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ARTHROSCOPY AND SPORTS MEDICINE

Popliteomeniscal fascicles tears with lateral meniscus instability: outcomes of arthroscopic surgical technique at mid-term follow-up

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Abstract

Purpose The popliteomeniscal fascicles (PMFs) are a crucial part of the posterolateral corner of the knee. They provide stability to the lateral meniscus and stabilize the joint during tibial internal rotation. The clinical diagnosis of a torn PMFs is difficult, and magnetic resonance imaging (MRI) may be inconclusive as well. The aim of the present study was to report the outcomes of a continuous series of patients affected by PMF lesions and treated with an arthroscopic repair.

Methods Seventeen patients (average age of 22 ± 3.6 years) with PMF lesions and lateral meniscus instability were prospectively enrolled. All patients were evaluated with clinical examination, International Knee Documentation Committee (IKDC), Lysholm and Tegner scores and 1.5 T MRI. All patients had the same arthroscopic procedure consisting of meniscal repair with an all-inside meniscal repair system (mean 2.2 ± 0.77 anchors) and followed with the same postoperative protocol.

Results All patients were available at a mean follow-up of 68 ± 24 months (range 49–84 months). Mean IKDC increased from 60.2 ± 13.5 to 83.1 ± 12, mean Lysholm score improved from 56.7 ± 8.2 to 89.8 ± 3.2, and mean Tegner score improved from 2.9 ± 1.3 to 6.5 ± 2. No intraoperative or postoperative complications were reported. MRI evaluation at 6-month follow-up showed successful healing of the menisco-popliteal fascicles in all cases.

Conclusions The diagnosis and treatment of tears of the PMFs is still debated. Diagnostic confirmation of tearing of the PMFs is usually determined at the time of arthroscopy. Meniscal repair with an all-inside meniscal repair system appears to be an excellent treatment option, since it yields good functional results at mid-term follow-up, no local complications, and complete radiographic healing at 6-month follow-up MRI. Further studies are needed to confirm these promising early results.

Level of evidence Case series, 4.

Keywords Popliteomeniscal fascicles · Arthroscopic repair · Meniscal instability · All-inside

Introduction

The anatomy of posterolateral corner (PLC) of the knee is complex, and variable injury patterns of the PLC contribute to diagnostic and treatment dilemmas [1]. The PLC is composed of several structures, including the lateral meniscal wall, the popliteus muscle and its tendon, and the arcuate popliteal ligament. All of these structures are reinforced by the deep lateral collateral ligament [2]. The popliteomeniscal fascicles (PMFs) are a part of the PLC [1, 3, 4]; they include the posterosuperior popliteomeniscal fascicle (sPMF) and an anteroinferior popliteomeniscal fascicle (iPMF) [5]. They connect the lateral meniscus to the popliteal hiatus [6] and are provide stability to the lateral meniscus and stabilize the joint during tibial internal rotation and sudden changes of direction [4, 7–9].

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The clinical diagnosis of these lesions is complicated given the high percentage of PMF tears occurring during multi-ligamentous injuries [9]. In particular, a high percentage of knees with acute and chronic ACL and/or posterolateral injuries have concurrent damage to the popliteomeniscal fascicles [10]. Therefore, an isolated ACL tear should always be investigated for additional lateral structure involvement [11]. PMF tears lead to lateral pain, painful squatting and locking sensation [5].

Imaging analysis of these lesions is difficult, even though magnetic resonance imaging (MRI) using proton density sequences may be useful [12, 13]. MRI and the fig. 4 test allow to assess PMF tears pre-operatively. Although the combination of patient's history, clinical examination and MRI are helpful, the final confirmation is given after the arthroscopic evaluation which represent the most reliable tool [14]. Once the diagnosis is given, many surgical treatments are available including open and arthroscopic techniques [12].

