

Arthroscopic meniscus repair for recurrent subluxation of the lateral meniscus

Jin Hwan Ahn¹ · Sang Hak Lee² · Kang Il Kim² · Juhyun Nam²

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Abstract

Purpose This study was undertaken to diagnose and to document the clinical results and technical aspects of arthroscopic meniscus repair for recurrent subluxation with peripheral tears around the popliteal hiatus of the lateral meniscus.

Methods Twenty-three patients (24 knees) with symptomatic recurrent subluxation of the lateral meniscus treated by arthroscopic meniscus repair were included. The inclusion criteria were: (1) patients with knee pain, locking or snapping symptoms despite 3 months of conservative treatment; (2) non-discoid lateral meniscus; (3) stable knee, and (4) tears involving the red–white or red–red zone. All tears were repaired by either the modified all-inside suture technique only or a combination of the modified all-inside and modified outside-in suture techniques. Clinical results were evaluated preoperatively and at final follow-up according to Tegner activity level, Lysholm knee, and Hospital for Special Surgery (HSS) scores.

Results No reoperations were required after a median follow-up of 41 months (range 24–124). Although recurrence of a locking episode was documented in one knee

and catching sensations were experienced in three knees, those patients did not require reoperation. At the last follow-up, the median Tegner activity level had improved significantly from 4 (range 2–6) to 7 (range 3–10, $p < 0.0001$), the median Lysholm knee score improved from 76 (range 25–90) preoperatively to 94 (range 76–100) at final follow-up ($p < 0.0001$), and the median preoperative HSS score improved from 86 to 95 at final follow-up ($p < 0.0001$).

Conclusion The described arthroscopic meniscus suture technique is effective for treating symptomatic recurrent subluxation of the lateral meniscus without any complications or recurrence. Clinical suspicion and understanding of recurrent subluxation with lateral meniscus are important to diagnose the disease especially when definite meniscal tear signs are absent on magnetic resonance imaging.

Level of evidence IV.

Keywords Knee · Lateral meniscus · Posterior horn · Popliteal hiatus · Meniscus repair · All-inside suture

Introduction

The lateral meniscus is circular in shape, smaller in radius, and more mobile than the medial meniscus because it has a loose attachment to the capsule, which is interrupted by the popliteal hiatus [28, 34]. Although the posterior horn of the lateral meniscus is more susceptible to subluxation than the medial meniscus, subluxation of the lateral meniscus is less frequently reported than that of the medial meniscus [7, 11, 13, 14, 22, 23, 35]. A displaced lateral meniscus is spontaneously reduced, and typically characterized by only intermittent locking symptoms without definite tear signs on magnetic resonance imaging (MRI) [10, 23, 27, 32]. The diagnosis of lateral meniscus hypermobility without

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✉ Sang Hak Lee
sangdory@hanmail.net

¹ Department of Orthopaedic Surgery, Sungkyunkwan University School of Medicine, Kangbuk Samsung Hospital, Seoul, South Korea

² Department of Orthopaedic Surgery, Center for Joint Diseases and Rheumatism, Kyung Hee University Hospital at Gangdong, 892 Dongnam-ro, Gangdong-gu, Seoul 134-727, South Korea

subluxation is difficult without thorough understanding of the lateral meniscus and high clinical suspicion of hypermobility even during arthroscopic examination, because tears of the popliteomeniscal fascicle are rare and shrouded in the parameniscal region [20, 23, 24, 33].

The nomenclature regarding such injuries varies, including recurrent subluxation of the lateral meniscus, popliteomeniscal fascicle tear, hypermobile posterior horn of lateral meniscus, and MRI-negative bucket-handle tears of the lateral meniscus [5, 13, 14, 16, 20, 21, 23, 24, 29]. Various treatments for recurrent subluxation of the lateral meniscus have been advocated, such as open repair of the popliteomeniscal fascicles of the lateral meniscus, arthroscopic subtotal meniscectomy, arthroscopic meniscus repair, and thermal shrinkage of the posterolateral capsule [14, 17, 19, 20]. With the advent of improved arthroscopic techniques, current treatment recommendations favor meniscal preservation through different arthroscopic repair techniques [2, 3, 6, 9, 15, 26].

