Journal of Orthopaedic Surgery and Research

RESEARCH

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Arthroscopic all-inside wrapping repair of lateral meniscus bucket-handle tears: clinical and imaging outcomes

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Abstract

Purpose This study aimed to assess the clinical and radiographic healing rates of the arthroscopic all-inside wrapping repair technique for lateral meniscus bucket-handle tears (LMBHTs).

Methods This retrospective study examined patients diagnosed with LMBHTs who underwent all-inside wrapping repair with or without anterior cruciate reconstruction between 2012 and 2021. Patients with previous knee surgeries, multiligamentous knee injuries, or advanced osteoarthritis were excluded. Clinical follow-up was at least 2 years. Clinical healing was defined as no reoperation of LMBHTs following initial repair and the absence of symptoms related to the LMBHT during follow-up. Postoperative clinical outcomes were assessed using the International Knee Documentation Committee (IKDC) score. At 6 months postoperatively, the healing of the repaired meniscus was evaluated using Henning's criteria through magnetic resonance imaging (MRI).

Results Of the 34 patients included, two required re-operation for a re-tear of the BHT, resulting in a clinical healing rate of 94.1% (95% confidence interval [CI]: 82.9–99.2%) at a mean follow-up of 4.2 years. Among the remaining 32 patients, the mean postoperative IKDC score was 83.7 ± 8.2 (range, 70–95). MRI evaluations at 6 months postoperatively revealed complete healing in 64.7% (22/34; 95% CI: 47.9–79.5%), partial healing in 23.5% (8/34), and failure to heal in 12.5% (4/34, including the two re-tear cases). Subgroup analyses indicated no significant difference in the IKDC scores between patients with complete healing and those with partial healing on MRI (85.5 ± 7.9 vs. 82.3 ± 8.5; $p = 0.53$). Future studies with larger cohorts and stratified analyses are needed to explore potential predictors of healing outcomes.

Conclusions The all-inside wrapping repair technique demonstrated favorable outcomes in patients with lateral BHTs and can be used as a viable alternative.

Keywords Lateral meniscus repair, Bucket-handle tear, All-inside wrapping repairn

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Introduction

The meniscus plays a critical role in various aspects of knee function, including shock absorption, load distribution, joint stability, lubrication, and proprioception [3, 21, 27, 31, 32]. Meniscus repair is frequently performed for knee injuries; extensive research has consistently demonstrated the advantages of meniscus repair compared with partial or total meniscectomy [1, 9, 17, 19].

Bucket-handle tears (BHTs) are vertical longitudinal type of meniscal tears that can be displaced toward the intercondylar notch. These tears account for approximately 10–16% of all meniscus tears and are frequently observed in males aged < 40 years [7, 22].

Despite meniscus repair having a higher reoperation rate than partial meniscectomy, meniscus repair is associated with superior long-term outcomes [25]. In a study by Kalifis G et al., specific long-term follow-up investigations of BHTs revealed that the chondroprotective effects associated with meniscus repair outweigh the significant failure risk [15].

Arthroscopic meniscus suture techniques encompass three main types: inside–out repair, outside–in repair, and all-inside repair [13]. The all-inside technique has gained popularity recently because of the wide range of suture devices available, offering advantages, including ease of use, reduced operative times, and lower risks of nerve injury [10, 14, 30]. Nevertheless, in cases where the meniscus fails to heal, implant-related complications can occur, such as chondral damage and synovitis [14, 16, 20]. A recent systematic review examining various suture devices has reported an overall failure rate of 29.3% for all-inside repair of BHTs [5].

Although the inside–out repair method remains the gold standard for meniscal repair [18], this technique necessitates an additional incision and carries a risk of injury to neurovascular structures. To date, no conclusive data have indicated the superior technique for addressing BHTs, making the choice of technique largely dependent on the surgeon's preference. Clinical survival studies investigating the all-inside technique for repairing BHTs have yielded mixed results, with most studies focusing on different suture devices [5, 18, 23].

This study presents clinical and radiographic outcomes of a technique for repairing lateral meniscus bucket-handle tears (LMBHTs) using arthroscopic all-inside wrapping of the torn meniscus. This approach combines the advantages of the all-inside repair technique while reducing potential complications linked to meniscus fixation devices.

Our hypothesis is that the all-inside wrapping repair technique achieves clinical and radiological outcomes comparable to those of established repair methods.

Methods

This study was approved by the Institutional Review Board. We retrospectively reviewed medical records to identify cases of lateral BHTs repaired at our institution by a single surgeon between 2012 and 2021.

This study had the following inclusion criteria: (1) confirmation of LMBHT during intraoperative assessment, with or without anterior cruciate ligament (ACL) tear, (2) repair of the LMBHT using the all-inside wrapping repair technique, (3) performance of follow-up magnetic resonance imaging (MRI), and (4) obtaining postoperative International Knee Documentation Committee (IKDC) scores and clinical outcome assessments after a minimum of 2 years.

In cases where the patient presented with symptoms suggestive of meniscus re-tear, an MRI was conducted before the 6-month postoperative mark. In other cases, as per our standard protocol, follow-up MRI scans were typically scheduled at around 6 months postoperatively.

