

A Modified Arthroscopic All-inside Repair for Lateral Meniscal Tears Anterior to the Popliteal Hiatus: A Retrospective Case Series with Minimum 2-Year Follow-Up

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Abstract

Background

To determine the clinical and MRI outcomes after modified arthroscopic all-inside repair for lateral meniscal tears anterior to the popliteal hiatus.

Methods

Patients who underwent modified arthroscopic all-inside repair for lateral meniscal tears anterior to the popliteal hiatus at our institution were identified. The clinical assessment consisted of the symptoms of meniscal tears, McMurray test, and patient-reported outcomes (Lysholm score, Tegner score, and International Knee Documentation Committee (IKDC) score). The status of meniscal healing was assessed using postoperative MRI scan.

Results

Twenty-five patients met the inclusion criteria. The mean age was 27.60 ± 8.37 years (range, 16 to 43 years). The mean follow-up period was 26.04 ± 2.88 months (range, 24 to 36 months). At final follow-up, the symptoms of meniscal tears disappeared in 23 patients with a negative McMurray test. The patient-reported outcomes of Lysholm, Tegner, and IKDC score improved significantly compared to the preoperative values ($P = 0.001$). No significant differences were observed in postoperative clinical outcomes between patients with or without concomitant ACL tears ($P > 0.05$). Postoperative MRI scan showed that the repaired lateral meniscus anterior to the popliteal hiatus obtained healing in 23 (92.0%) patients and no healing in 2 patients.

Conclusion

This modified arthroscopic all-inside repair technique was safe and effective to treat lateral meniscal tears anterior to the popliteal hiatus, resulting in significantly improved clinical outcomes with a high healing rate and low risk of adjacent structures injury.

Background

Over the past decades, the anatomy and function of the lateral meniscus have been well recognized. The arthroscopic techniques for lateral meniscal repair have also evolved dramatically [1, 2]. However, arthroscopic repair for lateral meniscal tears anterior to the popliteal hiatus still presents a clinical challenge for orthopedic surgeons. The reason for this is multifactorial. First, several important structures are immediately behind the lateral meniscus, such as popliteus tendon, inferior lateral genicular artery (ILGA), and common peroneal nerve. There is a consensus regarding the possibility of iatrogenic injury to these adjacent structures during surgical procedure [3-7]. Recently, Uchida et al. reported that the rate of popliteus tendon injury could be as high as 94% during lateral meniscal repair anterior to the popliteal hiatus using FasT-Fix system [7]. Secondly, the joint capsule around the popliteal hiatus is quite thin.

Therefore, suture knots or anchors could not be placed securely over the capsule [3]. Thirdly, the connection between the lateral meniscus and the joint capsule in this region is interrupted by popliteal hiatus, resulting in poor vascular supply and low healing rate. In a previous study, Horibe et al. demonstrated that the lateral meniscus anterior to the popliteal hiatus had a significantly lower healing rate compared with lateral meniscal posterior horn (63% vs. 97%, $P < 0.05$) [8]. Therefore, how to safely and effectively repair the lateral meniscal tears anterior to the popliteal hiatus and promote the healing are the main challenges in treating these lesions.

Although lateral meniscal tears anterior to the popliteal hiatus is quite common in clinical practice, to our best knowledge, there is still very limited data in the literature regarding optimal arthroscopic repair technique for these lesions [9-11]. Since July 2015, we started to perform a modified arthroscopic all-inside repair using spinal needle and suture hook for lateral meniscal tears anterior to the popliteal hiatus. This study aimed to determine the clinical and MRI outcomes after this procedure. We hypothesized that this procedure would yield satisfactory clinical and MRI outcomes with a high healing rate and low risk of adjacent structures injury.

Methods

Study design

From July 2015 to December 2017, the medical records of patients who underwent modified arthroscopic all-inside repair for lateral meniscal tears anterior to the popliteal hiatus at our institution were identified. The indication of this procedure was a lateral meniscal tear anterior to the popliteal hiatus which was full-thickness or nearly full-thickness, longitudinal, with a length of tear > 1 cm, and located in red-red zone or red-white zone. The inclusion criteria were (1) patients who were diagnosed with lateral meniscal tears anterior to the popliteal hiatus and underwent modified arthroscopic all-inside repair, and (2) patients with a minimum 2-year follow-up. The exclusion criteria were (1) age older than 45 years, (2) patients with concomitant medial meniscal tears, (3) significant osteoarthritis of the joint (Kellgren-Lawrence grade III or IV), or (4) previous surgery of the same knee.

