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A Review Comparasion of the Effectiveness of Reconstruction Anterior Cruciate Ligament with or Without Fat Pad in the Treatment of Anterior Cruciate Ligament Tear: A Systematic Review

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ABSTRACT

Introduction: Anterior Cruciate Ligament (ACL) reconstruction is widely performed to restore knee stability after injury. Optimizing surgical techniques is vital for better outcomes and fewer complications. One debated factor is the management of the infrapatellar fat pad (IPFP). This systematic review evaluates the impact of preserving versus resecting the IPFP during ACL reconstruction, focusing on knee function, pain, and graft revascularization.
Method: A systematic search of four databases identified clinical studies published from January 2019 to June 2025. Eligible studies compared ACL reconstruction with and without IPFP preservation and reported outcomes on function, pain, or revascularization. Six studies met the criteria for final analysis.
Method: Preserving the IPFP improved postoperative knee function, as shown by KOOS, Lysholm, and anterior knee pain (AKP) scores. Patients experienced less pain, reduced inflammation, and earlier recovery of knee range of motion. Preservation was also associated with reduced cartilage degeneration. Furthermore, the posterior cruciate ligament (PCL) fat pad transfer technique enhanced synovial coverage, promoted graft revascularization, and supported long-term graft viability.
Discussion: Evidence suggests IPFP preservation enhances functional recovery and creates a favorable biomechanical environment by reducing inflammation and supporting healing. The PCL fat pad transfer further strengthens graft revascularization, offering a promising strategy to improve reconstruction outcomes. Nevertheless, most studies provide short-term data, limiting conclusions on long-term benefits and cost-effectiveness.
Conclusion: Preserving the IPFP and exploring innovative methods like PCL fat pad transfer show significant potential to improve ACL reconstruction success. Future long-term, multi-center trials are needed to validate these promising results.

Keywords: Anterior Cruciate Ligament reconstruction, Infrapatellar fat par, Graft revascularization

INTRODUCTION

Anterior cruciate ligament reconstruction (ACLR) is among the most common knee

procedures in active populations, yet the optimal management of the infrapatellar fat pad (IPFP) during ACLR remains debated. Surgeons balance the improved arthroscopic visualization achieved by partial IPFP resection against the biological and biomechanical functions of the IPFP, including vascular and synovial support and potential contributions to anterior knee pain (AKP). This variability in practice has prompted comparative evaluations of IPFP preservation versus resection and biologic/technical adjuncts intended to enhance graft integration and recovery [1–6].

Across patient-reported outcomes, partial IPFP preservation has been linked to greater improvements in AKP and functional scores (KOOS, Lysholm) compared with resection[1,4]. Retaining ACL stump tissue (with or without associated fat pad) may improve early proprioception and facilitate graft revascularization, with long-term outcomes converging toward standard techniques[2].

Biologic and structural endpoints also appear sensitive to technique: fat-pad–based augmentation has been associated with greater synovial coverage and revascularization[3], while IPFP-preserving approaches have been associated with less IPFP fibrosis, lower IL-6, less cartilage degeneration, and faster early range-of-motion recovery[4].

Intraoperative workflow considerations further shape decision-making. Technical strategies such as higher portal placement, resection of the ligamentum mucosum, and tibial tunnel positioning with the knee in partial flexion can displace the IPFP anteriorly to improve notch visualization without full resection and may shorten operative time without increasing the difficulty of concomitant meniscal procedures[5].

Conversely, limited resection designed purely to confirm graft origin has not shown adverse effects on short-term AKP in selected series[6].

Nevertheless, the current evidence base is heterogeneous: most studies are retrospective, sample sizes range from ~35 to 130, outcomes and follow-up windows vary (3–48 months), and techniques span preservation, targeted resection, cannula-based preservation, and augmentation. These factors limit cross-study comparability and the strength of practice recommendations.

Accordingly, this systematic review synthesizes clinical and biologic effects of IPFP management during ACLR by (1) comparing preservation versus resection on AKP, validated knee function scores, and early range of motion; (2) evaluating synovial coverage, revascularization, and inflammatory profiles; and (3) assessing operative visualization strategies and efficiency-aiming to clarify contexts in which preservation confers advantages and when limited resection is reasonable.

MATERIALS & METHODS

We conducted a comprehensive literature search across four major databases: PubMed, Embase, Google Scholar, and the Cochrane Library, to identify relevant studies published between January 2019 and June 2025. The objective was to collect comparative clinical studies evaluating the effectiveness of Fat pad versus without fat pad reconstruction technique for anterior cruciate ligament tear. A structured search strategy was employed using the following Boolean keyword string: (“ACL Tear” OR “ACL Injury”) AND (“Fat Pad Reconstruction” OR “No Fat Pad Reconstruction”)

The inclusion criteria for eligible studies were as follows:

1. Original peer-reviewed clinical research articles;
2. Studies directly comparing fat pad reconstruction techniques to Without fat pad reconstruction for management anterior cruciate ligament injury
3. Studies reporting at least one of the following outcome measures: recurrence rate, complication rate, functional outcome scores, or operative parameters;
4. Full-text availability in English.