The exclusion criteria were (1) history of previous knee surgery, (2) presence of multiligamentous knee injuries, (3) discoid lateral meniscus rupture, (4) concurrent medial meniscus tear, and (5) osteoarthritis with Kellgren and Lawrence system grade > 1.

Surgical technique of the all-inside wrapping repair technique

All patients were placed in the supine position, and the lateral meniscus was accessed using the figure-of-four position. Diagnostic arthroscopy was performed through the anterolateral and anteromedial portals. In cases where an ACL tear was combined, it was reconstructed following meniscal repair. An additional medial accessory portal was created just medial to the patellar tendon for suture retrieval.

Generally, for suturing the anterior portion of lateral meniscus, we used the anterolateral portal as the viewing portal, the anteromedial portal as the working portal, and the medial accessory portal for suture retrieval. For suturing the posterior portion of the lateral meniscus, we used the anterolateral portal as the working portal, the anteromedial portal as the viewing portal, and the medial accessory portal for suture retrieval.

After identifying the BHT from the viewing portal, the initial step involves placing a "traction suture" for a mobile BHT, which gently applies traction to the torn part of the meniscus. This creates a space that facilitates the refreshment of the torn edge of the meniscus and allows for a thorough assessment of the extent of the tear.

Each individual wrapping knot was created using a suture hook (Spectrum, ConMed Linvatec, Largo, Florida, USA) loaded with Polydioxanone (PDS) suture. The hook is inserted through a working portal and passed under the torn lateral meniscus, ultimately penetrating

the meniscocapsular tissue. Special attention is given to avoid excessive engagement of the meniscocapsular tissue by the suture hook to prevent potential future flexion contraction. The PDS suture is retrieved above the torn lateral meniscus using a suture grasper through an accessory portal and then replaced with a no. 2 Ethibond suture (Ethicon, Somerville, NJ). After this, each loop is typically created from posterior to anterior without tying. Subsequently, the traction is released, and the looping Ethibond suture is individually tied from posterior to anterior through the anteromedial working portal. The knot was tied at the lateral aspect of the meniscus to prevent irritation and cartilage damage. As the knots are tied, the BHT is reduced, and a probe instrument can be used to aid in the reduction process.

The stability of the construct is assessed using a probe instrument. If any unstable portions are identified, additional all-inside wrapping sutures can be added (Fig. 1).

Postoperative rehabilitation

The rehabilitation protocol was the same for isolated BHT and ACL combined BHT cases. Patients were instructed to perform partial weight-bearing activities with crutches for 2 weeks. A hinged knee brace was applied in full extension immediately after the procedure, and quadriceps muscle training began concurrently. Range-of-motion training commenced after 2 weeks, with flexion increased by 30° per week until reaching 120°, at which point the brace was removed. Jumping and jogging were permitted after 3 months, with full return to sports typically allowed between 9 months and 1 year. Further details on progression milestones, criteria for advancing activity levels, and specific exercises would enhance clarity for future clinical application.

Evaluation protocols

As part of routine practice, MRI scans were conducted approximately 6 months postsurgery to evaluate the healing status based on Henning's criteria [26]. Complete

