Radial MRI of the hip with moderate osteoarthritis

Motoyuki Horii, Toshikazu Kubo, Yasusuke Hirasawa
From Kyoto Prefectural University of Medicine, Kyoto, Japan

We carried out radial MRI in 30 hips with moderate osteoarthritis and in ten normal hips. On a scout view containing the entire acetabular rim, 12 vertical radial slices were set at 15° intervals. Different appearances were observed in different parts of the joint. In the weight-bearing portion, from 45° anterosuperior to 45° posterosuperior, ‘attenuation’ (n = 16) and ‘disappearance’ (n = 25) were observed as abnormalities of the labrum with ‘capsular stripping’ (n = 29) and ‘extraosseous high signal lesion’ (n = 27) as capsular abnormalities, seen more often in the anterosuperior portion. In all 12 planes there were osteophytes on the acetabular edge (n = 24), femoral head (n = 22) and/or at the central acetabulum (n = 6), a bone cyst on the acetabulum (n = 18) and/or the femoral head (n = 9), irregularity of the articular cartilage (n = 30), and an effusion (n = 28). Our findings indicate that radial MRI may be a useful non-invasive diagnostic method for demonstrating pathology in moderate osteoarthritis of the hip.

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Involvement of the labrum of the acetabulum in osteoarthritis (OA) of the hip, termed the acetabular rim syndrome in dysplastic hips or an inverted acetabular labrum as a cause of primary OA, has attracted some attention. Arthrography and/or arthroscopy have been used in the evaluation of abnormalities of the labrum, but these methods are invasive and provide limited images of the hip. MRI is non-invasive and can clearly depict morphological and qualitative changes in any direction. We have previously reported a method using MRI to depict the entire acetabular rim by determining radial sections centred on the mid-point of the acetabulum. With this technique we have now obtained radial MR scans of patients with moderate OA because of dysplasia, in whom conventional radiographs depicted ‘marked narrowing of the joint space’, and examined abnormalities of the acetabular rim including the labrum in the weight-bearing portion.

Patients and Methods

We studied 24 patients (30 hips) with moderate OA whose conventional anteroposterior radiographs showed marked narrowing, but not obliteration, of the joint space. There were two men (two hips) aged 21 and 40 years and 22 women (28 hips) with a mean age of 45 years (29 to 57). The mean acetabular Sharp angle was 47.7 ± 4.3° and the mean centre-edge angle of Wiberg was 11.0 ± 12.2°.

Ten other hips, eight in four healthy volunteers aged from 23 to 35 years and two in patients with unilateral non-traumatic osteonecrosis of the femoral head, were examined as a control group.

For MRI we used a superconducting MR 1.5 Tesla imager (SMT-100X; Shimadzu, Kyoto, Japan) with an off-centre zoom technique and a local surface coil as a receiver antenna. The field of view was set at 20 cm and the matrix at 256 × 256. T2-weighted radial images with a section thickness of 4 mm were obtained at 15° intervals using the STAGE method (TR, 500 ms; TE, 20 ms; flip angle, 30°) in approximately four minutes. For this radial imaging, the scout view was determined as the section which included the entire acetabular rim, after adjustment of the anterior open angle and the slope of the acetabulum, and the epicentre as the mid-point of the acetabulum (Fig. 1). In this technique, all 12 planes cross the acetabular rim vertically, and 24 images of the rim (each plane includes two parts on the rim) are depicted. Of the 24 images, the most superior position was named mid-superior; the portions anterior to it were anterosuperior 15°, 30° and 45° and those posterior to it posterosuperior 15°, 30° and 45°. We looked for abnormalities of the acetabular rim, in particular of the labrum and the labral and capsular attachments, by monitoring those seven positions of the weight-bearing part of the joint in a range of 90° centred on the mid-superior portion. The anterior inferior iliac spine appeared in the
plane of anterosuperior 30°. All 12 planes were examined for bone abnormalities (e.g., osteophytes or bone cysts), thinning of the articular cartilage, and the presence of synovial fluid.

Results

The appearance of a normal hip is shown in Figure 2. The labrum is clearly depicted as a homogeneous area of low signal intensity. Its shape is slightly different in the anterior and posterior portions. The joint capsule is located adjacent to the base of acetabular labrum, and attached to the acetabular rim.

In the images of patients with moderate OA, there were several abnormalities when compared with normal hips. These varied according to the plane of imaging. Often more than one abnormality was found within a joint. In the labrum there were ‘attenuation’ abnormalities in 16 hips (53%) and ‘disappearance’ in 25 (83%) (Figs 3 and 4). The incidence of these two abnormalities was markedly higher in the anterosuperior images than in both the mid-superior and posterosuperior images (Table I). Abnormalities in the capsule were capsular stripping (29 joints, 97%), seen as a
Table I. The number of hips shown to have labral abnormalities in the weight-bearing part after MRI

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<th>Anterosuperior</th>
<th>Posterosuperior</th>
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<tbody>
<tr>
<td></td>
<td>45° 30° 15°</td>
<td>Mid-superior</td>
</tr>
<tr>
<td>Attenuation</td>
<td>3 4 10</td>
<td>3</td>
</tr>
<tr>
<td>Disappearance</td>
<td>23 21 13</td>
<td>5</td>
</tr>
<tr>
<td>Without these abnormalities</td>
<td>4 5 7</td>
<td>22</td>
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Table II. The number of hips with capsular and associated abnormalities in the weight-bearing part after MRI. Both abnormalities were found in some joints

