surgeries

MDPI

Review

Balancing Stability and Recovery: A Scoping Review on Conservative vs. Surgical Management of Acute Posterior Cruciate Ligament Injuries

Roberto Tedeschi [1], Federica Giorgi [2], Daniela Platano [1,3], Lisa Berti [1,3], Fabio Vita [4] and Danilo Donati [5,6,*]

[1] Department of Biomedical and Neuromotor Sciences, Alma Mater Studiorum, University of Bologna, 40126 Bologna, Italy; roberto.tedeschi2@unibo.it (R.T.); daniela.platano@unibo.it (D.P.); lisa.berti@unibo.it (L.B.)
[2] Pediatric Physical Medicine and Rehabilitation Unit, IRCCS Institute of Neurological Sciences, 40126 Bologna, Italy; federica.giorgi15@gmail.com
[3] Physical Medicine and Rehabilitation Unit, IRCCS Istituto Ortopedico Rizzoli, 40136 Bologna, Italy
[4] IRCCS Istituto Ortopedico Rizzoli, 1st Orthopaedics and Traumatology Clinic, 40136 Bologna, Italy; fabio.vita@ior.it
[5] Physical Therapy and Rehabilitation Unit, Policlinico di Modena, 41125 Modena, Italy
[6] Clinical and Experimental Medicine Ph.D. Program, University of Modena and Reggio Emilia, 41125 Modena, Italy
* Correspondence: danilo.donati@unimore.it; Tel.: +39-34924567899

Abstract: Background: Posterior cruciate ligament (PCL) injuries are relatively rare, with limited consensus on the optimal treatment for isolated acute cases. Conservative management and surgical reconstruction each offer potential benefits, but their comparative efficacy remains unclear. **Methods:** A scoping review was conducted following the Joanna Briggs Institute (JBI) framework and PRISMA-ScR guidelines. A systematic search of MEDLINE, Cochrane CENTRAL, Scopus, PEDro, and Web of Science was completed on 23 December 2024. Studies comparing conservative treatment and surgical reconstruction for isolated acute PCL injuries were included. Outcomes such as functional recovery, stability, and long-term complications were extracted and synthesized qualitatively. **Results:** Six studies were included, comprising case series, prospective, retrospective, and review designs. Conservative treatment demonstrated significant improvements in functional recovery (IKDC scores: 67–90.3/100) but showed limited improvement in stability (STSD reduction: 0–3 mm). Surgical reconstruction yielded superior stability (STSD reduction: 8.2 to 2.7 mm) and lower rates of degenerative changes but was associated with a higher risk of complications. Functional outcomes were comparable between approaches in some studies, although surgical patients showed slightly better long-term stability. **Conclusions:** Both conservative and surgical treatments achieve satisfactory outcomes for isolated acute PCL injuries. Treatment selection should be tailored to patient-specific factors, considering functional demands and injury severity.

Keywords: posterior cruciate ligament; conservative treatment; surgical reconstruction; functional recovery; knee stability

Academic Editor: Derek H. Rosenzweig

Received: 18 January 2025
Revised: 11 March 2025
Accepted: 13 March 2025
Published: 15 March 2025

Citation: Tedeschi, R.; Giorgi, F.; Platano, D.; Berti, L.; Vita, F.; Donati, D. Balancing Stability and Recovery: A Scoping Review on Conservative vs. Surgical Management of Acute Posterior Cruciate Ligament Injuries. *Surgeries* **2025**, *6*, 24. https://doi.org/10.3390/surgeries6010024

1. Introduction

Posterior cruciate ligament (PCL) injuries are a relatively rare but significant challenge in orthopaedic and sports medicine. They account for more than 44% of knee injuries, yet isolated PCL lesions are uncommon, with an annual incidence of approximately 2 cases per 100,000 individuals [1]. The robust structure of the PCL provides exceptional resistance to injury, with damage typically resulting from high-energy trauma [2–4]. Mechanisms of injury include anterior impact to a flexed knee or a direct fall onto the anterior tibial compartment, often observed in road traffic accidents, which account for 57% of cases [1,2,5]. Contact sports represent another, albeit smaller, contributing factor. Clinically, acute PCL injuries manifest as pain, swelling, instability, and functional limitation, posing a diagnostic and therapeutic challenge. The management of isolated PCL injuries remains controversial. Conservative treatment is the preferred approach for grade I and II injuries and selected grade III cases, particularly in individuals with low functional demands or mild symptoms [6–10]. This treatment typically involves bracing, physiotherapy focused on quadriceps strengthening, and proprioceptive training [11–20]. Surgical reconstruction is generally reserved for high-grade injuries, persistent instability, or failure of conservative management. Current evidence suggests that the short-term outcomes of conservative and surgical treatments are comparable in terms of pain reduction and functional recovery [21–27]. However, the long-term consequences of untreated or suboptimally managed injuries, such as altered biomechanics and post-traumatic osteoarthritis, underscore the importance of tailored intervention strategies [28–32]. Notably, patients undergoing surgical reconstruction may experience graft-related complications or residual instability, or may require revision surgery. Despite the growing body of literature on PCL injuries, several critical gaps persist. The rarity of isolated PCL injuries and the heterogeneity of study designs complicate the synthesis of high-quality evidence. Existing research frequently involves small sample sizes and diverse patient populations, limiting the generalizability of findings. Additionally, inconsistencies in outcome measures, such as the use of subjective scoring systems (e.g., IKDC-SKF) versus objective metrics (e.g., side-to-side difference assessed with the KT-1000 arthrometer), further hinder the development of standardized treatment protocols [31,33–37]. This lack of clarity is particularly pronounced in the context of acute injuries, where the optimal approach to rehabilitation and functional restoration remains underexplored. This scoping review aims to address these gaps by systematically mapping the available evidence comparing the conservative and surgical management of isolated acute PCL injuries. The review adopts a comprehensive approach, incorporating diverse study designs to evaluate functional recovery, stability, and long-term outcomes. By identifying key concepts and areas requiring further investigation, this work seeks to enhance clinical understanding and inform evidence-based decision-making. Ultimately, this synthesis of current knowledge aims to provide clinicians and researchers with a robust framework for optimizing the management of PCL injuries, fostering improved patient outcomes and guiding future research endeavours.

