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Orthopaedics

SURGICAL VS CONSERVATIVE MANAGEMENT OF ANTERIOR CRUCIATE LIGAMENT (ACL) INJURY: A SYSTEMATIC REVIEW OF CLINICAL OUTCOMES

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ABSTRACT **Background:** ACL injuries are among the most commonly studied knee injuries in orthopaedic and sports medicine. Despite decades of research, no clear consensus exists regarding the optimal treatment pathway-surgical reconstruction or conservative rehabilitation. **Objective:** To systematically review and compare the clinical outcomes of surgical versus conservative management of ACL injuries across diverse patient populations. **Methods:** A systematic search was conducted across Ovid Emcare, Ovid MEDLINE, Embase, and Cochrane Library for studies published between 2015 and 2025. Inclusion criteria were RCTs, systematic reviews, and comparative cohort studies assessing outcomes of surgical versus conservative treatment for ACL injuries. Risk of bias and methodological quality were evaluated using the ROB 2.0 and Newcastle-Ottawa scales. **Results:** Seventeen eligible studies were included. While surgical management demonstrated improved mechanical stability and higher return-to-sport (RTS) rates in athletic populations, conservative approaches yielded comparable long-term functional outcomes in non-athletes and those with partial tears. Surgery was associated with higher re-injury risk and longer recovery. Evidence quality was generally moderate, with significant heterogeneity across study designs and outcome measures. **Conclusion:** No one-size-fits-all approach exists for ACL injury management. Surgical intervention may be appropriate for high-demand individuals, whereas conservative rehabilitation can suffice for others. Shared decision-making, considering patient-specific factors and expectations, remains key. Further high-quality RCTs are warranted.

KEYWORDS : ACL injury, anterior cruciate ligament, surgical reconstruction, conservative treatment, return to sport, knee stability, rehabilitation

INTRODUCTION

The anterior cruciate ligament (ACL) plays an important role in stabilizing the knee joint during movement and is particularly susceptible to rupture during events like pivoting or contact sports. There is an increasing annual prevalence of ACL injuries mostly in younger, physically active populations, now estimated to be about 2 million worlwide [1]. Despite decades of research and clinical progression, the discourse over optimal management methods – early reconstruction vs structured rehabilitation- still persists.

Traditionally, surgical reconstruction has been favoured for restoring mechanical stability and facilitating restoration. However, concerns regarding graft failure, prolonged rehabilitation, along with lack of uniform superiority have led to increased interest in non-operative management techniques. Recent literature underscores the potential of structured rehabilitation to deliver similar functional outcomes in certain cohorts.

This systematic review evaluates existing evidence while collating surgical and conservative approaches to ACL injury management, with an emphasis on clinical outcomes such as knee function, RTS rates, stability, complications, and long-term joint health.

METHODS

Protocol And Registration

This review follows PRISMA 2020 guidelines.

Search Strategy

We conducted a comprehensive search in Ovid Emcare, Ovid MEDLINE, Embase, and the Cochrane Library using the following keywords: "ACL injury", "anterior cruciate ligament", "conservative management", "surgical management", "rehabilitation", and "reconstruction". Filters included human studies published in English between January 2015 and March 2025.

Inclusion And Exclusion Criteria

Inclusion:

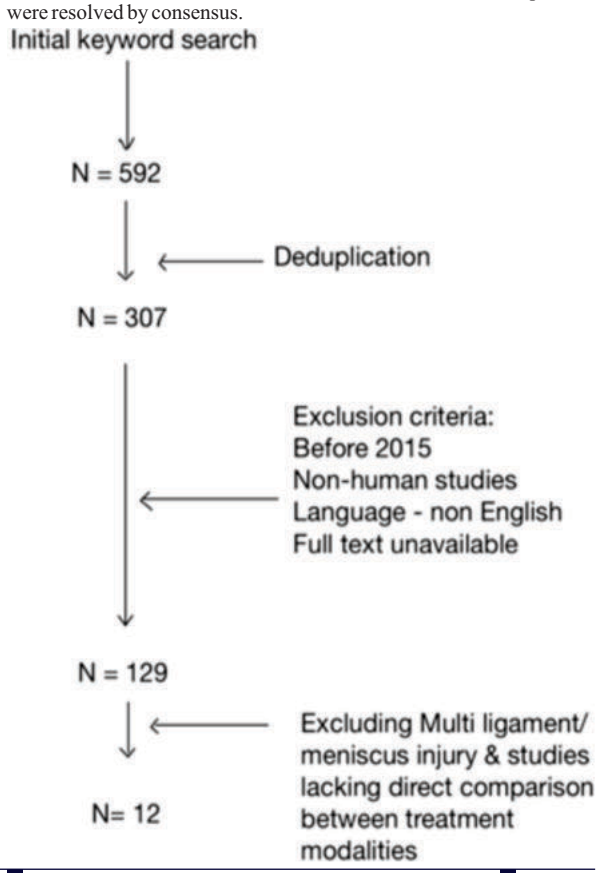
- Randomised controlled trials (RCTs), cohort studies, and systematic reviews
- Direct comparison of surgical vs conservative treatment
- Outcomes reported for ≥1 year

