Research Square

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Suture Retraction to Preserve the Infrapatellar Fat Pad During Anterior Cruciate Ligament Reconstruction: A Retrospective Cohort Study

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Research Article

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Abstract

Background

Selective resection of the infrapatellar fat pad (IPFP) is often used during anterior cruciate ligament reconstruction (ACLR) when the tissue obstructs arthroscopic visualization or instrument passage. We implemented an IPFP-preserving strategy using optimized portal placement and temporary polydioxanone (PDS) suture retraction. This study evaluated postoperative fibrosis and early clinical outcomes before and after implementation of this strategy.

Methods

This retrospective before-and-after cohort included 58 patients undergoing primary ACLR between September 2021 and September 2024. During the earlier period, 36 patients underwent conventional ACLR with selective, non-standardized IPFP resection when required for exposure. After implementation of the preservation strategy, 22 patients underwent ACLR using PDS suture retraction without IPFP resection. Outcomes included Kujala, International Knee Documentation Committee (IKDC), visual analog scale (VAS), and Lysholm scores, range of motion (ROM), operative time, and 6-month MRI-assessed IPFP fibrosis.

Results

At 3 months, the preservation group had a higher Kujala score (90.5 ± 16.76 vs 80.7 ± 12.30; P=.013), lower VAS score (0.9 ± 0.43 vs 2.2 ± 0.56; P<.001), and higher Lysholm score (89.2 ± 7.97 vs 76.9 ± 17.49; P=.003); IKDC scores did not differ significantly (P=.459). By 6 months, Lysholm scores and ROM were similar between groups. Moderate-to-severe IPFP fibrosis (grades II-III) occurred in 18.2% (4/22) of the preservation group and 83.3% (30/36) of the conventional group (risk ratio 0.22, 95% CI 0.09–0.54). Operative time did not differ significantly.

Conclusions

Implementation of PDS suture retraction for IPFP preservation during ACLR was associated with less severe MRI-detected IPFP fibrosis and more favorable early pain and functional outcomes. Because treatment strategy was chronologically allocated, these findings are associative and require prospective confirmation.

Introduction

The anterior cruciate ligament (ACL) is a major stabilizing structure of the knee and plays an essential role in controlling anterior tibial translation and rotational stability [1]. ACL injuries are common,

particularly among physically active individuals, and may result in recurrent instability, impaired knee function, and subsequent intra-articular injury [2–5]. Arthroscopic ACL reconstruction (ACLR) remains an established surgical treatment for patients with symptomatic instability who require restoration of knee stability and function.

The infrapatellar fat pad (IPFP), also known as Hoffa's fat pad, is an intracapsular but extrasynovial adipose structure located posterior to the patellar tendon and adjacent to the anterior compartment of the knee [6, 7]. In addition to mechanical functions such as cushioning and accommodation of changes in joint geometry, the IPFP contains abundant vascular and neural structures and participates in local inflammatory and nociceptive signaling [8–11].

During ACLR, adequate visualization of the intercondylar notch and femoral and tibial ACL footprints is essential for accurate tunnel placement. When the IPFP obstructs the operative field, surgeons may selectively resect the obstructing portion to improve visualization and instrument manipulation [12]. However, disruption of this highly vascularized and innervated structure may have unintended consequences. Previous studies have suggested associations between IPFP injury or fibrosis and postoperative anterior knee pain, altered IPFP morphology, impaired patient-reported function, and degenerative changes [13, 22–28].

Evidence regarding IPFP management during ACLR remains mixed. Earlier comparative studies have reported either limited differences in longer-term clinical outcomes or better early pain and patient-reported recovery with preservation [12, 15]. More recently, a retrospective study described a cannula-based IPFP-preservation technique and reported less fibrosis, pain, inflammatory activity, and cartilage deterioration [14]. Against this evolving literature, the rationale for the present study is not simply to re-test whether preservation is beneficial, but to evaluate a technically distinct, low-cost suture-retraction strategy intended to obtain working space without routine IPFP resection.

The purpose of this retrospective before-and-after cohort study was to describe the suture-retraction strategy and compare MRI-detected IPFP fibrosis, pain, functional outcomes, ROM, and operative time between patients treated before and after its implementation. We hypothesized that implementation would be associated with less severe postoperative IPFP fibrosis and more favorable early recovery, without a statistically significant increase in operative time.

Methods

Study Design and Patient Selection

This retrospective before-and-after cohort study included patients who underwent primary ACLR at Quzhou People's Hospital between September 2021 and September 2024. The study was approved by the Ethics Committee of Quzhou People's Hospital.

During the earlier study period, ACLR was performed using the conventional arthroscopic technique. In these patients, the IPFP was selectively resected when it interfered with arthroscopic visualization or instrument manipulation. The extent of resection was determined intraoperatively according to the degree of obstruction and was not standardized. Subsequently, an IPFP-preserving technique was introduced using optimized arthroscopic portal placement and temporary PDS suture retraction to obtain working space while maintaining IPFP integrity.

Patients were therefore classified chronologically into two cohorts: an earlier conventional cohort (n = 36), in which variable amounts of the IPFP were selectively resected according to intraoperative requirements, and a subsequent preservation cohort (n = 22), in which the modified IPFP-preserving technique was used. All procedures were performed by the same senior orthopedic surgeon.

Inclusion criteria were symptomatic knee instability; a positive Lachman test and/or anterior drawer test; MRI-confirmed ACL tear; and arthroscopic confirmation of the ACL tear. Exclusion criteria were concomitant ipsilateral ligament injuries, bilateral ACL injuries, pivot-shift test grade ≥ II, and severe systemic disease or contraindications to anesthesia or surgery.

Surgical Technique

Graft Preparation

Patients were positioned supine and a tourniquet was applied. The semitendinosus and gracilis tendons were harvested and prepared as a six-strand autologous tendon graft.

IPFP-Preserving Technique

A high anterolateral portal was used initially as the viewing portal and a low anteromedial portal as the working portal. An additional puncture point was established near the superomedial border of the patella for IPFP retraction.