A total of 39 patients (39 knees) were identified (**Fig. 1**). As 12 patients had concomitant medial meniscal tears, 1 patient had previous surgery and another patient was lost to follow-up, we studied the remaining 25 patients (25 knees). Among them, 16 patients had concomitant anterior cruciate ligament (ACL) tear. The remaining 9 patients were isolated lateral meniscal tear. Preoperatively, all patients had different degrees of symptoms of meniscal tears, including pain, effusion, snapping and catching. And a positive McMurray test was identified in all patients.

This study received approval from our institutional review board. Informed consent was obtained from all individual participants included in the study.

Surgical technique

All surgeries were performed under general anesthesia. The patients were placed in a supine position. A routine arthroscopic evaluation was conducted using two standard anterior knee arthroscopy portals. If the ACL was torn, the lateral meniscus was addressed before ACL reconstruction.

Once a lateral meniscal tear anterior to the popliteal hiatus was confirmed (**Fig. 2a**), the torn edge was refreshed using a meniscal rasp. An 18-gauge spinal needle could also be utilized to pierce the torn edge to encourage bleeding.

Then the arthroscopy was placed in anterolateral portal, and the anteromedial portal was used as working portal. Passed an 18-gauge spinal needle preloaded with a No. 2 polydioxanone suture (PDS; Ethicon, Somerville, NJ) through the skin approximately 1.5~2 cm anterosuperior to the tip of the fibular head, subcutaneous tissue, and capsule. The needle emerged from the inferior surface of the lateral meniscus. Advanced the PDS suture through the spinal needle and the end of PDS suture was pulled out via the anteromedial portal using a suture retriever (**Fig. 2b**). Pulled back the needle out of the skin and the other end of PDS suture was pulled out over the superior surface of the lateral meniscus.

A 45° suture hook preloaded with a suture loop was introduced via the anteromedial portal and pierced through the inner part of the meniscus approximately 5 mm away from the torn edge. The suture loop was used as a shuttle relay to transport the end of PDS suture (on the inferior surface of the lateral meniscus) to the superior surface of the lateral meniscus. Now both the ends of PDS suture were on the superior surface of the lateral meniscus and became a vertical mattress stitch ready to be tied (**Fig. 2c**). Tied the sutures with a knot-pusher and adjusted the knot into the popliteal hiatus to avoid knot impingement with articular cartilage (**Fig. 2d**). The same maneuver was repeated as necessary to provide a stable meniscal repair. According to our experience, two stitches were usually needed for lateral meniscal tears anterior to the popliteal hiatus. If the meniscal tears extended anteriorly to the meniscal body or posteriorly to the posterior horn, the extension part was repaired using FasT-Fix system (Smith & Nephew, USA). After completion of lateral meniscal repair, the suture tension was checked with a probe.

Postoperative rehabilitation

Postoperatively, a hinged brace was applied for 12 weeks. Quadricep-strengthening exercises were started on the second day. Flexion was limited to 90 degrees during the first 4 weeks and gradually increased to normal at 12 weeks. Toe-touch weight-bearing was permitted at 4 weeks and full weight-bearing with the brace was permitted at 6 weeks. Squatting and swimming were started at 3 months. Running and bicycling were started at 6 months. Full return to competitive sports was allowed at 12 months.

Assessment

Demographic data were collected from the database, including age, sex, side of injury, time from injury to surgery, and concomitant surgical procedures. Clinical outcomes were assessed preoperatively and at final follow-up.

The clinical outcomes were assessed based on (1) symptoms of meniscal tears, including pain, effusion, snapping and catching, (2) McMurray test, and (3) patient-reported outcomes (Lysholm score, Tegner score, and International Knee Documentation Committee (IKDC) score). For the patients undergoing concomitant ACL reconstruction, the KT-1000 arthrometer (Metric, San Diego, USA) was used to measure the side-to-side difference (SSD) for assessment of joint stability.

At final follow-up, all patients underwent MRI (3.0-T MR System, Signa Excite, GE Medical Systems, Waukesha, Wisconsin, USA) of the knee joint to assess the status of meniscal healing. According to Lim's criteria, if there was no high-signal-intensity linear area extending to an articular surface of the meniscus, it was regarded as meniscal healing. Otherwise, it was regarded as no healing [12].