The purpose of the present study was to validate a safe and effective diagnostic and therapeutic algorithm to identify and treat PMF tears associated with lateral meniscus instability using an all-inside arthroscopic procedure. Primary outcomes were change of the Tegner activity scale, the Lysholm scale, and the International Knee Documentation Committee (IKDC) score, as well, as healing of the fascicles at 6 months on MRI. Secondary outcomes were patient satisfaction and return to sport.

Materials and methods

Patients

Our investigation was carried out in accordance with the principles of the declaration of Helsinki, approved by the health director of the hospital and all patients gave their written informed consent prior to enrollment in the study.

Seventeen patients with PMF lesions and lateral meniscus instability were prospectively enrolled from February 2014 to May 2017. All patients reported lateral and posterolateral pain that was non-responsive to conservative treatment course including medications (NSAIDs) and physical therapy for at least 6 weeks. The majority of the patients had experienced symptoms (lateral pain, painful squatting and locking sensation) for more than 1 year (*n* 12, 70.6%), and the mean time from injury to surgery was 16 ± 13.6 months (range 2–28 months). Clinical examination revealed pain at the posterolateral corner ("fig. 4 test"), popping, limping and rotational instability [12]. These symptoms, of PMFs tears are aspecific leading to delayed diagnosis and surgery. All patients participated in sports at least at a recreational level. Tegner activity scale, Lysholm scale, and IKDC score were administered in all cases. 1.5 TeslaMRI evaluation confirmed the damage to the popliteomeniscal fascicles in the sagittal plane and T2 sequences (Fig. 1A, B). The diagnosis was confirmed with direct arthroscopic inspection and probing of the lateral meniscus.

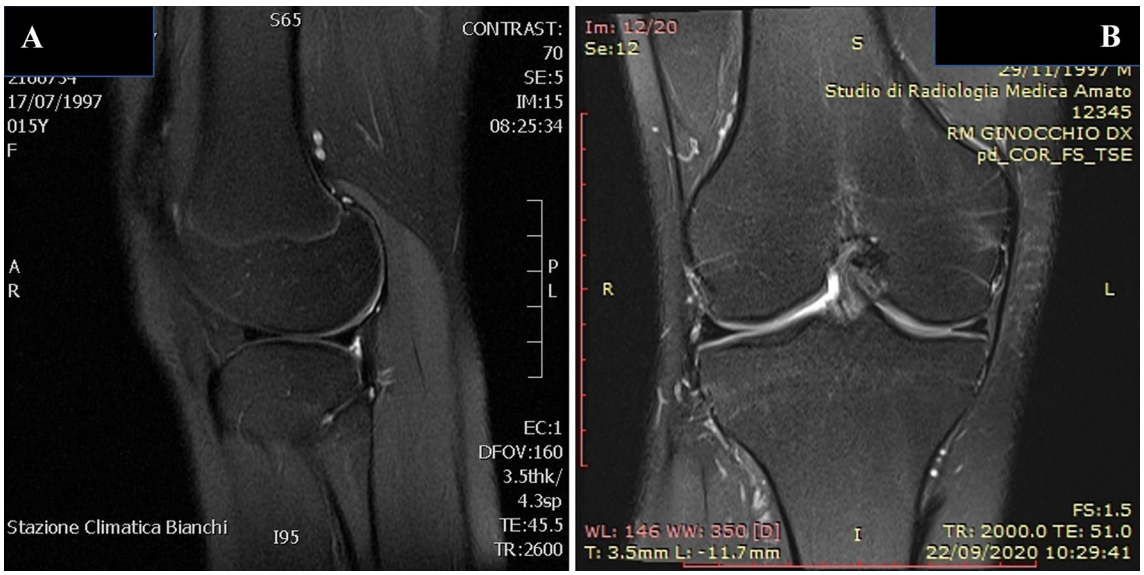

Fig. 1 **A**, **B** Preoperative MRI. Sagittal (**A**) and coronal (**B**) view of popliteomeniscal fascicles tears

