Usefulness of Two Indirect MR Imaging Signs to Diagnose Lateral Meniscal Tears

OBJECTIVE. We determined whether using two recently described indirect MR imaging signs would improve the sensitivity of diagnosis of lateral meniscal tears.

MATERIALS AND METHODS. We identified 121 consecutive patients who had undergone knee MR imaging and knee arthroscopy. Their MR imaging examinations were evaluated for the conventional criteria of a meniscal tear (meniscal distortion or intrameniscal signal contacting the surface) and the two new signs (presence of an abnormal popliteomeniscal fascicle and posterolateral pericapsular edema). These observations were correlated with the arthroscopic findings, which were used as the gold standard.

RESULTS. Thirty-two (89%) of the 36 torn lateral menisci had two or more images with distortion or signal contacting the surface. Three torn menisci and eight intact menisci had one image with distortion or surface signal. Only one of 75 menisci without distortion or surface signal was torn. An abnormal superior fascicle was highly associated (p < 0.001) with lateral meniscal tears but was not specific for a tear because three of the 14 menisci with abnormal fascicles were not torn. Posterolateral pericapsular edema was not associated with a lateral meniscal tear (p = 0.06). Using an abnormal fascicle as an additional criterion improved the sensitivity from 89% to 94%, but the difference was not statistically significant.

CONCLUSION. We confirmed that an abnormal fascicle is highly associated with a lateral meniscal tear but found that posterolateral pericapsular edema was not associated with lateral meniscal tears. Identifying an abnormal fascicle did not significantly improve the sensitivity of diagnosis of a lateral meniscal tear.

Meniscal tears are common musculoskeletal injuries, which are often diagnosed using MR imaging. In general, MR imaging of the knee is an accurate method for diagnosing a meniscal tear. However, whereas the specificity of MR imaging for lateral meniscal tears is greater than 90%, the reported sensitivity has been much lower. A recent review noted that in a series of more than 200 patients, the sensitivity of diagnosing lateral meniscal tears has ranged from 68% to 86%, with specificity ranging from 92% to 98% [1].

A commonly used criterion for the MR imaging diagnosis of meniscal tear is the presence of meniscal distortion or intrameniscal signal that contacts the meniscal surface on two or more MR images [1, 2]. Using this criterion, our experience has been similar to that reported in the literature, with a sensitivity for lateral meniscal tears between 80% and 90%.

Recently De Smet et al. [3] reported two new signs on MR imaging that were statistically associated with lateral meniscal tears. These signs were an abnormal superior popliteomeniscal fascicle and posterolateral pericapsular edema. However, these authors did not investigate the relationship between these indirect signs and the commonly used criterion for diagnosis of a meniscal tear. We decided to evaluate whether the detection of these two indirect signs would improve our sensitivity for the MR imaging diagnosis of a lateral meniscal tear.

Materials and Methods

We reviewed the operative reports of 121 consecutive patients who had both knee arthroscopy and knee MR imaging at our institution during the first half of 2000. In selecting our study group, we excluded patients who had a discoid lateral meniscus or prior surgery on the injured knee. On arthroscopy, 36 lateral meniscal tears and 34 anterior cruciate ligament (ACL) tears were found. The patient population consisted of 78 men and 43 women with an average age of 39 years.

All MR imaging studies were performed using a standard knee protocol on a 1.5-T MR unit (Signa...
Advantage; General Electric Medical Systems, Milwaukee, WI) with a phased array knee coil. Patients were imaged in the supine position with 10° external rotation of the knee. The following image sequences were obtained: coronal spin-echo T1-weighted (TR/TE, 600/15; number of excitations, 1), fat-saturated coronal fast spin-echo proton density–weighted (2000/54; number of excitations, 2; echo train, 5), sagittal fast spin-echo proton density (2000/15.8; number of excitations, 2; echo train, 4), and fat-saturated fast spin-echo T2-weighted (3500/68; number of excitations, 1; echo train, 6). Slice thickness of 3 mm with a 1.5-mm interslice interval, a field of view of 140 mm, and a matrix of 256 × 192–256 were used for all sequences.

Two musculoskeletal radiologists jointly reviewed all four sequences of the 121 knee MR images and were unaware of the operative findings and the original interpretations. The studies were reviewed in the order in which they had been performed. The observers evaluated each MR imaging study and reached a consensus as to the number of images in which intrameniscal signal contacted the inferior or superior surface of the meniscus or in which distortion of the meniscus, including shortening or blunting, was found. These two findings have been shown to be sensitive and specific signs of meniscal tear [2]. For analysis in this study, the lateral meniscus was diagnosed as torn on MR imaging if the meniscus was distorted and/or had signal contacting the superior or inferior surface of the meniscus on two or more coronal or sagittal images. A previous study reported a sensitivity of 78% and a specificity of 96% using these criteria for lateral meniscal tears [2].

