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Posterolateral approach for all-inside arthroscopic lateral meniscus repair in athletes: technique and outcomes

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Abstract

Introduction The past 2 decades have been marked by substantial progress in our knowledge of meniscus anatomy, function, and biomechanics, and also by the shifting of the surgical treatment of meniscal lesions from traditional meniscectomy towards arthroscopic repair to get away from the early osteoarthritis associated with meniscectomy. Posterior horn injuries of the lateral meniscus (LM) have been less studied due to their lower incidence and also due to the historical technical complexity of performing a repair in the posterolateral compartment.

Materials and methods A retrospective analysis of prospectively collected data was performed of all athletic patients who had a peripheral longitudinal tear of the lateral meniscal posterior horn and who underwent at least one repair procedure with a posterolateral approach between 2014 and 2018. The type of injury, extent of lateral meniscal tear, and characteristics of sutures placed were assessed. Clinical assessment included objective and subjective IKDC ratings. The Tegner activity level score was determined before the injury and at the last follow-up visit. Failure was defined as a need for revision surgery. All complications were documented.

Results The study population comprised 24 athletes with a mean follow-up of 25.2 ± 10 months. The Tegner activity level was exactly the same before the injury as after the surgery. The mean IKDC score significantly increased from 41.8 (12.2) before the surgery to 94.5 (9.1) after. There were four reoperations for failure (16.6%) that required a new suture repair. None of these revised repairs sustained a new failure as of the last follow-up.

Conclusion Despite the long learning curve, the posterolateral approach is a safe and effective technique for longitudinal tears of the posterior horn of the LM. The results of all-inside suture repair through a posterolateral portal are comparable to other techniques.

Keywords Posterolateral approach · All-inside lateral meniscus repair · Athletes · Meniscus suture

Introduction

The past 2 decades have been marked by substantial progress in our knowledge of meniscus anatomy, function, and biomechanics. These advancements have contributed to shifting the surgical treatment of meniscal lesions from traditional meniscectomy towards arthroscopic repair [1–3] to get away from the early osteoarthritis associated with meniscectomy [4–7].

Recent studies have mainly focused on lesions of the posterior horn of the medial meniscus. Posterior horn injuries of the lateral meniscus (LM) have been studied less due to their lower incidence and also the lower sensitivity of magnetic resonance imaging (MRI) for these lesions. The lack of studies on this subject can also be explained by the historical technical complexity of performing a repair in the posterolateral compartment [8–10].

Henning performed the first arthroscopic meniscal repair in the 1980s [11]. The techniques have improved since then to the point that multiple options are available for LM posterior horn repair including "all-inside", "inside-out" or

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"outside-in" suture techniques. The current generation of all-inside meniscal anchor devices is easier to use [12, 13]. These techniques have become widespread due to their availability; however, there is some concern about the increased rate of iatrogenic complications including implant irritation and cystic formation and the costs associated with meniscal anchors [14–18]. While "inside-out" and "outside-in" techniques resulted in better outcomes for the posterior portion of the LM at a lower cost, they are associated with a risk of neurovascular injury and require a skin incision [15, 17, 19, 20]. Modern methods and techniques for improving meniscal repair in anatomically challenging areas are still evolving. In 2006, Ahn et al. [21–23] described an arthroscopic "all-inside" technique using a posterolateral portal to repair these lesions with a suture hook and reported encouraging results in case series evaluation. The clinical failures and complications associated with these different techniques are reported in Table 1.

The purpose of this article was to evaluate the results of all-inside suture repair of longitudinal tears of the LM posterior horn with a suture hook using a posterolateral portal as described by Ahn et al. [23] in athletic patients. We hypothesized that an arthroscopic all-inside repair technique for longitudinal posterior horn tears of LM through a posterolateral portal with a suture hook device will provide clinical results that are at least equal to other meniscal repair techniques but with a lower complication rate.