Exclusion criteria included:

1. Studies involving non-surgical or non-comparative treatments for anterior cruciate ligament injury;
2. Studies focused on anterior cruciate ligament injury in anatomic locations other than the ACL ligament;
3. Review articles, letters, conference abstracts, technical notes, or animal studies;
4. Articles not published in English.

All identified titles and abstracts were screened for eligibility. Full-text versions of potentially relevant studies were retrieved for detailed assessment. In cases where multiple publications reported data from the same study cohort, only the most recent or most comprehensive version was included to avoid data duplication.

PICO Criteria

Population: Patients diagnosed with anterior cruciate ligament injury requiring surgical procedure

Intervention: fat pad reconstruction techniques

Comparison: Without fat pad reconstruction technique

Outcome: Functional outcome of knee function and motion

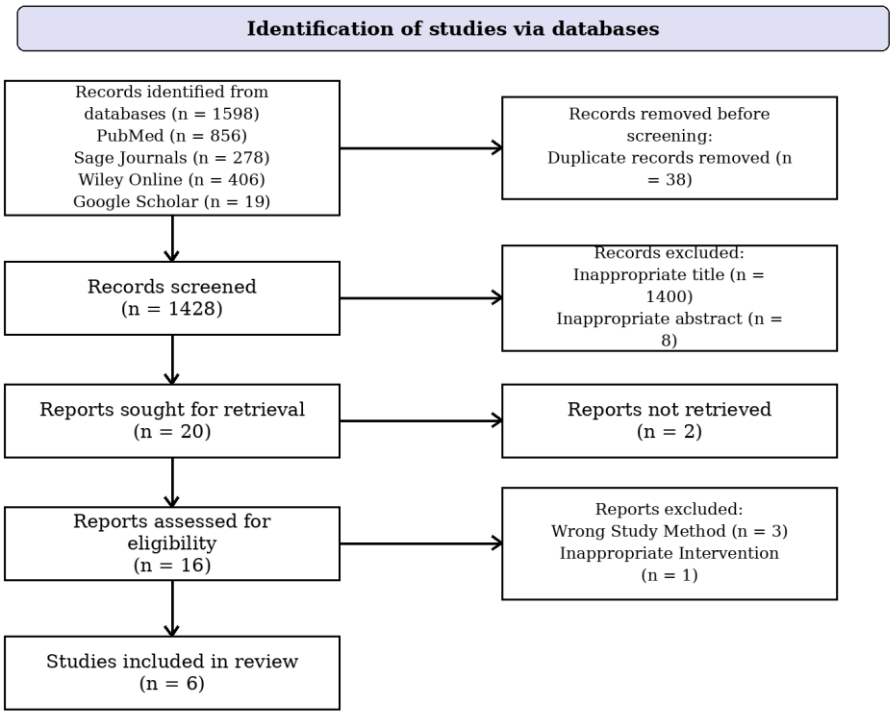


Figure 1. PRISMA Flowchart

RESULT

An initial search across three major databases; PubMed (n = 856), Google Scholar (n = 19), and the Sage Journals (n = 278), Wiley Online (n = 406) yielded a total of 1598 records. After removing 38 duplicate entries, 1428 articles proceeded to the screening phase.

During the screening of titles and abstracts, 1428 studies were excluded due to incompatibility with the target population or intervention. This left 16 full-text articles for detailed review. However, 6 of these were excluded because they lack of study methods or did not report outcomes relevant to the objective of the review. Consequently, 6 studies met all eligibility requirements and were included in the final systematic review. Shown in Figure 1.

This selection process reflects a focused and methodical approach to ensure only high quality, relevant studies comparing with or without fat pad reconstruction of anterior cruciate were analyze.