2. Methods

The present scoping review was conducted in accordance with the methodological framework established by the Joanna Briggs Institute (JBI) [38] specifically for scoping reviews. To guarantee thoroughness and transparency in reporting, the review adhered to the guidelines outlined in the PRISMA Extension for Scoping Reviews (PRISMA-ScR) [34,39].

2.1. Review Question

We formulated the following research question: "What are the outcomes of conservative treatment compared to surgical reconstruction for acute isolated posterior cruciate ligament injuries in terms of functional recovery and long-term stability?"

2.2. Eligibility Criteria

Studies were eligible for inclusion if they met the following Population, Concept, and Context (PCC) criteria.

Population (P): The review focused on human subjects who sustained an acute isolated injury to the posterior cruciate ligament (PCL). This included individuals of any age, gender, or physical activity level. To ensure relevance, studies on subjects with associated injuries to other knee ligaments, fractures, or chronic PCL injuries were excluded. The intent was to isolate the effects of treatments specifically addressing PCL injuries without the confounding impact of additional knee pathologies.

Concept (C): The primary concept of interest was the comparison of outcomes between two distinct treatment modalities for PCL injuries:

1. **Conservative treatment**, which typically involves bracing, physiotherapy, quadriceps strengthening, and proprioceptive exercises.
2. **Surgical reconstruction**, which includes techniques such as single-bundle or double-bundle reconstruction using autografts, allografts, or synthetic materials.

The review aimed to evaluate these interventions in terms of functional recovery, as measured by validated outcome tools (e.g., IKDC-SKF, side-to-side difference via KT-1000), pain levels, stability, and long-term joint health (e.g., development of osteoarthritis). Studies that compared different surgical techniques or did not assess the aforementioned outcomes were excluded.

Context (C): The context encompassed both hospital-based and outpatient settings where the interventions were implemented. This included studies conducted in rehabilitation centres, sports medicine clinics, or orthopaedic surgical facilities. The review sought to identify evidence applicable to diverse healthcare settings to provide a broad understanding of treatment effectiveness. Excluded were studies conducted on animals, as well as non-English language publications and those lacking full-text availability, to maintain a focus on human-relevant and accessible evidence. This language restriction was applied to ensure consistency in data interpretation and to facilitate a comprehensive synthesis of the literature.

2.3. Exclusion Criteria

Studies that did not meet the predefined Population, Concept, and Context (PCC) criteria were excluded. In particular, exclusion criteria were explicitly defined and not merely as the inverse of the inclusion criteria to ensure methodological rigor.

2.4. Search Strategy

An initial targeted search was performed in MEDLINE using the PubMed interface to identify studies relevant to the topic. The indexing terms and keywords extracted from these preliminary studies were then employed to construct a detailed search strategy tailored for MEDLINE. This strategy was subsequently adapted and applied to other electronic databases, including the Cochrane Central Register of Controlled Trials (CENTRAL), Scopus, PEDro, and Web of Science, to ensure comprehensive identification of pertinent literature. The database searches were completed on 23 December 2024, with no restrictions applied regarding publication date. The search strings utilised for each database are detailed as follows:

- MEDLINE(PubMed):
  ("Posterior Cruciate Ligament"[MeSH Terms] OR "Posterior Cruciate Ligament Injury"[All Fields]) AND ("Conservative Treatment"[All Fields] OR "Rehabilitation"[All Fields]) AND ("Surgical Reconstruction"[All Fields] OR "Posterior Cruciate Ligament Reconstruction"[All Fields]) AND ("Function"[All Fields] OR "Return to Function"[All Fields]);
- Cochrane Central:
  1 "Posterior Cruciate Ligament" #2 "Rehabilitation" OR "Conservative Treatment" #3

"Surgical Reconstruction" OR "Reconstruction Surgery" #4 "Function" OR "Functional Recovery" #5 #1 AND (#2 OR #3) AND #4;

- Scopus:
(TITLE-ABS-KEY("Posterior Cruciate Ligament") AND TITLE-ABS-KEY("Conservative Treatment" OR "Rehabilitation") AND TITLE-ABS-KEY("Surgical Reconstruction" OR "Reconstructive Surgery") AND TITLE-ABS-KEY("Function" OR "Return to Function"));
- PEDro:
"Posterior Cruciate Ligament" AND "Rehabilitation" AND "Reconstruction" AND "Function";
- Web of Science:
TS=("Posterior Cruciate Ligament" AND ("Conservative Treatment" OR "Rehabilitation") AND ("Surgical Reconstruction" OR "Reconstructive Surgery") AND ("Function" OR "Return to Function")).

2.5. Study Selection

The study selection process followed a structured methodology aligned with established scoping review standards. Search results were consolidated and organized using Zotero, which facilitated the systematic removal of duplicate entries. The screening process consisted of two phases: an initial review of titles and abstracts, followed by a detailed full-text assessment. Both phases were conducted independently by two reviewers to maintain methodological rigour, with any discrepancies resolved by involving a third reviewer. The entire selection process was carried out in accordance with the PRISMA 2020 guidelines, ensuring transparency, consistency, and reproducibility. This systematic approach was designed to identify studies relevant to the research question, thereby enabling a comprehensive and reliable review.