Statistical analysis

All statistical analyses were performed using SPSS software (IBM-SPSS statistics 22.0; New York, USA). Continuous variables were presented as the mean \pm standard deviation. A paired-samples t test was used to determine the differences between preoperative and postoperative quantitative variables. In order to assess the influence of concomitant ACL tears on postoperative patient-reported outcomes, an independent-samples t test was used to determine the differences in postoperative clinical outcomes between patients with or without concomitant ACL tears. The significance level was set at 0.05.

Result

Demographic data

In the end, 25 patients met the inclusion criteria and were enrolled in this study. There were 16 males and 9 females with a mean age of 27.60 ± 8.37 years (range, 16 to 43 years). Among this group, 16 patients underwent concomitant ACL reconstruction for ACL tear. The demographic data of the patients are summarized in **Table 1**.

Table 1. Demographic data of the patients

Variable	Value
Patients, n	25
Age, y	27.60 ± 8.37
Sex, male/female	16/9
Side, right/left	15/10
Time from injury to surgery, d	68.72 ± 83.63
Patients with concomitant ACL tear, n	16
Follow-up period, mo	26.04 ± 2.88

The data are shown as mean \pm standard deviation or n. ACL, anterior cruciate ligament.

Clinical outcomes

The mean follow-up period was 26.04 ± 2.88 months (range, 24 to 36 months). At final follow-up, the symptoms of meniscal tears disappeared in 23 patients with a negative McMurray test. Two patients occasionally felt slight activity-related pain in the posterolateral area of the knee joint and a suspicious positive McMurray test was identified in both patients. For the patients with concomitant ACL reconstruction, the preoperative and postoperative SSD were 8.11 ± 1.62 mm (range, 6 to 11 mm) and 1.35 ± 0.93 mm (range, 0 to 3 mm), respectively. There was a significant difference between preoperative and postoperative SSD ($P = 0.001$).

The preoperative Lysholm score, Tegner score, and IKDC score were 41.44 ± 17.66 , 1.89 ± 1.15 , and 42.26 ± 18.42 , respectively. The postoperative Lysholm score, Tegner score, and IKDC score were 99.60 ± 1.38 , 6.16 ± 0.89 , and 99.40 ± 1.47 , respectively. There were significant differences between preoperative and postoperative patient-reported outcomes ($P = 0.001$) (**Table 2**).

Table 2. Comparison of the preoperative and postoperative patient-reported outcomes

Variables	Preoperative	Postoperative	P Value
Lysholm score	41.44 ± 17.66	99.60 ± 1.38	.001
Tegner score	1.89 ± 1.15	6.16 ± 0.89	.001
IKDC score	42.26 ± 18.42	99.40 ± 1.47	.001

The data are shown as mean \pm standard deviation. IKDC score, International Knee Documentation Committee score.

The postoperative Lysholm score, Tegner score, and IKDC score in patients with concomitant ACL tear were 99.68 ± 1.25 , 6.18 ± 0.83 , and 99.43 ± 1.24 , respectively, and in patients without concomitant ACL tear were 99.44 ± 1.66 , 6.11 ± 1.05 , and 99.36 ± 1.90 , respectively. There were no significant differences in postoperative clinical outcomes between patients with or without concomitant ACL tears ($P > 0.05$) (**Table 3**).

Table 3. Comparison of postoperative patient-reported outcomes between patients with or without concomitant ACL tears

Variables	Patients with concomitant ACL tear (n=16)	Patients without concomitant ACL tear (n=9)	P Value
Postoperative Lysholm score	99.68 ± 1.25	99.44 ± 1.66	.683
Postoperative Tegner score	6.18 ± 0.83	6.11 ± 1.05	.843
Postoperative IKDC score	99.43 ± 1.24	99.36 ± 1.90	.927

The data are shown as mean ± standard deviation. IKDC score, International Knee Documentation Committee score.

MRI outcomes

At final follow-up, postoperative MRI scan showed that the repaired lateral meniscus anterior to the popliteal hiatus obtained healing in 23 (92.0%) patients and no healing in 2 patients (**Fig. 3**).

Complications

No infection, arthrofibrosis, or injury of adjacent structures (including popliteus tendon, ILGA, and common peroneal nerve) occurred among this group. Although two patients occasionally felt slight activity-related pain, no reoperation was required.

