Osteochondritis dissecans of the knee in children

A COMPARISON OF MRI AND ARTHROSCOPIC FINDINGS

M. A. O’Connor, M. Palaniappan, N. Khan, C. E. Bruce
From the Royal Liverpool Children’s Hospital, Alder Hey, Liverpool, England

The treatment of osteochondritis dissecans (OCD) in children and adolescents is determined by the stability of the lesion and the state of the overlying cartilage. MRI has been advocated as an accurate way of assessing and staging such lesions. Our aim was to determine if MRI scans accurately predicted the subsequent arthroscopic findings in adolescents with OCD of the knee.

Some authors have suggested that a high signal line behind a fragment on the T2-weighted image indicates the presence of synovial fluid and is a sign of an unstable lesion. More recent reports have suggested that this high signal line is due to the presence of vascular granulation tissue and may represent a healing reaction.

We were able to improve the accuracy of MRI for staging the OCD lesion from 45% to 85% by interpreting the high signal T2 line as a predictor of instability only when it was accompanied by a breach in the cartilage on the T1-weighted image. We conclude that MRI can be used to stage OCD lesions accurately and that a high signal line behind the OCD fragment does not always indicate instability.

We recommend the use of an MRI classification system which correlates with the arthroscopic findings.

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In 1870, Paget described a process of ‘quiet necrosis’ which resulted in intra-articular osteochondral loose bodies. In 1888, König first used the term osteochondritis dissecans to describe the presence of loose bodies in joints. He thought that they were secondary to an inflammatory process. The aetiology of OCD remains unknown, but trauma, ischaemia, defects in ossification and genetic causes have all been suggested.

The treatment of OCD is determined by the stability of the fragment and the status of the overlying cartilage. It varies from observation, splintage and rest to drilling, fixation or excision of the lesion and osteochondral autogenous grafting. In juvenile osteochondritis, unlike adult OCD, it is well documented that spontaneous healing with good results can often be obtained by conservative measures and observation. Yoshida et al reported that simply resting from sporting activities gave a healing rate of 81%. The presence of intact overlying articular cartilage improves the prognosis in this age group. A reliable method of assessing the integrity of the overlying cartilage is therefore required if unnecessary arthroscopy or surgery is to be avoided.

Although the diagnosis can usually be made on plain radiographs, they do not show breaks in articular cartilage and cannot identify whether the lesions are partially or firmly attached to the underlying bone. Several papers have shown a poor correlation between the appearance of the lesion on plain radiography and that at subsequent arthroscopy.

MRI has been used successfully to evaluate the lesion in several studies. It has been reported to predict accurately the stability of the lesion and hence the need for surgical intervention. Several different systems of classification have been used for the MRI assessment of OCD lesions in each of these previous reports, making interpretation of the results difficult.

We report our experience of the use of MRI in evaluating the stability of OCD of the knee in children.

Patients and Methods

The records of all patients who had undergone both MRI and arthroscopy of the same knee between 1995 and 1998 were reviewed. A diagnosis of OCD had been made in 35
Osteochondritis was diagnosed in 29 of the 33 knees from the plain films alone. The physe were open in 30 knees.

The grading of Dipaola et al\textsuperscript{3} from the initial MRI report correlated poorly with the arthroscopic findings. Only 45\% of the reports accurately predicted the arthroscopic findings. In most cases the MR scan suggested the presence of a flap lesion with a breach in the cartilage which was not seen at arthroscopy.

We classified 21 of the 33 knees as grade III or grade IV based on the wording of the original report. Of the remainder, two were grade III, five grade I and five had no appreciable disease. The grade-III or grade-IV knees were considered to have unstable lesions, requiring surgery either to fix or remove the flap. At arthroscopy, however, ten of these 21 supposedly unstable lesions were found to be grade-I lesions. None of these had other pathology as seen on MRI or at arthroscopy and were therefore potential candidates for conservative management.

The original MR scans re-reported by the ‘blinded’ radiologist (MP) according to the classification of Diapola et al\textsuperscript{3} correlated with the subsequent arthroscopic findings more closely, with 85\% (28 of 33) accurately predicting the arthroscopic findings.

In contrast to the initial report of the MR scan, the reviewed grading suggested that only 12 lesions were grade III or grade IV (Fig. 1).