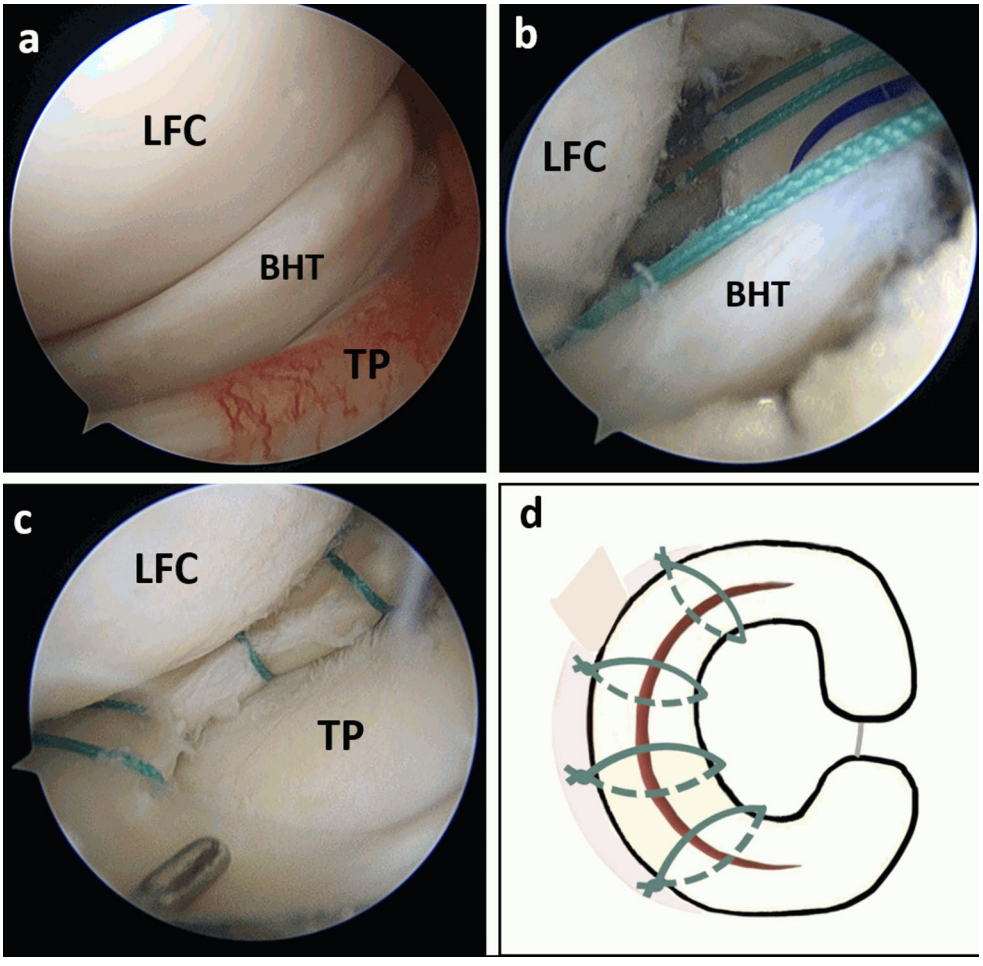

Fig. 1 All-inside wrapping repair technique (**a**) A lateral meniscus bucket-handle tear of right knee seen in the intercondylar notch. (**b**) Temporary loops with Ethibond (green) and traction suture (blue). (**c**) Wrapping suture repair. (**d**) illustration of the All-inside wrapping repair. LFC, lateral femoral condyle; TP, tibia plateau; BHT, bucket-handle tear

Table 1 Summary of patients baseline characteristics and clinical outcome

Variable	Value
Number of Patients (n)	34
Mean Age (years)	29.5 ± 6.5 (Range: 16–44)
Gender	Male: 23 (67.6%), Female: 11 (32.4%)
Type of Tear	Isolated BHT: 11 (32.4%)
	BHT with ACL Tear: 23 (67.6%)
Follow-up Duration (years)	Mean: 4.2 ± 2.5 (Range: 2–11)
Clinical Healing Rate	94.1% (32/34)
Reoperation Rate	5.9% (2/34)
Mean Postoperative IKDC Score	83.7 ± 8.2 (Range: 70–95)
MRI-Based Healing Outcomes	Complete Healing: 64.7% (22/34)
	Partial Healing: 23.5% (8/34)
	Failure to Heal: 12.5% (4/34)

NOTE: ACL, anterior cruciate ligament; LMBHT, lateral meniscus bucket-handle tear; IKDC, the International Knee Documentation Committee Subjective Knee Form; MRI, Magnetic Resonance Image

healing was diagnosed when no intrameniscal fluid was observed (Henning Type I). Partial healing was diagnosed when the fluid equivalent signal was present in < 50% of the meniscal height (Henning Type II). Failure to heal was diagnosed when the fluid equivalent signal was observed in > 50% of the meniscal height (Henning Type III). The classification of healing status on MRI was assessed by a sports specialist with over 15 years of experience, a radiologist with over 10 years of practice, and an orthopedic fellow. All of them were not involved in the initial surgery.

The postoperative IKDC score was used to assess function and sports activity, whereas clinical healing was defined as no reoperation of the LMBHT following the initial repair and the absence of symptoms related to the LMBHT in the follow-up.

Statistical analysis

Statistical analyses were performed to evaluate the clinical and radiographic outcomes of the all-inside wrapping repair technique. Descriptive statistics, including mean, standard deviation, and range, were used to summarize continuous variables such as age, follow-up duration, and postoperative IKDC scores. Categorical variables, such as clinical healing rates and MRI-based healing outcomes, were expressed as frequencies and percentages and using Fisher's exact test .

Comparative analyses were conducted to explore differences in IKDC scores between subgroups (e.g., complete vs. partial healing on MRI) using independent samples t-tests. Statistical significance was defined as a p-value < 0.05. Confidence intervals (95% CI) were calculated for key outcome measures to provide additional context regarding the precision of the results.

All analyses were conducted using statistical software (e.g., SPSS, version 24, IBM Corp., Armonk, NY, USA).

Table 2 Patients baseline characteristics and subgroup analysis

Patient data	LMBHT + ACL tear	Isolated LMBHT	Total	*p*-value
Patients (n)	23	11	34	-
Mean age, years (range)	31.1 (19–44)	26.3 (16–43)	29.5 (16–44)	0.09
Sex (male: female)	15:8	8:3	23:11	0.66
Side (right: left)	9:14	6:5	34	0.40
Body Mass Index, mean (Kg/m^2) (Range)	25.4 (17.2–33.1)	26.2(17.9–34.2)	25.7(17.2–34.2)	0.67

Note: ACL, anterior cruciate ligament; LMBHT, lateral meniscus bucket-handle tear

Results

Of the initially recruited 43 patients, data from nine patients were excluded from the study because of various reasons, including seven with lateral discoid meniscus rupture, one with a posterior cruciate ligament tear, and one with a multiligamentous knee injury. Therefore, 34 patients were included in the final analysis. The mean clinical follow-up duration was 4.2 years (range, 2–11 years).