Figure 2. Characteristic of study

No.	Reference	Type of Study	Sample Size	Outcome	Follow Up Duration
1.	Wen, Y et al., 2023	Retrospective Study	104	Knee function (KOOS, AKP, Lysholm)	3, 6, 12, and 24 months
2.	Chen, T.Z et al., 2019	Retrospective Study	130	Proprioception and graft revascularization	24 - 38 months
3.	Malinowski, K et al., 2020	Retrospective Study	35	Synovial coverage and promotes revascularization	12 - 48 months
4.	Li, S et al., 2021	Retrospective Study	86	Postoperative pain, IPFP fibrosis, cartilage damage, and improves knee function recovery (Kujala, VAS, ROM)	28 months
5.	Cottet, B et al., 2011	Retrospective Study	112	Duration of operation and no additional meniscal procedures	12 months
6.	Asai, K., 2020	Retrospective Study	42	Anterior knee pain level	6 - 24 months

Figure 2. Outcome of study

No.	Reference	Outcome
1.	Wen, Y et al., 2023	ACL reconstruction with primary hamstring grafts achieves good results both with and without IPFP resection, but partial infrapatellar fat pad (IPFP) preservation leads to better improvements in anterior knee pain and knee function.
2.	Chen, T.Z et al., 2019	Retaining the ACL stump (with or without fat pad) during reconstruction improves early proprioception and likely enhances graft revascularization and biological viability, though long-term outcomes are similar to standard techniques..
3.	Malinowski, K et al., 2020	ACL reconstruction enhanced with PCL fat pad transfer notably increases synovial coverage and promotes revascularization—providing indirect proof that the graft is biologically viable ("alive") compared to standard ACL procedures without fat pad augmentation.
4.	Li, S et al., 2021	The IPFP preservation group showed better Kujala scores, lower pain (VAS), significantly reduced IPFP fibrosis, lower inflammatory IL-6 levels, less cartilage degeneration, and faster early knee range of motion recovery compared to non-preservation.
5.	Cottet, B et al., 2011	Preserving the IPFP during ACL reconstruction—achieved through higher arthroscopic portals, resection of the ligamentum mucosum, and tibial tunnel placement at 40° flexion—shortens operative time without increasing the difficulty of meniscal procedures
6.	Asai, K., 2020	Six months post-surgery, while the IPFP size decreased more in the resection group than in the preservation group, partial IPFP resection, aimed at improving ACL visualization, had no effect on clinical outcomes, including anterior knee pain (AKP).

Figure 3. Characteristic of Technique

No.	Reference	Duration of Incidence	Technique Operation
1.	Wen, Y et al., 2023	86 days (IPFP-R) and 94 days (IPFP-P)	Partial infrapatellar fat pad (IPFP) resection or preservation during ACLR
2.	Chen, T.Z et al., 2019	10 months	Open or arthroscopic release of joint contractures with soft tissue releases, capsulotomy, and osteophyte excision
3.	Malinowski, K et al., 2020	6 months - 3 years	Open or arthroscopic surgical release including capsulotomy and soft tissue release
4.	Li, S et al., 2021	21 - 23 days	ACL reconstruction with novel cannula-based IPFP preservation technique versus standard procedure
5.	Cottet, B et al., 2011	-	Arthroscopic reconstruction where portal placement and resection of the ligamentum mucosum improve notch visualization and displace the IPFP anteriorly
6.	Asai, K., 2020	-	ACL reconstruction with hamstring tendon autografts were randomly assigned to either preserve or resect the intercondylar IPFP to confirm the ACL origin

DISCUSSION

The findings from the retrospective studies included in this review strongly support the hypothesis that modifications in surgical techniques, specifically the preservation of the infrapatellar fat pad (IPFP) during anterior cruciate ligament (ACL) reconstruction, can significantly influence postoperative outcomes. In ACL reconstruction, removing the infrapatellar fat pad (IPFP) may aid exposure but is linked to more anterior knee pain within a year and poorer early KOOS pain/symptom/sport scores-likely due to dense innervation, increased free nerve endings, and fibrosis/patellar tendon shortening. ROM, stability, and functional tests improved similarly between groups, except for more patellar tendon tenderness at 3 months after resection. Complications were comparable (slightly higher with resection). Overall, the data favor preserving the IPFP.[1]

In ACL reconstruction, Chen et al (2019) clearing the stump improves visualization, tunnel accuracy, and reduces impingement/cyclops risk, but removing native tissue can eliminate mechanoreceptors and hinder graft revascularization; because early revascularization comes mainly from the synovium and the infrapatellar fat pad (IPFP), careful IPFP handling-and often preserving a ~10 mm tibial stump-can promote faster graft revascularization without increasing cyclops, as multiple studies report similar cyclops rates with or without stump retention and earlier revascularization when the stump is kept. Surgical pearls include using an anteromedial femoral tunnel approach, ensuring the residual stump doesn't snag on the drill, and centering the graft through the preserved stump; clinical outcomes (Lysholm/Tegner) typically improve in both strategies, but preserving the stump and treating the fat pad gently may better support biological healing.[2]

