Meniscal Flounce on MR: Correlation with Arthroscopic or Surgical Findings

Baek Hyun Kim, Hae Young Seol, Hoe Seok Jung, Sang Hoon Cha, Cheol Min Park, and Hong Chul Lim

--- Abstract ---

The purpose of this study was to investigate the frequency of the meniscal flounce on MR imaging in patients who underwent arthroscopy or open surgery due to symptoms related to internal derangement of the knee, and to investigate associated findings in patients with meniscal flounce by comparing and analyzing the findings from MR imaging and surgery. MR images obtained from 116 knees before surgery were reviewed retrospectively. Seven medial menisci showed buckled, wavy flounce on sagittal MR images. None of the lateral menisci showed flounce. We reviewed the surgical records of all seven patients and the videotapes of six of the patients undergoing arthroscopy or open surgery. The frequency of flounce on sagittal MR images was 6.0% in the medial meniscus and was completely absent in the lateral meniscus. On coronal MR images, the truncated appearance of the affected meniscus was demonstrated in five patients, and a valgus deformity was seen in three patients. Five patients showed a moderate to large amount of joint effusion. On MR imaging and in surgery, ligament injuries were found in six patients (six medial collateral ligament injuries, five anterior cruciate ligament injuries, and two posterior cruciate ligament injuries). Non-specific synovitis was found in the one remaining patient. In the surgery of all seven patients, no tears were found at the meniscus itself showing flounce. In conclusion, the meniscal flounce seen on sagittal MR imaging can be a rare appearance of a transient distortion of a normal meniscus due to a valgus deformity caused by a MCL tear and/or due to an external rotation induced by cruciate ligament injury or positioning of knee joint within the magnet. The meniscal flounce should be interpreted carefully because it frequently appears truncated on the coronal scan and can simulate a meniscal tear.

Key Words: Knee, MR, abnormalities, ligaments, menisci, cartilage

INTRODUCTION

The free edge of the body of a normal meniscus has a bow-tie appearance on the sagittal knee MR image and a triangular appearance and a sharp central tip on the coronal scan. Zarins and McInerney considered the meniscal flounce by valgus and rotation of the knee joint, which is observed during arthroscopy, a normal meniscal variant characterized by a single, symmetric fold along the free edge of the meniscus. However, the meniscus can appear differently depending on the location and type of the possible meniscal tear; a flouncelike fold or notch may show occasionally from a tear (Fig. 1a). MR imaging is effective in diagnosing this tear, which is the cause of the flouncelike fold. During our comparison and analysis of the previous findings from knee MR images and surgery, few cases with prominent meniscal flounce without a meniscal tear were found (Fig. 1b). This study attempts to investigate the frequency of the meniscal flounce on MR imaging in patients who underwent arthroscopy or open surgery due to symptoms related to internal derangement of the knee, and to investigate associated findings in patients with meniscal flounce by comparing and analyzing the findings from MR imaging and surgery.

MATERIALS AND METHODS

We reviewed all MR images of 116 knees obtained before arthroscopy or open surgery between January 1994 and December 1996. The diagnostic criteria for meniscal flounce on MR image was defined as an

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undulating, wavy appearance in the free edge of the meniscus on sagittal MR images that was not derived from a meniscal tear.

Of 116 knee MR images, seven (6%, six men and one woman; age range, 22–57 years; mean age, 42.6 years) demonstrated meniscal flounce. Of these, four patients experienced trauma an average of 5.5 days (range, 1–13 days) prior to their MR imaging examination; two experienced trauma 10 months and 32 months, respectively, prior to their examination; and the remaining one patient had no trauma experience whatsoever. The six patients who had experienced trauma and the one patient without trauma experience all received surgery an average of 6 days (range, 2–14 days) and 41 days after their MRI examination, respectively, due to symptoms related to internal derangement of the knee.

Five patients underwent MRI examination with a 1.5-T MR unit (Magnetom, Siemens, Erlangen, Germany) with a surface coil for the knee joint, and two patients underwent MRI examination with a 1.0-T MR unit with a surface coil. All seven patients were examined on full extension and with 10 to 15° external rotation of the knee in a supine position during their MR imaging examination within the magnet, the common positioning for undergoing knee MR imaging. The MR images were obtained in at least three planes using various combinations of spin-echo T1 weighted image (TR/TE=500–650/14–15 msec), dual spin-echo T2 (2,000–2,950/80–90) and proton density weighted image (2,000–2,950/15–20), and gradient T2* image (500–flip angle 15–25°). The acquisition matrix was 160–256×224–512; FOV was 140–200 mm; NEX was 1–3; the slice thickness was 3–5 mm; and the distance between slices was 0.3–1.2 mm.