Materials and methods

All patients with traumatic unstable longitudinal LM tears involving the posterior horn and for which at least one suture repair with a posterolateral approach was performed with a suture hook (all-inside suture hook technique) between 2014 and 2018 were identified from a database of prospectively collected data. Approval from the institutional review board (XXXXX blinded for review) was granted prior to commencement of this study.

All the procedures were performed by two specialized knee surgeons at the same facility. The all-inside suture hook technique was performed in active patients engaged in competitive sports, for reducible longitudinal tears located in the red–red zone or in the red–white zone of the LM.

Athletes with tears associated with anterior cruciate ligament (ACL) reconstruction were included. Patients with previous menisectomy/meniscal repair; multiligament injuries; evidence of arthritic changes on preoperative X-ray were excluded.

Bilateral weight-bearing radiographs, including AP, lateral, Schuss, or Rosenberg, and skyline views at 30 degrees of flexion were performed preoperatively. An MRI of the involved knee was performed in all patients.

Table 1 Failure and complication reported for the different meniscal repair techniques

Ref.	Type of study	Healing/clinical failure	Complication
Seo et al. [15]	Second look all-inside suture hook/all-inside anchor devices	Better healing status for all-inside suture hook ($p = 0.0048$)	NR
Westermann et al. [17]	Meta-analysis (21 Studies) Inside-out technique all-inside anchor device Technique	16% for all-inside anchor device versus 10% for inside out ($p = 0.016$)	Implant irritation and migration for all-inside anchor device technique
Fillingham et al. [24]	Systematic review (27 studies) inside-out versus all-inside anchor device	10% for all-inside anchor device versus 11% for inside out	4.6% for all-inside anchor device (DVT, infection, chondral injury) versus 5.1% for Inside Out (mainly nerve injury)
Grant et al. [25]	Systematic review (99 studies) Inside-out technique all-inside anchor device technique	19% for all-inside anchor device versus 17% for inside out	Nerve injury 9% for inside-out versus 2% for all-inside anchor device. Local irritative symptoms (14%) for all-inside anchor device
Ahn et al. [21]	Case series ($n = 13$) Bucket handle tear of LM repair with only All-inside suture hook or combined with outside-in technique	No clinical failure	No complications reported
Ahn et al. [21]	Case series ($n = 24$) recurrent subluxation of the lateral meniscus repair with only All-inside suture hook or combined with outside-in technique	No clinical failure	No complication reported

Arthroscopic assessment

During the surgery, the tear pattern was evaluated as being limited to the posterior horn (PH), affecting the posterior horn and mid-body (PH–MB), or extending to the anterior horn (PH–MB–AH), and also if it was a bucket handle or had posterior detachment. The number and type of "all inside" repairs with meniscal anchor, "all inside" with a hook by the posterolateral approach or "outside-in" were noted.

Clinical assessment

Patients were examined by the team who performed the surgery. In addition to traditional criteria such as body mass index, age, and time elapsed between injury to surgery, the objective and subjective IKDC questionnaire was completed for all patients before surgery and at the last follow-up visit. Patients were evaluated by the Tegner activity level score, which was related to their sports activity, before injury and after surgery at the last follow-up visit. For the failure cases, IKDC and Tegner evaluation was also performed at the last follow-up visit after the revision surgery. Failure of the suture repair was defined as a need for revision surgery for an LM lesion.

Statistical analysis

All calculations were made with SAS for Windows (v9.4; SAS Institute Inc). The level of statistical significance was set at $p < 0.05$. Descriptive data analysis was conducted depending on the nature of the considered criteria. For quantitative data, this include number of observed (and missing, if any) values, mean, standard deviation, median, first and third quartiles, and minimum and maximum. For qualitative data, this included the number of observed (and missing, if any) values, and the number and percentage of patients per class. The characteristics of the studied population were described for the meniscal repair failure group and for the non-failure group.