Several case reports examining the recurrent subluxation of lateral meniscus concentrated on the diagnosis or results obtained from arthroscopy [13, 14, 24]. However, few follow-up clinical studies following arthroscopic treatment for the recurrent subluxation of lateral meniscus have been undertaken [32]. Therefore, the purpose of this study was to document clinical results and the technical aspects of arthroscopic meniscus repair for recurrent lateral meniscus subluxation. In this current study, it was hypothesized that arthroscopic meniscus repair would yield satisfactory clinical results without recurrence of symptomatic recurrent subluxation.

Materials and methods

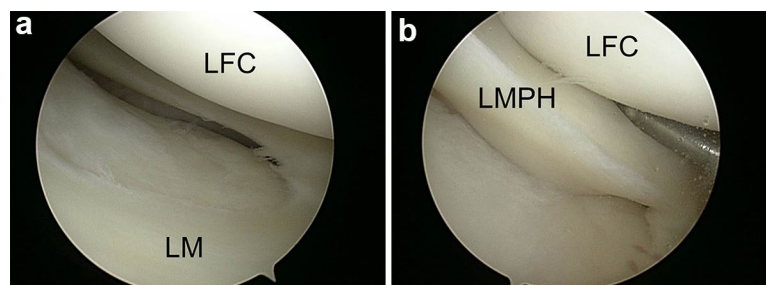
Thirty-nine patients (40 knees) were treated with a modified arthroscopic technique to repair tears of the popliteomeniscal fascicle of normally shaped lateral meniscus from March 2004 to April 2014. All procedures were performed by two surgeons, with the same arthroscopic techniques used for all operations. The inclusion criteria were: (1) patients with knee pain, locking or snapping symptoms

despite 3 months of conservative treatment; (2) non-discoid lateral meniscus; (3) stable knee, and (4) peripheral tears involving the red–white or red–red zone. Exclusion criteria were: (1) displaced bucket-handle tears of the lateral meniscus demonstrated on MRI and (2) any combined intra-articular ligament surgery. Thirteen patients were excluded because of bucket-handle tears demonstrated by MRI. Three patients were lost during follow-up. Thus, our sample included 23 patients (24 knees) who returned for the final evaluation after a minimum of 2 years (median, 41 months; range 24–124 months). Median age at the time of the operation was 24.5 years (range 13–57 years). Ten of the 24 knees were right knees, and ten were female knees. After 3 months of conservative treatment if a patient still had persistent lateral knee pain, locking or snapping, MRI evaluation was recommended, while arthroscopic treatment was recommended for subjects who persistently complained of symptoms despite normal MRI findings.

Surgical technique

The arthroscopic meniscus repair technique for the posterior horn of the lateral meniscus has been described previously [2, 6]. Careful probing was performed with an anteromedial viewing portal in a figure-4 position, which enabled better inspection of the lateral meniscus with the popliteal hiatus. Careful probing was applied to observe hypermobility of the lateral meniscus, peripheral detachment of the posterior horn of the lateral meniscus, or popliteal hiatus widening (Fig. 1; Video 1). Peripheral longitudinal tears at the posterior horn of lateral meniscus are difficult to visualize through standard anterior portals, and therefore the posterolateral compartment was assessed with the posterolateral viewing portal or a 70° arthroscope that was inserted in the anteromedial portal if the posterior horn of the lateral meniscus was unstable and hypermobile (Fig. 2). All repairs were performed using absorbable sutures (No. 0 PDS: Ethicon, Sommerville, NJ, USA) and different suture techniques were used depending on the properties of the tear site after freshening the tear sites using a motorized shaver. A modified all-inside suture technique was used with a 45° curved neck suture hook (Linvatec, Largo, FL,

Fig. 1 **a** The arthroscope inserted from the anteromedial portal shows normal shape of the lateral meniscus (LM). **b** The posterior horn of the lateral meniscus (LMPH) was displaced to the lateral compartment by probing. LFC lateral femoral condyle