Of the 34 patients, 23 patients (15 males and 8 females) with a mean age of 31.1 years (range, 19–44 years) had combined ACL and BHT. Additionally, 11 patients (8 men and 3 women) with a mean age of 26.3 years (range, 16–43 years) had isolated BHT. Note that the isolated BHT group was on average 4.8 years younger (Tables 1 and 2).

Following the all-inside wrapping repair of the lateral BHT in the 34 patients included in the study, two patients (5.9%) required subsequent meniscectomy for recurrent BHT, which presented with knee locking. This indicates a clinical healing rate of 94.1% (95% confidence interval [CI]: 82.9–99.2%) in the repaired cases. Both patients were males, with one patient having an isolated BHT and the other patient having a concomitant ACL tear before the surgery. No cases of infection or neurovascular complications were reported postoperatively.

On postoperative MRI examination at the 6-month follow-up, the results revealed that 64.7% (22/34; 95% CI: 47.9–79.5%) of the patients showed complete radiological healing, 23.5% exhibited partial healing, and 12.5% showed no signs of healing. Detailed information regarding these findings is presented in Tables 3 and 4.

Excluding the two patients who underwent reoperation, the average postoperative IKDC score was 83.7 ± 8.2 (range, 70–95) in a mean of 4.2 years of follow-up, indicating a satisfactory outcome. No statistically significant difference in the IKDC score was observed between patients who experienced complete healing and those who experienced partial healing on MRI (85.5 ± 7.9 vs. 82.3 ± 8.5; $p = 0.53$).

Table 3 Detailed healing result on MRI examination

MRI	LMBHT repair + ACLR	Isolated LMBHT repair	Total (percentage)	p-value
Complete healing (n)	16	6	22 (64.7%)	0.41
Partial healing (n)	4	4	8 (23.5%)	-
Failure to heal (n)	2	2	4 (12.5%)	-

NOTE: MRI, magnetic resonance imaging; ACLR, anterior cruciate ligament reconstruction; LMBHT, lateral meniscus bucket-handle tear

Table 4 Clinical and radiological healing results after repair

	Clinical	
MRI	Healing	Failure
Complete healing	22 (64.7%)	0 (0%)
Partial healing/failure to heal	10 (29.41%)	2 (5.88%)

NOTE: MRI, magnetic resonance imaging

One patient underwent reoperation 3 years after combined ACLR and all-inside wrapping repair due to a re-tear of the ACL following another knee sprain, providing an opportunity for a second-look arthroscopy. Immediately after the repair, the repaired meniscus often presents as a round shape when enveloped by the sutures. However, during the second-look arthroscopy, we observed a remarkable phenomenon of meniscus remodeling, wherein the previously repaired meniscus transitioned from a round shape to its original triangular shape. Additionally, we observed successful integration of the sutures into the meniscus, and no evidence of chondral damage associated with the sutures was found (Fig. 2). Meniscus remodeling, characterized by a return to the original triangular shape, was also observed on MRI (Fig. 3).

Discussion

The all-inside wrapping repair technique for lateral meniscus BHT resulted in a clinical healing rate of 94.1%. Postoperative MRI indicated a radiological healing rate of 64.7%. No complications were observed during the surgical procedure. At a mean follow-up of 4.2 years, the average postoperative IKDC score was 83.7. Notably, meniscus remodeling from an irregular to a triangular shape was observed on both MRI and second-look arthroscopy, highlighting the successful restoration of the meniscus.

The advantages of the all-inside wrapping repair technique are as follows: (1) the preservation of meniscal tissue as the meniscus is not pierced but instead wrapped circumferentially; (2) increased contact surface area with the suture, enabling better fixation and reduction of the meniscus; (3) significant reduction in the risk of neurovascular injury; (4) reduction in the need for avoidance of additional incisions, as the only additional portal used is a medial accessory portal for suture retrieval; and (5) absence of fixation devices, which eliminates associated costs.

However, critical comparisons with other meniscus repair techniques highlight some nuances. Inside-out repair, considered the gold standard, offers high biomechanical stability but requires additional incisions and carries a greater risk of neurovascular injury. Contemporary all-inside techniques using suture-based devices avoid these risks but may introduce implant-related complications, such as chondral damage or synovitis.

In contrast, the all-inside wrapping technique eliminates the need for fixation devices, reducing cost and potential implant-related complications. Nonetheless, it relies on suture hooks and non-absorbable sutures, which may share some limitations with other suture-based techniques. Incorporating insights from recent studies,

