




CLINICAL ARTICLE

Arthroscopic Management of Giant Meniscal Cysts Among Young Patients: An Average Three-Year MRI Follow-Up

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Objective: To describe an arthroscopic technique for giant meniscal cyst excision with preservation of the functional meniscus, report the short- and medium-term outcomes, and assess magnetic resonance imaging (MRI) for follow-up imaging evaluations.

Methods: A total of 54 consecutive patients with symptomatic meniscal cysts were admitted to the Second Xiangya Hospital of Central South University between 2014 and 2019. Nine patients with giant meniscus cysts (six females and three males) were included in this study. The age range of the patients was 6–34 years. All patients underwent a complete physical examination, X-ray, Doppler ultrasound, and MRI of the knee preoperatively. After an arthroscopic diagnosis of a meniscal rupture with a giant meniscal cyst, partial meniscectomy, ablation of the cyst, and suturing of the retainable meniscus were performed. Lysholm and International Knee Documentation Committee (IKDC) scores were used preoperatively and at the most recent follow-up. Clinical outcomes were classified into four categories: excellent, good, fair, and poor. During the last visit, all patients underwent MRI to assess the recurrence of the cyst and meniscal suture healing.

Results: Preoperative MRI and arthroscopic examination revealed giant meniscal cysts combined with meniscal tears and congenital discoid meniscus, and all giant meniscal cysts occurred in the lateral meniscus. The main types of meniscal tears were horizontal and complex tears. The cysts were unicystic in one case and multicystic in eight cases. The mean size of the cysts on the MRI was 5.86 cm × 2.24 cm × 2.48 cm. The mean follow-up periods were 37.5 (19–60) months. Clinical outcomes were excellent in six patients and good in three patients. The postoperative scores were significantly improved compared to the preoperative scores (Lysholm: 90.78 ± 4.60 vs. 54.56 ± 7.25; IKDC: 96.2 ± 3.46 vs. 61.69 ± 3.36; $p < 0.01$). No recurrence of the cyst was indicated on the MRI, and there was good healing of the torn meniscus.

Conclusions: Arthroscopic cystectomy combined with the meniscus suture technique was effective to eradicate residual cyst cavities, and traffic orifices be highly recommended.

Key words: Arthroscopy; Cyst excision; Giant meniscal cyst; Meniscus suture; MRI

Introduction

Meniscal cysts are caused by accumulated synovial fluid in damaged meniscus parenchyma, which occurs more

commonly in young adults and is one of the main causes of knee pain in the clinic. Although meniscal cysts are often inadvertently detected on MRI of the knee, giant meniscal

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cysts with an anteroposterior diameter ≥ 5 cm are rare in clinical practice, and removing a giant meniscal cyst with the torn meniscus repaired is still challenging.

Although previous studies have reported giant meniscal cysts induced by degeneration in older people¹⁻³, to our knowledge, there have been few reports on giant meniscal cysts caused by trauma and meniscal dysplasia in young people⁴. In general, surgical treatment is considered when asymptomatic giant meniscal cysts fail to respond to conservative therapy⁵. There are many surgical treatment options for giant meniscal cysts, and each has its own advantages and disadvantages. Open extra-articular surgery to remove the meniscal cyst or ultrasound-guided percutaneous cyst aspiration followed by injection of sclerosing agent does not repair the torn meniscus and eliminate the cystic cavity, so there is a risk of recurrence of the cyst. Increasing evidence showed that total meniscectomy might lead to degenerative changes in the knee joint⁶, therefore it is essential to preserve the functional meniscus as much as possible⁷. Choi *et al.* reported a case of a large meniscal cyst in a patient with severe osteoarthritis of the knee who was treated with open cystectomy combined with total knee arthroplasty and followed up for 2 years with satisfactory clinical outcomes³. Tsuyoshi *et al.* reported that arthroscopic cyst decompression and meniscectomy for giant meniscal cysts also achieved satisfactory results². Ozkan Kose *et al.* also achieved good clinical results using open cystectomy with simultaneous arthroscopic meniscectomy or meniscal repair, which inevitably results in high surgical trauma, residual surgical scarring, and slow postoperative recovery⁴. Therefore, it is especially important to provide a minimally invasive, aesthetically pleasing, fast recovery and effective treatment option for young patients. With the advancement of arthroscopic instruments and techniques, arthroscopic meniscus sutures and giant meniscal cyst excision have gained popularity due to significant functional improvement, minimal invasiveness, and fast rehabilitation^{8,9}.