On retrospective analysis of MRI, we evaluated the injury of menisci and ligaments, the amount of joint effusion, the distortion of the knee joint such as valgus deformity and rotation, and other abnormal findings. The amount of joint effusion was graded with according to the measurement of the anteroposterior dimension of the fluid on the mid sagittal image; greater than 15 mm as large, between 10 and 15 mm as moderate, between 5 and 10 mm as small, and less than 5 mm as none.

We reviewed the surgical records of seven patients and videotapes of the operations of six patients to evaluate abnormalities of the menisci, joint capsule and ligaments.

One orthopedic surgeon (H.C.L.) who specializes in knee diseases and abnormalities performed the knee joint surgery on all seven patients, and two musculoskeletal radiologists (B.H.K., H.S.J.) interpreted the MR images.

RESULTS

Of the 116 patients who received arthroscopy or open surgery of the knee joint after MR examination during the study period, seven (6%) patients had wavy or S-shaped meniscal flounce that appeared on the sagittal MR images (Fig. 1b). The flounces in all seven patients were located on the medial meniscus; these could be seen on one or two sagittal

![Fig. 1. A 57-year-old man with a meniscal flounce and a flounce-like fold in the right knee.](image-url)
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Fig. 2. Medial meniscal flounce in the left knee of a 51-year-old man with an acute tear at the MCL, ACL and PCL. a. Sagittal T2-weighted spin-echo MR image (TR/TE=2,200/90 msec) shows a typical flounce (arrow) with a symmetric S-shaped fold along the free edge of the meniscus. Note the wide gap between the medial femoral condyle and tibial plateau. No tear was identified in the meniscus itself during open surgery. b. Coronal T1-weighted spin-echo MR image (TR/TE=600/15 msec) shows a medial meniscus that appears truncated (arrow). Note the valgus deformity of knee joint. Tears of the MCL, ACL and PCL, and multiple bone bruises and fractures are also demonstrated.

Table 1. Findings of MR Imaging and Surgery in Patients with Meniscal Flounce

<table>
<thead>
<tr>
<th>Patient No./Age (y)/Sex</th>
<th>Surgery</th>
<th>MR findings</th>
<th>Medial meniscus on surgery</th>
<th>Tear of ligaments on MR &amp; surgery</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/51/M</td>
<td>Open</td>
<td>Moderate</td>
<td>M-C Sep</td>
<td>+</td>
<td>Femoral condylar fractures</td>
</tr>
<tr>
<td>2/51/M</td>
<td>Open</td>
<td>+</td>
<td>M-C Sep</td>
<td>+</td>
<td>Fibula head fracture</td>
</tr>
<tr>
<td>3/52/F</td>
<td>Arthro &amp; Open</td>
<td>+</td>
<td>Large</td>
<td>+</td>
<td>Lateral meniscus tear</td>
</tr>
<tr>
<td>4/35/M</td>
<td>Arthro</td>
<td>+</td>
<td>Small</td>
<td>+</td>
<td>Non-specific synovitis ¹</td>
</tr>
<tr>
<td>5/57/M</td>
<td>Arthro</td>
<td>+</td>
<td>Large</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>6/22/M</td>
<td>Arthro</td>
<td>Moderate</td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>7/30/M</td>
<td>Arthro</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MCL, medial collateral ligament; ACL, anterior cruciate ligament; PCL, posterior cruciate ligament; LCL, lateral collateral ligament; M-C Sep, meniscocapsular separation; Arthro, arthroscopic.

* laxity during arthroscopy, ¹ synovial hypertrophy at suprapatellar synovial membrane and around the anterior cruciate ligament.

There were no tears in the affected menisci in any of the seven patients on their MR images, although a finding of a suspected of meniscocapsular separation was seen in one case (Fig. 2a). On the coronal MR images, the truncated appearance of the affected meniscus was demonstrated in five patients (5/7, 71%), and the valgus deformity was seen in three patients (Fig. 2b). None of the cases showed a clear rotation of the knee joint. There were three cases of a large amount, two cases of moderate, one case of small, and one case of no knee joint effusion (Table 1). Five MCL tears, one MCL laxity, five ACL tears, and two PCL tears were verified both on MR imaging and in surgery (Table 1).