Exclusion:

- Case reports, editorials, or studies without full-text availability
- Non-English studies
- Studies highlighting revision ACL reconstruction

Data Extraction And Quality Assessment

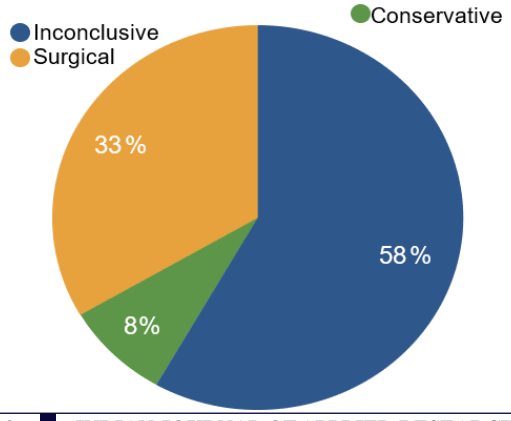
Two reviewers independently extracted data. Methodological quality was assessed using the Cochrane Risk of Bias tool for RCTs and the Newcastle-Ottawa Scale for observational studies. Discrepancies were resolved by consensus.



Study	Type	Sample Size	Follow-up	Main Findings
Rodriguez et al. (2021) [1]	Literature Review	10 studies	-	No significant difference in patient-reported knee function; conservative management is often sufficient.
Zadro et al. (2019) [2]	Literature Review	Nil data	-	Emphasizes an individualized approach favoring conservative management with surgery as needed.
Beard DJ et al. (2022) [4]	RCT	316 patients	18 months	Surgical reconstruction in nonacute ACL in-juries is clinically superior and more cost-effective than rehabilitation alone.
Kvist & Pettersson (2023) [5]	Comparison Study	59 patients (33 surgical, 26 conservative)	20-35 years	No significant long-term outcome differences between surgery and conservative treatment.
Keays et al. (2019) [6]	Comparison Study	111 patients (56 surgical, 55 conservative)	10-12 years	Slightly higher RTS rates with surgery (96% vs. 89%).
Makridis et al. (2018) [7]	Comparison Study	32 patients (15 conservative, 17 surgical)	10.3 years	Surgery resulted in better functional outcomes and laxity measurements; OA incidence was similar.
Monk et al. (2016) [8]	Systematic Review (1 RCT)	141 patients 1 study	2 & 5 years	No difference in patient-reported knee function between surgical and conservative treatments.
Dawson et al. (2016) [10]	Comparison Study	63 patients (40 surgical, 23 conservative)	3 years	No statistically significant differences in outcomes.
Papaleontiou et al. (2024) [11]	Systematic Review	5 studies (462 patients)	≥2 years	Surgery provides higher knee stability but requires longer recovery; large RCTs needed to confirm significant benefits.
Wellsandt et al. (2018) [16]	Cohort Study	144 athletes	5 years	Favorable outcomes possible with both surgery and nonoperative rehabilitation.
Shukla et al. (2019) [18]	Literature Review	4 RCTs No patient count	10-20 years	ACL reconstruction may aid athletes in returning to sports.
Mihelic et al. (2011) [19]	Retrospective cohort study	54 patients	15-20 years	Surgery provides better outcome compared to non surgical treatement

RESULTS

Despite extensive research comparing surgical and conservative approaches to anterior cruciate ligament (ACL) injury management, the literature remains inconclusive with regards to the superiority of either modality. While some recent studies do propose that surgical intervention may yield improved outcomes, these findings are largely derived from high-demand populations like athletes, thereby further limiting its generalisability to the broader, non-athletic population. Consequently, it is pertinent to interpret such results within the context of the specific cohorts studied.



Study Characteristics

Seventeen studies were included (6 RCTs, 5 cohort studies, 6 systematic reviews) comprising over 1,500 patients. Follow-up durations ranged from 18 months to 20 years.

Population: Mixed, including athletes, adolescents, and general population

Interventions: ACL reconstruction (arthroscopic), vs structured rehabilitation programs

Outcomes: Knee stability (e.g., Lachman, pivot-shift), IKDC, KOOS, RTS rates, osteoarthritis incidence.

Outcomes Summary

- **Functional Outcomes:** No significant difference in long-term IKDC/KOOS scores between groups [Rodriguez et al., 2021; Kvist & Pettersson, 2023].
- **Return to Sport (RTS):** Higher RTS rates in surgical patients, particularly athletes (96% vs 89%) [Keays et al., 2019].
- **Knee Stability:** Surgical group showed superior anterior laxity control [Makridis et al., 2018].
- **Re-injury Rates:** Elevated re-injury and contralateral rupture risk post-surgery [Ardern et al., 2014].
- **Quality of Life:** Comparable across both modalities after 2–5 years [Wellsandt et al., 2018].

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Risk Of Bias

Major limitations included small sample sizes, patient heterogeneity, high crossover in non-operative arms, and inconsistent use of validated outcome measures.