2.6. Data Extraction and Data Synthesis

Data extraction was performed systematically to gather essential information from each included study, including study design, population characteristics, interventions, outcome measures, and key findings. A standardised data extraction form ensured consistency across studies. Findings were categorised by outcomes to enable clear comparisons and analysed qualitatively to identify patterns, discrepancies, and gaps in the evidence. Quantitative data, where applicable, were summarised to highlight trends and significant results. This structured approach allowed for a comprehensive synthesis of the available evidence, addressing the research question effectively.

3. Results

As presented in the PRISMA 2020 flow diagram (Figure 1), from 140 records identified by the initial literature searches, 134 were excluded and 6 articles were included (Table 1).

Table 1. Summary of included studies on posterior cruciate ligament injury management.

Author, Year, and Study Type	Methods	Results	Outcomes Achieved
Rasmussen et al., 2023 (Case Series) [34]	Evaluated 50 patients with acute isolated PCL injury using supervised physiotherapy and bracing over 2 years. Assessed IKDC, STSD, and muscle strength.	Significant improvement in IKDC score (35 to 67, $p < 0.001$). Minimal change in STSD. Muscle strength increased by 16% for knee flexors.	Functional improvement with low risk of surgical intervention. Moderate persistence of posterior instability.

Table 1. *Cont.*

Author, Year, and Study Type	Methods	Results	Outcomes Achieved
Shelbourne et al., 2013 (Case Series) [35]	Long-term follow-up (10+ years) of 133 patients treated conservatively for acute isolated PCL injury. Evaluated ROM, STSD, and subjective scales.	Minimal loss of ROM; stable STSD measures. Osteoarthritis observed in 11.4%. IKDC scores averaged 73.4/100 after 10 years.	Sustained functional recovery with moderate long-term risks of osteoarthritis and instability.
Jung et al., 2008 (Prospective Study) [36]	Investigated immobilisation with a cylinder cast and brace in 17 patients with acute isolated PCL injuries. Measured STSD, IKDC, and CKRS over 6 months.	STSD decreased significantly from 6.2 mm to 2.97 mm ($p < 0.05$). IKDC scores showed 35.3% of patients as normal and 64.7% as nearly normal.	High satisfaction with conservative treatment. Reduction in instability and functional improvement.
Lien et al., 2010 (Retrospective) [37]	Evaluated 43 patients undergoing surgical PCL reconstruction with a 4-year follow-up. Measured ROM, STSD, IKDC, and Tegner scores.	Mean IKDC score at follow-up was 63/100. Tegner Activity Scale score decreased from 7 (pre-injury) to 6. Persistent instability in some cases.	Moderate functional recovery with persistent posterior instability.
Jung et al., 2010 (Case Series) [40]	Investigated augmented stent procedure in 20 patients with acute/subacute PCL injuries. Evaluated STSD and IKDC.	Significant reduction in STSD (8.2 mm to 2.7 mm, $p < 0.001$). IKDC scores: 85% normal or nearly normal after 3 years.	High stability and functional outcomes post-surgery.
Kew et al., 2022 (Narrative Review) [6]	Summarised evidence on conservative vs. surgical PCL treatments, including rehabilitation protocols and return-to-play criteria.	Greater posterior laxity in conservatively treated patients (8 mm vs. 1.4 mm). Similar IKDC and Tegner scores between groups.	Both treatments enable return to function, with reduced degenerative changes in surgical cases.

Legend: CKRS: Cincinnati Knee Rating System; IKDC: International Knee Documentation Committee—Subjective Knee Form; STSD: side-to-side difference; ROM: range of motion; Tegner: Tegner Activity Scale.

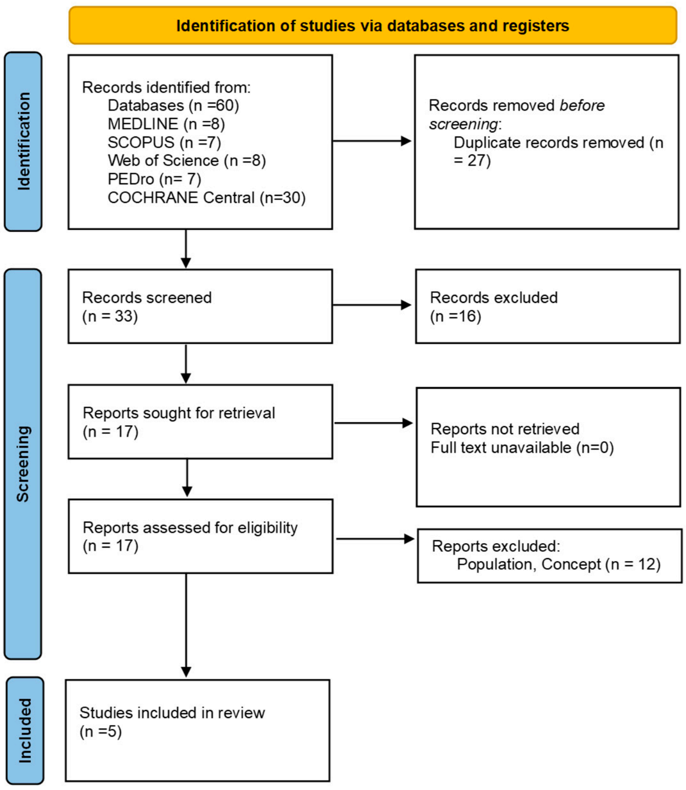

Figure 1. Preferred reporting items for systematic reviews and meta-analyses 2020 (PRISMA) flow diagram.