In the present study, we conducted a retrospective observational study to evaluate the effectiveness and feasibility of arthroscopic techniques and the clinical outcomes in the treatment of giant meniscal cysts with meniscal tears among young patients. The objective of this study was: (i) to describe an arthroscopic technique for the resection of giant meniscal cysts with preservation and suturing of the meniscal substance and report short- to medium-term clinical outcomes; (ii) to use MRI to assess the healing of the sutured meniscus and the recurrence of meniscal cysts; (iii) to investigate the etiology of giant meniscal cysts in this study.

Materials and Methods

Demographics and Data Collection

A single-center, single-surgeon retrospective cohort study design was adopted. This study was approved by the Ethics Committee of the Second Xiangya Hospital of Central South University in China. The inclusion criteria were as follows:

(i) symptomatic meniscal cysts and longest anterior and posterior meniscal diameter greater than 5 cm; (ii) treatment with arthroscopic surgery; (iii) the main comparison variables included the patients' preoperative and postoperative knee function scores. The exclusion criteria were as follows: (i) recurrent meniscal cysts; (ii) infected meniscal cysts; and (iii) popliteal cysts.

From 2014 to 2019, a total of 54 consecutive patients with symptomatic meniscal cysts were treated in our hospital. Nine patients (six females, three males) suffering from giant meniscal cysts were included in this study. The most common complaints included the presence of a mass and pain after activity, which was alleviated by rest. Other symptoms were mechanical locking, snapping, clicking, limited range of motion, and weakness.

All patients underwent a detailed physical examination, Doppler ultrasound, MRI, and X-ray of the knee preoperatively, and the maximum length, width, and height of the cyst were measured on MRI (Figure 1). For clinical and radiographic outcome evaluations, the preoperative and postoperative Lysholm score¹⁰ and International Knee Documentation Committee (IKDC) score¹¹ were documented. Finally, follow-up MRI was performed on all patients. Patient satisfaction with the surgery was evaluated according to a modified version of the Dorfmann classification at the latest follow-up¹². Patient demographics and characteristics of the meniscus pathology are described in Table 1, and outcomes of the patients undergoing arthroscopy are described in Table 2. The study protocol was approved by the medical ethics committee of the Second Xiangya Hospital of Central South University (2019141).

Surgical Technique

All surgeries were performed by the same senior surgeon at the Second Xiangya Hospital of Central South University. A schematic diagram of the arthroscopic procedure for a giant meniscal cyst is shown in Figure 2. The detailed surgical steps are as follows. (i) Anesthesia and position: The surgery was performed under general anesthesia and in the supine position in all cases without a pneumatic tourniquet. (ii) Approach: A standard high anterolateral portal and standard anteromedial portal were adopted, and routine arthroscopy was performed. (iii) Confirmation of the cyst boundary: For cysts whose borders were difficult to confirm, 0.5% methylene blue solution was injected percutaneously into the cyst, and the cyst borders were confirmed arthroscopically according to the staining range of the cyst wall (Figure 3). (iv) Confirmation of meniscal tears and cartilage damage: The type of meniscus laceration and the location of the cyst were ascertained under arthroscopy (Figure 4(A)-(C)). An intraoperative Outerbridge classification based on cartilage defects and removal of the irreparable meniscus was determined. (v) Arthroscopic resection of meniscal cysts: For cysts in which visible cyst fluid outflow could be seen in the articular cavity, fluid suction through the cyst cavity was performed. Then, for cysts that were not interlinked with the

