Plain radiography in the degenerate knee

A CASE FOR CHANGE

A. P. Davies, D. A. Calder, T. Marshall, M. M. S. Glasgow

From the Norfolk and Norwich Hospital, Norwich, England

We took posteroanterior weight-bearing radiographs, both with the joint fully extended and in 30° of flexion, in a consecutive series of 50 knees in 37 patients referred for the primary assessment of pain and/or stiffness. These radiographs were reported ‘blind’ both by an orthopaedic surgeon and a radiologist. Direct measurement of the joint space, together with grading of the severity of erosion according to the Ahlback criteria, was undertaken. Any other abnormality present was also documented.

The radiographs of the knees in 30° of flexion consistently showed more advanced erosion in both the medial (p = 0.001) and the lateral (p = 0.0001) tibiofemoral compartments, when compared with those of knees in full extension. The Ahlback classification of 25 joints was altered, in some cases by several grades, by the flexed position of the joint. In every case in which another abnormality was identified on the radiograph in full extension, it was also noted on that of the knee in 30° of flexion. In a further four cases, additional pathology could only be seen in the flexed knee. Every patient was able to complete the radiological examination without difficulty. Our study supports the adoption of a weight-bearing view in 30° of flexion as the standard posteroanterior radiograph for the assessment of tibiofemoral osteoarthritis in patients over 50 years of age.

Patients and Methods

Between January and September 1997, 50 consecutive patients were referred for the first assessment of presumed osteoarthritis of the knee. Their mean age was 67 years (52 to 87). We excluded patients under the age of 50 years or with a diagnosis of rheumatoid arthritis. Weight-bearing posteroanterior radiographs of each knee with symptoms were taken in full extension and in 30° of flexion. Full informed consent was obtained from every subject before the additional projection was taken. The conventional radiograph in full extension was taken as described by Ahlbäck and the additional weight-bearing view with the patient facing the wall holding a wall-mounted support bar (Fig. 1) with their weight equally distributed on each leg. The patella touched the wall-mounted film cassette and the toes were pointed anteriorly. With the tibia vertical, the patient leant back away from the wall to achieve a tibiofemoral angle of 30°. This was confirmed by the radiographer using a goniometer. The x-ray beam was horizontal and the x-ray source a standard distance from the cassette. The additional weight-bearing view with the patient facing the wall holding a wall-mounted support bar (Fig. 1) with their weight equally distributed on each leg. The patella touched the wall-mounted film cassette and the toes were pointed anteriorly. With the tibia vertical, the patient leant back away from the wall to achieve a tibiofemoral angle of 30°. This was confirmed by the radiographer using a goniometer. The x-ray beam was horizontal and the x-ray source a standard distance from the cassette. All radiographs were taken with the patient weight-bearing.

Subsequent authors have noted that flexion of the knee can enhance the radiological demonstration of loss of articular cartilage. Intraoperative findings by the senior author (MMG) have confirmed the findings of Rosenberg et al that areas of articular cartilage which are often eroded in early osteoarthritis form the tibiofemoral contact surfaces for the knee when in partial flexion. It therefore seemed that the area of the femoral condyle most at risk could be better examined by a plain radiograph taken with the knee partially flexed. In this prospective study we compared weight-bearing posteroanterior radiographs taken in full extension with others taken with the knee in 30° of flexion to determine whether the latter projection could effectively replace the view in full extension.

Standard radiographs of the knee are an integral part of the primary assessment for osteoarthritis. Ahlbäck recorded four different types of bony changes namely sclerosis, cysts, osteophytes and defects of attrition of articular surfaces with narrowing of the joint space. These changes were best seen when the posteroanterior radiograph was taken with the patient weight-bearing.

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views. The radiograph of the leg in 30° of flexion took less than four minutes for each subject. No difficulty was encountered even in patients of advanced age.

Each radiograph was reported ‘blind’ by a radiologist (TM) and an orthopaedic surgeon (DAC). All reporting was carried out in an identical manner and a standardised report form completed for each film. The two projections of the same knee were never seen together. The joint space of both the medial and lateral tibiofemoral compartments was measured directly in the middle of the horizontal width of each compartment using a ruler. The knee was graded according to the classification of Ahlbäck and any other visible pathology documented. These data were recorded in a ‘Microsoft Excel’ file and submitted for independent statistical analysis using the Student’s t-test for paired data.