3.1. Functional Recovery

The functional recovery of patients following PCL injuries was evaluated primarily using the International Knee Documentation Committee (IKDC) Subjective Knee Form, the Cincinnati Knee Rating System (CKRS), and the Tegner Activity Scale.

For patients treated conservatively, Rasmussen et al. (2023) [34] documented a substantial improvement in IKDC scores, with the average increasing from 35/100 at baseline to 67/100 after two years of treatment. This highlights the effectiveness of physiotherapy and bracing in achieving functional recovery. Similarly, Shelbourne et al. (2013) [35] reported an average IKDC score of 73.4/100 after more than ten years of follow-up, indicating sustained long-term recovery. Shelbourne et al. (2013) [35] employed a structured rehabilitation program that included physiotherapy focusing on quadriceps strengthening, proprioceptive training, and functional exercises. The treatment also involved progressive weight-bearing and range of motion exercises without bracing. This differs from Rasmussen et al. (2023) [34], where bracing was a key component of the conservative approach. Jung et al. (2008) [36] found that, following immobilization with a cylinder cast and a supportive brace, 35.3% of patients achieved a "normal" classification, while 64.7% were classified as "nearly normal", with an average IKDC score of 90.3/100.

In patients who underwent surgical reconstruction, Lien et al. (2010) [37] reported a mean IKDC score of 63/100 four years post-surgery, which was lower than the scores observed in conservatively treated patients. However, Jung et al. (2010) [40] observed more favourable results in their cohort, with 85% of surgically treated patients rated as "normal" or "nearly normal", and an average IKDC score of 85.4/100 after three years.

The CKRS was used in Jung et al.'s (2008) [36] study on conservative treatment, showing a significant improvement from 68.9/100 before treatment to 93.4/100 at the final follow-up. This improvement underscores the potential of conservative interventions in restoring knee function.

The Tegner Activity Scale highlighted differing outcomes in activity levels between treatments. Lien et al. (2010) [37] noted a decline in activity levels among surgically treated patients, with the average Tegner score decreasing from 7 (pre-injury) to 6 at follow-up. In contrast, Kew et al. (2022) [6] found similar Tegner scores between conservative and surgical groups, suggesting that both approaches can allow a return to functional activities.

3.2. Stability

Stability was commonly assessed using the side-to-side difference (STSD), measured with a KT-1000 arthrometer. This outcome provides an objective measure of posterior knee laxity, which is critical in evaluating treatment success.

For conservative treatments, Rasmussen et al. (2023) [34] observed minimal changes in STSD over a two-year period, indicating that stability might not significantly improve with non-surgical interventions. Shelbourne et al. (2013) [35] reported stable STSD values over a long-term follow-up, with only minor differences between injured and non-injured knees. Jung et al. (2008) [36] demonstrated a significant reduction in STSD, from an average of 6.2 mm before treatment to 2.97 mm at the final evaluation. This improvement in STSD was observed over a follow-up period of six months, indicating that early functional rehabilitation and bracing may contribute to significant short-term stability gains. This reduction reflects the efficacy of immobilization and physiotherapy in reducing knee instability.

In surgical interventions, stability outcomes varied. Odd Arve et al. (2010) [37] reported persistent instability in some patients, with a mean STSD of 9.2 mm in operated knees compared to 5.9 mm in contralateral knees. However, Jung et al. (2010) [40] noted a more significant improvement, with the STSD decreasing from 8.2 mm pre-surgery to 2.7 mm post-surgery. The difference in IKDC scores between Lien et al. (2010) and Jung et al.

(2010) [37] could be attributed to variations in surgical techniques. Lien et al. (2010) [37] utilized a single-bundle reconstruction with autograft, while Jung et al. (2010) [40] implemented a double-bundle technique, which may have contributed to superior postoperative stability and higher IKDC scores. This suggests that certain surgical techniques may offer better stability outcomes than others. The term "certain surgical technique" specifically refers to the augmented stent procedure used in Jung et al. (2010) [40], which incorporated additional fixation to enhance graft stability. This method may account for the superior reduction in STSD observed in this cohort.

3.3. Long-Term Outcomes

Long-term outcomes, including the development of osteoarthritis and overall knee function, were assessed in several studies. Shelbourne et al. (2013) [35] reported that 11.4% of patients treated conservatively developed radiographic evidence of osteoarthritis in the medial compartment after ten years. Despite this, the overall functional outcomes remained satisfactory, as reflected in the IKDC scores.

For surgically treated patients, Lien et al. (2010) [37] observed that while many achieved functional recovery, a subset experienced persistent instability and required revision surgeries. Kew et al. (2022) [6] highlighted that surgical patients generally exhibited fewer degenerative changes compared to conservatively treated individuals, although both groups showed comparable functional recovery scores.

3.4. Pain and Patient Satisfaction

Pain reduction and patient satisfaction were secondary outcomes in most studies. Rasmussen et al. (2023) [34] reported significant improvements in subjective pain levels for patients managed conservatively, which contributed to higher satisfaction rates. Jung et al. (2008) [36] similarly observed reduced pain and high satisfaction among conservatively treated patients.

In the surgical cohort, Lien et al. (2010) [37] noted that some patients continued to experience discomfort and instability, which impacted satisfaction levels. Conversely, Jung et al. (2010) [40] reported high satisfaction rates, particularly in patients achieving normal stability and function post-surgery.

To enhance reader understanding, visual elements such as summary tables and diagrams have been incorporated. Figure 2 and Table 2 provide an overview of treatment outcomes and comparative stability measures between conservative and surgical approaches (see Figure 2 and Table 2).