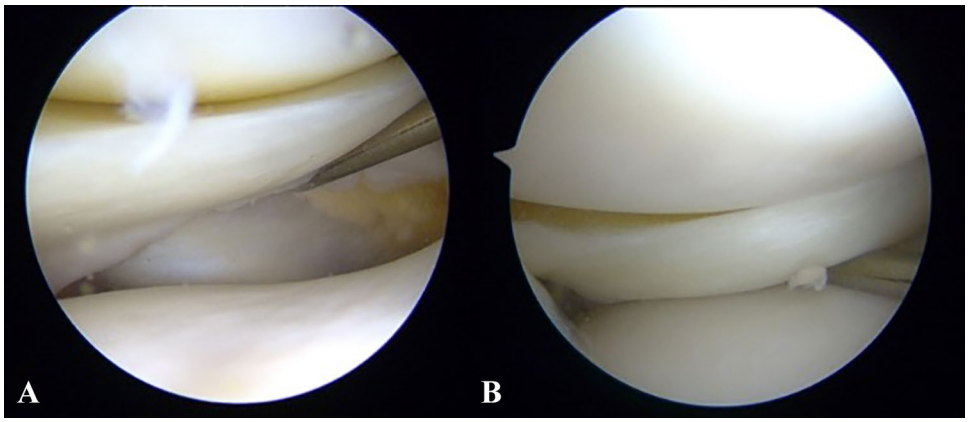

Fig. 2 **A**, **B** Intra-operative arthroscopic images of lateral meniscal instability. The instability was demonstrated by probing the lateral meniscus

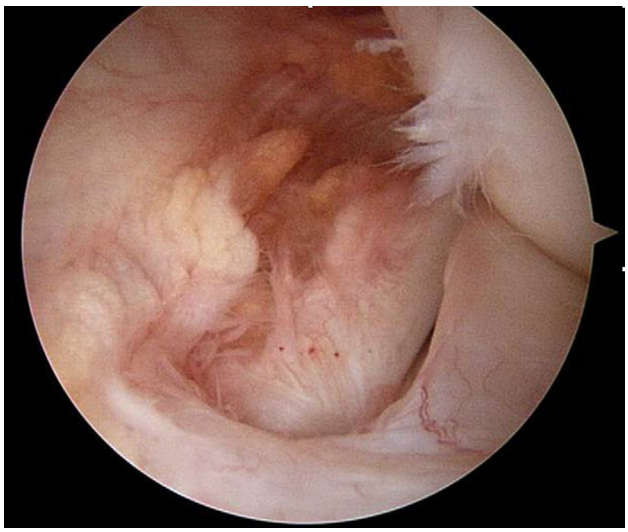

Fig. 3 Presence of a chondral lesion of the outer area of the lateral femoral condyle was associated with longer delays between injury and surgery

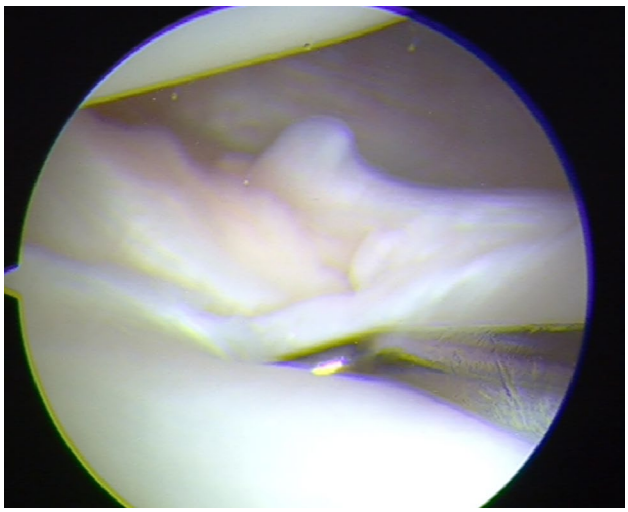

Fig. 4 Incoming lesion of the lateral meniscus is highly suspicious for an instability of the meniscus itself

Three specific intraoperative signs confirmed the diagnosis of PMF tears: hypermobility of the lateral meniscus (> 5 mm) during the probing test (Fig. 2A, B), the presence of a chondral lesion of the outer area of the lateral femoral condyle (especially when surgery was performed later than 12 months after trauma) (Fig. 3) and partial tear of the posterior horn of the lateral meniscus (incoming lesion) (Fig. 4). An all-inside arthroscopic meniscal repair including suturing of the injured PMFs was performed in in all cases.

