The Relationship Between the MPP Test and Arthroscopically Found Medial Patellar Plica Pathology

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Purpose: This study investigated whether the mediopatellar plica (MPP) test developed by the authors could be used preoperatively to predict MPP pathology found at arthroscopy. Methods: Between January 1999 and August 2004, 65 patients (66 knees, group I) with anteromedial knee pain were examined using the MPP test before undergoing an arthroscopic procedure. In the control group, 101 patients (106 knees, group II) with lateral tibiofemoral joint line pain were examined by the MPP test. After arthroscopic excision of a thickened MPP, the visual analogue scale and the Lysholm scoring scale were recorded during follow-up. Results: Of the 172 knees evaluated, the sensitivity, specificity, and positive and negative predictive value for the MPP test were 89.5%, 88.7%, 78.7%, and 94.4%, respectively. The accuracy value was 89.0%. Thirteen knees (7.6%) were categorized as false positives, 7 knees had fat pad synovial fringe entrapments, 5 knees had localized synovitis, and 1 knee had a focal cartilage lesion on the medial femoral condyle. In 53 knees diagnosed with pathologic MPP entrapment in group I, the mean postoperative VAS was 1.3 (range, 0 to 4) and the mean postoperative Lysholm score was 91.4 (range, 74 to 100), while all knees showed a negative MPP test after the mean follow-up of 48.1 months (range, 24 to 96 months). Conclusions: The MPP test is reliable to predict the pathologic MPP entrapment, and arthroscopic excision of pathologic MPP shows satisfactory clinical results. Level of Evidence: Level III, diagnostic study of nonconsecutive patients without consistently applied gold standard. Key Words: Mediopatellar plica (MPP) test—Pathologic medial patellar plica—Physical examination.

Synovial plica of the knee was first presented by Fullerton in 1916. Iino described the arthroscopic appearance of plica and classified the different shapes of mediopatellar plica (MPP) into 4 types in 1939. Kim and Choe classified MPP into the following types: absent, vestigial, shelf, reduplicated, fenestrated, or high riding. The MPP originates on the medial wall of the knee joint, runs obliquely down in coronal plane, and inserts into the medial synovial lining of the infrapatellar fat pad. The reported incidence of MPP ranges from 22% to 72%. Although the MPP is a normal structure, an inflammatory reaction by various etiologic factors can cause fibrosis of the MPP, which then loses its elasticity and becomes a thick and inflexible structure. As a result, the hardened bow-string plica over the medial femoral condyle impinges the condyle and could be trapped between the patellar and the femoral condyle. Tenderness, effusion, or chondromalacia on the medial femoral condyle or medial facet of patellar can develop from this pathologic phenomenon, which is known as MPP syndrome. The diagnosis of MPP syndrome has been troublesome, because there are no well accepted diagnostic modalities, although several physical examinations, such as the knee extension test, flexion test, and other provocation tests have been introduced. Therefore, the accuracy of a diagnosis depends largely on the clinician’s experience. The authors introduced a new clinical test—the MPP...
test—for the prediction of pathologic MPP entrapment in previous reports. The purpose of this study was to investigate the relationship between the MPP test and arthroscopically found MPP pathology.

METHODS

Between January 1999 and August 2004, 65 patients (66 knees) in group I with anteromedial knee pain who underwent subsequent arthroscopic procedures were examined preoperatively using the MPP test. Patients who did not respond to conservative treatments (such as supervised physiotherapy, including quadriceps-strengthening and hamstring-stretching exercise daily, activity modification, and non-steroidal anti-inflammatory medications for 6 months) were included, and patients were excluded if they had medial meniscus lesions, knee ligament injuries, previous knee operations, radiographic degenerative osteoarthritis, or patella instability. The study group consisted of 29 males and 36 females. The average age of the patients was 40 years (range, 15 to 54 years).

For the control population, 101 patients (45 males, 56 females; 106 knees) in group II were examined. These patients underwent an arthroscopic procedure for lateral tibiofemoral joint line pain. Exclusion criteria were the same as for group I. The average age of the patients was 39.5 years (range, 17 to 54 years).