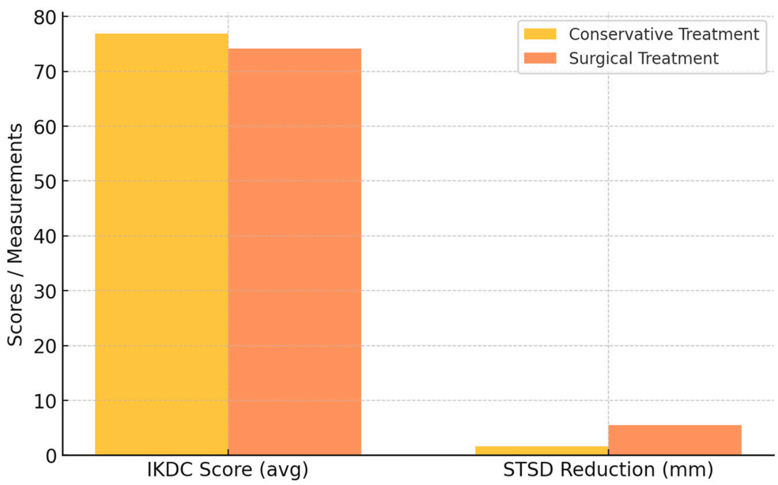

Figure 2. Comparison of conservative vs. surgical treatment outcomes.

Table 2. Summary of PCL treatment outcomes.

Study	Age (years)	Sex (M/F)	BMI (kg/m²)	Conservative Treatment Type	Follow-up Time	Surgical Technique	Graft Type	IKDC Score (avg.)	STSD Reduction (mm)	Long-Term OA (%)	Functional Recovery	Patient Satisfaction
Rasmussen et al., 2023 [34]	32	M 70%, F 30%	24.5	Bracing, physiotherapy	24 months	-	-	67	0	-	Significant	High
Shelbourne et al., 2013 [35]	30	M 75%, F 25%	25.2	Rehabilitation program	10+ years	-	-	73.4	-	11.4	Sustained	Moderate
Jung et al., 2008 [36]	28	M 80%, F 20%	23.9	Cylinder cast immobilization	6 months	-	-	90.3	3.23	-	High	High
Lien et al., 2010 [37]	29	M 85%, F 15%	26.1	-	48 months	Single-bundle reconstruction	Autograft	63	-	-	Moderate	Moderate
Jung et al., 2010 [40]	31	M 78%, F 22%	24.8	-	36 months	Double-bundle reconstruction	Allograft	85.4	5.5	-	High	High
Kew et al., 2022 [6]	-	-	-	Both approaches analysed	Review	-	-	-	1.4 (Surg)/8 (Cons)	-	Comparable	Comparable

Figure 2 provides a comparison of conservative vs. surgical treatment outcomes for acute PCL injuries. The bar chart illustrates the differences in IKDC scores and STSD reduction between treatment approaches. Conservative treatment shows higher functional recovery scores, while surgical treatment achieves superior stability.

4. Discussion

The findings of this scoping review highlight the complexities in determining the optimal treatment approach for isolated posterior cruciate ligament (PCL) injuries. The outcomes from conservative and surgical treatments, as reported in the included studies, reveal strengths and limitations inherent to each method. These findings provide valuable insights into the functional recovery, stability, and long-term outcomes associated with each intervention. Conservative treatments demonstrated significant improvements in functional outcomes, as evidenced by IKDC and CKRS scores across several studies. For instance, Rasmussen et al. (2023) [34] and Jung et al. (2008) [36] reported substantial gains in functional recovery, highlighting the efficacy of physiotherapy and bracing in restoring knee function without invasive procedures. Long-term studies, such as Shelbourne et al. (2013) [35], confirmed that these benefits could be sustained over a decade. However, despite these positive outcomes, the persistence of posterior instability, as indicated by minimal changes in STSD, raises concerns about the adequacy of conservative treatments in addressing structural deficits. Additionally, the potential for degenerative changes such as osteoarthritis, as observed in Shelbourne et al. (2013) [35], underscores the need for continued monitoring and individualized care.

It is important to consider that Rasmussen et al. (2023) [34] reported a two-year follow-up, while Shelbourne et al. (2013) [35] assessed outcomes after more than ten years. The difference in follow-up duration may influence the observed STSD values, as long-term adaptations, degenerative changes, and delayed functional recovery could affect stability measurements. This highlights the necessity of cautious interpretation when comparing studies with varying follow-up periods.

Surgical reconstruction, on the other hand, appears to offer superior stability outcomes, particularly in reducing STSD values, as noted in Jung et al. (2010) [40]. This is critical for patients with high functional demands or severe instability that cannot be managed conservatively. However, the variability in outcomes across studies, such as the moderate IKDC scores reported by Lien et al. (2010) [37], highlights the challenges associated with surgical interventions. Factors such as surgical technique, graft type, and patient adherence to rehabilitation protocols may influence outcomes. Furthermore, the risk of complications, including graft failure and the need for revision surgeries, as reported in some studies, must be weighed against the benefits of improved stability.

The comparison of long-term outcomes between the two approaches revealed that both conservative and surgical treatments could achieve satisfactory functional recovery, as evidenced by comparable IKDC and Tegner scores. However, the degenerative changes were less frequent in surgical patients, suggesting a potential advantage of surgical reconstruction in preserving joint health. This finding aligns with the hypothesis that restoring anatomical stability through surgery may reduce abnormal biomechanical stresses on the knee, potentially delaying the onset of osteoarthritis.