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<th>Posterosuperior</th>
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<tbody>
<tr>
<td></td>
<td>45° 30° 15°</td>
<td>Mid-superior</td>
</tr>
<tr>
<td>Capsular stripping</td>
<td>7 20 25</td>
<td>12</td>
</tr>
<tr>
<td>Extraosseous high-signal lesion</td>
<td>16 22 24</td>
<td>17</td>
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The left hip of a 53-year-old woman showing a) an anterosuperior 30° MR scan, b) a mid-superior MR scan, c) a posterosuperior 30° MR scan and d) a conventional radiograph. In the anterosuperior 30° and mid-superior images the acetabular labrum is obscure, and capsular stripping and marked thinning of the articular cartilage are observed. An extraosseous high-signal lesion is seen in the anterosuperior 30° scan and small osteophytes also appear on the acetabular rim. In the posterosuperior 30° scan, the acetabular labrum shows a moderate increase in signal intensity (Cp, capsule; HL, extraosseous high-signal lesion; St, capsular stripping; FH, femoral head; Lb, acetabular labrum; O, osteophyte).
step between the articular surface and the capsule, and extraosseous high-signal-intensity lesions (27 joints, 90%), located outside the initial confines of the joint (Table II). In addition to these changes, many patients had bone changes such as osteophytes (Figs 3 and 4) and bone cysts (Fig. 4). An osteophyte on the acetabular rim (Fig. 3) is difficult to evaluate, but was found in 24 hips (80%). An osteophyte on the head of the femur and in the central acetabulum (Fig. 4) was clearly depicted, and found in 21 (70%) and six (20%) hips, respectively. Bone cysts were seen quite clearly, and found in the acetabulum of 18 hips (60%) and nine femoral heads (30%).

It was difficult to distinguish clearly the articular cartilage of the acetabulum from that of the head of the femur, but all joints examined showed some variation in the thickness of the cartilage. A joint effusion was found around the femoral neck (Fig. 4) in 28 hips (93%).

Discussion

Radial MRI has been used in studies of the knee and shoulder, but has been rarely used in the hip. A scout view of radial imaging depicts the acetabular rim as a circular form in one plane. Therefore vertical sections of this plane which are radially determined using the ‘mid-point’ of the acetabulum as the epicentre, cross vertically the tangent line on the rim. This minimises imaging artifacts induced by a partial volume effect. In the production of radial section images there may be artifacts due to ‘cross talk’ at the epicentre, but this is not an important problem.
since the diameter of the acetabular rim in adults is more than 4 cm. With the sequence parameters used in our study, normal fibrous tissue (e.g., labrum) was depicted at low signal intensities, and articular cartilage and joint effusion at high signal intensities. In the normal hip the acetabular labrum was depicted as an area of homogeneous low-signal intensity.

Our findings of labral attenuation, labral disappearance, capsular stripping, and extraosseous high-signal lesions in patients with OA were not found in the normal hips. The changes appeared mainly in the anterosuperior images in the hips with OA, possibly because the anterosuperior parts of the joint are the most susceptible to secondary arthritic changes in dysplastic hips.

Disappearance of the acetabular labrum on the images does not always represent pathological change. Variation in signal intensity due to degeneration, with or without displacement, could make the labral image obscure, and this condition was assessed as ‘disappearance’. Another possible reason for such ‘disappearance’ is the magic angle phenomenon, a well-known artifact, which could occur, even in a normal labrum, because of circumferentially orientated collagen fibres. This phenomenon, however, was not likely to be the major reason in our patients, because in the normal hips no acetabular labra showed similar ‘disappearance’.

Extraosseous high signal lesions in the images were not examined histologically, and their pathological counterpart was not determined. If the capsule was stripped away from its normal attachment and there was a joint effusion, we would have expected to find MR signals for the fluid outside the confines of the joint. Extraosseous high signal lesions may reflect the combination of capsular stripping and joint effusion.

Radial MRI also showed osteophytes and bone cysts. They can usually be demonstrated by plane radiography or CT. Radial MRI makes it easier to understand the location of the lesions.

Data are available from recent studies to compare MRI findings with biochemical, gross pathological and histological results, and the use of contrast medium for imaging. There has also been an improvement in imaging techniques. The usefulness of MRI in the evaluation of the articular cartilage in OA of the hip has been reported. With the sequence parameters used in our study, however, both articular cartilage and a joint effusion showed high signal and therefore the thickness of the cartilage was not always shown accurately. In the gradient-echo sequence, the strength of T1 saturation can be controlled by the flip angle. Setting the flip angle at 90° makes the T1 saturation strongest and decreases the signal intensity of an effusion. This will allow cartilage to be distinguished from an effusion, although the depiction of the labrum may become indistinct.

To differentiate the articular cartilage of the acetabulum from that of the head of the femur, improvements in MRI will be needed with a decreased field of view, increased matrix and higher resolution of the images with short imaging time. Radial MRI, which has a signal void area caused by ‘cross talk’ around the epicentre, may not be the best way to investigate the detail of changes in cartilage, especially at the early stages of OA. By contrast, the artifact induced by a partial volume effect can be ignored on any planes obtained by radial MRI. Although it lacks precision, we consider that radial MRI can be applied to the evaluation of the irregularity of the articular cartilage in moderate OA of the hip as well as to abnormalities of the labrum and capsular insertion.

The authors do not choose to respond to the request for a conflict of interest statement.

References