In five knees the new MRI grade differed from the arthroscopic grading. One arthroscopic grade-I lesion was classified as MRI grade II and an arthroscopic grade-II lesion was classified as MRI grade III. In the three remaining knees, MRI showed no obvious OCD lesion on either the original report or on review of the scan. At arthroscopy, all three knees had grade-IV osteochondral defects. The interval between MRI and arthroscopy was, however, 52, 28 and 26 weeks, respectively. The arthroscopy had been carried out in each case for deteriorating symptoms.

All 17 cases which proved to be grade-I lesions received no surgical intervention apart from the diagnostic arthroscopy and were subsequently treated conservatively by modification of activity. One of the two-grade-II lesions was treated by arthroscopic drilling of the lesion. The two grade-III lesions had fixation of the lesion by a Herbert screw, with a mini-arthrotomy. All 12 grade-IV lesions were treated by removal of the loose body and debridement of the defect of the articular surface.

In addition to OCD, other disorders were reported in 12 of the 33 knees (36\%) on the original MR scan. These included seven tears of the medial and five of the lateral meniscus. Only six of these abnormalities had been seen arthroscopically and treated accordingly. No evidence of a meniscal tear was found on arthroscopy in the remaining six knees. Three of these reported tears of the medial meniscus were in knees which had grade-IV lesions. The remaining three knees with reported meniscal tears had no

Table I. The arthroscopic and MRI classification of OCD

<table>
<thead>
<tr>
<th>Grade</th>
<th>Arthroscopic (Guhl\textsuperscript{10})</th>
<th>MRI (Dipaola et al\textsuperscript{3})</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Irregularity and softening of cartilage. No fissure. No definable fragment</td>
<td>No break in articular cartilage Thickening of articular cartilage</td>
</tr>
<tr>
<td>II</td>
<td>Articular cartilage breached. Not displaceable</td>
<td>Articular cartilage breached, low signal rim behind fragment indicating fibrous attachment</td>
</tr>
<tr>
<td>III</td>
<td>Definable fragment, displaceable, but still attached partially by some cartilage, i.e., a flap lesion</td>
<td>Articular cartilage breached with high signal T2 changes behind fragment suggesting fluid behind the lesion</td>
</tr>
<tr>
<td>IV</td>
<td>Loose body and defect of the articular surface</td>
<td>Loose body with defect of articular surface</td>
</tr>
</tbody>
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knees of 33 patients. Two patients were excluded since they had had arthroscopy before MRI, leaving 33 knees in 31 patients for study. There were 18 boys and 13 girls with a mean age of 11.8 years (6 to 15). The medial femoral condyle was affected in 17 knees, the lateral femoral condyle in 13 and the patella in four. One knee had both medial and lateral femoral condylar lesions.

Arthroscopy had been undertaken under general anaesthesia with two standard portals and a tourniquet. The surgeon was either one of four consultants or an orthopaedic trainee supervised by a consultant.

For MRI we used a Philips Gyroscan NT 0.5 Tesla unit (Philips Medical Systems, Best, The Netherlands) with surface knee coils. T1-weighted spin-echo sequences were obtained in the sagittal and coronal planes, with a slice thickness of 3 mm and 4 mm, respectively. T2-weighted spin-echo sequences were obtained in the sagittal plane at a slice thickness of 1.7 mm with T2 fat-suppressed images in the coronal and sagittal plane with 5 mm slices.

The operating notes were reviewed. The arthroscopic findings were allocated a grade according to the classification system described by Guhl\textsuperscript{10} (Table I). The indication for arthroscopy was based either on clinical findings, deteriorating symptoms or an original MRI report suggesting a breach in the overlying articular cartilage. These scans were reported by consultant radiologists. No consistent grading system had been used to report the original MRI findings. For the purpose of this study, each of the original reports was reviewed. A single orthopaedic surgeon (CEB) was asked to interpret the wording of each report and grade it according to the MRI OCD classification of Dipaola et al\textsuperscript{3} (Table I). For example, if the original MRI report suggested a separated fragment this would be allocated a Dipaola grade III or grade IV depending on whether it was partially or completely separated. This was done without knowledge of the arthroscopic findings.

A ‘blinded’ radiologist was also asked to report the original images according to the same classification. This classification was chosen since it corresponds closely to the arthroscopic classification of Guhl\textsuperscript{10}. We then compared the results of the original MRI report, the revised version of this report and the arthroscopic findings.
evidence of a tear and a stable OCD lesion and could therefore have been managed conservatively.

