the consultant, registrar and the senior house officer coincided. There was a difference of up to 1 mm in the remaining measurements. A mean of these different readings was taken for analysis.

The mean medial tibiofemoral joint space in all the knees was 6.04 mm (3 to 7; median 5 mm) in the full-extension view and 5.54 mm (3 to 7; median 5 mm) in the 30° flexion view. The height of the lateral tibiofemoral joint space was measured in 20 knees and had a mean of 5.9 mm (3 to 8; median 6 mm) in the full-extension view and of 5.2 mm (3 to 8; median 5 mm) in the 30° flexion view. In two patients the lateral tibiofemoral joint space could not be measured because of the shape of the condyles as seen on the radiographs.

The difference between the medial tibiofemoral joint space on the full extension and 30° flexion views was 0 mm.
in 16 patients, 1 mm in three, 2 mm in two and 4 mm in one patient. For all the patients with narrowing on the medial side, this was seen in the 30° flexion views.

The difference between the lateral tibiofemoral joint space on the full-extension and 30° flexion views was 0 mm in seven patients, 1 mm in six and 2 mm in seven. Of the six with a difference of 1 mm, five showed this in the 30° flexion view and one in the full-extension view. Of the seven with a difference of 2 mm, six showed this in 30° flexion and one on the full-extension view.

It was hypothesised that there was no difference in the medial and lateral tibiofemoral joint spaces in the full-extension and 30° flexion views. We used the non-parametric Wilcoxon signed rank testing to test this hypothesis since the data were not normally distributed. This rejected the hypothesis for the difference in both the medial (p = 0.026) and lateral (p = 0.021) tibiofemoral joint spaces.

Discussion

There have been many reports in the literature which have supported the use of weight-bearing radiographic views of the knee in a flexed position in comparison with conventional views in full extension.2-10 It has been suggested that flexed weight-bearing views are more accurate and more reproducible for the measurement of the joint space than weight-bearing views in extension.1,11,12

It has also been noted that a tunnel view taken in an anteroposterior projection is equally likely to show destruction of the articular cartilage as a view taken in a posteroanterior projection.3 Boegard et al7 found posteroanterior weight-bearing radiographs of the knee to be reproducible and compared them with MRI for detecting defects of the articular cartilage. Rosenberg et al4 noted that the affected areas of an osteoarthritic knee which were observed peroperatively were the contact areas when the knee was positioned in 30° to 60° of flexion.

These studies all indicate that weight-bearing flexed radiographs of the arthritic knee are better in terms of specificity, sensitivity and reproducibility for the detection of changes in the joint space and represent a strong case for a change of conventional practice as proposed by Davies et al.9

All of these studies have been carried out in osteoarthritic knees. It has been assumed that any decrease in the joint space seen on the radiographs is due to a loss of articular cartilage. It can be argued that any decrease in joint space which can be seen in the semiflexed views is not a true reflection of the loss of articular cartilage but actually represents an inherent differential thickness of articular cartilage in different areas of the femoral and tibial condyles. Furthermore, the area of contact between the femoral and tibial condyles changes as the knee flexes from full extension.13 This may contribute to an observed decrease in the joint space in the flexion view.

We found that there may be a difference of up to 2 mm in the measurement of the joint space of the medial and lateral tibiofemoral joints on the two views of normal knees which cannot be explained by chance alone. The explanation could be a natural variation in the thickness of the articular cartilage in different parts of the femoral and tibial condyles in normal knees, and the change of contact area between the femoral and tibial condyles when moved from full extension to 30° flexion.

We can thus classify any narrowing of the joint space in the 30° flexion view in comparison with the full extension view as class A if it is < 2 mm and class B if it is > 2 mm. Class A narrowing may be present in the absence of osteoarthritic change while class B is indicative of a loss of articular cartilage and may consequently influence the choice of treatment. This is also supported by earlier work in which 2 mm was taken as the cut-off point for major narrowing.4,6,10

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