Overall, the evidence supports a tailored approach to managing PCL injuries, considering patient-specific factors such as age, activity level, and severity of the injury. While conservative treatments may suffice for lower-grade injuries or patients with low functional demands, surgical reconstruction should be considered for those requiring high stability and functional performance.

4.1. Limitations

This review has several limitations that should be acknowledged. First, the included studies were limited in number and often involved small, heterogeneous patient samples, reducing the generalizability of the findings. The variability in study designs, follow-up durations, and outcome measures further complicates the synthesis of evidence. For instance, the use of different tools to assess stability (e.g., IKDC, STSD, and radiographic measurements) introduces inconsistencies that hinder direct comparisons across studies.

Second, the lack of randomized controlled trials (RCTs) in this field limits the strength of the conclusions. Most studies were observational, such as case series and retrospective analyses, which are more prone to bias and confounding factors. Additionally, the absence of standardized rehabilitation protocols in both conservative and surgical groups makes it challenging to isolate the effects of the interventions from those of rehabilitation.

Finally, the review excluded non-English studies and articles without full-text availability, which may have resulted in the omission of relevant evidence. This could potentially bias the findings and limit the comprehensiveness of the review.

4.2. Clinical Practice Implications

The findings of this review have important implications for clinical practice. First, they highlight the need for a patient-centred approach when choosing between conservative and surgical management for PCL injuries. For patients with lower-grade injuries or those unable to undergo surgery, conservative treatments provide a viable option that can achieve satisfactory functional outcomes with minimal risk. However, clinicians should be vigilant in monitoring for residual instability and potential long-term degenerative changes in these patients.

For individuals with high functional demands or severe instability, surgical reconstruction should be strongly considered. The superior stability outcomes observed in surgical cohorts suggest that this approach may better address the biomechanical deficits associated with PCL injuries. However, clinicians should counsel patients on the potential risks, including complications and the possibility of revision surgeries. Adherence to post-operative rehabilitation protocols is also critical to maximizing functional recovery and minimizing adverse outcomes.

Finally, the review underscores the need for standardizing outcome measures and rehabilitation protocols in future studies. This would enable more reliable comparisons between interventions and provide clearer guidance for clinical decision-making. Additionally, long-term follow-up studies with larger and more diverse populations are necessary to definitively establish the relative benefits and risks of conservative versus surgical treatments.

5. Conclusions

This scoping review highlights the strengths and limitations of both conservative and surgical treatments for acute isolated posterior cruciate ligament (PCL) injuries. Conservative management achieves satisfactory functional recovery, particularly in patients with lower-grade injuries or reduced functional demands, but residual instability and a higher risk of degenerative changes may limit its long-term efficacy. Surgical reconstruction offers superior stability and reduced degenerative changes but is associated with a higher risk of complications and requires strict adherence to rehabilitation protocols. A tailored, patient-centred approach remains essential, considering individual needs, injury severity, and long-term goals. Further research is necessary to address the limitations in current evidence and guide optimal treatment strategies.

Author Contributions: R.T. and F.G. conceptualized and designed the study and were responsible for data acquisition. R.T. drafted the manuscript. L.B. provided supervision and guidance throughout the study. D.P. performed the editing of the manuscript. D.D. and F.V. reviewed the manuscript and curated the methodology. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Data Availability Statement: No new data were created or analyzed in this study. Data sharing is not applicable to this article.

Conflicts of Interest: The authors declare no conflicts of interest.