Surgical technique

A comprehensive arthroscopic exploration was performed through standard anterolateral and anteromedial arthroscopic portals. With the knee positioned in the figure-of-four position, a trans-notch exploration of the posterolateral compartment was systematically performed, When a peripheral longitudinal tear of the posterior horn was observed or suspected, a needle was introduced in an outside-in manner from the posterolateral aspect of the knee, 1 cm proximal to the joint line, and 1 cm posterior to the medial edge of the lateral condyle (Fig. 1).

Transillumination was used to identify the veins and nerves to ensure safe needle placement. When the presence of the tear was not easily visible and just suspected, the meniscal tear was probed with the needle to confirm the diagnosis [24]. The needle was then removed, and a posterolateral portal was created with a scalpel, under arthroscopic control.

Using the trans-notch view, the posterolateral tear of the LM was then debrided with a shaver introduced through the posterolateral portal (Fig. 2a). A 25° hook (Quick Pass Lasso Low profile; Arthrex, Naples, FL) loaded with a size 0 PDS absorbable suture (Ethicon, Inc., Somerville, NJ) was introduced through the posterolateral portal. The suture hook was manipulated by hand, so that the sharp tip penetrated the peripheral wall of the LM from top to bottom (Fig. 2b). Next, the suture hook was passed through the central (inner portion) of the torn LM from bottom to top (Fig. 2d). The free ends of the suture were grasped through the posterolateral portal and a sliding knot was tied and positioned onto the most posterior part of the meniscus with the help of a knot pusher (Fig. 2d). This maneuver was repeated as required depending on the length of the tear—one stitch was

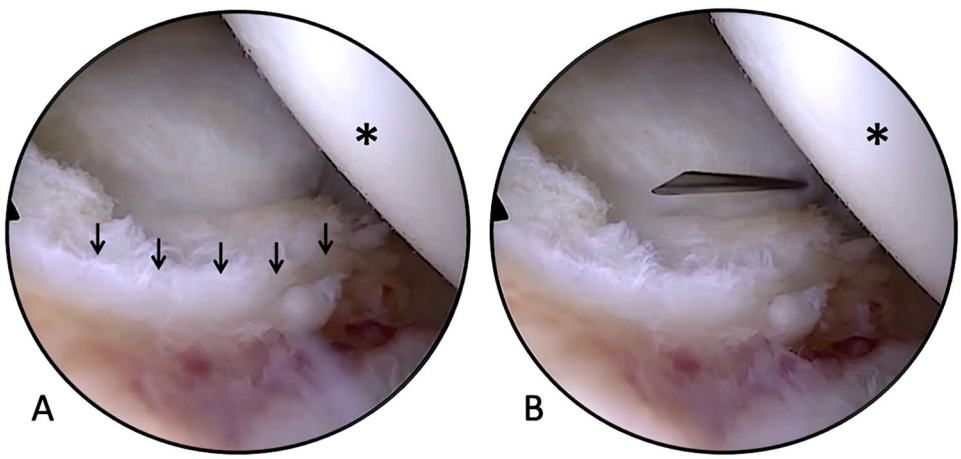

Fig. 1 Left knee. **a** Exploration of the posterolateral compartment using trans-notch view. A peripheral longitudinal tear (black arrows) is visible. **b** A needle is introduced in an outside-in manner to prepare the posterolateral portal placement. Asterisk lateral femoral condyle