The two observers also assessed whether there was an abnormal superior popliteomeniscal fascicle [3, 4] or posterior pericapsular edema [3]. A superior fascicle was considered abnormal if it was disrupted or absent on the sagittal images (Fig. 1). Edema was considered present if it was noted in or around the posterior capsule of the lateral compartment of the knee on the sagittal T2-weighted images (Figs. 1 and 2).

These MR imaging findings were then correlated with the presence or absence of lateral meniscal and ACL tears on arthroscopy using two-sided Pearson’s chi-square analysis. A $p$ value of 0.05 or less was considered statistically significant.

### Results

Using the conventional criterion for a meniscal tear of two or more images showing distortion or signal contacting the surface, we diagnosed 32 of the 36 torn lateral menisci and three of the 85 intact lateral menisci as being torn, giving a sensitivity of 89% (95% confidence interval [CI], 73%, 96%) and specificity of 96% (95% CI, 89%, 99%).

The four examinations of the lateral meniscus with false-negative MR imaging findings using the conventional criterion revealed one tear at the popliteal hiatus, one root tear, and two anterior horn tears. Of these four examinations with false-negative findings, three had one MR image that showed intrameniscal signal contacting the surface of the lateral meniscus (Fig. 3), and the remaining examination showed no abnormality of the meniscus on MR imaging. In eight intact lateral menisci, a single MR image showed intrameniscal signal contacting the surface of the meniscus. Thus,

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**Fig. 1.**—21-year-old man with lateral meniscal tear and anterior cruciate ligament tear. Sagittal fast spin-echo T2-weighted MR image with fat saturation shows disruption at superior fascicle (straight arrow) and posterior pericapsular edema (curved arrow). Bone bruises are present in femoral condyle and beneath tibial plateau.

**Fig. 2.**—59-year-old man with lateral meniscal tear. Sagittal fast spin-echo T2-weighted MR image with fat saturation shows intact superior fascicle (straight arrow) and posterior pericapsular edema (curved arrow).

**Fig. 3.**—32-year-old man with lateral meniscal tear. A, Sagittal proton density-weighted MR image shows disruption at superior fascicle (curved arrow). Note subtle intrameniscal signal contacting inferior surface of posterior horn of lateral meniscus (straight arrow). This was only image showing signal contacting surface. Superior fascicle is disrupted. B, Sagittal fast spin-echo T2-weighted MR image with fat saturation confirms disruption of superior fascicle (arrow). Bone bruise is present posteriorly beneath tibial plateau.
in the 11 examinations with one image showing intrameniscal signal contacting the surface, only three menisci (27%) were torn. Only one of 75 lateral menisci that had no MR image with distortion or surface signal was torn.

The first of the two new signs, an abnormal superior fascicle, was highly associated ($p < 0.001$) with a lateral meniscal tear. Eleven of the 36 torn menisci had an abnormal fascicle, giving a low sensitivity of 31% for a tear, whereas 82 of the 85 intact menisci had a normal fascicle, giving a high specificity of 96%. The positive predictive value of an abnormal fascicle was moderately high at 79% (11/14).

The second new sign, posterolateral pericapsular edema, was not associated ($p = 0.06$) with a lateral meniscal tear because 13 (36%) of the 36 torn menisci had such edema as did 17 (20%) of the 85 intact menisci.

Two of the four torn lateral menisci that were not shown on MR imaging had abnormal fascicles. If the criteria for diagnosing a lateral meniscal tear was changed to either two or more images with distortion or signal to the surface or an abnormal fascicle, sensitivity increased to 94% ($p = 0.4$) and specificity decreased to 93% ($p = 0.3$). If the criteria for diagnosing a lateral meniscal tear was changed to either two or more images with distortion or signal to the surface or both an abnormal fascicle and one MR image with distortion or surface signal, the sensitivity increased to 94% ($p = 0.4$) and the specificity decreased to 95% ($p = 0.7$). Figure 3 shows the MR images in a patient with a lateral meniscal tear in whom there was an abnormal fascicle and only one MR image with signal only contacting the surface.

The first of the two new signs, an abnormal fascicle, was significantly associated ($p = 0.001$) with an ACL tear. Abnormal fascicles were seen in 10 (29%) of the 34 patients with an ACL tear but in only four (5%) of the 87 patients with an intact ACL. The other new sign, posterior pericapsular edema, was also associated ($p = 0.008$) with an anterior cruciate ligament tear with edema seen in 15 (44%) of the 34 patients with ACL tears, but in only 15 (17%) of the 87 patients without an ACL tear.