The PCL fat pad transfer is a simple adjunct to ACL repair or reconstruction that delivers a vascularized "synovial graft" to enhance synovialization, remodeling, and graft maturation. Because the ACL receives little blood from its bone attachments and instead depends on synovial vessels (notably branches of the middle genicular and infrapatellar arteries), clinical data show that greater synovial coverage correlates with better outcomes-higher repair survival, less anterior laxity and pivot shift, and improved IKDC and Lysholm scores. The ACL midsubstance is particularly prone to necrosis due to sparse vascularity; a pedunculated PCL fat pad graft fills this critical zone, likely preserving middle genicular artery branches between the cruciates and providing immediate vascular supply. Performed after fixation, it does not hinder graft passage, avoids foreign scaffolds and donor-site morbidity, and can be combined with remnant preservation. Limitations include longer operative time (and potential tourniquet-related ischemia), the need for an additional medial parapatellar portal, theoretical PCL hypoperfusion (mitigated by robust posterior capsular blood supply), and a possible increased risk of arthrofibrosis. Overall, it appears to be a practical, combinable method to biologically augment healing of repaired or reconstructed ACLs.[3]

Study from Li et al (2021) explored a cannula-assisted method to truly preserve the infrapatellar fat pad (IPFP) during ACL reconstruction using standard AM/AL portals-routing a cannula posterior to the IPFP and anchoring it behind the patellar tendon-to maintain visualization without resection. Compared with non-preservation, IPFP preservation yielded less fibrosis, lower postoperative inflammatory response (lower synovial IL-6), reduced anterior knee pain with higher Kujala scores, and better cartilage integrity on second-look arthroscopy. These benefits likely stem from dampened inflammation, healthier cartilage, and avoidance of exposing free nerve endings. The findings contrast with a small RCT that used only partial preservation and found no differences, suggesting adequate IPFP conservation is key to improved outcomes.[4]

High anterolateral and anteromedial portals in ACL reconstruction improve visualization while avoiding infrapatellar fat pad (IPFP) penetration, aiding assessment of the medial gutter and anterior horn of the lateral meniscus and facilitating resection of the ligamentum mucosum (present in ~78%). Using an outside-in femoral guide maintains tunnel accuracy (inside-out can be trickier), and high portals generally do not hinder meniscal work; if access is limited, the anteromedial portal can be extended distally, and curved suture devices help with posteromedial repairs. Resection of the ligamentum mucosum allows the IPFP to translate anteriorly, reducing the need to shave it. Because the IPFP shifts posteriorly with flexion and anteriorly with extension, creating the tibial tunnel at ~30–40° flexion optimizes visualization of the tibial footprint. Overall, prioritizing IPFP preservation via higher portals and early ligamentum mucosum resection shortens operative time without adding difficulty to concurrent meniscal procedures.[5]

Asai et al. (2020) found that although the infrapatellar fat pad (IPFP) shrank more after resection than preservation at 6 months, limited arthroscopic IPFP resection to visualize the ACL footprint did not worsen postoperative outcomes-including anterior knee pain (AKP)-after ACL reconstruction with hamstring autografts: Kujala scores improved from 3 to 6 months, IKDC/KOOS were good at 1–2 years, and MRI showed similarly high rates (>70%) of IPFP fibrosis and patellar tendinopathy-like changes in both groups with no >40% IPFP volume loss. While the IPFP's rich innervation and posterior segment vascularity can contribute to AKP, the resected amounts here were likely small and not clinically harmful. Clinically, careful IPFP resection can enhance visualization and allow precise tunnel creation without added complications. Limitations include non-quantified resection, small sample size, delayed and coarse MRI volumetry, absence of very early outcomes, and non-standard AKP criteria[6].

CONCLUSION

In conclusion, this systematic review infrapatellar fat pad (IPFP) during ACL reconstruction is associated with less early anterior knee pain, lower inflammatory response, and better early patient-reported outcomes (e.g., Kujala/KOOS pain–symptom–sport) without sacrificing ROM, stability, or increasing complications or cyclops; limited, targeted trimming appears safe when essential for footprint visualization. Techniques that enable preservation-high AM/AL portals with early ligamentum mucosum resection, cannula-assisted behind-pad viewing, and short tibial-stump retention-maintain visualization while supporting biologic revascularization, and a pedunculated PCL fat-pad transfer is a feasible adjunct to enhance synovialization and graft maturation. On balance, the evidence favors routine IPFP-sparing strategies with judicious, minimal resection only as needed; however, definitive practice recommendations await well-powered randomized trials using standardized IPFP definitions and quantitative measures (extent preserved/resected, serial imaging, biomarkers, and harmonized PROMs) to confirm durability of benefit.

Limitation

This review is limited by the heterogeneity of surgical techniques and outcome measures among the included studies. Further standardized studies are warranted to validate these findings.

Declaration by Authors

Consent: As per international standards or university standards, patient(s) written consent has been collected and preserved by the author(s).

Disclaimer (Artificial Intelligence): Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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