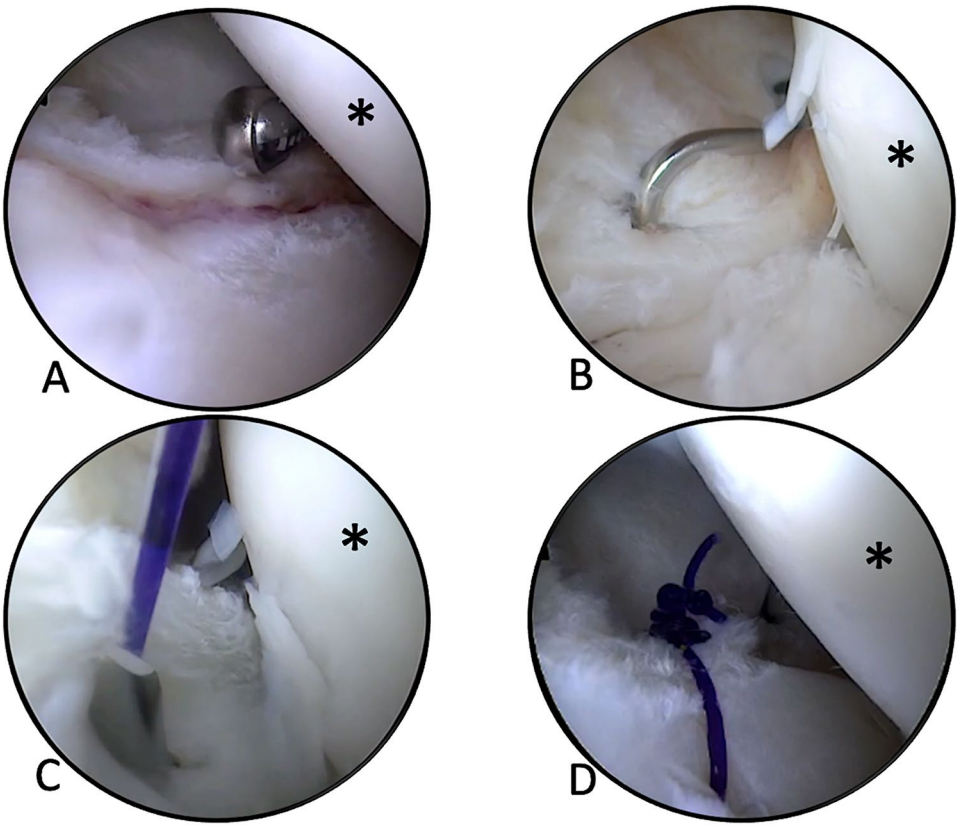

Fig. 2 Left knee. Trans-notch view **a** Debridement of the lesion with a shaver introduced through the posterolateral portal. **b** Suture hook loaded with size 0 PDS first penetrates the posterior edge of the lesion. **c** Suture hook emerges in the center of the lesion before penetrating the anterior edge of the meniscal tear. **d** Final appearance of the repair. Asterisk lateral femoral condyle

placed every 5 mm for tears limited to the posterior segment. When the tear extended towards the mid-body or up to the anterior horn, additional suture repair was performed using a meniscal suture anchor device through the anterior portal or using an outside-in technique. To finish the procedure, the repair's stability was tested with a probe.

Rehabilitation

Active and passive range of motion was limited to 0°–90° in the first 4 weeks. The range of movements was increased gradually with the aim of achieving full range within 6 weeks. Gradual weight bearing was initiated with the help of crutches after 4 weeks proceeding to full weight bearing by 8 weeks postoperatively. Jogging was started after 3 months followed by pivot activities after 5 months. Full return to the patient's preinjury activity and sport was allowed after 6 months of rigorous rehabilitation. ACL reconstruction did not alter the rehabilitation protocol.

Results

Between December 2014 and January 2018, 27 patients had an arthroscopic repair of a longitudinal tear involving the posterior horn of the LM. Two patients were not included as long as they had their repair performed in the posterior horn area with meniscal suture anchors through standard anterior portal, and one patient who presented with a multiligament injury was excluded leaving 24 patients for final analysis.

All the 24 patients were involved in competitive sports. Meniscal tears were found in 14 right and 10 left knees. An ACL injury was also present in 4 cases and ACL reconstruction was performed each time.