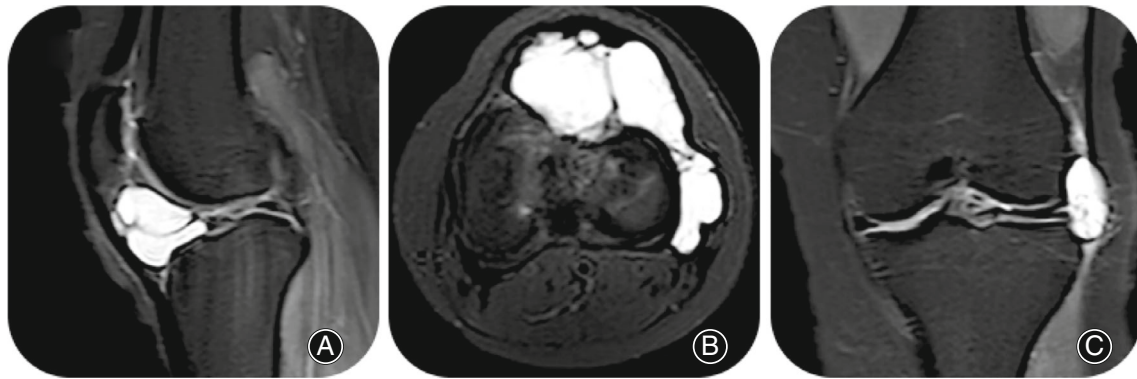


Fig. 1 Preoperative sagittal (A), axial (B) and coronal (C) proton-density-weighted (PDW) MRI of the left knee shows a giant lateral meniscal multilocular cyst (anteroposterior diameter ≥ 5 cm) and a complex meniscal tear. The maximum length, width, and height of the cyst were measured on MRI. (The length of the diameter from the anterior edge to the posterior edge of the meniscus cyst was the maximum length, and the length from the innermost edge to the outermost edge of the meniscus cyst was the maximum width on the maximum axial image of the meniscus cyst.) The length of the diameter from the upper edge to the bottom of the cyst was measured as the maximum height on the largest coronal image.)

TABLE 1 Demographics of the patients with giant meniscal cysts

No.	Sex	Age (years)	Side	DMS	Cyst size on MRI (cm)	Tear type	Lobulation of cyst
1	F	28	L	Yes	7.25*3.20*2.73	Flap	Multiple
2	F	6	L	Yes	6.84*2.86*2.65	Complex	Multiple
3	F	24	R	No	5.03*1.82*2.75	Complex	Multiple
4	F	31	L	No	5.87*1.86*2.94	Horizontal	Multiple
5	F	30	L	Yes	6.26*2.35*2.47	Horizontal	Multiple
6	F	26	R	No	5.12*1.45*2.60	Complex	Single
7	M	22	R	No	5.42*1.79*2.05	Horizontal	Multiple
8	M	27	L	No	5.63*2.52*2.12	Complex	Multiple
9	M	34	L	No	5.36*2.34*2.03	Horizontal	Multiple

Abbreviations: DMS, Discoid meniscus; F, female; L, left; M, male; R, right.

TABLE 2 Clinical scores of the patients with giant meniscal cysts

No.	Pre-Lysholm S	Post-Lysholm S	Pre-IKDC S	Post-IKDC S	F/U time (mths)	Dorfmann CLS
1	41	90	56.3	94.3	60	Excellent
2	51	95	58.6	92	34	Excellent
3	64	95	60.9	95.4	46	Excellent
4	56	90	67.8	96.6	37	Excellent
5	51	84	63.2	89.7	45	Good
6	57	84	59.8	87.4	29	Good
7	49	89	62.1	88.5	40	Good
8	61	96	64.4	96.6	27	Excellent
9	61	94	62.1	93.1	19	Excellent

Abbreviations: Dorfmann CLS, Dorfmann classification; F/U time (mths), follow-up time (months); Post-IKDC S, postoperative IKDC score; Post-Lysholm S, postoperative Lysholm score; Pre-IKDC S, preoperative IKDC score; Pre-Lysholm S, preoperative Lysholm score.

articular cavity, we chose a banana knife to open an incision 5–10 mm in diameter. According to the methylene blue solution staining range, we removed the cyst wall and freshened the meniscus tear edge with a shaper. (vi) Meniscus

plasty and suture: After a thorough examination, we ruled out the presence of multilocular cysts to avoid recurrence. Instability and the split posterior horn were addressed by suturing with FasT-Fix (Smith & Nephew, USA); the body