Surgical technique

All of the procedures were performed by two senior surgeons (G.D.V and R.S.). Preoperative antibiotic prophylaxis with 1 g of cefazolin was administered 30 min before surgery [3]. Patients were placed supine without a leg-holder. A thigh tourniquet was inflated to 300 mmHg. A diagnostic arthroscopy was first performed using standard anterolateral and anteromedial portals. After evaluating the intra-articular environment of the knee and excluding other concomitant sources of pain (chondral lesion, foreign bodies, ACL tears, medial meniscus lesions), the lateral compartment was evaluated by positioning the knee in the "fig. 4" position, opening the posterolateral corner. The lateral meniscus was hooked with an arthroscopic probe to check its stability. If the meniscus body tended to move medially more than 5 mm, it was considered unstable and the popliteal hiatus was checked for PMF disruption (Fig. 2A, B). The extent of lateral meniscus hypermobility as a sign of PMFs tears is discussed. Shin et al. defined a threshold of more than half of the lateral meniscus excursion at probing [15]. We set the threshold of medial displacement at 5 mm, since it seemed easily reproducible with the aid of a graduated probe. Close arthroscopic inspection was performed to identify indirect arthroscopic signs, such as "incoming sign" and "chondral lesions." In the case of torn fascicles and a chondral lesion, it was often possible to find and treat the chondral lesion

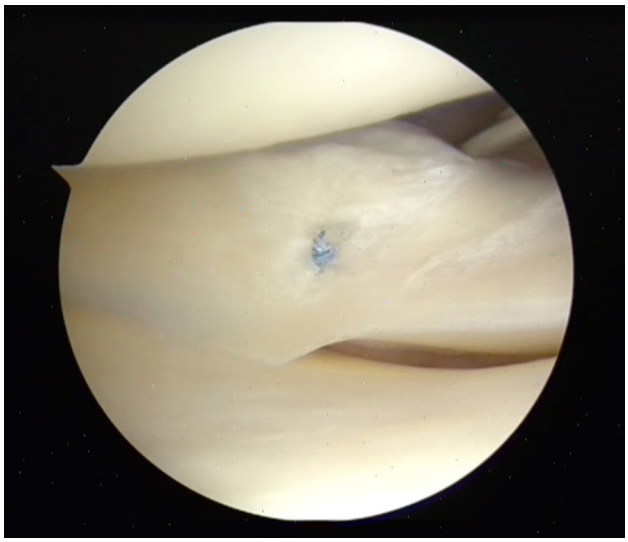

Fig. 5 Suture of PMF tears. After demonstrating the PMF tear and the instability of lateral meniscus, two or three stitches were placed to stabilize the lateral meniscus and making sure that the knots were on the capsular side

using a 70° scope and looking at the posterior area of the lateral femoral condyle. The fixation of the torn PMFs was performed with an all-inside technique (FAST-FIX meniscal repair system; Smith & Nephew, Andover, MA). Usually, 2–3 sutures (mean 2.2 ± 0.77) were placed on either side of the popliteal hiatus (Fig. 5), in a vertical fashion between the capsule and the meniscus, taking care to position the knots on the capsular side. Once meniscal stability was confirmed, the skin wounds were sutured, and the knee was placed in a hinged brace locked in full extension for 2 weeks.