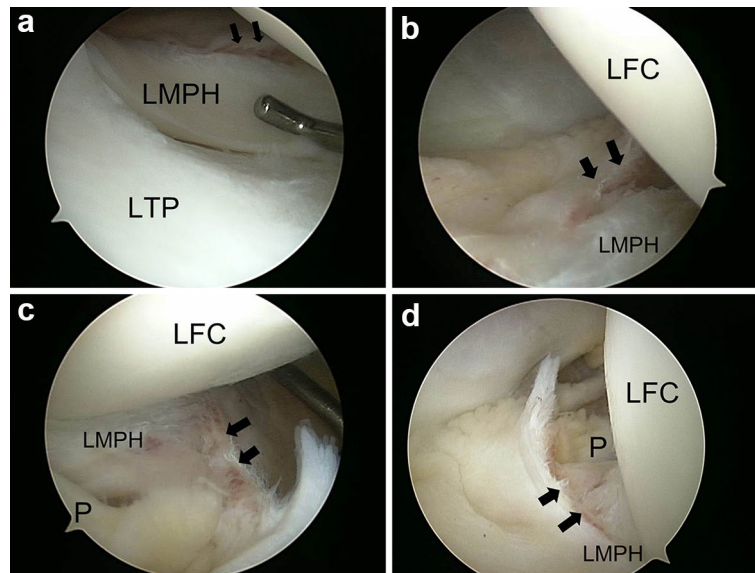


Fig. 2 **a** The arthroscope inserted from the anteromedial portal shows a longitudinal tear with hemorrhage in the posterior horn of the lateral meniscus (LMPH) at the meniscocapsular junction area (*black arrows*). **b** The 30° arthroscope inserted from the anteromedial portal to the posterolateral compartment shows a longitudinal tear of the posterior horn of the lateral meniscus (LMPH) at the meniscocapsular junction area (*black arrows*). **c** The 30° arthroscope

inserted from the posterolateral portal shows longitudinal tears (*black arrows*) at the meniscocapsular junction of the posterior horn of the lateral meniscus (LMPH). **d** The 70° arthroscope inserted from the anteromedial portal shows longitudinal tears (*black arrows*) at the meniscocapsular junction of the posterior horn of the lateral meniscus (LMPH). *LFC* lateral femoral condyle, *LTP* lateral tibial plateau, *P* popliteus tendon)

USA) for suture tears in the posterior horn through a single posterolateral portal (Fig. 3, Video 2) [3, 6]. When the posterolateral capsule was weak, the suture was applied between the meniscus of the posterior horn and capsule, including the popliteus tendon. If the tear extended from the posterolateral corner to the midbody of the lateral meniscus, a modified outside-in technique was used with a straight-necked suture hook (Linvatec, Largo, FL, USA) and a spinal needle preloaded with No. 0 nylon to pull out the PDS [4]. This technique was performed using a small posterolateral incision to retrieve and tie the sutures and protect the peroneal nerve. Rehabilitation was performed as previously described [2].

Evaluation

All preoperative evaluations were performed the day before surgery for each parameter, and postoperative evaluations were performed at the final follow-up by two of the authors. Careful histories were taken documenting the nature of the pain and a physical examination was performed in each case. The median duration of symptoms before surgery was 6.0 months (range 3–60 months). Four patients (four knees) underwent arthroscopic exploration at other hospitals before visiting our hospital due to symptoms of recurrent subluxation of the lateral meniscus, but their symptoms remained the same after surgery and the patients did

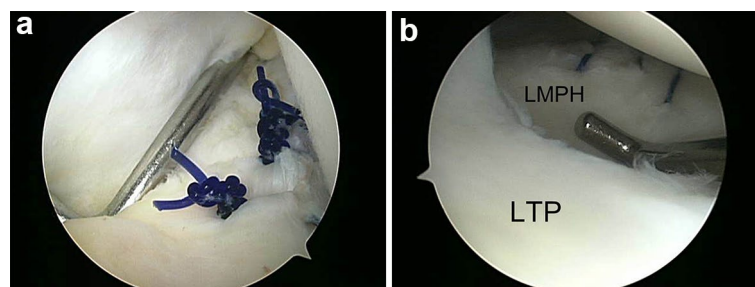


Fig. 3 **a** The 70° arthroscope, inserted from the anteromedial portal to the posterolateral compartment, shows three vertical sutures at the longitudinal tear of the posterior horn of the lateral meniscus