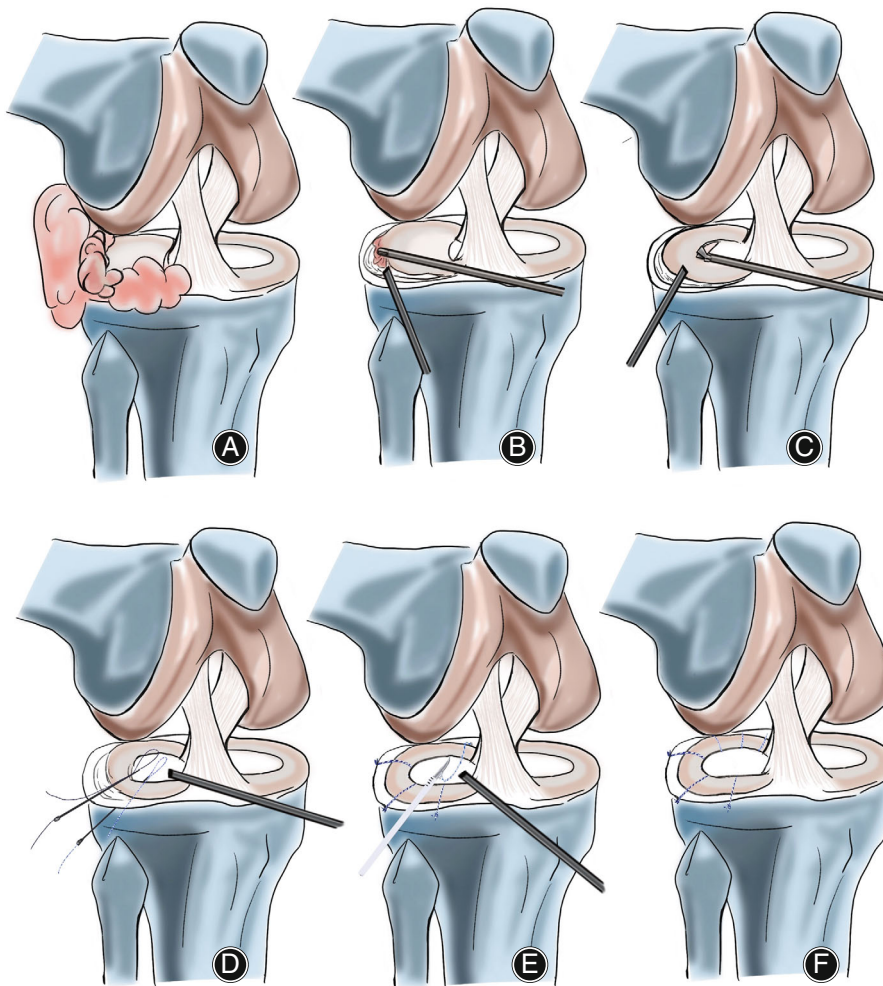


Fig. 2 Schematic diagram of the arthroscopic procedure for a giant meniscal cyst. (A) Diagrammatic drawing of a giant meniscal cyst formed after tearing of the lateral disc meniscus. (B) The arthroscope was placed using a standard anterolateral portal, and the planer was positioned using a standard anteromedial portal to remove the cyst wall of the giant meniscal cyst. (C) The torn meniscal tissue was trimmed with punch forceps. (D–F) The posterior horn of the meniscus was sutured using fast fixation, and the body and anterior horn of the meniscus were sutured using the outside-in technique. The cystic cavity was closed

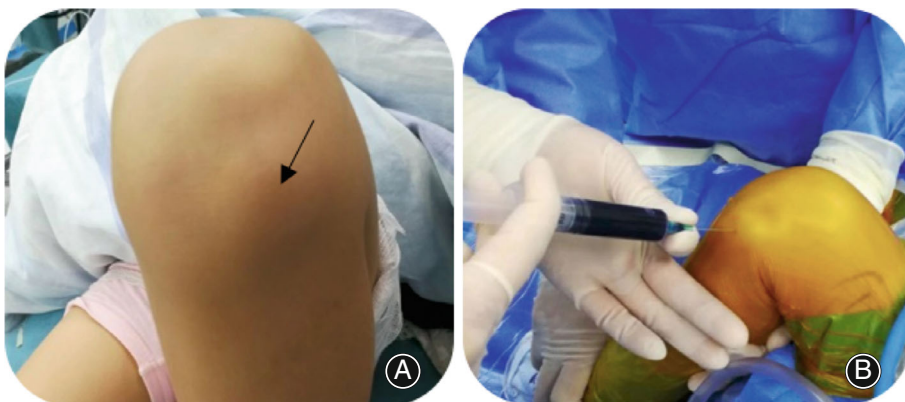


Fig. 3 Preoperative photograph showing a large cystic mass on the anterolateral side of the left knee (A). Intraoperatively, for cysts whose borders were difficult to confirm, 0.5% methylene blue solution was injected into the cyst percutaneously (B)

and the anterior horn were sutured with outside-in or inside-out techniques (Figure 4(D)–(F)). The subcutaneous knots were tight to obtain optimum tension of the knot to

reduce postoperative pain. (vii) Postoperative rehabilitation: A standard postoperative rehabilitation protocol was performed as previously described¹³.