A 16-gauge catheter needle carrying a PDS suture was introduced into the joint through the superomedial patellar puncture point. With the arthroscope in the high anterolateral portal, the suture was visualized within the joint. The free end was retrieved through the low anteromedial portal and the suture loop was retrieved through the high anterolateral portal. Both free ends were passed through the loop and tightened, creating temporary traction that retracted the IPFP toward the patellar tendon(Fig. 1,2). This maneuver increased working space while avoiding IPFP and ligamentum mucosum resection.

Diagnostic arthroscopy was performed and concomitant meniscal or cartilage lesions were treated as indicated. For visualization of the femoral ACL footprint, the arthroscope was transferred to the high anteromedial parapatellar portal and the low anteromedial portal was used as the working portal. The

center of the native femoral footprint was identified and marked. A guide pin was introduced through the low anteromedial portal; with progressive knee flexion to at least 120°, the femoral tunnel was drilled with a diameter matched to the graft(Fig. 3).

The tibial tunnel was created with the knee flexed to approximately 40°. The external aperture was positioned approximately 10 mm medial to the tibial tuberosity and the intra-articular aperture at the native ACL tibial footprint. The graft was passed through the tunnels, fixed on the femoral side using cortical suspension and on the tibial side using an interference screw after tensioning. Knee flexion and extension were assessed to confirm satisfactory graft tension and absence of notch impingement(Fig. 4).

Conventional Technique

In the conventional cohort, when the IPFP obstructed visualization of the intercondylar notch, ACL footprint, or operative field, the obstructing portion was selectively resected using arthroscopic instruments. The amount removed was determined intraoperatively according to visual obstruction and the requirements for safe instrument manipulation; no standardized amount or proportion of IPFP resection was predefined. After adequate visualization was achieved, ACLR was completed according to the same general principles of autologous hamstring graft preparation, anatomical tunnel placement, graft passage, and fixation.

Postoperative Rehabilitation and Follow-up

Both groups underwent a standardized rehabilitation protocol including early ROM exercises and progressive muscle-strengthening exercises. A functional brace was worn for 6 weeks. Follow-up assessments were performed at 6 weeks, 3 months, and 6 months after surgery. Standardized postoperative MRI for assessment of IPFP fibrosis was obtained at 6 months.

Clinical and Imaging Outcomes

Clinical outcomes included the Kujala score, IKDC score, VAS pain score, Lysholm score, knee ROM, and operative time. Kujala, IKDC, and VAS scores were assessed at 3 months postoperatively. Lysholm scores and ROM were assessed at 3 and 6 months. MRI and clinical assessments were performed by orthopedic surgeons blinded to the operative records.

IPFP fibrosis on sagittal MRI was classified as grade 0 (no fibrosis), grade I (focal fibrotic bands), grade II (continuous fibrosis), or grade III (diffuse fibrosis). For an additional clinically interpretable summary, grades II and III were grouped as moderate-to-severe fibrosis.

Statistical Analysis

Continuous variables are presented as means ± standard deviations or medians with interquartile ranges, as appropriate, and categorical variables as frequencies and percentages. The original between-group analyses used Welch two-sample t tests, Wilcoxon rank-sum tests, Pearson chi-square tests, or Fisher exact tests, as appropriate. For moderate-to-severe IPFP fibrosis (grades II-III), the risk ratio (RR) and 95% confidence interval (CI) were calculated from the observed cell counts. All reported P values are two-sided, with P<.05 considered statistically significant.

Results

Patient Characteristics

A total of 58 patients were included: 22 in the preservation group and 36 in the conventional group. No statistically significant between-group differences were detected in age, BMI, sex, injured side, meniscal injury distribution, time from injury to surgery, or follow-up duration. Injury mechanism differed numerically between groups but did not reach conventional statistical significance (P=.052); sports-related injuries accounted for 54.5% of the preservation group and 83.3% of the conventional group. Median follow-up was 26.6 months (25.9–30.2) and 26.2 months (23.9–28.6), respectively (P=.157).

Clinical Outcomes

At 3 months, the preservation group had a higher Kujala score than the conventional group (90.5 ± 16.76 vs 80.7 ± 12.30; P=.013) and a lower VAS pain score (0.9 ± 0.43 vs 2.2 ± 0.56; P<.001).

At 3 months, the preservation group had a higher Lysholm score (89.2 ± 7.97 vs 76.9 ± 17.49; P=.003). By 6 months, Lysholm scores were similar (93.0 ± 7.82 vs 92.2 ± 5.43; P=.634). The 3-month IKDC score did not differ significantly (94.8 ± 10.10 vs 92.4 ± 12.59; P=.459).

At 3 months, ROM was numerically greater in the preservation group (110.9° ± 27.00° vs 95.2° ± 32.10°; P=.060). At 6 months, ROM was comparable (139.7° ± 6.33° vs 137.3° ± 6.60°; P=.179). Mean operative time was 97.7 ± 24.41 minutes versus 89.6 ± 17.62 minutes (P=.182).

Postoperative IPFP Fibrosis

The distribution of 6-month MRI fibrosis grades differed substantially between groups (P<.001). In the preservation group, 18 of 22 patients (81.8%) had grade I fibrosis and 4 (18.2%) had grade II fibrosis; no grade III fibrosis occurred. In the conventional group, 6 of 36 patients (16.7%) had grade I, 17 (47.2%) grade II, and 13 (36.1%) grade III fibrosis. Moderate-to-severe fibrosis (grades II-III) therefore occurred in 18.2% (4/22) versus 83.3% (30/36), corresponding to an RR of 0.22 (95% CI, 0.09–0.54)(Fig. 5,6).

Discussion

The principal finding was that the period after implementation of the IPFP-preserving suture-retraction strategy was associated with markedly less severe IPFP fibrosis on 6-month MRI than the earlier

conventional period, in which the IPFP was selectively resected when necessary for exposure. The preservation cohort also had lower postoperative pain scores and better early patient-reported function, whereas Lysholm score and ROM were similar between groups by 6 months. Operative time was not significantly different.