The mean follow-up was 25.2 ± 10 months. The mean age at surgery was 24.4 ± 8.8 years. The time elapsed between the injury event and surgery was 86.4 ± 106 days (min 2–max 539). Patient characteristics are given in Table 2.

An LM tear had been suspected based on the preoperative MRI in 14 of the 24 patients. Based on the intraoperative assessment, 19 of the lesions were bucket handle tears, 1 was an unstable discoid meniscus detached from its posterior menisco-synovial junction, and 4 were tears of the posterior horn of the lateral meniscus (PHLM) detached at the menisco-synovial junction. In more than half of the cases (13), the posterior horn tear also affected the mid-body (PH–MB); 8 were limited to the posterior horn (PH) and 3 affected the entire meniscus (PH–MB–AH) (Table 3).

The mean number of stitches placed was 3.3 (± 1). The number of all-inside stitches performed with the suture hook through the PL portal was 3 in one case, 2 in 13 cases, and 1 in 10 cases.

Table 2 Patient characteristics according to successful and failed repairs

	Success ($n=20$)	Failure ($n=4$)	Total ($N=24$)
Age at injury	24.5 ± 9.2	22.4 ± 6.3	24.1 ± 8.7
Sex			
Male	14 (70.0)	4 (100.0)	18 (75.0)
Female	6 (30.0)	–	6 (25.0)
Anthropometric data			
Height (cm)	178 ± 9	175 ± 7	177 ± 9
Weight (kg)	77.3 ± 17	72.8 ± 13	76.5 ± 17
BMI	24.3 ± 4	23.6 ± 2.7	24.2 ± 3.8
Sport activity			
Soccer	6	4 (100.0)	10 (41.7)
Soccer and biking	1	–	1 (4.2)
Soccer and gymnastics	2	–	2 (8.3)
Rugby	4	–	4 (16.7)
Handball	2	–	2 (8.3)
Judo	1	–	1 (4.2)
Basketball	1	–	1 (4.2)
Equestrian events	1	–	1 (4.2)
Badminton and dance	1	–	1 (4.2)
Competitive gymnastics	1	–	1 (4.2)
Time from injury to surgery (days)	96.7 ± 113	35 ± 25	86.4 ± 106
Follow-up (months)	23.8 ± 10	32.4 ± 9	25.2 ± 10

Data are reported as mean ± SD or *n* (%)

Table 3 Arthroscopic findings according to successful and failed repairs

	Success	Failure	Total
Lesion type			
Bucket handle	15 (75.0)	4 (100.0)	19 (79.2)
PHLM tear	4 (20.0)	–	4 (16.7)
Discoid meniscus (type 3*)	1 (5.0)	–	1 (4.2)
Lesion zone			
PH–MB	10 (50.0)	3 (75.0)	13 (54.2)
PH	7 (35.0)	1 (25.0)	8 (33.3)
PH–MB–AH	3 (15.0)	–	3 (12.5)
ACL tear (%)			
No	16 (80.0)	4 (100.0)	20 (83.3)
Yes	4 (20.0)	–	4 (16.7)

Data are reported as *n* (%)

PHLM posterior horn lateral meniscus, *PH* posterior horn, *MB* mid-body, *AH* anterior horn

*Watanabe M, Takeda S, Ikeuchi H (1979) Atlas of arthroscopy. Igaku-Shoin, Tokyo

For 20 patients, we used an all-inside meniscal anchor technique for the mid-body area and/or the anterior horn, and in 8 cases, an outside-in technique. None of the patients who suffered a failed repair had an outside-in procedure.

Table 4 IKDC scores according to successful and failed repairs

	Success	Failure	Total
0	41.2 ± 12.3	44.5 ± 13.1	41.8 ± 12.2
I.KDC postoperative	94.1 ± 9.7	96.5 ± 6.1	94.5 ± 9.1
Δ IKDC	52.9 ± 15.1	51.9 ± 17.5	52.7 ± 15.1

Data are reported as mean ± SD

The median Tegner score before the injury was 7 (min 4–max 10) and all patients had regained the same level at the last follow-up.

