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Characterizing Osteochondral Lesions by Magnetic Resonance Imaging

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Summary: In a double-blind prospective study, 12 patients with osteochondral lesions of either the knee or talus were studied using magnetic resonance imaging (MRI) prior to arthroscopic treatment. MRI correctly staged 11 of the 12 lesions. We developed a new staging system for osteochondral lesions, which accurately correlates MRI with arthroscopic findings. **Key Words:** Osteochondritis dissecans—Magnetic resonance imaging (MRI)—Knee—Ankle—Talus.

The treatment of osteochondral lesions in the knee and ankle is dictated by the stability of the osteochondral fragment and the status of the overlying articular cartilage. Arthroscopic techniques have proven to be accurate and effective in the evaluation and treatment of these lesions (1–3).

An accurate noninvasive method for evaluating osteochondral lesions would allow surgeons to determine the need for surgical treatment and also aid in preoperative planning.

In 1959, Berndt and Harty (4) described a staging system based on conventional radiographic evaluation. Conventional radiographs, however, do not allow visualization of the articular cartilage and do not indicate whether there is fibrous attachment of the osteochondral fragment to underlying bone. Recently, magnetic resonance imaging (MRI) has been advocated as an accurate method of preoperative staging for osteochondral lesions (5). The purpose of this study was to prospectively evaluate the ability of MRI to characterize osteochondral lesions of the knee and ankle.

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MATERIALS AND METHODS

In a prospective double-blind study spanning 14 months, 14 patients were studied. Of the 14 patients, two were eliminated from the study. In one of these patients, fixation hardware around the ankle joint prevented adequate MRI and radiographic visualization. The second patient was found to have developed posttraumatic degenerative changes throughout the ankle joint with no discrete osteochondral lesions and was therefore dropped from the study. The 12 remaining patients included six knees and six ankles. Average patient age was 26.5 years (range of 13–58 years), with a male to female ratio of 2:1.

Each patient was indicated for arthroscopy based on clinical and radiographic criteria. These patients had presented with pain, tenderness, joint swelling, catching, or locking of the affected joint. Anteroposterior (AP) and lateral conventional radiographs were obtained on all patients and reviewed by the surgeon prior to the arthroscopy.

Prior to surgery, an MRI scan of the affected joint was performed, the results of which were not revealed to the operating surgeon. The MRI scans were reviewed prospectively by the radiologist (D.N.) without knowledge of the arthroscopic findings. MRI scans were then reviewed by a second radiologist without the knowledge of either the arthroscopic findings or the findings of the first radiologist in order to evaluate agreement between readers.

All MRI examinations were performed on a Diasonics 0.35-Tesla magnet. Surface coils were used for both the knee and ankle studies. All examinations were performed using a spin-echo technique. Intermediate or "spin density" images were obtained using 1,000/40 (TR/TE) as the imaging parameters. Ankle and knee studies were performed with a slice thickness of 5 mm. Scans were overlapped 2.5 mm on the coronal ankle images and sagittal knee images. Five millimeter contiguous scans were obtained on the sagittal ankle images and coronal knee images.

Arthroscopy was performed through standard portals under general or regional anesthesia. All arthroscopic examinations were performed within 7 weeks after MRI.

A classification system was devised by expanding the concept of the Berndt and Harty (4) classification to reflect changes in the overlying articular cartilage associated with each stage. This provided a system by which the radiographic, MRI, and arthroscopic findings could be compared (Table 1). At the conclusion of the study, operative reports and videotapes of each operative procedure were reviewed by the two orthopedic surgeons and assigned an arthroscopic stage according to the new classification system. At the conclusion of the study, the orthopedic surgeons and radiologists then reviewed the videotapes, MRIs and radiographs together as a learning exercise.

RESULTS

The results are summarized in Table 2. The arthroscopic findings served as the standard to which the radiographic and MRI results were compared.

Two ankles that were indicated for surgery based on clinical symptoms of pain and signs of swelling were found to have no evidence of osteochondral injury at arthroscopy. Conventional radiographs and MRI in these two ankles also were felt to show no evidence of osteochondral injury.

Conventional radiography

Conventional radiography incorrectly interpreted the Stage I lesion as Stage II. The three Stage II lesions seen at arthroscopy were each incorrectly staged by conventional radiography with one lesion read as Stage I and two lesions read as Stage III. Of the three arthroscopic Stage III lesions, one was correctly interpreted by conventional radiography, whereas two were incorrectly read as Stage II. All three arthroscopic Stage IV lesions (i.e., loose body) were correctly staged by conventional radiography.

MRI

MRI correctly staged all Stage I, III, and IV lesions. One patient was incorrectly staged. This was a patient with a Stage II lesion of the talus that was misread as a Stage III lesion.

TABLE 1. *Staging system for characterizing osteochondral lesions*

	Arthroscopic	MRI	Radiographs (Berndt & Harty)
Stage I	Irregularity and softening of articular cartilage. No definable fragment.	Thickening of articular cartilage and low signal changes.	Compression lesion. No visible fragment.
Stage II	Articular cartilage breached, definable fragment, not displaceable.	Articular cartilage breached, low signal rim behind fragment indicating fibrous attachment.	Fragment attached.
Stage III	Articular cartilage breached, definable fragment, displaceable, but attached by some overlying articular cartilage.	Articular cartilage breached, high signal changes behind fragment indicating synovial fluid between fragment and underlying subchondral bone.	Nondisplaced fragment without attachment.
Stage IV	Loose body.	Loose body.	Displaced fragment.