Discussion

The main finding of this study was that this modified arthroscopic all-inside repair for patients with lateral meniscal tears anterior to the popliteal hiatus yielded favorable clinical and MRI outcomes at a mean follow-up of 26.04 months. A high rate of meniscal healing (92.0%) and low risk of adjacent structures injury were observed. In addition, patients with concomitant ACL tears had similar postoperative patient-reported outcomes compared to patients without concomitant ACL tears.

In 1979, Cohn was the first to report that the popliteal hiatus was a constant feature of normal knee anatomy, with an average length of 1.3 cm [13]. Similarly, Aman et al. described that the mean length of superior popliteal hiatus exceeded 12.1 mm and the mean length of inferior popliteal hiatus was up to 36.9 mm [3]. It is generally considered that a meniscal tear requires surgery for better stability if the length of tear exceeds 1cm [1]. Therefore, when a lateral meniscal tear anterior to the popliteal hiatus occurs and exceeds 1 cm, surgery should be considered. Currently, the surgical methods for meniscal tears mainly include meniscectomy and meniscal repair. As multiple studies have shown that meniscectomy would lead to decreased tibiofemoral joint contact area, increased cartilage stress load, and accelerate

degenerative joint changes [14-16]. Therefore, meniscal repair should be considered a priority in managing meniscal tears, especially for young patients.

For lateral meniscal repair anterior to the popliteal hiatus, some authors suggested using the popliteus tendon for meniscal repair device placement, and preliminary data have been reported [10, 11]. Nevertheless, this technique has several disadvantages. First, it provides a non-anatomical repair, which would close down the popliteal hiatus, reduce the normal mobility of lateral meniscus, and even cause iatrogenic lateral meniscus extrusion [17-19]. Second, it has a high risk of adjacent structures injury, including popliteus tendon, ILGA, and common peroneal nerve [4-7]. The ILGA has been reported to be the main source of blood supply for lateral meniscus anterior to the popliteal hiatus, so its injury would significantly influence the meniscal healing [20]. Third, the suture anchors placed within or outside the popliteus tendon was a risk factor for local irritation, as well as suture loosening because of the anterior movement of the anchors in popliteus tendon during knee motion [21, 22].

Alternatively, Farrow et al. described placing the suture anchors just outside the lateral meniscus without penetrating the popliteus tendon [9]. This technique aimed to restore the native physiologic properties of the lateral meniscus and avoid injury to adjacent structures. However, this technique is more technically challenging as it requires an accurate depth of penetration to avoid overpenetration or underpenetration. Thus, it is not fit for the surgeons in early learning curve. Furthermore, it requires both sides of the torn edge have sufficient tissue, resulting in a limited clinical application.

In this study, we present a modified arthroscopic all-inside repair technique using spinal needle and suture hook for lateral meniscal tears anterior to the popliteal hiatus. Compared with other techniques, we believe our technique has some advantages. First, our technique provides an anatomical repair. Therefore, it preserves the native physiologic properties of the lateral meniscus. Second, all the manipulations are conducted before the adjacent structures and under direct arthroscopic visualization, resulting in a relatively low risk of adjacent structures injury. Third, our technique is less technically challenging and does not require specific repair instrumentation, so it is fit for surgeons in early learning curve.

Limitations

There are some limitations in this study. First, this study was a retrospective study with all the inherent limitations of a retrospective study. Second, this study did not involve any control group. Future blinded comparative study is required to determine whether our technique is superior to other repair techniques. Third, successful healing of the repaired lateral meniscus was not confirmed by second-look arthroscopy. Second-look arthroscopy allows for direct inspection of the repair site. However, since it is invasive and expensive, it is rarely performed at our institution.

Conclusions

Overall, this modified arthroscopic all-inside repair technique was safe and effective to treat lateral meniscal tears anterior to the popliteal hiatus, resulting in significantly improved clinical outcomes with a high healing rate and low risk of adjacent structures injury.

Abbreviations

IKDC: International Knee Documentation Committee

ILGA: inferior lateral genicular artery

ACL: Anterior cruciate ligament

PDS: polydioxanone suture

SSD: side-to-side difference

Declarations

Ethics approval and consent to participate

All patients provided signed informed consent to allow their clinical and radiologic data to be used for research programmes.

The name of the Board: Institutional Review Board of Fuzhou Second Hospital of Xiamen University. Approval number is INR 10020190112.

Consent for publication

All patients signed informed consent regarding publishing their data and photographs.

Availability of data and materials

The raw data are available from the corresponding author upon reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

None.