The technique was developed to address a practical conflict in ACLR: adequate visualization is necessary for safe instrumentation and anatomical tunnel placement, yet tissue resection used to obtain that visualization may disrupt the IPFP. By combining optimized portals with temporary PDS traction, the IPFP can be displaced rather than removed. The absence of a significant difference in operative time supports procedural feasibility;

The most pronounced difference between cohorts concerned postoperative fibrosis. More than 80% of patients in the preservation group had only grade I fibrosis, whereas more than 80% of the conventional group had grade II or III fibrosis. Prior studies have highlighted potential associations of postoperative IPFP fibrosis with pain, altered morphology, impaired function, and degenerative changes [13, 22–28]. The present findings provide imaging, not histological, evidence that implementation of a tissue-preserving strategy is associated with less severe postoperative fibrotic change.

The preservation cohort also showed lower VAS scores and higher Kujala and 3-month Lysholm scores. The IPFP is richly innervated and vascularized and participates in inflammatory and nociceptive pathways [16–19], providing biological plausibility for an early symptomatic effect of minimizing tissue disruption. Nevertheless, patient-level data linking fibrosis grade to pain were unavailable, so the present study cannot establish that reduced fibrosis mediated the pain difference.

The temporal pattern of outcomes is clinically important. The 3-month Lysholm advantage disappeared by 6 months, and ROM showed a similar pattern of early numerical difference followed by convergence. Thus, the potential clinical advantage of the preservation strategy appears most relevant to early postoperative recovery rather than persistent superiority in overall knee function.

Previous ACLR studies provide important context for interpreting these findings. Wen et al. reported more favorable early anterior knee pain and KOOS recovery with IPFP preservation than with partial resection[12], whereas Asai et al. found no meaningful adverse effect of partial resection on clinical outcomes[15]. Importantly, Li et al. subsequently reported a retrospective cohort of 86 patients using a cannula-based IPFP-preservation technique, with lower pain, less MRI-detected fibrosis, lower synovial IL-6, and less cartilage deterioration in the preservation group[14]. The present study therefore should not claim priority for the general concept of IPFP preservation or for an association with reduced fibrosis. Its narrower contribution is technical: temporary PDS suture retraction combined with portal optimization as an alternative means of avoiding routine IPFP resection, with an observed 6-month MRI fibrosis signal and early clinical outcome differences.

Clinically, the findings support a tissue-sparing principle rather than a mandate for universal IPFP preservation. Temporary suture retraction may be useful when it provides adequate visualization and safe instrument passage, but selective resection remains reasonable when exposure is otherwise inadequate. Future studies should compare preservation strategies prospectively and should quantify visualization, tunnel position, resection volume, complications, and patient-reported outcomes using predefined time points.

Limitations

This study has several limitations. First, the retrospective nature of the study design introduces potential selection bias and confounding factors, which may affect the interpretation of the results. Second, the relatively small sample size limits statistical power, and some findings may be subject to bias. Third, with a follow-up period of only six months postoperatively, the long-term effects of IPFP preservation on joint degeneration and osteoarthritis development cannot yet be evaluated. Future prospective randomized controlled trials with larger sample sizes and extended follow-up periods are warranted to further validate the conclusions of this study.

Conclusion

In this retrospective before-and-after cohort, implementation of a PDS suture-retraction strategy for IPFP preservation during ACLR was associated with less severe 6-month MRI-detected IPFP fibrosis and more favorable early pain and functional outcomes than an earlier conventional strategy involving selective IPFP resection. Between-group functional differences diminished by 6 months, and operative time was not significantly different. These findings do not establish causality because treatment strategy was chronologically allocated and the extent of resection in the conventional cohort was not standardized. Prospective comparative studies with predefined outcome time points, quantitative assessment of exposure and tunnel position, and patient-level adjusted analyses are needed.

Tables

Table 1
Patient demographics and baseline characteristics

Characteristic	group			p-value[2]
	Overall	Preservation	Conventional	
	N = 58	N = 22	N = 36	
age, Mean ± SD	39.6 ± 3.7	38.8 ± 4.1	40.0 ± 3.4	0.256
bmi, Mean ± SD	23.25 ± 2.72	23.18 ± 2.19	23.29 ± 3.02	0.872
gender, n (%)				> 0.999
Male	45 (77.6%)	17 (77.3%)	28 (77.8%)	
Female	13 (22.4%)	5 (22.7%)	8 (22.2%)	
Injured-side, n (%)				0.777
Left	33 (56.9%)	12 (54.5%)	21 (58.3%)	
Right	25 (43.1%)	10 (45.5%)	15 (41.7%)	
Causes-of-injury, n (%)				0.052
Slip	11 (19.0%)	7 (31.8%)	4 (11.1%)	
Exercise	42 (72.4%)	12 (54.5%)	30 (83.3%)	
Traffic accidents	5 (8.6%)	3 (13.6%)	2 (5.6%)	
Meniscus-injury, n (%)				0.792
Medial	25 (43.1%)	9 (40.9%)	16 (44.4%)	

Note: Statistical tests in the original analysis included Welch two-sample t test, Fisher exact test, Pearson chi-square test, and Wilcoxon rank-sum test, as appropriate.

Table 2
Comparison of clinical and imaging outcomes

	Group		p-value[2]
	Preservation	Conventional	
	N = 22	N = 36	
Kujala score	90.5±16.76	80.7±12.30	0.013
IKDC score	94.8±10.10	92.4±12.59	0.459
VAS score	0.9 ± 0.43	2.2±0.56	< 0.001
Lysholm score			
Postop 3rd month	89.2 ± 7.97	76.9±17.49	0.003
Postop 6rd month	93.0 ± 7.82	92.2±5.43	0.634
ROM(Flexion and extention)(°)			
Postop 3rd month	110.9 ± 27.00	95.2±32.10	0.060
Postop 6rd month	139.7 ± 6.33	137.3±6.60	0.179
Surgery duration	97.7 ± 24.41	89.6 ± 17.62	0.182
IPFP Fibrosis Grading			< 0.001
I	18(81.8%)	6(16.7%)	
II	4(18.2%)	17(47.2%)	
III	0(0%)	13(36.1%)	

Abbreviations

ACL, anterior cruciate ligament; ACLR, anterior cruciate ligament reconstruction; BMI, body mass index; CI, confidence interval; IKDC, International Knee Documentation Committee; IPFP, infrapatellar fat pad; MRI, magnetic resonance imaging; PDS, polydioxanone; ROM, range of motion; RR, risk ratio; VAS, visual analog scale.