(LMPH). **b** The 30° arthroscope inserted from the anteromedial portal also shows anatomic coaptation of the lateral meniscus posterior horn (LMPH) tear. *LTP* lateral tibial plateau

not receive satisfactory explanations about their symptoms. The causes of injury were sports in nine, abrupt standing up from sitting in two, and unknown in 13 knees.

Preoperative radiographic evaluations including anteroposterior, lateral, tunnel and Merchant views were taken for each patient, as well as MRI evaluations. Radiographic findings were unremarkable for 22 knees, whereas one knee revealed minimal patellofemoral joint osteophytes and one knee revealed mild lateral joint space narrowing. All MRI studies were retrospectively reviewed as film hard copies by a musculoskeletal radiologist and an orthopedic surgeon blinded to the arthroscopic findings, clinical histories, and initial MRI interpretations. MRI findings were unremarkable for 17 knees, whereas 7 knees revealed suspicious peripheral tears at the posterior horn of the lateral meniscus. Clinical results were evaluated using Tegner activity level as well as Lysholm Knee and Hospital for Special Surgery (HSS) scores, preoperatively and at final follow-up. The study was reviewed and approved by the institutional review board of Kyung-Hee University Hospital at Gangdong, Seoul, Korea (No. 2013-01-047), and all patients signed informed consent forms.

Statistical analysis

The Wilcoxon signed rank test was used to identify significant differences between preoperative and last follow-up clinical evaluations. All statistical analyses were performed with SPSS (SPSS for Windows Release 11.0, SPSS Inc., Chicago, IL, USA), and 95% confidence intervals were used throughout.

Results

Upon arthroscopic examination, each patient's lateral meniscus was normal in shape. Hypermobility of lateral meniscus with hiatus widening was observed in all knees through the anterolateral portal as well as the posterolateral portal. All tears were repaired with either the modified all-inside technique only (17 patients) or a combination of the modified all-inside suture and modified outside-in techniques (7 patients). The combined intra-articular pathologies were: a chondral lesion at the lateral compartment in four knees, medial plica in one knee, and Baker's cyst in one knee.

At the last follow-up all knees had achieved full ranges of motion, and all patients had returned to their prior life activities with little or no limitations and without requiring additional operations. Five patients had persistent mild symptoms about which they had complained before arthroscopic repair: catching sensation in three knees and limited function during squatting and jumping in two knees.

Since their symptoms were mild compared to their original symptoms and daily activities were possible, they refused follow-up MRI exams. A locking episode recurred in one patient during the follow-up period, but the symptoms had subsided at the final follow-up.

The median Tegner activity level was 4 (range 2–6) preoperatively and had significantly improved to 7 (range 3–10, $p < 0.0001$) at the last follow-up. The median Lysholm knee score improved from 76 (range 25–90) preoperatively to 94 (range 76–100) at the final follow-up ($p < 0.0001$), and the median preoperative HSS score improved from 86 (range 13–95) to 95 (range 84–100) at the final follow-up ($p < 0.0001$).

Discussion

The most important finding of this current study was the modified all-inside and modified outside-in techniques resulted in excellent clinical outcomes for treating symptomatic recurrent subluxation of the lateral meniscus. It is difficult to determine whether arthroscopic repair of the lateral meniscus results in better outcomes than other treatments. However, such repair should be considered as a treatment option if possible. With this technique, patients can preserve the lateral meniscus without partial or total removal, which is preventive against further damages.