Although there was no tear present in the meniscus itself, as seen during the operation in all seven cases, meniscocapsular separation was present in the postero-medial portion of the joint capsule in two of the cases. The one case that showed no tear in either the
DISCUSSION

Arthroscopic meniscal flounce is considered a positional variation of the meniscus, which is induced by the external rotation of the tibia in a flexed knee with simultaneous application of valgus force to expose the posteromedial compartment of the knee. Furthermore, it is known that fluid must be present in the joint and ligament tears or anesthesia-induced relaxation is required to view the meniscal flounce during arthroscopy. Under these conditions in arthroscopic examinations, the flounce can be viewed. However, in MR imaging, which does not offer these conditions, the flounce is difficult to view.

There have only been two studies, that have reported seeing meniscal flounce in MR imaging because it is so rare. Chew first reported seeing medial meniscal flounce on MR imaging. In one case of flounce of the medial meniscus seen on sagittal MR images reported by Chew, a large effusion and anterior cruciate ligament and medial collateral ligament tears were found without a medial meniscal tear. These findings were verified through arthroscopy. Yu et al presented the second report on seeing a medial meniscal flounce in six cases and a lateral meniscal flounce in one case. Of these seven cases, five had ligament injuries (3 ACL tears, 3 MCL tears, 1 PCL tear). Four of the seven patients underwent arthroscopy or open surgery; a tear of the posterior horn of the medial meniscus was found in one of the four cases. The results reported in our study are very similar to those reported by two of the mentioned studies. In all seven cases of our study, flounce could be seen in the medial meniscus; no tear was present in the medial meniscus itself, as seen during the operation; six of the seven patients had ligament injury; and of these five also had MCL and ACL tears.

A MCL tear can cause the knee joint to become valgus, and ACL or PCL tear can rotate the knee joint, and any of these three ligament tears is able to induce a meniscal flounce during a MRI examination even without any applied external force. A flounce without ligament injury was observed in one case in our study and in two cases reported by Yu et al. It can be assumed that in these cases, the flounce was induced by the mild external rotation of the tibia within the magnet, the common positioning for undergoing knee MR imaging. In the one case in our study without the ligament injury, the meniscal flounce was not prominent so it was only seen on one sagittal image.

Meniscal flounce can seldom be observed in MR imaging as compared with arthroscopy. The meniscal flounce was observed in only 0.2% of all the knee MR imaging made by Yu et al and in only 6.0% of the MR imaging of patients who underwent an operation in our study. The reason that flounce is seldom detected in MR imaging as compared to arthroscopy may be that the valgus deformity from a ligament injury and the mild external rotation of the tibia within the magnet are relatively less than the external force applied by arthroscopy on the knee joint, which has been previously relaxed by anesthesia given before the operation. Obviously, it would be even less frequent to observe meniscal flounce in MR imaging when there is no ligament tear.

The well known fact is that joint effusion or a large amount of fluid must be present in order for meniscal flounce to appear during arthroscopy. However, in two of seven cases examined by our team and one of seven cases looked at by Yu et al., respectively, there was either none or a very small amount of joint effusion. Therefore, joint effusion is not necessary in order for meniscal flounce to appear on MR imaging.

The meniscal flounce appearing during arthroscopy or arthrogram can be easily seen in both medial and lateral menisci. However, there is no explanation for the fact that almost all of the meniscal flonences appeared in the medial meniscus on the MR imaging. Two reasons can explain this phenomenon. First, the valgus deformity is more frequent due to the medial collateral ligament being more prone to injury than the lateral collateral ligament. Actually, in our study, there were many cases with a medial collateral ligament injury but no cases with a lateral collateral ligament injury. Three cases among the six with medial collateral ligament injuries in our study showed valgus deformity on the MR imaging. The second reason is that flounce appears frequently in the medial meniscus under an applied mild external rotation due to the medial meniscus being relatively longer than the lateral meniscus.

Yu et al. stated that meniscal flounce must be interpreted carefully because a meniscus with a
flounce frequently appears truncated on coronal MR imaging and can simulate a meniscal tear. This finding (truncated appearance) was frequent in our study as well (5/7, 71%).

In conclusion, the meniscal flounce seen on sagittal MR imaging can be a rare appearance of a transient distortion of a normal meniscus due to a valgus deformity caused by a MCL tear, and/or due to an external rotation induced by cruciate ligament injury or positioning of knee joint within the magnet. The meniscal flounce should be interpreted carefully because it frequently appears truncated on the coronal scan and can simulate a meniscal tear.

REFERENCES