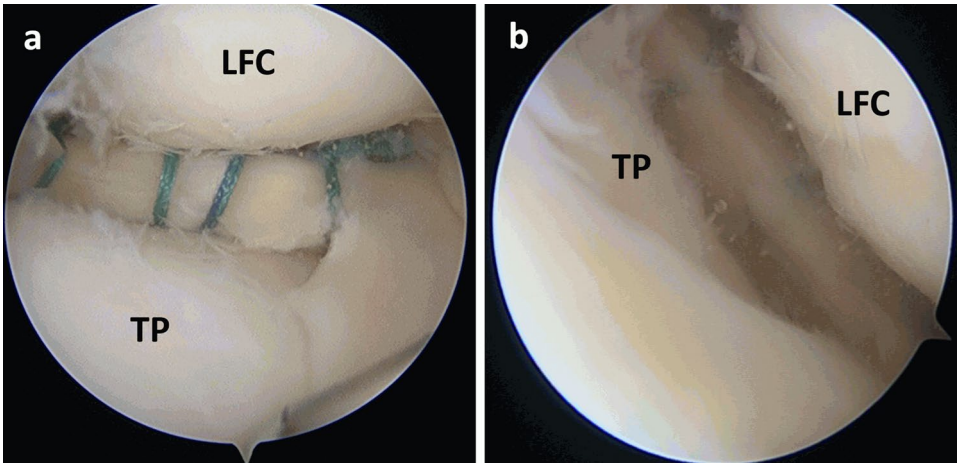

Fig. 2 Meniscus remodeling (**a**) Time zero after the all-inside wrapping suture technique. (**b**) Remodeling of repaired meniscus observed 3 years postoperatively, suture integration (arrow), and the meniscus regains its original triangular shape. TP, tibia plateau; LFC, lateral femoral condyle

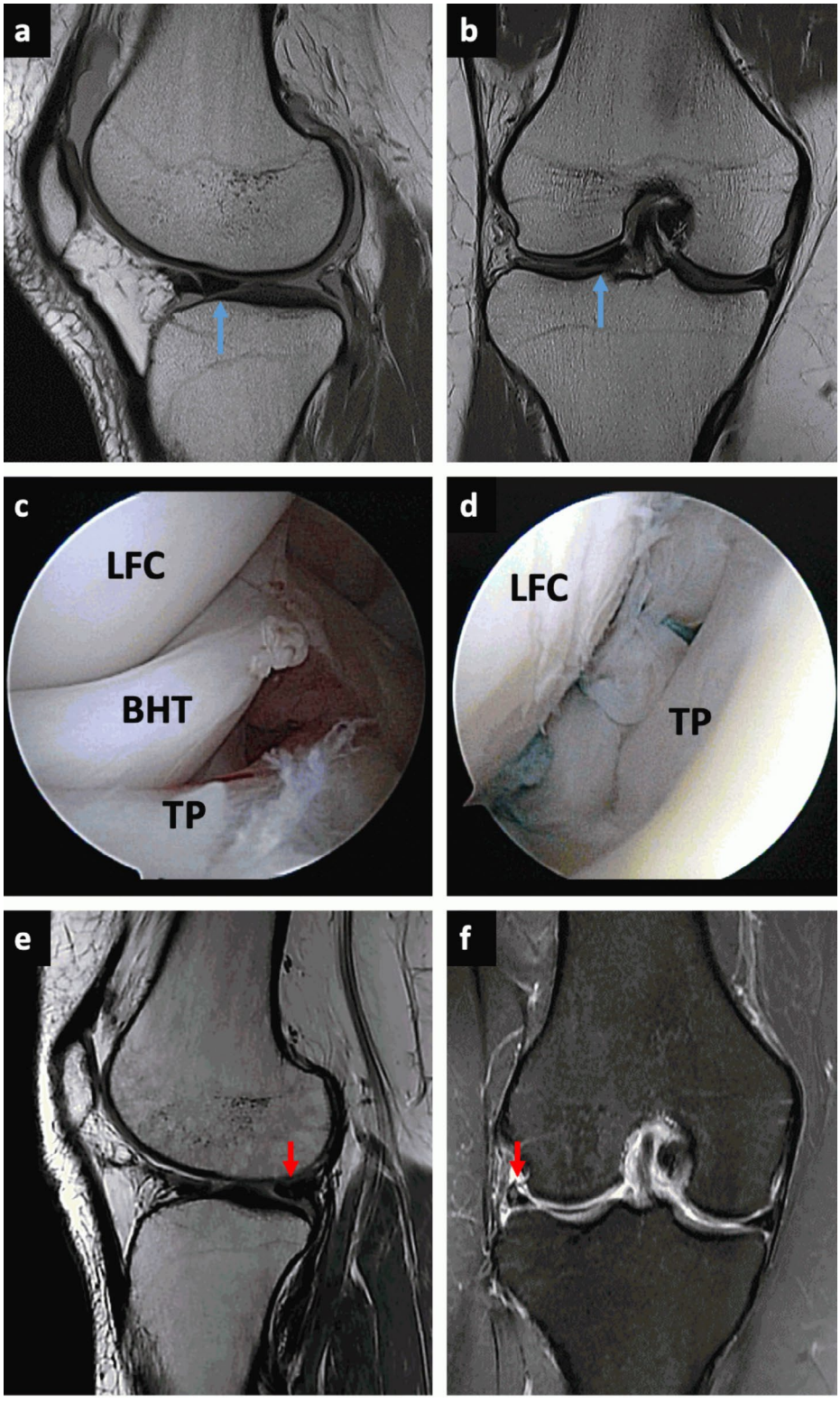

Fig. 3 Complete healing of a lateral meniscus bucket-handle tear (**a**) Sagittal MRI view reveals double anterior meniscus (blue arrow). (**b**) Coronal MRI view shows a fragment in the intercondylar notch (blue arrow). (**c**) Preoperative arthroscopic image of the lateral meniscus bucket-handle tear. (**d**) Postoperative arthroscopic image of the all-inside wrapping repair suture technique. (**e**) Sagittal MRI view reveals reduction and healing of the posterior lateral meniscus (red arrow). (**f**) Coronal MRI view shows reduction and healing of the lateral meniscus (red arrow). LFC, lateral femoral condyle; BHT, bucket-handle tear; TP, tibia plateau

such as Uchida et al. [28], could provide a more comprehensive understanding of how this technique compares in terms of biomechanical performance, complication rates, and long-term outcomes.