Postoperative rehabilitation

The same postoperative protocol was used in all cases, with patients being positioned in an extension brace for 2 weeks and partial weight bearing as tolerated allowed with crutches. Passive 0–90° range of motion was allowed during the first 2 weeks, together with single leg raise. At 2 weeks, the extension brace was removed and active assisted 0–90° range of motion allowed for the next 2 weeks. At 1-month, full weight bearing and full passive range of motion were allowed; closed kinetic chain exercises with knee flexion limited to 90° were started. Running was allowed at 3–4 months, and unrestricted return to sport at 4–6 months. All patients were evaluated at a mean 68 ± 24 months (range 49–84 months) with the same follow-up questionnaires. Routine 1.5 TeslaMRI was performed in all cases at 6-month postop after resuming sport activities.

Statistics

Statistical analysis was performed using statistical software (SPSS v24.0; IBM, Armonk, NY, USA). Data were tested for normal distribution by use of the Shapiro–Wilk test. Continuous variables were expressed by mean ± standard deviation (SD) for normally distributed data and categorical variables were expressed as frequencies and percentages. Statistical differences between pre- and post-operative of clinical outcomes (IKDC, Lysholm and Tegner scores) were tested by paired *t* test for unpaired data.

Significance was set at $P < 0.05$.

Results

All patients were available at follow-up (mean 68 ± 24 months, range 49–84 months). Demographic data are summarized in Table 1. At preoperative clinical assessment, all patients reported a preoperative locking sensation and popping (*n* 17), limping (*n* 9), and experienced tenderness to palpation of the lateral compartment (*n* 17) with rotational instability in cutting maneuvers. A positive "Fig. 4 test" was present in all patients [12]. All PMF tears were confirmed by preoperative MRI. Nine patients showed isolated PMFs lesion while combined associated lesions (ACL rupture, medial meniscus tear and chondral lesions of the lateral femoral condyle *n* 10) were found in additional eight patients. All associated injuries (ACL tears, medical meniscal tears, or chondral lesions of the lateral femoral condyle) were treated during the

Table 1 Demographic data of the patients

Total no	17 patients
Age (years), mean ± SD (range)	22 ± 3.6 (14–35)
Time from injury to surgery, mean ± SD (range)	16 ± 13.6 (2–28)
Follow-up (months), mean ± SD (range)	68 ± 24 (49–84)
Gender, *n* (%)	
Male	14 (82)
Female	3 (18)
Isolated PMFs lesions	9 (52.9)
Patients with PMFs and associated lesions	8 (47.1)
Associated lesions, *n* (%)	
ACL tear	5 (29.4)
Medial meniscus tear	1 (5.8)
Chondral lesion of the lateral femoral condyle	4 (23.5)
Pre-injuries sport activities, *n* (%)	
Semi-professional	7 (41)
Recreational	10 (59)