Declarations

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Authors' contributions

Conception and study design: H.R.C.B; acquisition of data: S.B.H, Q.C, and H.Y; analysis and interpretation of data: S.B.H and Z.X.Z; drafting of the manuscript: S.B.H and H.R.C.B; critical revision: Z.X.Z and H.R.C.B. All authors reviewed and approved the final version of the manuscript and agreed to be accountable for all aspects of the study.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

The study protocol was reviewed and approved by Quzhou People's Hospital (clinical research review reference: ▯▯2026-002; approval dated 2 January 2026). The review document approved initiation of the study. The study was conducted in accordance with the Declaration of Helsinki and relevant institutional requirements. The requirement for informed consent was waived because of the retrospective nature of the study.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Clinical trial number

Not applicable.

References

1. MIGLIORINI F, MOK Y R LUCENTIL et al. Anterior Cruciate Ligament Reconstruction Using Lateral Extra-Articular Procedures: A Systematic Review [J]. Med (Kaunas), 2025, 61(2).
2. URREIZTIETA H C, SPENCE D B, BANKHEAD C P. RICHTER D L. Treatment strategies for concomitant ligament injury in anterior cruciate ligament-injured athletes, a narrative review [J]. Ann Jt. 2025;10:41.
3. TOLAN GA, RADUCAN I D UIVARASEANUB et al. Nationwide Epidemiology of Hospitalized Acute ACL Ruptures in Romania: A 7-Year Analysis (2017–2023) [J]. Med (Kaunas), 2025, 61(9).

4. D'AMBROSI R, ARORA E S MEENAA, et al. Reconstruction of the anterior cruciate ligament: a historical view [J]. Ann Transl Med. 2023;11(10):364.
5. FILBAY SR. Evidence-based recommendations for the management of anterior cruciate ligament (ACL) rupture [J]. Best Pract Res Clin Rheumatol. 2019;33(1):33–47.
6. LEESE J, DAVIES DC. An investigation of the anatomy of the infrapatellar fat pad and its possible involvement in anterior pain syndrome: a cadaveric study [J]. J Anat. 2020;237(1):20–8.
7. EDAMA M, OTSUKI T, YOKOTA H, et al. Morphological characteristics of the infrapatellar fat pad [J]. Sci Rep. 2022;12(1):8923.
8. AN JS, TSUJI K, ONUMA H, et al. Inhibition of fibrotic changes in infrapatellar fat pad alleviates persistent pain and articular cartilage degeneration in monoiodoacetic acid-induced rat arthritis model [J]. Osteoarthritis Cartilage. 2021;29(3):380–8.
9. HUO Z, XU C, LI S, et al. The thickness change ratio and preservation ratio of the infrapatellar fat pad are related to anterior knee pain in patients following medial patellofemoral ligament reconstruction [J]. J Orthop Surg Res. 2024;19(1):375.
10. ZHANG C, ZHANG Z, LIN Y, et al. A Novel Infrapatellar Fat Pad Preservation Technique in Total Knee Arthroplasty Reduced Postoperative Pain and Wound Complications [J]. Orthop Surg. 2024;16(8):1946–54.
11. LI Y, LU P. Observation of the Effects of Infrapatellar Fat Pad Excision on the Inflammatory Progression of Knee Osteoarthritis in Mice [J]. J Inflamm Res. 2025;18:6653–72.
12. WEN Y, XU F, LIU Y, et al. Outcome analysis of infrapatellar fat pad partial resection or preservation in patients with anterior cruciate ligament reconstruction [J]. Sci Rep. 2023;13(1):6945.
13. YOON K H, TAK D H, KO T S, et al. Association of fibrosis in the infrapatellar fat pad and degenerative cartilage change of patellofemoral joint after anterior cruciate ligament reconstruction [J]. Knee. 2017;24(2):310–8.
14. LI S, LU M, ZHAO L, et al. A novel infrapatellar fat pad preservation technique in anterior cruciate ligament reconstruction reduces postoperative pain and cartilage damage: a retrospective study [J]. J Orthop Surg Res. 2025;20(1):728.
15. ASAI K, NAKASE J, OSHIMA T, et al. Partial resection of the infrapatellar fat pad during anterior cruciate ligament reconstruction has no effect on clinical outcomes including anterior knee pain [J]. Arch Orthop Trauma Surg. 2020;140(11):1751–7.
16. CHAIYAKIT P, PETCHARAT B. Preservation of the infrapatellar fat pad during total knee arthroplasty reduces subacute postoperative anterior knee pain: a randomized controlled trial [J]. BMC Musculoskelet Disord. 2025;26(1):734.
17. BRAUN S, ZAUCKE F, BRENNEIS M et al. The Corpus Adiposum Infrapatellare (Hoffa's Fat Pad)-The Role of the Infrapatellar Fat Pad in Osteoarthritis Pathogenesis [J]. Biomedicines, 2022, 10(5).
18. KOUROUPIS D, BOWLES A C, WILLMAN M A, et al. Infrapatellar fat pad-derived MSC response to inflammation and fibrosis induces an immunomodulatory phenotype involving CD10-mediated Substance P degradation [J]. Sci Rep. 2019;9(1):10864.