Further research is warranted to directly compare the all-inside wrapping technique with these alternatives, particularly in randomized controlled trials or large-scale prospective studies, to validate its relative efficacy and safety.

These benefits make the all-inside wrapping repair technique a favorable option for lateral BHTs. However, this technique still has some disadvantages of the all-inside circumferential suture hook technique, including: (1) the risk of chondral damage during suturing, particularly when performed by an inexperienced surgeon; (2) a relatively steep learning curve; and (3) the need for additional assistance during the procedure.

Several studies comparing the inside–out repair technique with the all-inside repair technique have demonstrated similar clinical failure rates. Grant et al., in a systematic review of 19 studies, reported no significant difference in clinical failure rates between the two techniques (17% for the inside–out repair technique vs. 19% for the all-inside repair technique) [14]. In a laboratory study by Marchetti et al., examining BHTs in cadaveric specimens, both the all-inside and inside–out repair techniques demonstrated comparable ability to restore native meniscus biomechanics to a near-intact level [20]. In a recent systematic review by Fillingham et al., comprising 27 studies, no significant differences in both clinical and anatomical failure rates were found between the inside–out and all-inside repair techniques (11% vs. 10%) [10]. Furthermore, the inside–out repair technique carries a risk of neurovascular injury, as highlighted in previous studies [4, 8]. However, in our study, no instances of neurovascular complications occurred. This can be attributed to our approach of using a suture hook and grasping only a partial capsule tissue during knee flexion, thereby reducing the risk of neurovascular injury. Given that comparable results can be achieved compared with the inside–out technique while decreasing the risk of neurovascular injury, favoring the all-inside wrapping technique seems reasonable.

Until now, various all-inside techniques using suture hooks have been developed for longitudinal meniscus tears; however, all of these techniques involve piercing the torn part of the meniscus. Ahn et al. introduced a technique that uses a suture passer hook to repair the meniscus through the posterolateral portal. However, this technique necessitates the creation of an additional posterolateral portal and involves piercing the torn part of the meniscus [2]. Fiorentino et al. described a similar technique that used standard anteromedial and anterolateral portals; however, it still involved piercing the torn part of the meniscus [11]. In cases of BHTs of the meniscus, the torn portion can be fragile, and penetrating it may compromise its structural integrity. Moreover, because of the mobility of the torn part, accurately penetrating the desired site for repair can be challenging, potentially leading to multiple penetrations. These factors increase the risk of iatrogenic injury to the meniscus during the repair procedure. The all-inside wrapping technique offers a method for repairing the meniscus by wrapping the torn part without compromising its structural integrity. By eliminating the need to penetrate the mobile torn portion of the meniscus, this wrapping technique also simplifies the reduction process, reducing the operative time while maintaining equivalent outcomes.

According to a systematic review by Ardizzone et al., the overall failure rate following all-inside repair of BHTs was 29.3% at an average follow-up of 13 months. Furthermore, no significant difference in the healing rate was observed between medial and lateral meniscus repairs [5]. Muench et al. conducted a study reporting a clinical healing rate of 83.3% and a radiological healing rate of 60.4% with a minimum follow-up of 2 years after repairing BHTs using either a meniscus fixation device or the inside–out technique. The study found that healing rates were not influenced by the laterality of the tear [23]. Goh et al. reported that repairing BHTs using a meniscus fixation device resulted in a healing rate of 90.4% on MRI and significant functional outcome improvement [12]. Uzun et al. reported the results of repairing lateral meniscus vertical longitudinal and BHTs of the lateral meniscus using the all-inside (meniscus fixation device) and hybrid (meniscus fixation device with inside–out) techniques. The results showed a success rate of 88.3% [29]. The aforementioned studies mostly featured the all-inside repair technique with suture devices; none purely looked at the all-inside repair technique with suture hooks. In this study, we introduced the all-inside wrapping repair technique, which has demonstrated comparable outcomes to existing methods but at a significantly lower cost. This approach could serve as a viable treatment alternative for lateral BHTs.

Generally, meniscal repair with concomitant ACL reconstruction has a higher healing rate than isolated meniscal tear repair. This is because of the growth factors and fibrin clots that originate from the bone tunnels in ACL reconstruction. Cannon et al. found only a 59% healing rate in isolated meniscal tears and a 94% healing rate when ACL reconstruction was performed in conjunction with meniscal repair [6]. In our study, we observed a similar failure rate, which agrees with the findings of Nepple et al. [24]. This similarity in results could be attributed to the fact that notchplasty was performed in all cases of isolated BHT repair, which could have induced bleeding and facilitated the healing process. Another factor that

may have contributed to the comparable healing rates in our study is the younger age of the isolated BHT group, which was on average 4.7 years younger than the group undergoing concomitant ACL reconstruction.