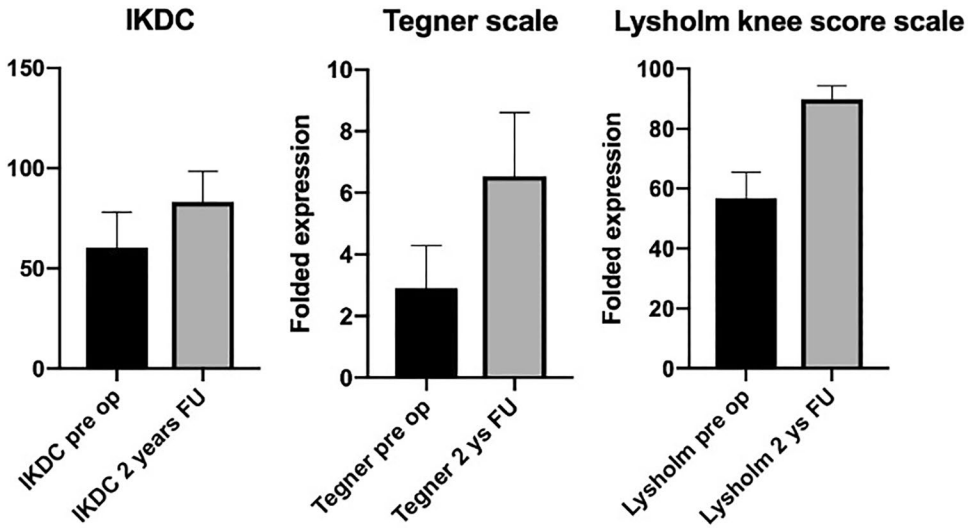

Fig. 6 Subjective evaluation scales

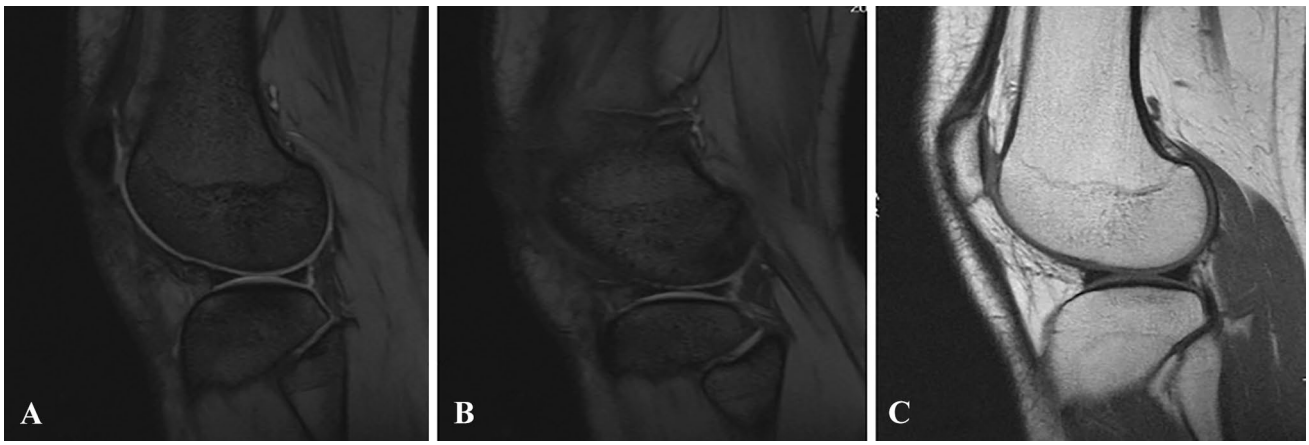

Fig. 7 **A**, **B**, **C** MRI post-operative. It is shown the successful repair of PMFs both in T1 and T2 in sagittal view

same surgical procedure. The medial meniscus tear was removed, the four chondral lesions of the lateral femoral condyle (stages 1–2 according the Outherbridge classification) were shaved with motorized instrument and the five ACL tears were reconstructed with autologous hamstrings.

No post-surgical complications were noted in any patients at mean follow-up of 68 ± 24 months (range 49–84 months). Clinical results are summarized in Fig. 6.

Significative improvement from the pre-operative values to the final follow-up for all outcome measurements (Fig. 6). The average subjective IKDC improved from 60.2 ± 13.5 (range 27 to 92) to 83.1 ± 12 (range 43 to 100) at last follow-up ($P < 0.05$). The mean Lysholm knee scoring scale improved from 56.7 ± 8.2 (range 40 to 68) to 89.8 ± 3.2 (range 80 to 96) at last FU ($P < 0.0001$). The mean pre-operative Tegner Activity scale score was 2.9 ± 1.3 (range 0 to 5) while at final evaluation it improved to 6.5 ± 2 (range 2 to 9) ($P < 0.0001$). Fourteen (82%) out of 17 patients reported good to excellent outcomes and 3 (18%) patients good to fair outcomes. Full return to pre-injury level of sports was observed in 13 out of 17 patients (76%).

MRI at 6-month follow-up showed successful healing of the repaired menisco-popliteal fascicles in all cases (Fig. 7). Return to sport data are summarized in Table 2.

