Distribution of MR-detected cartilage defects of the patellofemoral joint in chronic knee pain

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Summary

Objectives: The aim of the study was to detect cartilage defects and determine the center of these defects in MR imaging of the patellofemoral joint (PFJ) in middle-aged people with chronic knee pain.

Design: In the format of a prospective study of early osteoarthritis (OA), this cross-sectional study of the signal knee (the most painful one at inclusion in the study in 1990) in 59 individuals, 30 women and 29 men (aged 41–58 years, mean 50 years) with chronic knee pain, with or without radiographically determined knee OA, was examined using MR imaging on a 1.0 T imager. Cartilage defects and the center of these defects in the PFJ were recorded.

Results: Cartilage defects were found more often in the patella (40 knees) than in the femoral trochlea (23 knees) (P<0.001) and were unevenly distributed in the patella (P<0.001), with most cartilage defects in the mid-patella.

Conclusions: Since cartilage defects occur more commonly in the mid-patella, radiographs obtained with a knee flexion of approximately 45° may be more accurate to show cartilage defects of early OA of the PFJ than views with another knee flexion.

Key words: Knee, Osteoarthritis, Radiographs, MR imaging.

Introduction

Osteoarthritis (OA) of the patellofemoral joint (PFJ) has previously attracted little interest. Recently, however, it has been recognized as an important cause of pain and disability¹, and thus studies have been initiated to assess the reproducibility of different radiographic views, axial and lateral, and their ability to identify symptomatic OA of the PFJ²,³ and to detect significant joint space loss over time³. The axial view proved better than the lateral view in all respects²–⁴.

Various techniques have been advocated for adequate evaluation of the PFJ in the axial view, as shown in Fig. 1. A minimal joint space width of <5 mm⁵ has been proposed as a limit in the diagnosis of joint space narrowing in the axial view, using the technique in standing as suggested by Ahlbäck⁶. He modified the technique introduced by Knutsson⁷ and performed the examination with the patient in a standing position with a vertical X-ray beam (Fig. 2) and with the beam parallel to the dorsal articular aspect of the patella. This method has been used routinely in our departments since the early 1970s. The degree of knee flexion with this technique is estimated to be 40°–60°⁵. With this knee flexion, the middle third of the patella is in contact with the femoral trochlea, but when the knee is fully extended, the lower pole of the patella is in contact with the most superior aspect of the femoral trochlea, and in full knee flexion, the upper pole of the patella is in contact with the most inferior aspect of the femoral trochlea⁶. The distribution of the cartilage defects in the patella and in the femoral trochlea is thus of importance when choosing the most accurate radiographic technique to obtain the axial view of the PFJ.

The aim of the study was to detect cartilage defects and to determine the center of these defects by MR imaging of the PFJ in middle-aged people with chronic knee pain.

Methods

SUBJECTS

The patients in this study are all from the Spenshult cohort, which has been defined in previous articles⁵,⁹. A subgroup of 61 people was chosen as a random sample from the initial cohort. MR imaging of the signal knee (the most painful one at inclusion) was performed in 60 of the 61 people. One patient could not take part in the MR study because of claustrophobia. There were 30 women (aged 42–58 years, mean 51 years) and 29 men (aged 41–57 years, mean 50 years).
MR EXAMINATION

MR imaging of the signal knee was performed with a 1.0 T imager (Impact, Siemens) with a circular polarized surface coil with a proton-density- and T2-weighted turbo spin-echo sequence (tSEPdT2) in the sagittal, coronal and axial views. The sagittal sequence was perpendicular to a line connecting the dorsal aspects of the femoral condyles, and the axial sequence was perpendicular to the long axis of the patella. The sequence parameters for the tSEPdT2 were TR/TE 4200/15–105 ms, with two signals averaged, echo train length 7, FOV 145×145 mm, section thickness 3 mm with a 0.3–0.6 mm intersection gap, matrix size 252×256 and acquisition time 5 min and 8 s. However, the initial seven patients in the study were not examined exactly according to the final protocol, which has been used since then. The first seven patients were examined with a coronal T1-weighted spin-echo (SET1) sequence, a sagittal tSEPdT2 and a 3D gradient echo sequence (Dess) obtained in the sagittal view.

To assess the location of the cartilage defects within the patella and the femoral trochlea, the articular surfaces of the patella and of the trochlea femur were divided into nine areas each (Fig. 3). The areas of each articular surface were arranged into three columns and three rows, and the columns and rows each comprised three areas. As the medial joint facet of the patella and of the trochlea femur is in most cases smaller than the lateral joint facet, the middle column of the patella and of the trochlea femur comprise the lateral third of the medial joint facet and the medial third of the lateral joint facet. The rows, however, were divided into thirds. Therefore, the areas were usually not of exactly the same size. The center of the MR-detected cartilage defects was noted, and in cases with two or more defects in the patella or in the femoral trochlea, the largest defect was chosen.