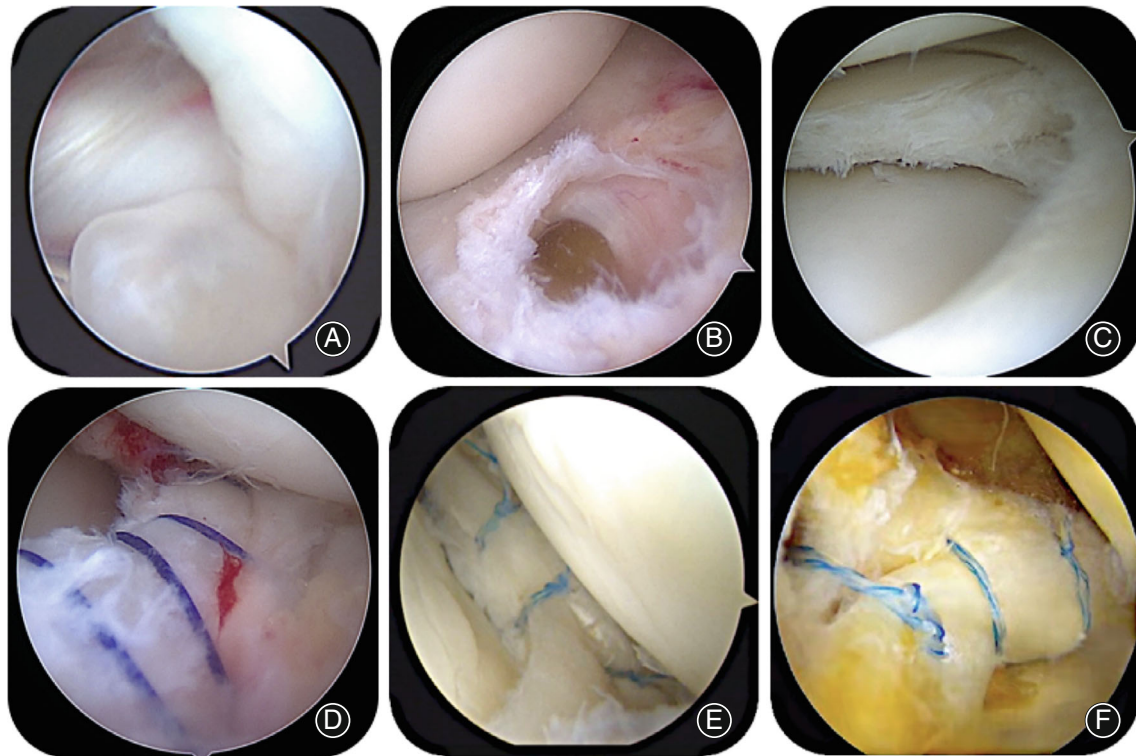


Fig. 4 Arthroscopic image of the left knee showing a giant lateral meniscal cyst (A) interlinked with the articular cavity (B) and a complex meniscal tear (C). Arthroscopic images showing final construction after removal of the giant meniscal cyst and repair of the meniscus anterior horn (D), body (E), and posterior horn (F)

Clinical Evaluation

Lysholm Knee Scoring Scale

The Lysholm scale yields a knee function score that has been repeatedly validated in patients with meniscal injuries and anterior cruciate ligament injuries. The Lysholm scale system consists of eight factors with a total score of 100 points. A score of 95 to 100 is considered “excellent,” 84 to 94 is “good,” 65 to 83 is “moderate,” and 65 or less is “poor.” Therefore, we compared the preoperative and postoperative knee function scores to objectively evaluate the surgical outcomes and patient satisfaction.