Several clinical studies have reported the pathophysiology and clinical features of recurrent subluxation of the lateral meniscus. LaParade et al. [20] reported that six patients with isolated tears of the popliteomeniscal fascicles that caused lateral meniscal hypermobility were identified by positive figure-4 test results. However, Suganuma et al. [33] determined that it remains difficult to suspect recurrent subluxation of the lateral meniscus based on clinical examination alone and believed that a finding of subluxation of the lateral meniscus with the peripheral margin of the posterior segment moving anteriorly at 90° of flexion of the knee joint on arthroscopy is needed for the diagnosis of recurrent subluxation of lateral meniscus if the patient has a history of mechanical locking episodes with pain on the lateral joint line. In our series, four patients were received arthroscopic exploration at other hospitals due to locking episodes before visiting our hospital, but still had the same symptoms after initial treatment and did not receive clear explanations of their symptoms. Therefore, it is important for surgeons not to overlook recurrent subluxation of the lateral meniscus and to suspect recurrent subluxation when patients report symptoms related to deep flexion, especially with locking episodes of the knee joint.

Discoid lateral meniscus, meniscal tear, and loose bodies in the knee joint also cause locking symptoms [1, 18]. MRI is useful to rule out other diseases, especially discoid

lateral meniscus, which is relatively common. Suganuma et al. [32] defined the recurrent subluxation of lateral meniscus as a disorder with locking episodes but no definite tears or abnormalities of the lateral meniscus. According to Suganuma et al. [33], recurrent subluxation of the lateral meniscus and popliteomeniscal fascicle tear are parts of the same disease entity, and it is difficult to define popliteomeniscal fascicle on MRI or arthroscopy, which is important when determining meniscal stability [12, 30]. Hypermobility of the posterior horn with probing during arthroscopic examination suggests peripheral tears of the lateral meniscus posterior horn or tears of the popliteomeniscal fascicle, and such tears may be confirmed by viewing through the posterolateral portal.

As described in case reports, several treatment modalities have been applied for treatment of recurrent subluxation of the lateral meniscus, but each case report involved only a few patients [16, 17, 20, 24, 25]. In the present study, only patients exhibiting symptomatic recurrent subluxation of the lateral meniscus without displaced bucket-handle tears on MRI were included. The same surgical technique was applied to all cases, and arthroscopic probing was applied to determine whether the repaired lateral meniscus was stable from the posterolateral corner to the midbody. If the repaired lateral meniscus was not stable, additional modified outside-in techniques were applied. The modified outside-in technique [4] added more accurate and stronger anatomic fixation in such cases. However, arthroscopic repair of the posterior horn of the lateral meniscus can be challenging to an experienced surgeon because of the difficulty of performing arthroscopic repair due to the anatomically more confined posterolateral compartment and the anatomic complexity of the peroneal nerve, popliteus tendon, and popliteal hiatus [8, 31]. After applying appropriate arthroscopic techniques based on the locations of tears of the lateral meniscus near the popliteal hiatus, excellent clinical results were achieved after a median follow-up of 41 months.

There are some limitations in this study. First, because this study was initiated in 2001, the arthroscopic repair techniques were modified during the study period, and the arthroscopic repair treatments were performed by two different surgeons. However, both surgeons applied the same arthroscopic repair techniques that were developed by a senior author. Second, this study had a minimum 2-year follow-up, which is relatively short. Third, successful and definite healing of the repaired lateral meniscus was not confirmed with postoperative MRI or arthroscopic exploration. Fourth, the number of cases included is small and cannot be analyzed sample size calculation, because of the low incidence of this condition.

Symptomatic recurrent subluxation of the lateral meniscus without an obvious tear on MRI is rare, and it is

challenging to suspect or diagnose recurrent subluxation of the lateral meniscus at a glance. Therefore, a thorough understanding of anatomy and clinical suspicion are essential for clinicians to prevent missing the disease.

Conclusion

The described arthroscopic meniscus suture technique is effective for treating symptomatic recurrent subluxation of the lateral meniscus without any complications or recurrence. Clinical suspicion and understanding of recurrent subluxation with lateral meniscus are important to diagnose the disease especially when definite meniscal tear signs are absent on MRI.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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Ethical approval The study was reviewed and approved by the institutional review board of Kyung-Hee University Hospital at Gangdong, Seoul, Korea (No. 2013-01-047).

Informed consent All patients signed informed consent forms prior to study inclusion.

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