19. BOHNSACK M, MEIER F, WALTER G F, et al. Distribution of substance-P nerves inside the infrapatellar fat pad and the adjacent synovial tissue: a neurohistological approach to anterior knee pain syndrome [J]. Arch Orthop Trauma Surg. 2005;125(9):592–7.
20. OO W M DUONGV, DING C, et al. Evaluation and Treatment of Knee Pain: A Review [J]. JAMA. 2023;330(16):1568–80.
21. MCCARTHY M M, STRICKLAND SM. Patellofemoral pain: an update on diagnostic and treatment options [J]. Curr Rev Musculoskelet Med. 2013;6(2):188–94.
22. SATAKE Y, IZUMI M, ASO K. Association between infrapatellar fat pad ultrasound elasticity and anterior knee pain in patients with knee osteoarthritis [J]. Sci Rep. 2023;13(1):20103.
23. SHIRAISHI R, UEDA S. Relationship between the change in infrapatellar fat pad thickness assessed using ultrasonography and anterior knee pain on squatting after anterior cruciate ligament reconstruction [J]. J Med Ultrason (2001), 2023, 50(2): 237 – 43.
24. DUAN G, LIU C, LIN W, et al. Different Factors Conduct Anterior Knee Pain Following Primary Total Knee Arthroplasty: A Systematic Review and Meta-Analysis [J]. J Arthroplasty. 2018;33(6):1962–e713.
25. HART H F, CULVENOR A G, PATTERSON B E, et al. Infrapatellar fat pad volume and Hoffa-synovitis after ACL reconstruction: Association with early osteoarthritis features and pain over 5 years [J]. J Orthop Res. 2022;40(1):260–7.
26. KANO T, MINEGISH Y, TERADA H, et al. The infrapatellar fat pad contributes to spontaneous healing after complete anterior cruciate ligament injury [J]. Exp Biol Med (Maywood). 2023;248(20):1895–904.
27. NAKAGAWA Y, TSUJI K, NAKAMURA T, et al. Association of Infrapatellar Fat Pad Fibrosis at 3 Months After ACL Reconstruction With Short-term Clinical Outcomes and Inflammatory Cytokine Levels in the Synovial Fluid [J]. Orthop J Sports Med. 2023;11(4):23259671231164122.
28. WALLACE K G, PFEIFFER S J, PIETROSIMONE L S, et al. Changes in Infrapatellar Fat Pad 6 to 12 Months After Anterior Cruciate Ligament Reconstruction and Associations With Patient-Reported Knee Function [J]. J Athl Train. 2021;56(11):1173–9.

Figures

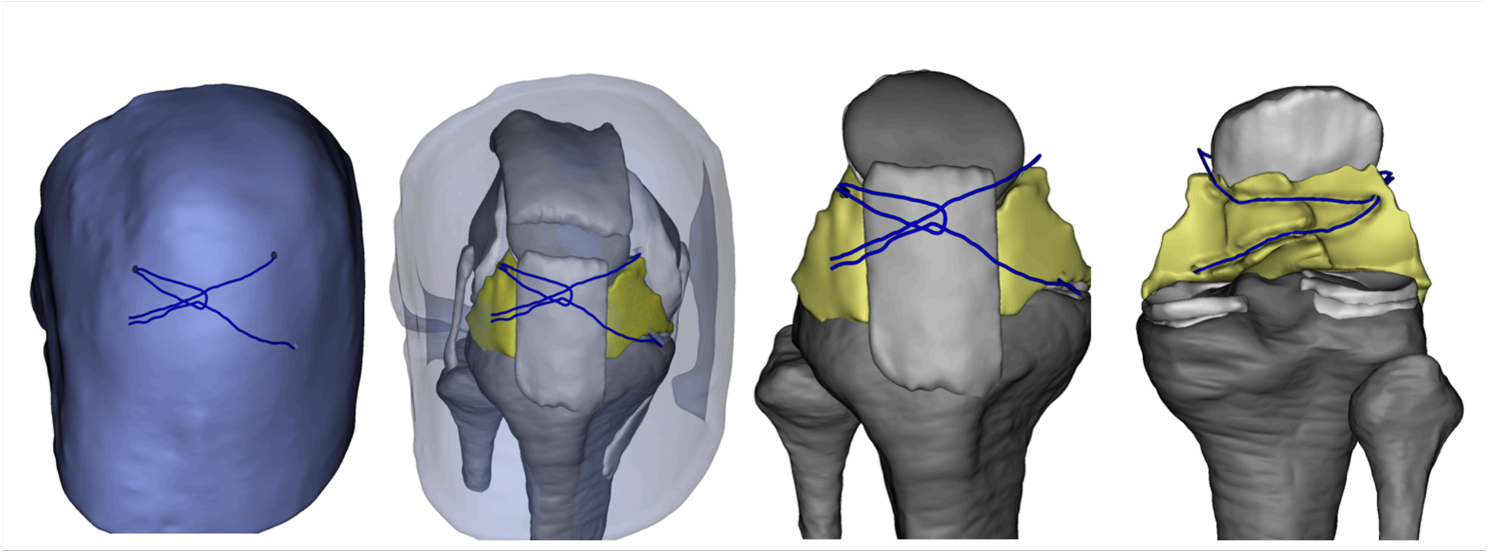


Figure 1

Schematic diagram of the 3D model of the IPFP preservation technique.