In 53 knees with pathologic MPP entrapment in group I, the average duration of symptoms was 12.7 months (range, 6 to 31 months). In 19 cases with a history of abrupt trauma to the knee, 10 cases were related to direct trauma (slipping in 6 cases and being struck by a light object in 4 cases). The others were related to twisting injuries suffered while participating in sporting activities. In cases without abrupt trauma, 18 cases had a history of overuse to the knee (from sports activity in 13 cases and heavy work in 5 cases). Pain was aggravated during walking downstairs in 52 knees (98.1%), while climbing upstairs aggravated 37 knees (69.8%). A palpable snap or crepitus was noticed in 32 knees (60.4%) and joint effusion in 10 knees (18.9%).

All patients were evaluated through an imaging study and physical examination. Standing posterior, lateral knee, and axial patellar radiographs at 30° knee flexion and magnetic resonance imaging were performed for the imaging study. If needed, a KT-1000 arthrometer (MEDmetric, San Diego, CA)

FIGURE 1. The mediopatellar plica (MPP) pathology through a superolateral portal on the right knee. (A) The pathologic MPP specified with fibrotic and thickened edge is entrapped between the patellar (P) and medial femoral condyle (F). (B) After the plica is excised with the shaver, the entrapment of plica disappears.
was used. The following physical examinations were performed for exclusion: patella apprehension test, lateral and medial patella glide and quadriceps angle for patella instability, McMurry’s and Appley’s tests for meniscal tears, and stress tests for ligament injuries.

At every follow-up, a 10-cm interval visual analogue scale (VAS) was used to measure pain, with 10 cm representing maximum pain and 0 cm representing no pain. The functional evaluation was made according to the Lysholm scoring scale by a doctor who was blinded to the patients’ file.17

The MPP Test

The MPP test is conducted while the patient is placed in the supine position. While applying manual force to the inferomedial patellofemoral joint with the

![Figure 2](image-url)

**Figure 2.** During the MPP test, arthroscopic view through a superolateral portal with pathologic MPP entrapment on the left knee. (A) When manual force is applied to the inferomedial patellofemoral joint with the examiner’s thumb while the knee was extended, the fibrotic plica (arrow) is entrapped between the patellar (P) and medial femoral condyle (F). (B) While the knee is flexed to 90°, the fibrotic plica slips away from the condylar ridge and entrapment disappeared. (C) After the plica is excised with the shaver, the entrapment of plica disappears during the part of the MPP test involving knee extension.
examiner’s thumb, the examiner identifies the presence of tenderness. If this tenderness is markedly diminished at 90° of flexion with maintaining manual force, the MPP test is considered to be “positive.” The rationale of the MPP test can be proved by arthroscopic examination through the superolateral portal. The MPP is located on the medial femoral condyle during knee extension. When manual force is applied to the inferomedial patellofemoral joint, the pathologic MPP is inserted and squeezed between the patellar and medial femoral condyle. The entrapped MPP slips away from the medial condyle at 90° of flexion even with maintaining manual compression. The MPP test was performed by the senior author prospectively at preoperative, intra-operative, and follow-up period.

Operative Procedures

A normal MPP looks like soft membrane. Its margin is somewhat transparent. If abnormal MPP was suspected in the medial patellofemoral space during a routine arthroscopic evaluation, a superolateral portal was used to gain a better view with which to examine the MPP. The pathologic MPP specified with avascular fibrotic and thickened edges, which were sometimes torn or frayed. We defined MPP entrapment as squeeze of pathologic MPP between medial femoral condyle and patella in extension and also slipping over medial femoral condyle suddenly during flexion through a superolateral portal with inflow blocked (Fig 1). Associated pathologic conditions were assessed, including medial patellar or femoral trochlear chondromalacia, and medial peripatellar synovitis.

Excision of entrapped pathologic MPP and fat pad synovial fringes was conducted using a motorized shaver inserted through the anteromedial portal. After the procedures, it was confirmed that there was no entrapment of the plica by repeating the MPP test (Fig 2). Chondromalacia was treated according to the grade. Arthroscopic meniscectomy or repair was performed in cases with lateral meniscus tears. Arthroscopic surgical findings and procedures were recorded immediately after surgery.

Statistical Analysis

Diagnostic values were calculated with a $2 \times 2$ table for sensitivity, specificity, positive predictive, and negative predictive values. A $\chi^2$ test was applied to the categorical variables, and a Student $t$ test was applied to the continuous variables. A $P$ value < .05 was considered significant. All statistical analysis was performed using the SPSS software package (version 13.0; SPSS, Chicago, IL).