Following the all-side wrapping repair, the repaired meniscus initially exhibited an irregular or round shape. However, an interesting observation was made during second-look arthroscopic surgery or follow-up MRI, where remodeling to a triangular cross-sectional configuration was observed. This finding is unique and has not been previously reported. However, one concern arising from this study is the quality of the remodeled meniscus once it has healed. Additional research is warranted to investigate the long-term effects of this observation.

Limitations

This study had several limitations. First, the retrospective nature of the study introduces inherent risks of selection bias, which could influence the generalizability of the findings. Second, the relatively small sample size of 34 patients impacts the statistical power of the analysis and limits the ability to draw generalized conclusions. While the results provide valuable insights into the efficacy of the all-inside wrapping repair technique, they should be interpreted with caution due to the potential variability introduced by the sample size.

Third, the absence of a control group (e.g., patients treated with inside-out or other all-inside techniques) restricts the ability to directly compare the outcomes of this method to other established techniques. Additionally, postoperative second-look arthroscopy was not routinely performed in all patients because of ethical considerations, which may have underestimated the true rate of healing or complications.

Moreover, the postoperative IKDC score was used to assess function and sports activity, providing a reliable measure of patient-reported outcomes. However, additional functional scales, such as the Lysholm or Tegner Activity Scale, could have provided a more comprehensive assessment of patient outcomes, particularly in evaluating broader aspects of knee functionality and activity levels.

The decision to use only the IKDC score was based on its widespread acceptance and specific relevance to knee injuries. Nonetheless, the inclusion of other functional scales in future studies could offer valuable insights into various dimensions of patient recovery, such as daily activity levels and return to sports. Incorporating these scales would allow for a more holistic evaluation of the effectiveness of the all-inside wrapping repair technique.

Furthermore, this study was conducted by a single surgeon with substantial expertise in the wrapping technique, which introduces potential bias and limits the generalizability of the findings. A multicenter study involving surgeons with varying levels of experience could provide more balanced insights into the reproducibility and learning requirements of the technique.

Conclusions

The all-inside wrapping repair technique demonstrated favorable outcomes in patients with lateral BHTs. The clinical healing rate was 94.1%, with a corresponding MRI healing rate of 64.7%. Additionally, postoperative activity levels were satisfactory, indicating positive functional outcomes. Notably, no complications related to this repair technique occurred. Future research should focus on biomechanical testing, cost-effectiveness analyses, and long-term functional outcomes to further validate and optimize this technique. These investigations would enhance understanding of its clinical utility and broader impact.

Author contributions

Concept, literature search and data collection: H-HM, AF, K-HC. Statistics, data analysis and interpretation: E-RC, H-YW. Drafting article: H-HM, AF, K-HC. Critical revision of article: H-HM, E-RC. All authors have read and approved the manuscript.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

Data availability

No datasets were generated or analysed during the current study.

Declarations

IRB information

IRB approval has been obtained for this retrospective study. (IRB-TPEVGH No. 2023-04-011AC)

Competing interests

The authors declare no competing interests.

Received: 22 October 2024 / Accepted: 12 January 2025
Published online: 30 January 2025

References

1. Abrams GD, Frank RM, Gupta AK, Harris JD, McCormick FM, Cole BJ. Trends in meniscus repair and meniscectomy in the United States, 2005–2011. Am J Sports Med. 2013;41:2333–9.
2. Ahn JH, Oh I. Arthroscopic all-inside lateral meniscus suture using posterolateral portal. Arthroscopy. 2006;22:e572571–574.
3. Allen CR, Wong EK, Livesay GA, Sakane M, Fu FH, Woo SL. Importance of the medial meniscus in the anterior cruciate ligament-deficient knee. J Orthop Res. 2000;18:109–15.
4. Anderson AW, LaPrade RF. Common peroneal nerve neuropraxia after arthroscopic inside-out lateral meniscus repair. J Knee Surg. 2009;22:27–9.
5. Ardizzone CA, Houck DA, McCartney DW, Vidal AF, Frank RM. All-inside repair of bucket-handle Meniscal tears: clinical outcomes and prognostic factors. Am J Sports Med. 2020;48:3386–93.
6. Cannon WD Jr., Vittori JM. The incidence of healing in arthroscopic meniscal repairs in anterior cruciate ligament-reconstructed knees versus stable knees. Am J Sports Med. 1992;20:176–81.
7. Chen KH, Chiang ER, Wang HY, Ma HL. Correlation of Meniscal tear with timing of Anterior Cruciate Ligament Reconstruction in patients without initially concurrent Meniscal tear. J Knee Surg. 2019;32:1128–32.