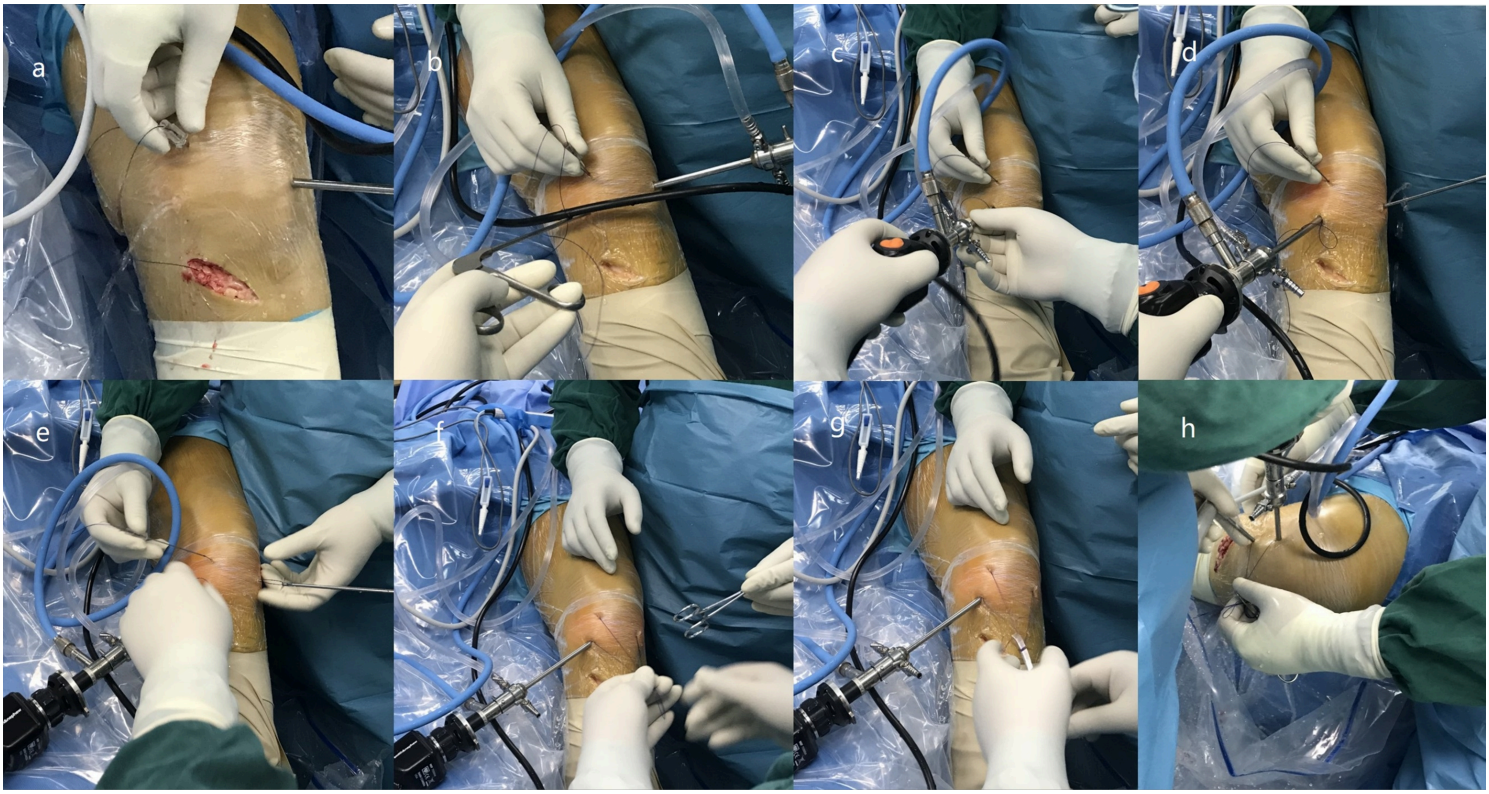


Figure 2

IPFP preserving procedure, the patient is lying supine (left knee). Step 1: The needle loaded with the PDS suture is introduced through the parapatellar anteromedial portal to the knee joint, and the 30° arthroscope is placed in the high anterolateral portal (a). Step 2: The free limb of the suture was brought up to the low anteromedial portal (b). Step 3: The arthroscope is switched to the low anteromedial portal. Grasp and pull out the closed loop of the PDS suture through the high anterolateral portal with a

suture grasper, and the needle is pulled out. (c, d, f). Step 4: The two free ends of the suture are inserted into its closed loop of the suture, and the suture is tightened with a small haemostat clamp (g, h).