International Knee Documentation Committee (IKDC)

Subjective Knee Evaluation Form

The IKDC scale is a patient-completed form that contains sections on knee symptoms (e.g. pain, swelling, stiffness, locking/catching, etc.), sports activities, and functions. The score ranges from 0 to 100 points, with higher scores indicating the best functioning or less severe knee symptoms. The form is the standard one for all publications on the outcome of treatment of knee ligament injuries, meniscal tears, knee cartilage lesions, and traumatic knee dislocations. In the present study, we applied it to the functional assessment of the treatment of giant meniscal cysts.

Dorfmann Classification

The Dorfmann classification is based on the patient’s postoperative knee mobility, symptoms, and cyst recurrence in four categories: excellent (the knee joint can be moved in a full range of flexion and extension, there is no restriction of activity, there is no pain and swelling after activity, and there is no recurrence of the cyst on MRI), good (full range of motion of the knee joint, no significant restriction of activity, slight pain but no swelling during strenuous activity, and no recurrence of the cyst on MRI), fair (limited knee flexion and extension activities, swelling and pain sometimes, and no recurrence of the cyst on MRI) and poor (pain and swelling associated with daily activities of the knee joint and recurrence of the cyst on MRI).

MRI assessment. Preoperative MRI of the knee was routinely performed, and MRI was also performed at the last follow-up. Two orthopaedic surgeons analyzed the patients’ preoperative and postoperative knee MRI and graded each torn meniscus (grade 0–5). The preoperative MRI assessed the meniscal tear, the size and location of the cyst. Postoperative follow-up MRI evaluated the healing rate of the meniscus and the recurrence rate of the meniscal cysts.

Statistical Analyses

All statistical analyses were performed using SPSS 24.0 software (IBM Corp., Armonk, NY, USA). The baseline characteristics of the patients are presented as numbers for categorical data and as the mean \pm standard deviation (SD) for continuous data. A paired t-test was used to compare continuous data; a p -value <0.05 was considered statistically significant.

Results

Patient Demographics

In this study, among the nine patients with giant meniscal cysts, eight were young adults, and one was a child who was only 6 years old. The mean age was 25.3 ± 8.1 years old (range 6 to 34 years). The demographic data are presented in Table 1. Eight patients suffered from varying levels of preoperative knee injury. The chief complaints were knee pain, popping, and difficulty in flexion. All operative procedures were performed by the same experienced senior arthroscopic surgeon. All patients were followed-up in the outpatient clinic or by telephone interview, and the mean follow-up time was 37.5 months (range 19–60 months). All giant meniscal cysts were located on the lateral side. Meniscal tears were mostly located in the anterior horn and body of the meniscus. Notably, according to the preoperative MRI and intraoperative findings, most of the meniscus tears were horizontal, flap, and complex rupture types (Table 1), and all patients had meniscus tears interlinked with the cyst. The giant meniscal cysts were extended extra-articularly with various sizes on the axial, coronal, and sagittal MRI views. No patients experienced a significant injury in the medial meniscus or the cruciate ligament. A cartilage injury was observed in the medial compartment of an obese male patient (Outerbridge grade 2). Giant meniscal cyst excision, partial meniscectomy, and meniscus suture were performed in all patients with meniscus tears.

Clinical Outcomes

At the 3-year follow-up, these patients had excellent postoperative clinical and radiographic outcomes. No significant

complications occurred during the operation or in the early postoperative period. There was no noticeable pain in the knee and no obvious limitation in routine activities for any patient at the most recent postoperative follow-up. The McMurray test was negative, no mass around the knee was detected, and no tenderness during palpation over the knee joint line was observed. The clinical function of the operated knee improved significantly in all patients. The mean Lysholm score and IKDC score improved from 54.56 ± 7.25 and 61.69 ± 3.36 points preoperatively to 90.78 ± 4.60 and 96.2 ± 3.46 points at the most recent evaluation, respectively ($p = 0.000$). Concerning the satisfaction of the surgery, the Dorfmann classification was excellent in six patients and good in three patients. The clinical data are presented in Table 2.

No patients had clinical or radiographic recurrence of meniscal cysts after the operation, but one had synovial effusion within 3 months of surgery, which was considered synovial aseptic inflammation caused by strenuous physical activity postoperatively. The joint effusion disappeared after hot physiotherapy and instructive exercise. Another patient occasionally heard clicks at the time of the particular event, and this sound was associated with a discoid meniscus tear. After the meniscus was repaired, the thickness of the meniscus was still thicker than that of the normal meniscus, and the meniscus edge was not entirely wedge-shaped. The meniscus was reshaped, the free edge of the meniscus was thinned to form a slope, and the previous relevant symptoms disappeared. No complications were related to intra-articular arthroscopy after follow-up at 6 months postoperatively in any patients.