Results

Both observers consistently measured a reduced joint space in both the medial and lateral tibiofemoral compartments in the view in 30° flexion compared with that in full extension (Table I).

Some joints showed minimal evidence of osteoarthritis in full extension while in 30° flexion there were gross changes (Fig. 2). Other joints showing changes of osteoarthritis had an apparently well-preserved joint space in full extension, but obliteration of the space in partial flexion (Fig. 3). Both observers consistently classified the view in 30° flexion at a higher Ahlbäck grade than that in full extension (p < 0.0001 for both observers). The classification of 25 knees was altered by the radiographs in 30° of flexion. In most cases this was confined to an increase of one grade, but in one an increase of four grades was seen (Fig. 4).

Additional pathology was also noted in five radiographs taken in full extension. These were loose bodies in two cases, chondrocalcinosis in two and lateral tibial...
subluxation in one. All these changes were also identified in the radiograph taken in 30° of flexion.
In a further four patients further abnormality was only identified on radiographs in 30° of flexion. There were loose bodies in one, a femoral condylar defect in one and lateral tibial subluxation in two.
Table I. The number of patients with changes in joint space when the 30° flexed radiological view of the knee was compared with that of the extended view

<table>
<thead>
<tr>
<th>Joint space</th>
<th>Increased</th>
<th>Decreased</th>
<th>Unchanged</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medial</td>
<td>Observer 1</td>
<td>3</td>
<td>26</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Observer 2</td>
<td>5</td>
<td>30</td>
<td>15</td>
</tr>
<tr>
<td>Lateral</td>
<td>Observer 1</td>
<td>4</td>
<td>34</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Observer 2</td>
<td>6</td>
<td>32</td>
<td>12</td>
</tr>
</tbody>
</table>

* there is an apparent increase in joint space as a few joints fell into varus or valgus deformities with decreased joint space in the other tibiofemoral compartment

Discussion

Since Ahlbäck showed the importance of weight-bearing in emphasising the radiological changes of osteoarthritis seen in posteroanterior radiographs, his view in full extension has been regarded as the 'standard' examination. Several authors have pointed out that the contact zones of tibiofemoral articulation alter as flexion of the knee occurs. Flexion in the stance phase of gait results in the contact area moving posteriorly and becoming smaller. The articular cartilage in these areas is therefore subjected to greater loads per unit area and hence is more susceptible to the degenerative changes of osteoarthritis. Due to their more posterior position on the curved surface of the femoral condyle, these areas are not shown on the current 'standard' posteroanterior radiograph in full extension.

Rosenberg et al used flexed weight-bearing posteroanterior radiographs at 45° to show the increased sensitivity and specificity of degeneration of articular cartilage in knees which then had arthroscopy. They did not, however, advocate such projections for routine use. It has been our experience at operation that knee flexion of 30° brings together the most seriously worn areas of articular cartilage and hence this angle was chosen for the present investigation. Every patient entered into our study was able to complete the additional radiological examination without difficulty. Patients of advanced age or frailty can undergo this procedure without distress, and the additional workload for the radiographers was minimal. The radiation exposure for radiographs in 30° of flexion is identical to the traditional radiograph in full extension.

The differences between the two radiographs was highly statistically and clinically significant. In no case was additional pathology noted in the conventional film in extension which could not be seen in the examination in 30° of flexion. Four cases of abnormality only visible in the 30° flexed view were reported.

We have shown that the Ahlbäck grading can alter according to the position of the knee at the time of radiological examination. This implies that all studies based on Ahlbäck grading must be treated with caution. Our study supports the adoption of weight-bearing posteroanterior radiographs in 30° of flexion instead of in full extension as the routine examination for osteoarthritis in those over 50 years of age. This would result in the improved detection of erosion of the articular cartilage and of other pathological processes with minimal implications in regard to cost and time for radiology departments.

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References