Authors' contributions

All authors contributed to the study conception and design. HZ analysed and interpreted the patient data. FZ and LP were major contributors to manuscript writing. JL performed all the surgeries. All authors read

and approved the final manuscript.

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Figures

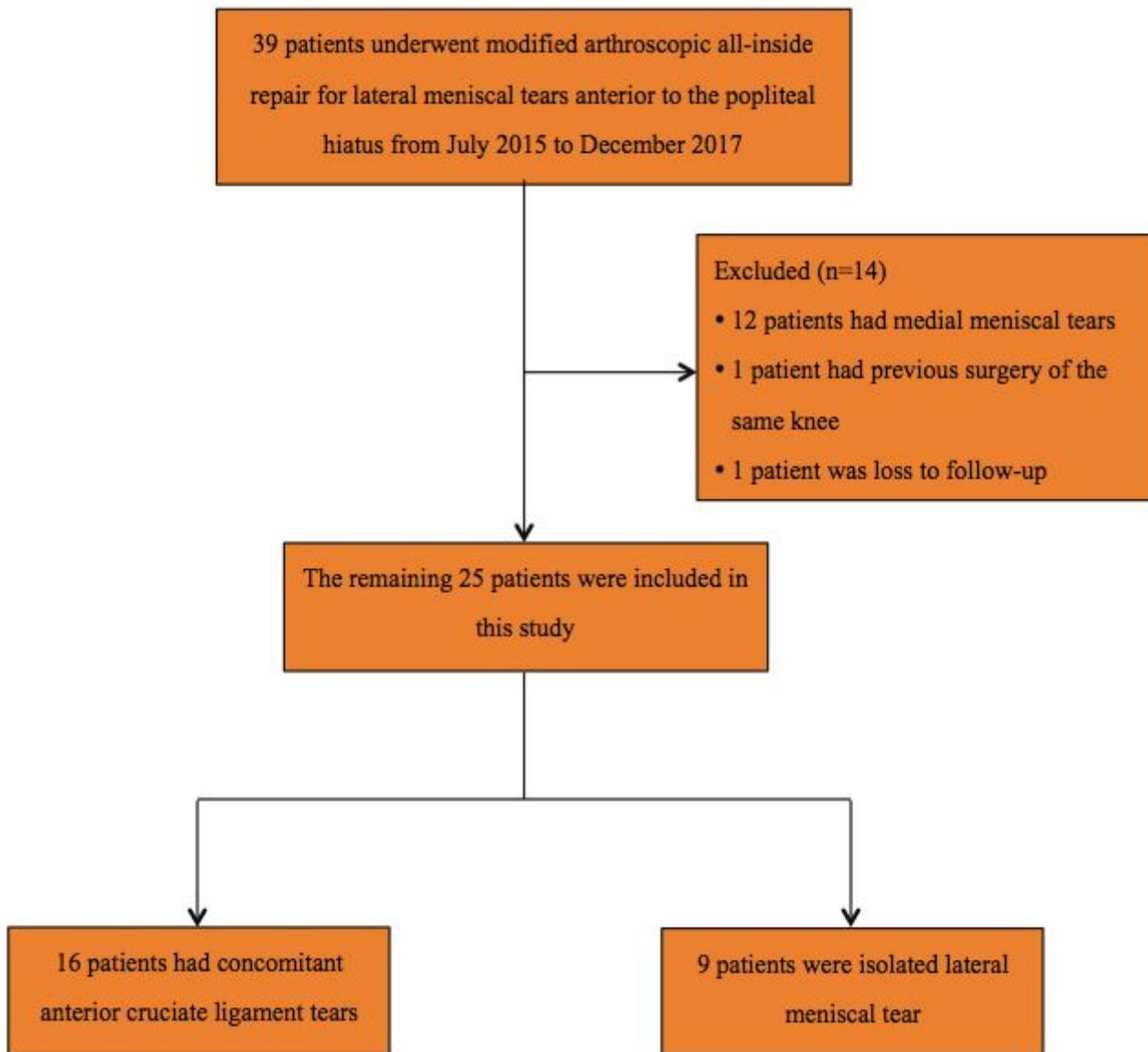


Figure 1

Flow chart of this study.