**Discussion**

Our study confirmed the previous report that there is a significant association between an abnormal superior popliteomeniscal fascicle and a lateral meniscal tear [3]. However, an abnormal superior fascicle was not specific for a lateral meniscal tear because three of the 85 intact menisci had an abnormal fascicle. This finding is similar to that in an earlier study of the fascicles in which two of 66 intact lateral menisci had abnormal fascicles [4]. Similarly, in a study of distortion of the popliteus bursa and fascicles on arthrography, Pavlov and Goldman [5] noted that three of 29 patients with a distorted bursa had an intact lateral meniscus at surgery. The popliteomeniscal fascicles consist of thin superior and inferior synovial-covered bands of connective tissue that attach the posterior horn of the lateral meniscus to the joint capsule [6]. The popliteus tendon passes through the bursa formed by these fascicles. It has been shown that these fascicles are normally seen on MR imaging when the lateral meniscus is not torn [4]. When arthrography is used for the diagnosis of meniscal tears, it has also been noted that failure to visualize the fascicles on knee arthrography is a strong indicator of a lateral meniscal tear [5]. Presumably fascicle abnormalities are associated with lateral meniscal tears because the biomechanical forces that tear the meniscus also cause disruption of the fascicles.

When we used the standard criterion of two or more MR images showing meniscal signal contacting the surface or meniscal distortion, we had a sensitivity of 89% for the diagnosis of a lateral meniscal tear. This was better than the previously reported sensitivity of 78%, using this criterion [2]. Although identifying an abnormal fascicle did improve our sensitivity for diagnosing a lateral meniscal tear to 94%, the improvement was not statistically significant. Possibly with a larger sample size, this improvement might have been statistically significant.

Our study also found that the presence of a single image showing either meniscal distortion or signal contacting the surface is not specific for a lateral meniscal tear. Only three (27%) of 11 menisci having one image with an abnormality were noted to be torn at arthroscopy. Our results are similar to those of an earlier study in which only 30% of lateral menisci with a single abnormality on MR imaging were torn [2]. The reason for these false-positive MR imaging findings is unknown, but possible explanations include healed tears that have an MR imaging appearance similar to that of an acute tear and tears that are present but missed on arthroscopy [7, 8]. We also found that the sensitivity of diagnosing a lateral meniscal tear was not improved by using a criterion of one image with a meniscal abnormality and an abnormal fascicle.

Since completing this study, we routinely assess the superior fascicle on each of our clinical MR imaging examinations of the knee. We have found that detecting an abnormal fascicle has helped our diagnostic accuracy by heightening our sensitivity to subtle abnormalities of the lateral meniscus. We agree with the earlier study’s conclusion that those interpreting MR imaging studies should pay close attention to the superior fascicle because there is likely a tear in the posterior horn of the lateral meniscus if a fascicle is abnormal [3]. However, we have not been diagnosing a tear on the basis of the presence of an abnormal fascicle alone because this sign is not specific for a tear.

In contrast to the previous study, we did not find an association between posterolateral pericapsular edema and a lateral meniscal tear. In the earlier study, 11 of 30 patients with lateral meniscal tears had pericapsular edema, but only two of the 29 patients with intact menisci had pericapsular edema [3]. In our study, 13 of the 36 patients with lateral meniscal tears had pericapsular edema, but pericapsular edema was also seen in 17 of the 85 patients with intact menisci. However, posterolateral pericapsular edema was associated with an ACL tear ($p = 0.008$). As previously noted, this edema is likely caused by hemorrhage resulting from capsular tearing or stretching [3].

We are not sure why our study found pericapsular edema in a higher percentage of patients with intact menisci than in those in the previous study [3]. One reason for the different findings might be that we used fat-saturated fast spin-echo sagittal T2-weighted images whereas the earlier study used conventional spin-echo T2-weighted images. Because our technique is more sensitive to fluid than conventional spin-echo imaging without fat saturation, we may have detected milder degrees of edema than we would have seen in the earlier study.

We found that an abnormal fascicle is also associated with an ACL tear. A tear of the ACL is usually due to extension or rotation of the knee, and this same mechanism of injury is likely to tear the attachments of the lateral meniscus.

One limitation of our study is that the observers evaluated both for the conventional and new MR imaging signs of a meniscal tear at the same time. This combined evaluation had the potential for creating observer bias. However, because the arthroscopic results were not known by the observers, they could not be sure whether the new signs might be present or absent regardless of the presence or absence of the conventional signs. We, therefore, believe that the effect of any bias would be minimized. An additional limitation would be that we used fast spin-echo sagittal MR images rather than conventional spin-echo images. Thus, our results might not ap-
ply to MR imaging studies performed with conventional spin-echo technique.

In conclusion, our study has shown that an abnormal superior popliteomeniscal fascicle is indeed associated with a lateral meniscal tear. However, this indirect sign is not specific for a tear. We feel that its greatest value is in directing attention to the posterior horn of the lateral meniscus because a subtle tear is often present. We also found that posterolateral pericapsular edema was not useful in the diagnosis of a lateral meniscal tear because it was not associated with this kind of tear.

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