8. Cuellar A, Cuellar R, Diaz Heredia J, Cuellar A, Garcia-Alonso I, Ruiz-Iban MA. The all-inside meniscal repair technique has less risk of injury to the lateral geniculate artery than the inside-out repair technique when suturing the lateral meniscus. Knee Surg Sports Traumatol Arthrosc. 2018;26:793–8.
9. Fairbank TJ. Knee joint changes after meniscectomy. J Bone Joint Surg Br. 1948;30B:664–70.
10. Fillingham YA, Riboh JC, Erickson BJ, Bach BR Jr., Yanke AB. Inside-out Versus All-Inside repair of isolated meniscal tears: an updated systematic review. Am J Sports Med. 2017;45:234–42.
11. Fiorentino G, de Caro F, Cepparulo R, Guardoli A, Berni L, Delcogliano M, et al. Easy and Safe All-Inside suture technique for posterior Horn tears of lateral Meniscus using Standard Anteromedial and Anterolateral portals. Arthrosc Tech. 2013;2:e355–359.
12. Goh JKM, Tan TJ, Kon CKK, Leo SPM, Lee YHD. All-inside repair of bucket handle meniscus tears - mid-term outcomes with postoperative magnetic resonance imaging. Knee. 2021;30:195–204.
13. Goodwillie AD, Myers K, Sgaglione NA. Current strategies and approaches to meniscal repair. J Knee Surg. 2014;27:423–34.
14. Grant JA, Wilde J, Miller BS, Bedi A. Comparison of inside-out and all-inside techniques for the repair of isolated meniscal tears: a systematic review. Am J Sports Med. 2012;40:459–68.
15. Kalifis G, Raoulis V, Panteliadou F, Liantsis A, D'Ambrosi R, Hantes M. Long-term follow-up of bucket-handle meniscal repairs: chondroprotective effect outweighs high failure risk. Knee Surg Sports Traumatol Arthrosc. 2022;30:2209–14.
16. Kotsovolos ES, Hantes ME, Mastrokalos DS, Lorbach O, Paessler HH. Results of all-inside meniscal repair with the FasT-Fix meniscal repair system. Arthroscopy. 2006;22:3–9.
17. Krause WR, Pope MH, Johnson RJ, Wilder DG. Mechanical changes in the knee after meniscectomy. J Bone Joint Surg Am. 1976;58:599–604.
18. Laible C, Stein DA, Kiridly DN. Meniscal repair. J Am Acad Orthop Surg. 2013;21:204–13.
19. Lau BC, Conway D, Mulvihill J, Zhang AL, Feeley BT. Biomechanical consequences of Meniscal tear, partial meniscectomy, and Meniscal Repair in the knee. JBJS Rev. 2018;6:e3.
20. Marchetti DC, Phelps BM, Dahl KD, Slette EL, Mikula JD, Dornan GJ, et al. A contact pressure analysis comparing an All-Inside and Inside-Out Surgical repair technique for bucket-handle medial Meniscus tears. Arthroscopy. 2017;33:1840–8.
21. Markolf KL, Mensch JS, Amstutz HC. Stiffness and laxity of the knee–the contributions of the supporting structures. A quantitative in vitro study. J Bone Joint Surg Am. 1976;58:583–94.
22. Metcalf MH, Barrett GR. Prospective evaluation of 1485 meniscal tear patterns in patients with stable knees. Am J Sports Med. 2004;32:675–80.
23. Muench LN, Achtnich A, Krivec L, Diermeier T, Woertler K, Braun S et al. (2022) Clinical outcome and healing rate after meniscal bucket handle tear repair. BMC Musculoskelet Disord 23.
24. Nepple JJ, Dunn WR, Wright RW. Meniscal repair outcomes at greater than five years: a systematic literature review and meta-analysis. J Bone Joint Surg Am. 2012;94:2222–7.
25. Paxton ES, Stock MV, Brophy RH. Meniscal repair versus partial meniscectomy: a systematic review comparing reoperation rates and clinical outcomes. Arthroscopy. 2011;27:1275–88.
26. Scott GA, Jolly BL, Henning CE. Combined posterior incision and arthroscopic intra-articular repair of the meniscus. An examination of factors affecting healing. J Bone Joint Surg Am. 1986;68:847–61.
27. Seedhom BB, Dowson D, Wright V. (1974) Proceedings: Functions of the menisci. A preliminary study. Ann Rheum Dis 33:111.
28. Uchida R, Horibe S, Ohori T, Shino K. All-inside suture meniscal repair using suture passer. Ann Jt. 2024;9:29.
29. Uzun E, Misir A, Kizkapan TB, Ozcamdalli M, Akkurt S, Guney A. Evaluation of Midterm Clinical and Radiographic outcomes of Arthroscopically Repaired Vertical Longitudinal and bucket-handle lateral meniscal tears. Orthop J Sports Med. 2019;7:2325967119843203.
30. Vint H, Quartley M, Robinson JR. All-inside versus inside-out meniscal repair: a systematic review and meta-analysis. Knee. 2021;28:326–37.
31. Voloshin AS, Wosk J. Shock absorption of meniscectomized and painful knees: a comparative in vivo study. J Biomed Eng. 1983;5:157–61.
32. Zimny ML, Albright DJ, Dabezies E. Mechanoreceptors in the human medial meniscus. Acta Anat (Basel). 1988;133:35–40.

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