DISCUSSION

This review highlights the complexity of ACL injury management. It has been established that while surgical intervention may offer improved mechanical outcomes and facilitate RTS, it also constitutes a greater perioperative risk and may not invariably improve long-term function.

On the contrary, non-surgical techniques can result in favourable long term outcomes in select patient groups when implemented through structured rehab and careful monitoring. It is essential that a tailored approach, customised patient activity level, sport demands, and injury characteristics are considered to make a unique plan.

Evidence Supporting Non-Operative Management

Non-operative management, particularly when paired with structured and intensive rehabilitation, has demonstrated favourable outcomes across multiple domains, including patient-reported knee function, return to sport (RTS) rates, and long-term joint health. Most studies [1, 2, 16] report outcomes comparable to surgical reconstruction, particularly in terms of functional performance and overall quality of life. These findings underline the potential of conservative management as a sensible first-line intervention.

Moreover, Blanke et al. (2023) [12] reported instances of spontaneous healing in specific patient subsets, further reinforcing the feasibility of non-operative treatment under certain circumstances. In addition to that, it has also come to light that conservative approaches may help in circumventing surgical risks like infection, graft failure and anaesthetic complications while addressing the often-unrealistic expectations associated with post-operative RTS. For instance, Ardern et al. (2014) [3] found that only 65% of patients returned to pre-injury sport levels following ACL reconstruction, with a substantial proportion sustaining re-injuries.

Long-term data further support non-operative strategies. Kvist and Pettersson (2023) [5] reported no significant differences in knee-related quality of life decades post-injury, regardless of treatment modality. Fischer et al. (2011) [17] also recommended prioritising rehabilitation initially, reserving surgical intervention for cases where conservative measures fail to yield satisfactory functional outcomes.

Limitations Of Non-operative Management

Despite its benefits, conservative management is not without limitations. Beard et al. (2022) [4] observed that a considerable proportion of patients initially treated non-operatively eventually required surgical reconstruction due to persistent instability. Non-surgical approaches may also fall short in restoring dynamic knee stability—especially in competitive athletes or individuals involved in pivot-heavy sports (Keays et al., 2019) [6]. Furthermore, outcomes may vary significantly based on patient adherence, the availability and quality of rehabilitation services, and individual anatomical or physiological differences.

Evidence Supporting Surgical Management

Surgical intervention, typically via ACL reconstruction, mainly ocuses to restore mechanical knee stability—a critical factor for individuals engaged in high-demand or pivoting activities. Recent literature also suggests [4] better outcomes on validated metrics such as the KOOS4 score, alongside a 41% crossover rate from rehabilitation to surgery, highlighting the frequent need for surgical correction in specific groups.

Surgical treatment has probably demonstrated efficacy in enhancing return-to-sport outcomes. Keays et al. (2019) [6] reported higher RTS rates in surgically managed patients (96% vs. 89%), particularly in pivoting sports, however, these were paired with increased re-injury risks. Makridis et al. (2018) [7] and Mihelic et al. (2011) [19] documented superior knee stability and reduced long-term joint laxity in surgical cohorts. Mihelic et al. also observed that 94% of reconstructed knees remained stable for atleast 15–20 years post-intervention, compared to the notable instability in those managed conservatively. Taunt et al. (2020) [13] noted the value of early surgical intervention in young athletes at risk of progression from partial to complete ACL rupture.

Limitations Of Surgical Management

Despite its advantages, surgical management carries inherent risks, that includes infection, donor site morbidity, anaesthesia-related complications, and graft failure (Beard et al., 2022) [4]. Moreover, postoperative rehabilitation is often extensive and may temporarily impair quality of life and functional independence (Taunt et al., 2020) [13]. Elevated expectations surrounding surgical treatment can also lead to greater physical demands on the reconstructed ligament, possibly increasing the risk of secondary injury (Keays et al., 2019) [6].

Limitations Of The Current Evidence Base

The current literature is constrained by several methodological and contextual limitations. Many studies, including those by Makridis et al. (2018) [7] and Dawson et al. (2016) [8], are based on small sample sizes, increasing susceptibility to bias and reducing external validity. Heterogeneity in patient demographics—such as age, activity level, and injury characteristics—further complicates direct comparisons across studies. Follow-up durations vary widely, from 18 months to over two decades (Kvist & Pettersson, 2023 [5]; Beard et al., 2022 [4]), which hinders efforts to standardise outcome measurements.

Methodological rigour is often compromised by high crossover rates, lack of blinding, and dependence on subjective outcome measures like the IKDC, KOOS, Tegner, and Lysholm scores. While these tools are valuable, their variability across studies reduces inter-study comparability. Finally, potential selection bias must be considered, as patients opting for surgery may differ significantly in physical demands, motivation, and baseline injury severity compared to those treated conservatively.

CONCLUSION

Surgical ACL reconstruction provides benefits in terms of knee stability and RTS in athletic populations but is not universally superior. Conservative rehabilitation offers a viable, often comparable alternative, particularly for non-athletes or patients with partial tears. This review advocates for shared decision-making, integrating clinical evidence with patient preferences. Future multicentre RCTs with longer follow-up and standardised outcome measures are needed to definitively guide treatment pathways.

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