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RECENT TRENDS IN ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION: A COMPREHENSIVE REVIEW

Orthopaedics

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ABSTRACT

Anterior cruciate ligament (ACL) injuries represent one of the most common and clinically significant ligamentous injuries of the knee, particularly among young and physically active individuals. Such injuries often result in knee instability, reduced functional capacity, prolonged absence from sports, and an increased risk of post-traumatic osteoarthritis. Over the past two decades, ACL reconstruction has evolved considerably due to improved understanding of knee biomechanics, refinement of surgical techniques, innovations in graft selection, and advances in postoperative rehabilitation. Contemporary approaches increasingly emphasize anatomical reconstruction, individualized treatment strategies, and holistic recovery models incorporating psychological readiness. This review synthesizes recent literature to provide an in-depth overview of current trends in ACL reconstruction, including surgical advancements, graft options, biological augmentation, rehabilitation strategies, and long-term outcomes.

KEYWORDS

Anterior cruciate ligament; ACL reconstruction; Graft selection; Surgical techniques; Rehabilitation

INTRODUCTION

The anterior cruciate ligament plays a vital role in maintaining anteroposterior and rotational stability of the knee joint. Rupture of the ACL is a debilitating injury that frequently affects athletes involved in pivoting sports, although it is also prevalent in the general population. The incidence of ACL injuries and subsequent reconstructions has increased steadily worldwide, driven by greater participation in sports and heightened diagnostic awareness. Despite advances in surgical management, optimal restoration of knee function and prevention of long-term complications such as post-traumatic osteoarthritis remain ongoing challenges.

AIM OF THE STUDY

The aim of this review is to critically evaluate current trends in anterior cruciate ligament reconstruction, focusing on surgical techniques, graft selection, adjunctive procedures, rehabilitation strategies, psychological factors, and long-term clinical outcomes.

MATERIALS AND METHODS

A comprehensive narrative review of the literature was conducted using PubMed, Scopus, and Google Scholar databases for articles published between 2020 and 2025. Search terms included combinations of 'anterior cruciate ligament reconstruction', 'ACL surgical techniques', 'graft selection', 'rehabilitation protocols', and 'biological augmentation'. Priority was given to randomized controlled trials, systematic reviews, and meta-analyses. Relevant cohort studies addressing surgical outcomes, rehabilitation strategies, and patient-reported outcomes were also included.

Surgical Techniques And Adjunctive Procedures

Modern ACL reconstruction techniques increasingly emphasize anatomical graft placement to restore native knee kinematics. Independent femoral tunnel drilling and anatomical footprint reconstruction have been associated with improved rotational stability and reduced risk of post-traumatic osteoarthritis. Adjunctive procedures such as lateral extra-articular tenodesis and combined anterolateral ligament reconstruction have gained popularity, particularly in high-risk athletes, to enhance rotational control and reduce graft failure rates.

GRAFT SELECTION

Graft choice remains a critical determinant of ACL reconstruction outcomes. Autografts, including hamstring tendon, bone–patellar tendon–bone, and quadriceps tendon grafts, continue to demonstrate reliable biomechanical properties and favorable clinical outcomes. Recent evidence suggests that quadriceps tendon autografts offer comparable or superior functional results with lower donor-site morbidity. Allografts are associated with higher failure rates in younger and highly active patients and are therefore used selectively.

Biological Augmentation

Biological enhancement strategies, including platelet-rich plasma, stem cell therapy, and scaffold-based techniques such as bridge-enhanced ACL repair, are emerging as potential adjuncts to improve graft healing and ligamentization. While preclinical and early clinical studies demonstrate promising results, robust long-term human data remain limited, and further research is required before routine clinical adoption.

Rehabilitation Strategies

Postoperative rehabilitation is a cornerstone of successful ACL reconstruction. Criterion-based, individualized rehabilitation protocols focusing on strength restoration, neuromuscular control, and progressive loading have been shown to reduce complications and improve functional outcomes. Both open and closed kinetic chain exercises play important roles, and a combined approach is often recommended.

Psychological Factors

Psychological readiness is increasingly recognized as a critical factor influencing rehabilitation adherence and return-to-sport outcomes. Fear of reinjury, confidence levels, and self-efficacy significantly affect functional recovery. Integrating psychological assessment and support into rehabilitation programs can enhance patient engagement and long-term success.

Long-term Outcomes And Osteoarthritis

Despite successful reconstruction, individuals with ACL injuries remain at increased risk of developing post-traumatic osteoarthritis. Evidence suggests that early, structured rehabilitation and restoration of normal knee biomechanics may mitigate this risk. Long-term follow-up studies highlight the importance of comprehensive management strategies to preserve joint health.

CONCLUSION

Anterior cruciate ligament reconstruction continues to evolve with advancements in surgical techniques, graft selection, rehabilitation science, and biological augmentation. Current evidence supports anatomical reconstruction using autografts combined with individualized, criterion-based rehabilitation and psychological support. A multidisciplinary approach remains essential to optimize functional recovery, reduce long-term complications, and improve quality of life following ACL injury.

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Conflict Of Interest

The authors declare no conflict of interest.

Data Availability

Not applicable.

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