Radiographic Outcomes

MRI examination is expensive and time-consuming in China, and all patients were asymptomatic. MRI was performed 6 months postoperatively in two of nine patients, and seven other patients were re-examined with MRI at the most recent follow-up. All nine patients showed complete cyst removal, no radiographic recurrence of the meniscal cyst, and good healing of the torn meniscus (Figure 5). Based

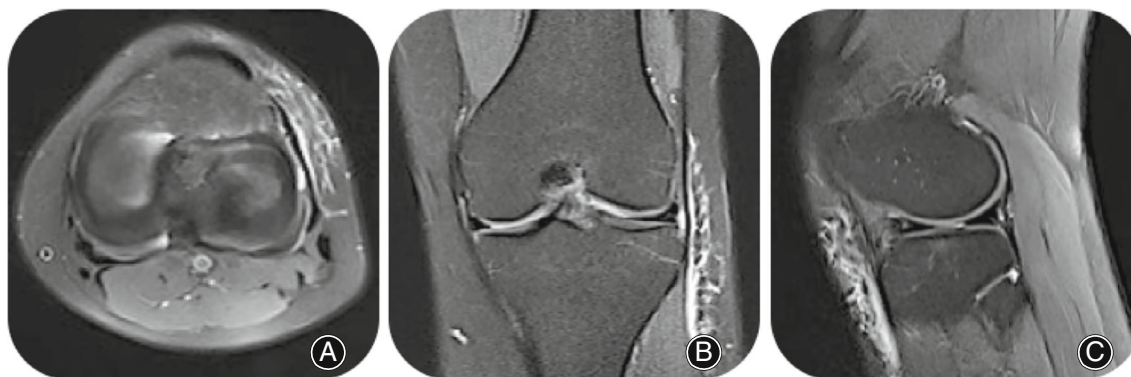


Fig. 5 MRI at 1 year after arthroscopic surgery of the left knee showed no radiographic recurrence of a lateral giant meniscal cyst and good healing of the torn meniscus. Axial (A), coronal (B), and sagittal (C)

on the grading of meniscal signal alterations, no grade 3 or 4 meniscal signal changes were found in any patient in this study.

Discussion

According to the postoperative clinical outcomes of the patients with giant meniscal cysts, the present study showed that the use of arthroscopic resection of a giant meniscal cyst with meniscus plasty and suturing is a safe and successful treatment option.

Generally, it is not challenging to diagnose a giant meniscal cyst. In all nine patients, we were able to palpate an enormous cystic mass with a soft texture and well-defined boundaries in the knee. Most of the patients complained about mild to moderate tenderness during palpation. Preoperative knee MRI showed T1W images with an equal signal or low signal and T2W images with a high signal, all indicating a tear signal inside the meniscus, and a clearly defined, irregular oval cystic signal connected to the meniscal tear. Unlike MRI, the Doppler ultrasound scan can distinguish cystic or solid masses and whether the boundaries are distinct¹⁴. Additionally, it can determine whether there is a blood flow signal inside the cyst to identify hemangioma. Accordingly, Doppler ultrasound can be more easily used for meniscal cyst diagnosis.

Management of Giant Meniscal Cysts

Giant meniscal cyst management raises considerable controversy¹⁵, as some clinicians still believe that conservative management with follow-up is the best option for asymptomatic cases. Traditional treatment, including open cystectomy, complete or partial meniscectomy, arthroscopic meniscus repair, and cyst excision, is the best method of management. However, simple cyst excision cannot achieve etiological treatment or alleviate the symptoms effectively, and it inevitably leads to high recurrence if the injury of the meniscus is severe and requires subtotal or total meniscectomy, which might significantly increase the incidence of degenerative osteoarthritis^{6,16}. In contrast, there are more reports in the literature that torn meniscus can be sutured arthroscopically with different methods to obtain better treatment results, reduce the incidence of osteoarthritis and avoiding the development of meniscal cysts¹⁷⁻¹⁹. Moreover, decompression drainage reduces the incidence of osteoarthritis, but cyst drainage from the remaining meniscus impairs the blood supply of the meniscus, hence affecting meniscal healing. In addition, as the cyst wall is not eradicated, the cyst might relapse if the drainage orifice is closed. For giant meniscal cysts, complete eradication of the cyst wall completely frees the anterior horn and body of the meniscus. Therefore, it is necessary to refresh the meniscus laceration edge with a planer so that the laceration side becomes fertile in blood supply. Then, sutures in the anterior horn and body in arthroscopy might firmly fix the meniscus to allow natural healing and eliminate the cyst. This indicates that the technique not only allows for complete arthroscopic removal of