TABLE 2. *Staging of patients with osteochondral lesions of the knee and ankle*

			Stage		
Patient	Age	Location	Arthroscopy	MR	Conventional Radiograph
T.R.	13	Medial femoral condyle	I	I	II
J.M.	26	Talus	II	II	I
M.G.	25	Medial femoral condyle	II	III	III
E.P.	16	Medial femoral condyle	II	II	III
E.M.	14	Medial femoral condyle	III	III	II
S.O.	15	Medial femoral condyle	III	III	III
H.M.	16	Medial femoral condyle	III	III	II
D.S.	32	Talus	IV	IV	IV
V.S.	58	Talus	IV	IV	IV
T.B.	28	Talus	IV	IV	IV

DISCUSSION

Most investigators have concluded that osteochondral lesions (i.e., osteochondritis dissecans) of the talus are actually fractures that occur secondary to trauma (1–6). The etiology of osteochondritis dissecans in the knee joint is less clear (1). Whether due to spontaneous osteonecrosis or traumatic subchondral fracture, the osteochondral fragment is deprived of its blood supply and there is disruption of the subchondral surface.

It is felt that healing and revascularization of the osteochondral lesion is dependent on both the stability of the fragment and upon the amount of intact viable overlying articular cartilage. Surgical treatment of osteochondral lesions in adults is evolving, but generally is based upon these two factors. Stage I lesions are generally felt to require no surgical treatment (1–4,7). Stage II lesions are stable and have mostly intact overlying articular cartilage. They may be percutaneously drilled in order to promote revascularization of the fragment (1,2,7). Stage III lesions are unstable and are felt to require fixation in order to maximize chances of healing and revascularization (1,2,7). Stage IV lesions may occasionally be replaced but usually require removal and debridement of the bony bed from which the fragment arose (1–3).

Because of the differences in treatment for the various stages, accurate preoperative staging is very useful. A widely accepted staging system for osteochondral lesions of the talus was developed by Berndt and Harty in 1959 (4). They correlated location and configuration of the fragment with the mechanism of injury and developed a classification system based on radiographic appearance. Recent studies, however, have emphasized the limitations of conventional radiographic methods in characterizing osteochondral lesions of the knee and ankle (5,8). Our study also showed a poor correlation between radiographic and arthroscopic staging.

Recent studies utilizing MRI in the evaluation of osteochondral lesions are encouraging (5,8). Articular cartilage defects also have been accurately demonstrated using MRI techniques (9). Our findings demonstrate the accuracy of MRI in evaluating osteochondral lesions of the knee and ankle. We found a 100% agreement in interpretation of the MR images by the two radiologists who read the MRIs independently. Thus, it appears that accurate MRI staging is reproducible without interexaminer variability.

We found the most useful diagnostic feature of MR imaging to be the ability to assess stability of a lesion (i.e., distinguish between Stage II and Stage III lesions). In Stage II lesions with stable fibrous attachment, a heterogeneous area of mixed higher and lower signal intensity is seen behind the lesion (Fig. 1). In contrast, Stage III lesions will show a thin, homogeneous intermediate signal behind the lesion, indicating synovial fluid between the fragment and underlying subchondral bone (Fig. 2). The ability to distinguish between Stage II and Stage III lesions preoperatively is extremely useful in planning surgery as well as in counseling the patient. The surgical and postoperative treatment of these two lesions is usually quite different.

Although in our study, all Stage IV lesions (loose bodies) were correctly identified, potential for error exists. If the loose body is not identified, the area of origin may be mistaken for a Stage I lesion. MRI is a poor technique to identify loose bodies. Therefore, high-quality conventional radiographs are always required when evaluating any osteochondral

FIG. 1. Stage II MRI. Heterogeneous area of mixed higher and lower signal intensities represents part of fragment, which is attached to underlying bone.

lesion, and a careful search for a loose body should be undertaken in any MR images that show a chondral defect.

In our study, only intermediate or "spin density" images were obtained. T2 images, which would show fluid as high-signal intensity, may be more useful in demonstrating the synovial fluid seen behind Stage III lesions. However, the high correlation between our MRI and arthroscopic findings is encouraging. The extended time required for T2-weighted images may not be required for accurate staging. At the time of our initial study, a relatively low field strength (0.35 Tesla) magnet was used. Intermediate, or "spin density," techniques were used due to time constraints. Higher power magnets and lower scanning time allow for more sequences, and thinner cuts. We are currently utilizing a 1.5-Tesla system to evaluate the capability of T2 and/or T2* (gradient echo sequences with extremely short scan times) imaging techniques to better demonstrate the synovial fluid behind Stage III lesions.

We have found MRI to be an accurate method for preoperatively staging osteochondral lesions of the knee and ankle. We have developed a staging system that correlates radiographic, MRI, and arthroscopic findings. Accurate preoperative staging will enable surgeons to determine the need for surgery and also the type of procedure most likely to be required. This preliminary study involves a relatively small number of patients (12); however, these initial results are promising. A prospective study is currently underway at our institution to further evaluate the effectiveness of MRI in evaluating osteochondral lesions.

FIG. 2. Stage III MRI. Thin, homogeneous intermediate signal behind fragment represents synovial fluid.

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