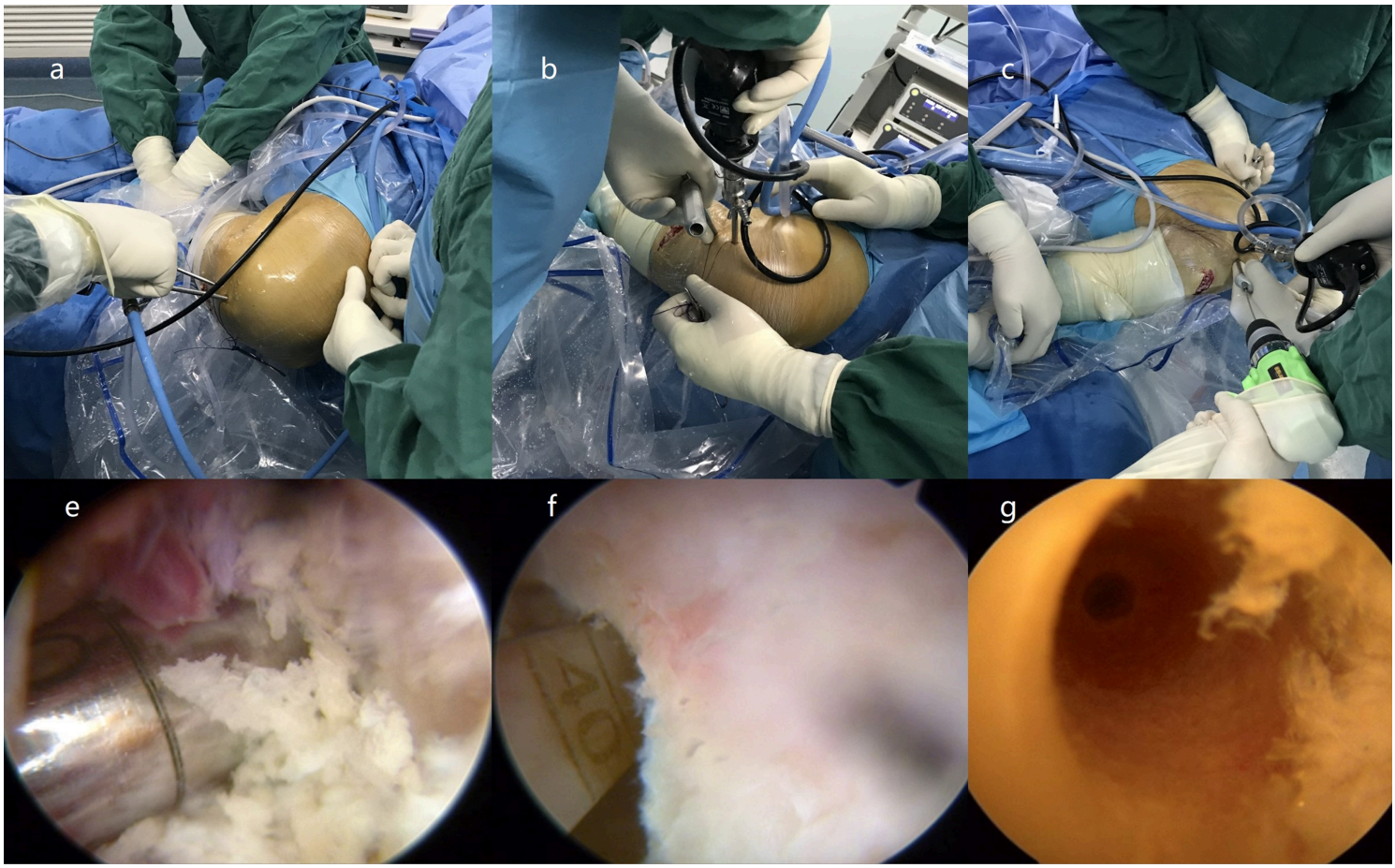


Figure 3

The patient is lying supine (left knee), the affected limb was placed in a figure-four position, and the knee was bent over 120°. The ACL femoral attachment site was observed through the parapatellar anteromedial portal, and the low anteromedial portal is used as a working portal to insert an instrument into the intercondylar notch and for drilling the ACL femoral tunnel (a, b, and c). Direct viewing of femoral tunnel establishment from the parapatellar anteromedial portal (e, f, and g).

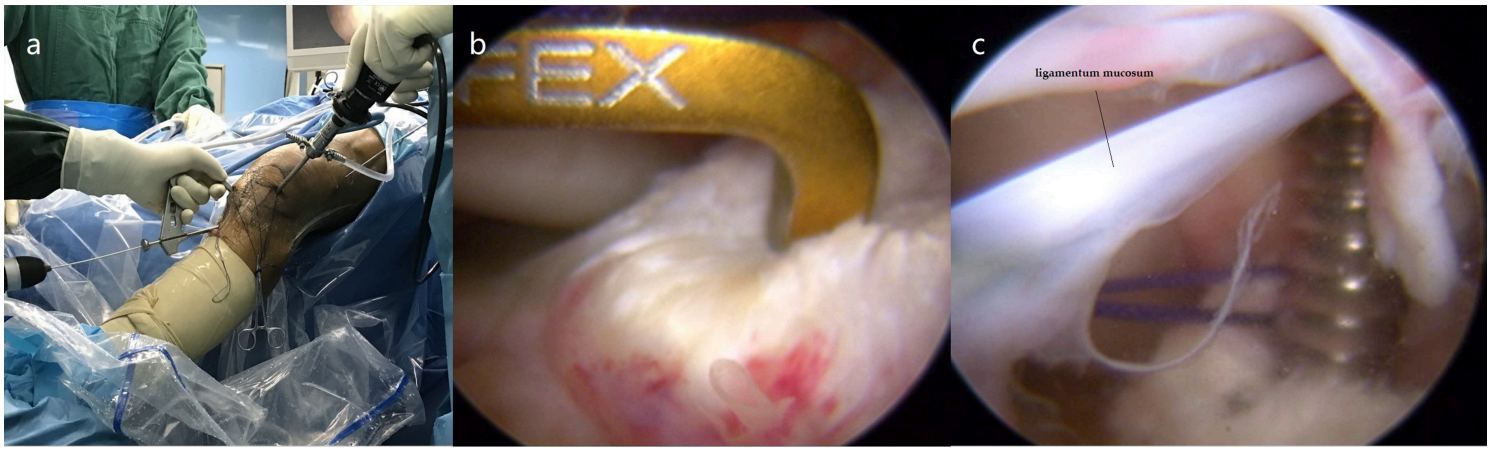


Figure 4

The tibial bone tunnel was drilled, viewing from the high anterolateral portal with the knee in 40°of flexion. The high anterolateral portal can avoid excessive penetration into the IPFP and provide a broader view of the ACL tibial attachment site. After the ACL's femoral and tibial bone tunnels have been established, the intact ligamentum mucosum can still be seen.