the meniscal cyst but also repairs the torn meniscus, providing optimal conditions for restoring meniscal function. A Brazilian scholar concluded that open excision of giant cysts combined with arthroscopic meniscal suturing with careful dissection and protection of neurovascular structures is an effective treatment for giant meniscal cysts and has the lowest likelihood of recurrence²⁰. The long-term results of different approaches for the treatment of giant meniscal cysts still need more cases and longer follow-up, and a second-look arthroscopic exploration might be more convincing.

Clinical and MRI Evaluation

Accompanied by regular postoperative outpatient follow-up, all patients were satisfied with the rehabilitation outcome. Postoperative knee pain, joint locking, and snapping symptoms due to meniscal injury ultimately disappeared or were significantly alleviated. The postoperative Lysholm score and IKDC score significantly improved, and no severe complications were documented. On the MRI review, there was no recurrence of cystic signs, and the meniscus suture healed well, and no grade 3 or 4 meniscal signal changes were found. However, radiographic performance and clinical symptoms are often inconsistent, and the long-term clinical outcome still requires continued follow-up and dynamic re-examination of the knee MRI and even re-arthroscopy to obtain a more intuitive assessment of meniscus healing.

Etiology of Meniscus Cysts

There are many reasons for meniscal cyst formation, and the fundamental theories include degeneration, trauma, bleeding, mucinous degeneration, meniscus surgery, congenital meniscus dysplasia, and so on^{21,22}. Aside from the child who failed to accurately describe the presence or absence of a history of relevant trauma, eight patients believed that there were various levels of knee injury. None of the patients experienced any previous joint-related surgery, and four of the nine patients had a congenital discoid meniscus. It is believed that synovial tissue might locally colonize the meniscus during embryonic development, and when the meniscus is subjected to traumatic stimulation, synovial cells secrete fluid leading to cystic swelling²³. In addition, trauma based on the discoid meniscus, even that caused by slight sprains, can lead to meniscus microtears, and the synovial fluid accumulates around the meniscus through the damaged part and then forms a cyst. There are few reports on giant meniscal cysts^{2,3}, and they all involved elderly individuals; all cases were deemed to be associated with degenerative osteoarthritis. However, for the giant meniscal cysts in our study, trauma and congenital meniscal dysplasia might have been the main triggers of the cysts. In particular, meniscus tears provide access to the articular cavity for cysts, where a one-way flap-valve mechanism is formed through the split meniscus. In the present study, all patients were young and had undergone trauma, and the etiology of meniscal cyst formation was clear, which might explain the better functional recovery of the knee in all patients after surgery.

Limitations

There are several limitations to our study. First, due to the limited number of patients and the fact that it was a non-randomized controlled retrospective study, the exact long-term clinical evaluation needs to be further studied. Second, the present study lacked arthroscopic follow-up of meniscal healing and whether sutured menisci lead to early articular cartilage damage. Third, the lack of control groups was another limitation of this study.

Conclusion

Arthroscopic cystectomy combined with the meniscus suture technique was effective to eradicate residual cyst cavities and traffic orifices and can be highly recommended. In future clinical studies, we need to collect more cases of giant meniscal cysts, randomly assign them to different interventions, and evaluate and compare the medium- and long-term clinical and imaging follow-up of each group to further illustrate the superiority of arthroscopic management.

Authorship Declaration

All authors listed meet the authorship criteria according to the latest guidelines of the International Committee of Medical Journal Editors, and all authors are in agreement with the manuscript.

Disclosure Statement

The authors declare that they have no conflict of interest.

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Ethical Review Committee Statement

Ethical approval was obtained from the Institutional Review Board of the Second Xiangya Hospital of Central South University.

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