RESULTS

Accuracy of MPP Test

The patients in both groups were similar with regard to age and gender.

In the 64 knees that showed a positive MPP test preoperatively, 51 knees (79.7%) had pathologic MPP entrapment, 7 knees (10.9%) had fat pad synovial fringe entrapments without pathologic MPP, and 5 knees (7.8%) had localized synovitis on the medial peripatellar region. One knee (1.6%) showed a focal cartilage defect lesion on the medial femoral condyle.

In the 108 knees that had a negative MPP test preoperatively, 6 knees (5.6%) were revealed to have pathologic MPP entrapment. Arthroscopic examination showed 53 knees with pathologic MPP entrapment (80.3%) in group I and 4 knees with pathologic MPP entrapment with lateral meniscal tears (3.8%) in group II (Table 1).

The sensitivity and specificity of the MPP test were 89.5% and 88.7%, respectively. The positive and negative predictive values were 78.7% and 94.4%, respectively, and the accuracy value was 89.0% (Table 2).

Clinical Results of 53 Knees With Pathologic MPP Entrapment in Group I

At the mean follow-up of 48.1 months (range, 24 to 96 months), all cases showed a negative MPP test. The

<table>
<thead>
<tr>
<th>Table 1. Arthroscopic Findings in Groups I and II</th>
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<tbody>
<tr>
<td>Number of Knees (%)</td>
</tr>
<tr>
<td>Group I</td>
</tr>
<tr>
<td>Pathologic MPP entrapment</td>
</tr>
<tr>
<td>53 (80.3)</td>
</tr>
<tr>
<td>Fat pad synovial fringe entrapment</td>
</tr>
<tr>
<td>7 (10.6)</td>
</tr>
<tr>
<td>Localized synovitis on the medial peripatellar region</td>
</tr>
<tr>
<td>5 (7.6)</td>
</tr>
<tr>
<td>Focal cartilage defect on medial femoral condyle</td>
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<tr>
<td>1 (1.5)</td>
</tr>
<tr>
<td>Group II</td>
</tr>
<tr>
<td>Isolated lateral meniscus tear</td>
</tr>
<tr>
<td>95 (89.6)</td>
</tr>
<tr>
<td>Isolated cartilage defect on lateral femoral condyle</td>
</tr>
<tr>
<td>4 (3.8)</td>
</tr>
<tr>
<td>Pathologic MPP entrapment with lateral meniscal tear</td>
</tr>
<tr>
<td>4 (3.8)</td>
</tr>
<tr>
<td>Localized synovitis with lateral meniscal tear</td>
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<td>3 (2.8)</td>
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Abbreviation: MPP, mediopatellar plica.
TABLE 2. Clinical Accuracy of the MPP Test in Diagnosing Pathologic MPP Entrapment

<table>
<thead>
<tr>
<th>Number of Knees</th>
<th>Pathologic MPP (+)</th>
<th>Pathologic MPP (−)</th>
<th>Total</th>
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<tr>
<td>MPP test (+)</td>
<td>51 (a)</td>
<td>13 (b)</td>
<td>64 (a + b)</td>
</tr>
<tr>
<td>MPP test (−)</td>
<td>6 (c)</td>
<td>102 (d)</td>
<td>108 (c + d)</td>
</tr>
<tr>
<td>Total</td>
<td>57 (a + c)</td>
<td>115 (b + d)</td>
<td>172 (a + b + c + d)</td>
</tr>
</tbody>
</table>

Abbreviation: MPP, mediopatellar plica.
Sensitivity = a/(a + c) × 100.
Specificity = d/(b + d) × 100.
Positive predictive value = a/(a + b) × 100.
Negative predictive value = d/(c + d) × 100.
Accuracy value = (a + d)/(a + b + c + d) × 100.

The mean postoperative VAS was 1.3 (range, 0 to 4), which was a significant improvement from the mean preoperative score of 3.8 (range, 3 to 5; P < .05). The mean postoperative Lysholm score was 91.3 (range, 74 to 100), which was a significant improvement from the mean preoperative score of 65.2 (range, 54 to 78; P < .05).