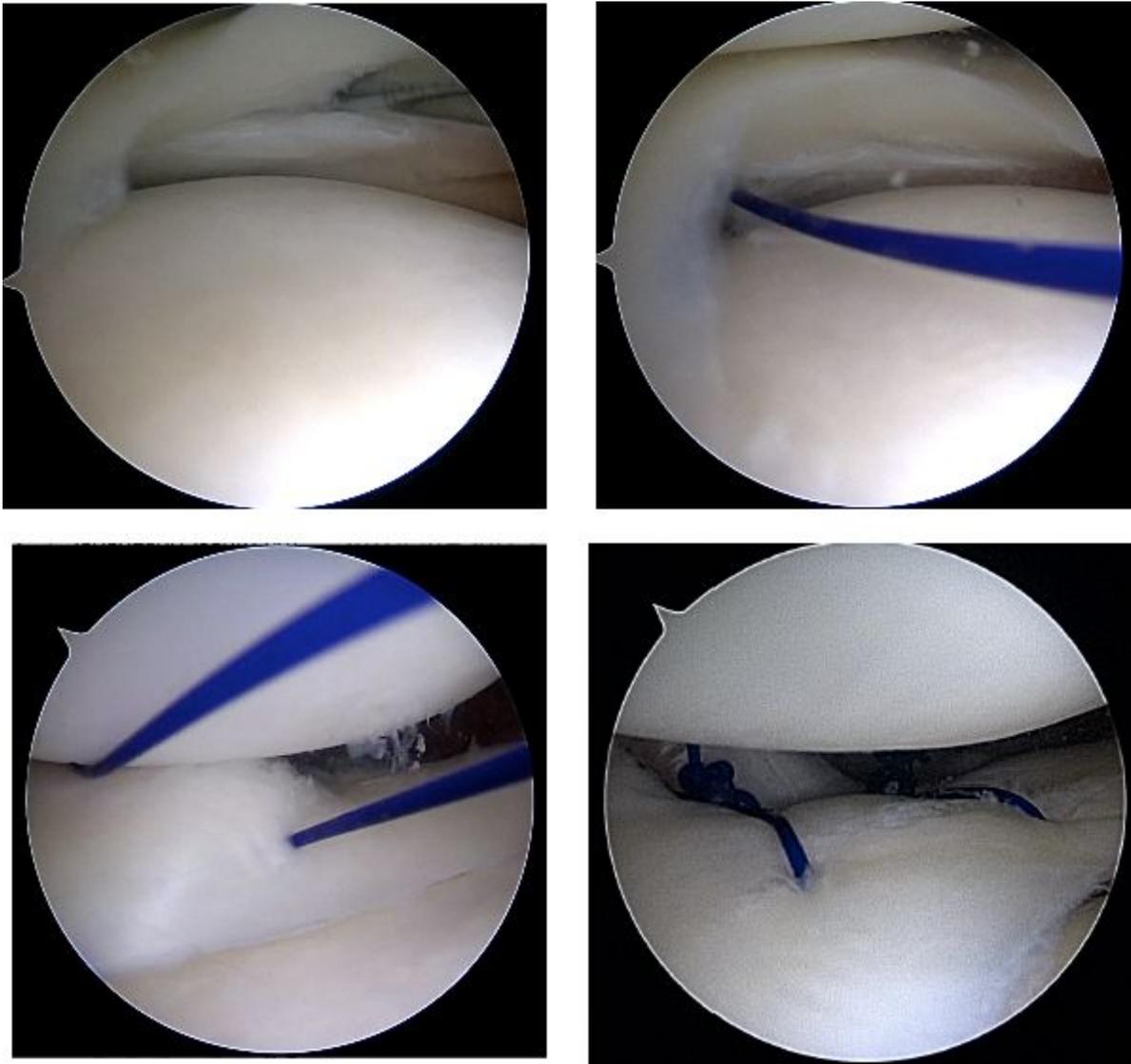


Figure 2

Modified arthroscopic all-inside repair for lateral meniscal tears anterior to the popliteal hiatus (right knee). a A lateral meniscal tear anterior to the popliteal hiatus was confirmed by a probe. b One end of PDS suture was pulled out from the inferior surface of the lateral meniscus. c Both the ends of PDS suture were on the superior surface of the lateral meniscus and became a vertical mattress stitch ready to be tied. d Adjusted the knot into the popliteal hiatus.



Figure 3

a Preoperative MRI showed a lateral meniscal tear anterior to the popliteal hiatus (white arrow). b Postoperative MRI showed that the repaired lateral meniscus obtained healing.

Supplementary Files

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