The *P* value for the Tegner score was not calculated, because the values before the injury and at last follow-up were exactly the same.

The objective and subjective IKDC scores were significantly improved at the last follow-up, and there was no difference between successful and failed repairs. The subjective IKDC rating increased from 41.8 (12.2) to 94.5 (9.1) (Table 4).

The objective IKDC score was C or less for 87.5% of the patients before surgery and A or B for 95.8% of the patients at the last follow-up.

Of the initial 24 patients, 4 (16.6%) had a failed repair and were re-operated by the same technique. Two more needed a new surgery: the first underwent arthroscopic arthrolysis for stiffness 4 months after the first surgery which included an

ACL reconstruction and the second underwent arthroscopic exploration for a suspected re-tear after almost 2 years. In both cases, the meniscus had healed (Table 5).

When we analyzed the failures, all of them occur in highly active athletes (preoperative Tegner score 9); these patients were professional soccer players or from a soccer training center. All the lesions were isolated bucket handle tears without associated ACL tear, all these patients were treated with an all-inside meniscal suture anchor for the midbody and/or the anterior portion of their LM (the outside-in repair technique was not used in the failures cases). The mean time elapsed between the surgery and failure was 9.3 months (± 7) and three of the revisions were for exactly the same lesion as initially. All of them underwent a successful second repair and were able to return to play at the same level than before the injury.

Discussion

The main finding of our study was that posterolateral all-inside suture repair of the LM is a safe and relatively effective technique in a population of athletes. Our failure rate was 16.6% and all cases were isolated LM bucket handle tears in professional soccer players. Surgical treatment for these bucket handle tears and for this specific population is still challenging. Nevertheless, all of them underwent a successful second repair using the same all-inside suture hook technique through posterolateral portal. This suggests that rehabilitation and return to sport should be cautiously monitored for these patients, especially in these cases of isolated meniscal tears as long as a faster and easier postoperative course is generally observed in contrast with patients who underwent a concomitant ACL reconstruction.

In our series, all the patients had an all-inside suture hook repair of the tear through a posterolateral in the posterior horn area, whereas different repair techniques were used for midbody and anterior horn. In these areas, some patients had an all-inside repair with a meniscal suture anchor devices, while other ones have and outside-in suture repair. The four patients with a suture repair failure had a meniscal suture anchor technique in the midbody area. Placement of meniscal anchors through anterior portal in the midbody area is challenging and an outside-in technique could be considered as a potential way of improvement that should be investigated in future studies.

To our knowledge, this is the first study focused on repair of longitudinal tears of the LM posterior horn using a posterolateral portal, especially in athletes. A similar study of 24 patients with posterolateral hook repair was published by Ahn et al. [22] in 2018, although they excluded bucket handle tears and concomitant ACL ruptures. They reported good outcomes with no failures with a mean follow-up of 41 months. In our study, we analyzed traumatic unstable longitudinal tears of the LM posterior horn including bucket handle tears; we believe that this extended lesion was the main reason for our higher failure rate [25, 26]. The second explanation for the higher failure rate is the higher sports competition level (median Tegner of 7 preinjury and postoperatively). Lower patient age, male gender, and higher activity have already been reported as a major risk factor for bucket handle tear repair failure [27]. Finally, it should be