Thirty knees (56.6%) had chondromalacia on the medial patellofemoral joint adjacent to the pathologic plica greater than the second grade as scored by the modified Outerbridge classification, including 14 knees (26.4%) on the medial patellar facet, 7 knees (13.2%) on the medial femoral condyle, and 9 knees (17.0%) on both the medial femoral condyle and medial patellar facet. The mean postoperative VAS was 1.6 in 30 cases with chondromalacia and 1.0 in 23 cases without chondromalacia. There was a significant difference of postoperative VAS (P = .023) in patients according to the presence of the chondromalacia. The mean postoperative Lysholm score was 89.4 in knees with chondromalacia and 93.7 in knees without chondromalacia. There was also a significant difference in postoperative Lysholm scores (P = .006).

In 6 knees (11.3%), pathologic MPP entrapment was combined with infrapatellar fat pad hypertrophy.

DISCUSSION

There was close correlation between the MPP test and arthroscopically found pathologic MPP entrapment in our study. A “positive MPP test” predicted “arthroscopically found MPP entrapment” with 78.8% accuracy and “all cases with no MPP entrapment by surgical resection” showed a “negative MPP test” at follow-up.

On physical examination, symptomatic MPP can often be palpated, demonstrating a tender, band-like structure paralleling the medial border of the patellar at 30° of flexion on knee motion. The reproducible palpable snap was present in about 70%, while only 60.4% in our study.6 Other clinical tests have been introduced in order to improve the diagnostic accuracy, such as the knee extension test, the flexion test, and two other provocation tests.12-15 The knee extension test, described by Pipkin,15 is performed by extending the knee to 90° of flexion, while internally rotating the leg and pushing the patellar medially. The knee typically pops as a consequence of a pathologic plica between 45° and 60° of flexion. However, the popping disappears during the day because of the formation of effusion in the knee. For this reason, this test is regarded as a “morning test.” The flexion test, devised by Flanagan,12 is considered “positive” when the patient experiences pain or discomfort that corresponds to their presenting symptoms when the knee is passively flexed no more than 6 times, while gentle pressure is simultaneously maintained over the plica.12 Two separate provocation tests were designed by Koshino and Okamoto.14 One is the rotation valgus test, where the examiner flexes the patient’s knee and forces it into a valgus position, with the patellar pushed medially and the lower leg internally or externally rotated. Another provocation test, the holding test, involves examiner-assisted knee flexion against the patient’s full extension, with the patellar pushed medially. Koshino and Okamoto14 reported unsatisfactory results in 5 of the 28 knees tested with the rotation valgus test, and 9 unsatisfactory results in 23 knees tested with the holding test, although our MPP test showed 89.5% sensitivity and 88.7% specificity.

The principal symptom of MPP syndrome is anteromedial knee pain whose incidence was reported from 92% to 100%.6,18,19 The pain increases with physical activity, particularly climbing stairs. In our cases, the anteromedial pain was noted more frequently while descending stairs (98.1%) than while ascending stairs (69.8%). Others symptoms are swelling, a feeling of snapping, and occasionally a sensation of instability.9,20,22

The reported incidence of blunt trauma to the knee preceding symptom onset varies from 13% to 74%.14,21-24 In our study, 35.8% (19 cases) of the patients had a history of abrupt trauma to the knee during everyday activities. Among 28 female patients in our study, 71.4% (20 cases) were housewives who habitually knelt in their daily activities.

Postoperatively, 51 cases (96.2%) showed a Lysholm score of ≥80. Other studies presented from excellent to good results ranging from 86% to 97% after
excision of MPP. Meanwhile, the surgical result of pathologic MPP was significantly affected by chondromalacia accompanied in 56.6% (30 cases; $P < .05$).

As a limit, this was not a comparative study with other physical examinations specialized for MPP, which will be needed in the future. Entrapment of hypertrophic infrapatellar fat pad is also not easy to differentiate from pathologic MPP entrapment using the MPP test, because it could be another cause of anteromedial knee pain and has similar clinical findings.

**CONCLUSIONS**

A MPP test may be used as an accurate and noninvasive method for the detection of arthroscopically found MPP entrapment, and arthroscopic excision of pathologic MPP shows satisfactory clinical results.

**REFERENCES**