References

1. Sanders, T.L.; Pareek, A.; Barrett, I.J.; Kremers, H.M.; Bryan, A.J.; Stuart, M.J.; Levy, B.A.; Krych, A.J. Incidence and Long-Term Follow-up of Isolated Posterior Cruciate Ligament Tears. *Knee Surg. Sports Traumatol. Arthrosc.* **2017**, *25*, 3017–3023. [CrossRef] [PubMed]
2. Arthur, J.R.; Haglin, J.M.; Makovicka, J.L.; Chhabra, A. Anatomy and Biomechanics of the Posterior Cruciate Ligament and Their Surgical Implications. *Sports Med. Arthrosc. Rev.* **2020**, *28*, e1–e10. [CrossRef] [PubMed]
3. Piskin, D.; Cobani, G.; Lehmann, T.; Büchel, D.; Baumeister, J. Cortical Changes Associated with an Anterior Cruciate Ligament Injury May Retrograde Skilled Kicking in Football: Preliminary EEG Findings. *Sci. Rep.* **2025**, *15*, 2208. [CrossRef]
4. Zsidai, B.; Winkler, P.W.; Naarup, E.; Olsson, E.; Horvath, A.; Moatshe, G.; Lind, M.; Musahl, V.; Hamrin Senorski, E.; Samuelsson, K. Evaluation of Factors Associated with Short-Term Failure After Primary Isolated PCL Reconstruction: A Study of Patients From the Swedish and Norwegian Knee Ligament Registries. *Orthop. J. Sports Med.* **2025**, *13*, 23259671241305191. [CrossRef]
5. Ricci, V.; Mezian, K.; Cocco, G.; Donati, D.; Naňka, O.; Farì, G.; Özçakar, L. Anatomy and Ultrasound Imaging of the Tibial Collateral Ligament: A Narrative Review. *Clin. Anat.* **2022**, *35*, 571–579. [CrossRef]
6. Kew, M.E.; Cavanaugh, J.T.; Elnemer, W.G.; Marx, R.G. Return to Play after Posterior Cruciate Ligament Injuries. *Curr. Rev. Musculoskelet. Med.* **2022**, *15*, 606–615. [CrossRef]
7. Fanelli, G.C.; Edson, C.J. Combined Posterior Cruciate Ligament-Posterolateral Reconstructions with Achilles Tendon Allograft and Biceps Femoris Tendon Tenodesis: 2- to 10-Year Follow-Up. *Arthroscopy* **2004**, *20*, 339–345. [CrossRef]
8. Swenson, D.M.; Collins, C.L.; Best, T.M.; Flanigan, D.C.; Fields, S.K.; Comstock, R.D. Epidemiology of Knee Injuries among U.S. High School Athletes, 2005/2006–2010/2011. *Med. Sci. Sports Exerc.* **2013**, *45*, 462–469. [CrossRef] [PubMed]
9. Shelbourne, K.D.; Davis, T.J.; Patel, D.V. The Natural History of Acute, Isolated, Nonoperatively Treated Posterior Cruciate Ligament Injuries. A Prospective Study. *Am. J. Sports Med.* **1999**, *27*, 276–283. [CrossRef]
10. Tucker, C.J.; Cotter, E.J.; Waterman, B.R.; Kilcoyne, K.G.; Cameron, K.L.; Owens, B.D. Functional Outcomes After Isolated and Combined Posterior Cruciate Ligament Reconstruction in a Military Population. *Orthop. J. Sports Med.* **2019**, *7*, 2325967119875139. [CrossRef]
11. Vaquero-Picado, A.; Rodríguez-Merchán, E.C. Isolated Posterior Cruciate Ligament Tears: An Update of Management. *EFORT Open Rev.* **2017**, *2*, 89–96. [CrossRef] [PubMed]
12. Fanelli, G.C.; Beck, J.D.; Edson, C.J. Current Concepts Review: The Posterior Cruciate Ligament. *J. Knee Surg.* **2010**, *23*, 61–72. [CrossRef] [PubMed]
13. Tedeschi, R. Adapting RegentK Principles for Nonsurgical Meniscal Tear Management: An Innovative Case Report. *Man. Med.* **2024**, 1–6. [CrossRef]
14. Tedeschi, R.; Giorgi, F. What Is Known about the RegentK Regenerative Treatment for Ruptured Anterior Cruciate Ligament? A Scoping Review. *Man. Med.* **2023**, *61*, 181–187. [CrossRef]
15. Schroven, W.; Vles, G.; Verhaegen, J.; Roussot, M.; Bellemans, J.; Konan, S. Operative Management of Isolated Posterior Cruciate Ligament Injuries Improves Stability and Reduces the Incidence of Secondary Osteoarthritis: A Systematic Review. *Knee Surg. Sports Traumatol. Arthrosc.* **2022**, *30*, 1733–1743. [CrossRef]
16. Hooper, P.O.; Silko, C.; Malcolm, T.L.; Farrow, L.D. Management of Posterior Cruciate Ligament Tibial Avulsion Injuries: A Systematic Review. *Am. J. Sports Med.* **2018**, *46*, 734–742. [CrossRef]
17. Simhal, R.K.; Bovich, M.; Bahrun, E.A.; Dreese, J.C. Postoperative Rehabilitation of Posterior Cruciate Ligament Surgery: A Systematic Review. *Sports Med. Arthrosc. Rev.* **2021**, *29*, 81–87. [CrossRef]