Table 2 Post-operative return to sport

Post-surgery sport activities, *n* (%)	
Pre-injury level	13 (76.4)
Semi-professional to recreational activity	3 (17.6)
Change of sport activity	1 (6)

Discussion

Our investigation showed that the described all-inside arthroscopic PMF repair with anchors is a reliable and safe option in the treatment of PMF tears. In addition, no complications were reported, and MRI follow-up at 6 months showed healing of the fascicles in all cases.

Posterolateral rotatory instability (PLRI) of the knee is complex and often unrecognized [12]. Providing both a static and dynamic connection between the lateral meniscus and the popliteus tendon, the popliteomeniscal fascicles are important in controlling the motion of the lateral meniscus during flexion and extension of the knee [1, 9, 10]

Popliteomeniscal fascicle tears, once recognized, can be repaired to prevent further disability [2, 15, 16]. If left untreated, a hypermobile meniscus will require a lateral meniscectomy representing the beginning of the degeneration of the lateral compartment [9]. Li et al. demonstrated that popliteomeniscal fascicle tears were found in approximately 25% of patients after acute ACL tears [12, 17]. PMF tears were associated with a lateral meniscal tear in about 21% at baseline. Moreover, patients with an ACL tear and an isolated PMF tear underwent accelerated cartilage degeneration in the lateral compartment at 2-year follow-up compared to patients without PMF tears [17]. According to this evidence, if a PMF tear is confirmed by MRI and arthroscopically, it is recommended to be repaired in all cases.

Regarding the surgical technique, Simonian et al. reported satisfactory outcomes on 3 patients treated with an inside-out technique [18]. Complete healing of the lateral meniscus was shown either by postoperative MRI or second-look arthroscopy [18]. Camarillo and Johnson reported on two cases treated with an inside-out repair [19]. While one patient was successfully able to return to sport activity, the other patient had subsequent surgery with revision of the repair and eventually partial lateral meniscetomy [19].

LaPrade and Konowalchuk described an open technique to repair the lateral meniscus with lesions of the popliteomeniscal fascicles and popliteus tendon complex [10]. They reported on 6 patients, who were asymptomatic postoperatively and all returned to unrestricted activity at an average 3.8-year follow-up [10].

Shin et al. reported an arthroscopic all-inside technique, using a posterolateral portal through which an arthroscopic suture hook was inserted. No outcome data were reported. The authors described two intraoperative signs which were associated with popliteomeniscal tears: hypermobility of the meniscus at probing and osteochondral lesion of the posterior aspect of the lateral femoral condyle [9].

Suganuma et al. [20] described an open repair with a harvested iliotibial band graft fixed to popliteal tendon to restore the continuity of the popliteomeniscal fascicles and stability of the lateral meniscus [5]. This is, however, a technically demanding procedure and involves a non-anatomical reconstruction, although the reported outcomes were encouraging. However, because of the lack of comparative studies, it is not possible to draw a definitive conclusion on which is the ideal surgical technique. The present all-inside arthroscopic surgical technique provides enough stability to the lateral meniscus to restore normal knee function. Although the reported results in our investigation are encouraging, the present study has several notable limitations.

First of all, the cohort is small with only 17 patients included. PMF lesions are quite rare; however, to the best of our knowledge, the present study has the largest reported cohort. Second, our investigation is a case series with no comparative group to confirm the outcomes. Finally, although the 6-month MRI confirmed radiographic healing of the PMFs, the lack of a second look arthroscopy did not allow direct arthroscopic confirmation of healing and stability of lateral meniscus. Further studies with a larger number of patients and comparative cohorts are required to validate the present all-inside arthroscopic surgical technique.

Conclusions

The diagnosis and treatment of tears of the PMFs is still debated. Diagnostic confirmation of tearing of the PMFs is usually determined at the time of arthroscopy. Meniscal repair with an all-inside meniscal repair system appears to be an excellent treatment option, since it yields good functional results at mid-term follow-up, no local complications, and complete radiographic healing at 6-month follow-up MRI. Further studies are needed to confirm these promising early results.

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Declarations

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

Ethical approval This study was exempt from institutional approval.

Informed consent Informed consent were collected from all included subjects.

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