Cartilage defects in each of the articular surfaces of the PFJ were classified as grade 1, a ≤50% reduction of the cartilage thickness, as grade 2 (Figs. 4 and 5), a >50% reduction of the cartilage thickness and as grade 3, a cartilage defect with bone loss. Signal changes of the cartilage with an intact surface were not registered. The MR studies were interpreted blindly and separately by two of the authors (TB, OR) with experience in musculo-skeletal MR imaging. They then reached a consensus for a combined score.

STATISTICAL ANALYSES

The distribution of the center of the cartilage defects was tested by a $\chi^2$ analysis, and comparison between the number of the cartilage defects of the patella and of the femoral trochlea was made by using McNemars’ test.

Results

An MR-detected cartilage defect of the patella was seen in 40 knees and of the femoral trochlea in 23 knees. The number and grade of these cartilage defects of the patella and of the femoral trochlea are shown in Table I. The cartilage defects of the patella were more frequent than
those of the femoral trochlea \((P<0.001)\). The number and the center of the MR-detected cartilage defects of the patella and of the femoral trochlea are shown in Fig. 3. The center of the cartilage defects of the patella was not evenly distributed \((P<0.001)\) owing to the high number of defects in the mid-patella. The cartilage defects of the femoral trochlea were evenly distributed between the areas of the rows \((P>0.101)\) and between areas of the columns \((P=0.738)\).

**Discussion**

MR imaging is considered an accurate means of detecting and grading moderate and advanced cartilage lesions in the knee joint\(^{10}\) and is, thus, useful in the evaluation of knee OA. The fast spin-echo 2D sequences used in this study do not differ in this respect and have also been used by other researchers\(^{11,12}\). The reason why we did not continue with the 3D gradient echo (Dess) was that the reconstruction in the coronal and axial planes was of inferior quality as regards the evaluation of hyaline cartilage. The examination time of the 3D gradient echo sequence was considerably longer than for the 1PdT2SE sequence, which gives an increased risk of motion artifacts. However, the examination quality of the initial seven patients was considered acceptable and they have, therefore, been included in the study. According to recent studies, it appears that high-resolution 3D-gradient echo...
sequences with the addition of fat suppression or magnetization transfer contrast are the best for depicting hyaline cartilage.\textsuperscript{10,13,14}

We found an uneven distribution of the center of the cartilage defects of the patella, with the majority of the cartilage defects in the middle third. The cartilage defects of the femoral trochlea, however, had an even distribution. We also found the number of the cartilage defects of the patella to be almost double the number of cartilage defects of the femoral trochlea in this group of people with less advanced PF OA. These findings have to be considered when choosing the radiographic technique to detect cartilage defects of the PFJ using the axial view.

The degree of knee flexion determines which part of the patella is in contact with the femoral trochlea when the radiograph is obtained.\textsuperscript{8} If the knee is straight, the inferior pole of the patella is in contact with the most proximal part of the femoral trochlea, but if the knee is flexed to 90°, the superior pole of the patella is in contact with the distal part of the femoral trochlea. However, if the knee is flexed approximately 45°, the middle third of the patella is in contact with the middle third of the femoral trochlea. With this degree of knee flexion, the center of the majority of the cartilage defects of the patella is in contact with the femoral trochlea.

In a previous study,\textsuperscript{5} we found, using the same axial radiograph in standing as presented in this study, that a minimal joint space width <5 mm of the PF joint has high specificity (94%), but low sensitivity (50%) for MR-detected cartilage defects in the same joint in middle-aged people with chronic knee pain. We also found good reproducibility of repeated joint space width measurements and of repeated examinations. Another study\textsuperscript{15} by the same group of people has revealed that a marginal osteophyte at the lateral aspect of the femoral trochlea in axial radiographs of the PFJ also has very high specificity (100%), but lower sensitivity (73%) for MR-detected cartilage defects in the same joint. This knowledge together with the importance of a knee flexion of approximately 45°, when obtaining the axial radiographs of the PFJ, could improve the accuracy of detection of cartilage defects in this joint.

Considering the results of our study, the techniques introduced by Settegast and Brattström [see Fig. 1(A, E)] seem to be less accurate than other techniques shown. To our knowledge, however, no studies have been performed comparing joint space width measurements using these different radiographic techniques [Fig. 1(B–D and F)], including the technique used in our study, and we suggest that such a comparative study ought to be performed.

In conclusion, it seems that since cartilage defects occur more commonly in the mid-patella, radiographs obtained with a knee flexion of approximately 45° may be more accurate to show cartilage defects of early OA of the PFJ than views with another knee flexion.

### Table I

<table>
<thead>
<tr>
<th>Grade of cartilage defect</th>
<th>Patella</th>
<th>Femoral trochlea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 0</td>
<td>19</td>
<td>36</td>
</tr>
<tr>
<td>Grade 1</td>
<td>15</td>
<td>13</td>
</tr>
<tr>
<td>Grade 2</td>
<td>25</td>
<td>10</td>
</tr>
<tr>
<td>Grade 3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>59</td>
<td>59</td>
</tr>
</tbody>
</table>

Fig. 5. (A) The axial and (B) the sagittal protodensity-weighted MR image in a 42-year-old woman demonstrating a cartilage defect of grade 2 of the trochlea femur, corresponding to the middle area of the lateral column (arrow).

**References**