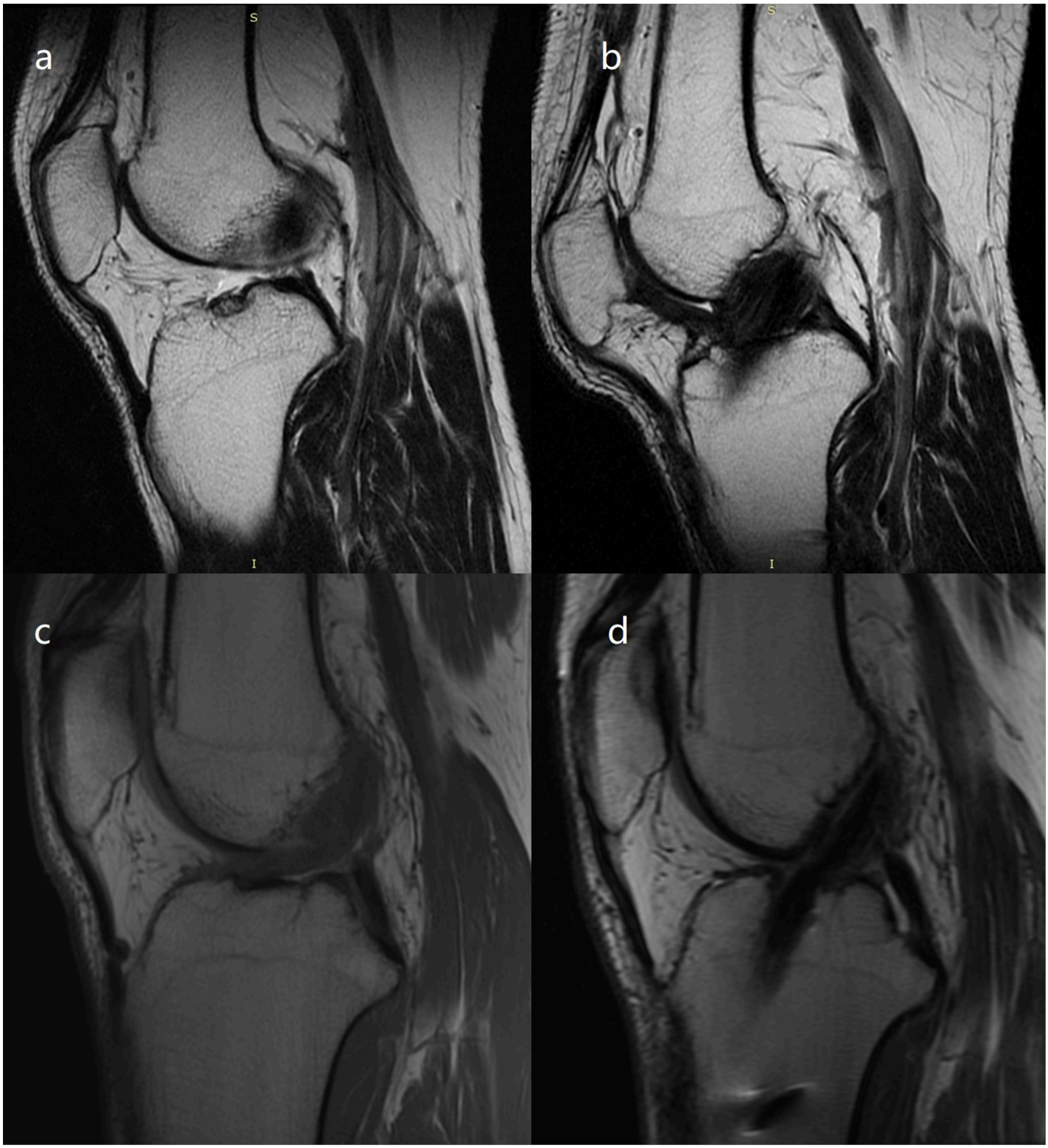


Figure 5

In conventional ACL reconstruction surgery, it can be seen from the sagittal MRI image of the knee joint that preoperative MRI showed no fibrosis in the infrapatellar fat pad. Postoperative MRI showed extensive fibrosis in the infrapatellar fat pad (a, b). There are no IPIP fibrosis on preoperative and postoperative knee MRI with the IPFP-preserving technique(c, d).

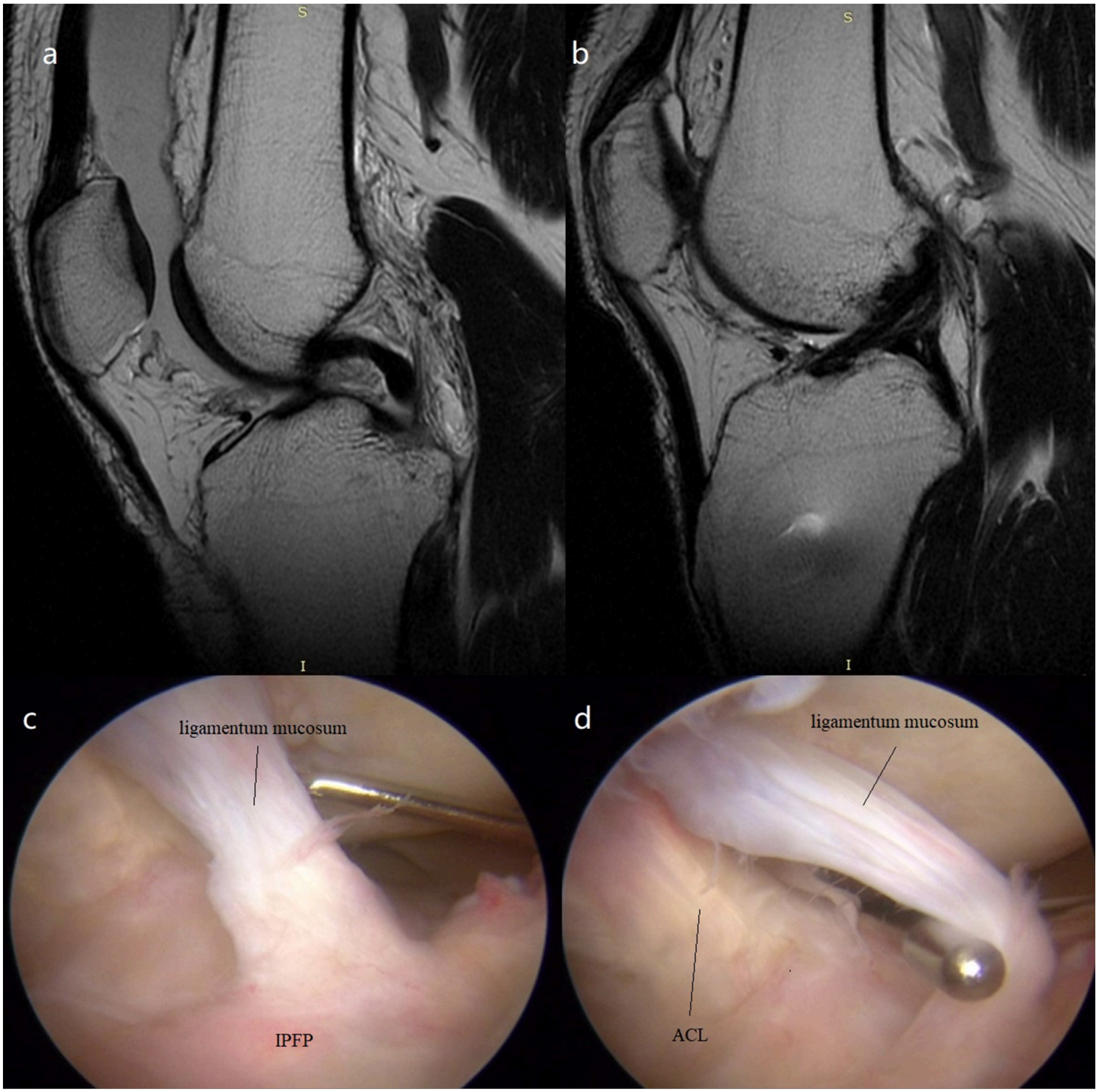


Figure 6

Preoperative sagittal knee MRI showed no fibrosis in the infrapatellar fat pad, and postoperative sagittal knee MRI showed mild fibrosis of IPFP at the site where the arthroscopic portal was established (a, b). The second arthroscopic detection shows that the ligamentum mucosum was intact, and the transplanted ACL healed well 18 months after ACL reconstruction (c, d).