18. Rochecongar, G.; Plaweski, S.; Azar, M.; Demey, G.; Arndt, J.; Louis, M.-L.; Limozin, R.; Djian, P.; Sonnery-Cottet, B.; Bousquet, V.; et al. Management of Combined Anterior or Posterior Cruciate Ligament and Posterolateral Corner Injuries: A Systematic Review. *Orthop. Traumatol. Surg. Res.* **2014**, *100*, S371–S378. [CrossRef]
19. Tedeschi, R.; Platano, D.; Giorgi, F.; Donati, D. To Operate or Not? Evaluating the Best Approach for First-Time Patellar Dislocations: A Review. *J. Clin. Med.* **2024**, *13*, 5434. [CrossRef]
20. Wind, W.M.; Bergfeld, J.A.; Parker, R.D. Evaluation and Treatment of Posterior Cruciate Ligament Injuries: Revisited. *Am. J. Sports Med.* **2004**, *32*, 1765–1775. [CrossRef]
21. Ahn, S.; Lee, Y.S.; Song, Y.D.; Chang, C.B.; Kang, S.B.; Choi, Y.S. Does Surgical Reconstruction Produce Better Stability than Conservative Treatment in the Isolated PCL Injuries? *Arch. Orthop. Trauma. Surg.* **2016**, *136*, 811–819. [CrossRef]
22. Boynton, M.D.; Tietjens, B.R. Long-Term Followup of the Untreated Isolated Posterior Cruciate Ligament-Deficient Knee. *Am. J. Sports Med.* **1996**, *24*, 306–310. [CrossRef]
23. Hughston, J.C.; Andrews, J.R.; Cross, M.J.; Moschi, A. Classification of Knee Ligament Instabilities. Part I. The Medial Compartment and Cruciate Ligaments. *J. Bone Jt. Surg. Am.* **1976**, *58*, 159–172. [CrossRef]
24. Panchal, H.B.; Sekiya, J.K. Open Tibial Inlay versus Arthroscopic Transtibial Posterior Cruciate Ligament Reconstructions. *Arthroscopy* **2011**, *27*, 1289–1295. [CrossRef] [PubMed]
25. Kim, Y.-M.; Lee, C.A.; Matava, M.J. Clinical Results of Arthroscopic Single-Bundle Transtibial Posterior Cruciate Ligament Reconstruction: A Systematic Review. *Am. J. Sports Med.* **2011**, *39*, 425–434. [CrossRef]
26. Farì, G.; Mancini, R.; Dell'Anna, L.; Ricci, V.; Della Tommasa, S.; Bianchi, F.P.; Ladisa, I.; De Serio, C.; Fiore, S.; Donati, D.; et al. Medial or Lateral, That Is the Question: A Retrospective Study to Compare Two Injection Techniques in the Treatment of Knee Osteoarthritis Pain with Hyaluronic Acid. *J. Clin. Med.* **2024**, *13*, 1141. [CrossRef]
27. Voos, J.E.; Mauro, C.S.; Wente, T.; Warren, R.F.; Wickiewicz, T.L. Posterior Cruciate Ligament: Anatomy, Biomechanics, and Outcomes. *Am. J. Sports Med.* **2012**, *40*, 222–231. [CrossRef]
28. Spiridonov, S.I.; Slinkard, N.J.; LaPrade, R.F. Isolated and Combined Grade-III Posterior Cruciate Ligament Tears Treated with Double-Bundle Reconstruction with Use of Endoscopically Placed Femoral Tunnels and Grafts: Operative Technique and Clinical Outcomes. *J. Bone Jt. Surg. Am.* **2011**, *93*, 1773–1780. [CrossRef] [PubMed]
29. Garofalo, R.; Jolles, B.M.; Moretti, B.; Siegrist, O. Double-Bundle Transtibial Posterior Cruciate Ligament Reconstruction with a Tendon-Patellar Bone-Semitendinosus Tendon Autograft: Clinical Results with a Minimum of 2 Years' Follow-Up. *Arthroscopy* **2006**, *22*, 1331–1338.e1. [CrossRef]
30. Winkler, P.W.; Zsidai, B.; Wagala, N.N.; Hughes, J.D.; Horvath, A.; Senorski, E.H.; Samuelsson, K.; Musahl, V. Evolving Evidence in the Treatment of Primary and Recurrent Posterior Cruciate Ligament Injuries, Part 1: Anatomy, Biomechanics and Diagnostics. *Knee Surg. Sports Traumatol. Arthrosc.* **2021**, *29*, 672–681. [CrossRef] [PubMed]
31. Forster, I.W.; Warren-Smith, C.D.; Tew, M. Is the KT1000 Knee Ligament Arthrometer Reliable? *J. Bone Jt. Surg. Br.* **1989**, *71*, 843–847. [CrossRef] [PubMed]
32. Gross, M.L.; Grover, J.S.; Bassett, L.W.; Seeger, L.L.; Finerman, G.A. Magnetic Resonance Imaging of the Posterior Cruciate Ligament. Clinical Use to Improve Diagnostic Accuracy. *Am. J. Sports Med.* **1992**, *20*, 732–737. [CrossRef] [PubMed]
33. MacGillivray, J.D.; Stein, B.E.S.; Park, M.; Allen, A.A.; Wickiewicz, T.L.; Warren, R.F. Comparison of Tibial Inlay versus Transtibial Techniques for Isolated Posterior Cruciate Ligament Reconstruction: Minimum 2-Year Follow-Up. *Arthroscopy* **2006**, *22*, 320–328. [CrossRef]
34. Rasmussen, R.G.; Jacobsen, J.S.; Blaabjerg, B.; Nielsen, T.G.; Miller, L.L.; Lind, M. Patient-Reported Outcomes and Muscle Strength after a Physiotherapy-Led Exercise and Support Brace Intervention in Patients with Acute Injury of the Posterior Cruciate Ligament: A Two-Year Follow-up Study. *Int. J. Sports Phys. Ther.* **2023**, *18*, 807–819. [CrossRef]
35. Shelbourne, K.D.; Clark, M.; Gray, T. Minimum 10-Year Follow-up of Patients after an Acute, Isolated Posterior Cruciate Ligament Injury Treated Nonoperatively. *Am. J. Sports Med.* **2013**, *41*, 1526–1533. [CrossRef]
36. Jung, Y.B.; Tae, S.K.; Lee, Y.S.; Jung, H.J.; Nam, C.H.; Park, S.J. Active Non-Operative Treatment of Acute Isolated Posterior Cruciate Ligament Injury with Cylinder Cast Immobilization. *Knee Surg. Sports Traumatol. Arthrosc.* **2008**, *16*, 729–733. [CrossRef]
37. Lien, O.A.; Aas, E.J.-L.; Johansen, S.; Ludvigsen, T.C.; Figved, W.; Engebretsen, L. Clinical Outcome after Reconstruction for Isolated Posterior Cruciate Ligament Injury. *Knee Surg. Sports Traumatol. Arthrosc.* **2010**, *18*, 1568–1572. [CrossRef] [PubMed]
38. Peters: Joanna Briggs Institute Reviewer's Manual, JBI. Available online: https://scholar-google-com.ezproxy.unibo.it/scholar_lookup?hl=en&publication_year=2020&author=MDJ+Peters&author=C+Godfrey&author=P+McInerney&author=Z+Munn&author=AC+Tricco&author=H+Khalil&title=Joanna+Briggs+Institute+Reviewer's+Manual,+JBI (accessed on 9 June 2022).

39. Tricco, A.C.; Lillie, E.; Zarin, W.; O'Brien, K.K.; Colquhoun, H.; Levac, D.; Moher, D.; Peters, M.D.J.; Horsley, T.; Weeks, L.; et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Ann. Intern. Med.* **2018**, *169*, 467–473. [CrossRef]
40. Jung, Y.-B.; Jung, H.-J.; Song, K.-S.; Kim, J.Y.; Lee, H.J.; Lee, J.-S. Remnant Posterior Cruciate Ligament-Augmenting Stent Procedure for Injuries in the Acute or Subacute Stage. *Arthroscopy* **2010**, *26*, 223–229. [CrossRef]