The arthroscopies were carried out at a mean of 18 weeks (1 day to 58 weeks) after MRI. This interval was thought to be too long in several cases. The accuracy of the MRI report may be improved by shortening the time interval between the scan and the arthroscopy.

Discussion

Osteochondritis of the knee can be diagnosed by plain radiographs alone, but they are poor at establishing the stability of the lesion or the state of the overlying cartilage.

Arthroscopy has been regarded as the procedure of choice for assessing these lesions. MRI, however, is non-invasive, uses non-ionising radiation and has been reported to allow accurate grading and determination of the stability of the lesion. This is particularly important in juvenile OCD.

The treatment depends on the grade of the lesion. All grade-III and grade-IV lesions require surgical intervention either to fix internally or to remove the fragment. Grade-I and some grade-II lesions can be treated conservatively by limitation of activities and observation. One study reported a healing rate of 81% in lesions in juveniles treated in this way.

The aim of MRI is to determine the stability of the lesion and differentiate those which need surgery from those which can be treated conservatively.

In our study, the initial report by experienced radiologists implied the presence of an unstable lesion in many knees. Subsequent arthroscopy, however, revealed that often these knees had stable grade-I lesions. In only 45% of cases did the initial report agree with the arthroscopic findings. Our radiologists regarded the presence of a high signal line behind the lesion on the T2-weighted image to indicate the presence of synovial fluid implying an unstable lesion. We were able to improve the accuracy to 85% by adhering strictly to the criteria of Dipaola et al when the MR scans were reviewed by a ‘blinded’ radiologist. A lesion can only be graded as an unstable grade-III flap lesion when the high signal line behind the lesion on the T2-weighted image is associated with a breach in the articular cartilage.

The significance and interpretation of the high signal line behind the lesion on T2 images have been discussed in several studies. De Smet et al described four MRI signs suggestive of instability of an OCD lesion of the knee and talus. The commonest sign of instability was a high signal line on T2-weighted images behind the lesion. This occurred in 72% of all unstable lesions in their study. Others have suggested that this high signal line indicates the presence of synovial fluid which has tracked through a breach in the cartilage to lie behind the lesion. They concluded that such a lesion would be unstable and would not heal without surgical intervention. Both studies of De Smet et al and that of Mesgarzadeh et al however, reported lesions with a high signal line on the T2-weighted image which were subsequently shown to be stable at arthroscopy.

Two recent studies have suggested that the appearance of a high signal line on the T2-weighted image does not mean a poor prognosis for the lesion. This high signal line may represent vascular granulation tissue and hence a healing response. Only if this high signal line is associated with a break in the articular cartilage can it be said to represent synovial fluid (Figs 2 and 3). Yoshida et al reported nine of 16 lesions with a high signal line on the T2-weighted image which subsequently healed spontaneously. In their study the presence of a double line predicted irreversible change and a poor prognosis (Fig. 4). Bohndorf also suggested that a high signal line behind the
lesion does not always suggest instability. He recommended the use of intravenous gadolinium enhancement to differentiate between synovial fluid and vascular granulation tissue. After intravenous contrast, enhancement of granulation tissue can be distinguished from synovial fluid, which does not enhance. This method can also demonstrate the vascularity of the lesion.

We agree with Bohndorf and Yoshida et al that the presence of a high signal line behind the lesion is not necessarily a poor prognostic indicator. We suggest that this
line can only be due to synovial fluid if there is a breach in the articular cartilage seen on T1-weighted images. If there is no such breach the lesion can be treated conservatively since healing may occur without surgery.

In our study ten knees with an initial MRI report suggesting a grade-III or grade-IV lesion with no other joint pathology had a stable grade-I lesion on arthroscopy. In all of these a review of the MR scan accurately graded the lesion. Arthroscopy could have been avoided in these patients. This has led to a further study to evaluate the correlation between meniscal tears reported by MRI and the subsequent arthroscopic findings.

Advances in the technology of MRI have allowed the development of imaging sequences tailored to the assessment of articular cartilage with very high accuracy. The use of MRI arthrography using gadolinium-diethylenetriamine penta-acetic acid has been shown to be helpful in the assessment of the overlying cartilage of OCD lesions and the differentiation between partial and complete separation of the lesion.

Special cartilage sequences and MRI arthrography should be used for the accurate assessment of both the cartilaginous and subchondral changes in OCD. At present, however, many centres still use conventional MRI to assess OCD. We have shown that a high degree of accuracy can be achieved using conventional MRI without the need for arthrographic or intravenous contrast.

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References