Table 5 Details on reoperations

	Success	Failure	Total
Reoperation			
No	18 (90.0)	–	18 (75.0)
Yes	2 (10.0)	4 (100.0)	6 (25.0)
Time between surgeries (mo)	12.9 ± 13	9.3 ± 7	10.5 ± 8
Surgery indication			
MB new lesion	–	1 (25.0)	1 (16.7)
Pseudo-locking knee	1 (50.0)	–	1 (16.7)
Stiffness	1 (50.0)	–	1 (16.7)
Suture failure	–	3 (75.0)	3 (50.0)
Reoperation procedure			
2 all-inside sutures + 3 fast fix	–	1 (25.0)	1 (16.7)
Suspicion of failure—meniscus healed at arthroscopy	1 (50.0)	–	1 (16.7)
Arthrolysis—meniscus healed	1 (50.0)	–	1 (16.7)
3 all-inside sutures + 1 fast fix	–	1 (25.0)	1 (16.7)
2 all-inside sutures + 1 outside-in suture	–	1 (25.0)	1 (16.7)
Outside-in suture—previous lesion healed	–	1 (25.0)	1 (16.7)

Data are reported as *n* (%) or mean ± SD

MB mid-body

emphasized that all the failure were isolated lateral meniscal tear without associated ACL tear.

The repair technique through the posterolateral portal is technically demanding with a learning curve. However, once learnt, it has several advantages including suture placement under arthroscopic view and efficient tear debridement. Moreover, we have not experienced any iatrogenic complications with this posterolateral portal.

In their cadaveric study, Sanz-Pérez et al. [20] demonstrated that the proximity of the LM posterior horn to the popliteal artery determines the risk of vascular injury during suture repair. Morgan et al. [28] first described the all-inside suturing technique for posterior horn tears of the meniscus in 1991. This technique provided surgeons with a way to place vertically oriented sutures through peripheral posterior horn tears without the risks of nerve, blood vessel, or posterior capsular entrapment associated with outside-in and inside-out techniques.

In Grant's [26] systematic review comparing inside-out and all-inside repair with meniscal anchors of isolated meniscal tears, he found that there was no differences in the clinical failure rate or subjective outcomes between these two techniques. He concluded that complications are associated with both techniques, but nerve symptoms are more likely with the inside-out repair and implant-related complications are more likely with the all-inside meniscal anchor suture technique. The failure rate was 17% for inside-out repairs compared to 19% for all-inside anchor repairs. In that systematic review, the prevalence of nerve injury/irritation was higher with the inside-out technique (9% vs 2%). The all-inside anchor techniques had a higher rate of local soft-tissue irritation, swelling, and implant migration or breakage, while the use of older generation, rigid, all-inside implants was associated with chondral injury. In another systematic review, Fillingham et al. found the same results [25]. In our practice, we have not had any complications associated with use of all-inside anchor devices such as implant irritation, device migration, device failure, and chondral injury, nor the neurovascular complications associated with inside-out techniques [18, 20, 29]. In some cases; minimal chondral damage can be caused by the arthroscope on the medial aspect of the posterior lateral condyle when it is pushed through the intercondylar notch to access to the posterolateral compartment.

Meniscectomy is another surgical option, but given the risk of rapid chondrolysis [30–32] reported after LM resection, we advocate doing everything possible to repair these lateral meniscal tears.

There are some limitations to our study. First, it was a retrospective analysis with a small population due to the rareness of this type of lesion. Second, our study was not a comparative study. Third, the follow-up period was short, which makes it impossible to draw conclusions on the long-term results of this technique. Finally, successful and definite healing of the repaired LM was not confirmed with postoperative MRI arthrogram or second-look arthroscopy.

Conclusion

Our study demonstrates that posterolateral suture of the LM posterior horn is safe. The results are comparable to other techniques. Failures were associated with extended meniscal lesions in high-demand sports. Revision of the failed repair with the same all-inside suture hook technique was successful in all cases.

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Compliance with ethical standards

Conflict of interest One or more of the authors has declared the following potential conflict of interest or source of funding: Bertrand Sonnery-Cottet is a paid consultant, receives royalties and research support, and has made presentations for Arthrex. Mathieu Thaunat is a Consultant for Arthrex.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee of Ramsay Générale de Santé no. IRB COS-RGDS-2019-03-004-THAUNAT-M and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

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