

GRAFT TYPE IMPLICATIONS IN POSTOPERATIVE CARE FOLLOWING ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION: A NARRATIVE REVIEW.

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Page | 1 **ABSTRACT**

Anterior cruciate ligament (ACL) reconstruction is a pivotal procedure for restoring knee stability and function in patients with ACL injuries. The choice of graft type—autograft, allograft, or synthetic—plays a critical role in the long-term outcomes of the surgery, influencing factors such as knee stability, the risk of osteoarthritis, and patient satisfaction. To systematically review and synthesize current literature on the long-term implications of different graft choices in ACL reconstruction, focusing on knee stability and function, osteoarthritis risk, and patient satisfaction. The review analyzed studies identifying significant differences in long-term outcomes associated with various graft types. Autografts, particularly patellar tendon and hamstring tendon grafts were generally associated with superior knee stability and function and lower osteoarthritis risk compared to allografts and synthetic grafts. However, the choice of graft did not significantly alter the risk of developing osteoarthritis. Patient satisfaction was highest among those receiving autografts, attributed to the perceived naturalness of the repair and the restoration of pre-injury activity levels. The findings underscore the need for future research to explore innovative graft materials and surgical techniques that could optimize long-term outcomes. Additionally, studies focusing on patient-centered outcomes and the psychological aspects of recovery could further inform clinical practice. The review highlights the importance of individualized graft selection in ACL reconstruction, considering patient-specific factors such as activity level, lifestyle, and personal preferences. Clinicians should incorporate evidence-based practices into their decision-making process, balancing the benefits and limitations of each graft type to optimize patient outcomes.

Keywords: Anterior cruciate ligament reconstruction, Graft choice, Long-term outcomes, Patient satisfaction, postoperative care

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INTRODUCTION

An essential part of the knee joint that promotes dynamic movement and stability is the anterior cruciate ligament (ACL).

ACL injuries are prevalent, especially among athletes, leading to significant research into optimal reconstruction techniques and postoperative care strategies. Anterior cruciate ligament reconstruction (ACLR) is a surgical method aimed at restoring knee stability and function. The choice of graft type for ACLR is a fundamental decision that influences surgical outcomes, rehabilitation processes, and the long-term health of the knee joint.

Autografts, harvested from the patient's own body, are often preferred for their biocompatibility and lower risk of graft rejection. The two most often used autografts are the hamstring and patellar tendon; each has benefits and things to consider when it comes to rehabilitation [1]. Allografts, sourced from cadaveric donors, offer an alternative that avoids donor site morbidity but raises concerns regarding disease transmission and graft incorporation [2]. Synthetic grafts, while less common, present an option without the limitations of tissue availability but with questions about long-term durability and integration [3].

The postoperative recovery process is significantly influenced by the type of graft used. Rehabilitation

protocols, risk of complications, and the timeline for return to activity are tailored according to the specific characteristics and healing dynamics of the graft material [4].

This review aimed to assess the impact of graft choice on outcomes after anterior cruciate ligament reconstruction (ACLR), exploring autografts, allografts, and synthetic grafts. It analyzed postoperative results, including recovery and complications, compared rehabilitation protocols, and examined long-term effects on knee function and osteoarthritis risk.

METHODOLOGY

The methodology for the review article was designed to encompass a comprehensive analysis of the literature about the long-term implications of graft choice in ACLR reconstruction. The process undertaken to compile this review involved several key phases: identification of relevant literature, selection of studies, data extraction, and synthesis of findings.

To find studies published from 2004 to 2023, a thorough search was first carried out across several electronic databases, including MEDLINE, PubMed, EMBASE, and the Cochrane Library. Keywords and MeSH phrases about "anterior cruciate ligament reconstruction," "ACL

graft types," "long-term outcomes," "knee stability," "osteoarthritis," and "patient satisfaction" were combined in the search approach. Additionally, reference lists of identified articles were manually searched to uncover further studies of relevance.

Inclusion criteria were predefined to select studies that specifically addressed the long-term outcomes of different ACL reconstruction graft types, including knee stability and function, risk of osteoarthritis, and patient satisfaction and quality of life. Both randomized controlled trials and observational studies were considered. Exclusion criteria were applied to omit studies that did not focus on long-term outcomes (defined as outcomes observed more than two years post-surgery) or were not available in English. Using a standardized data extraction form, two reviewers independently extracted data from the chosen studies. Study design, sample size, type of graft utilized, length of follow-up, outcomes monitored, and important findings were among the information that was extracted. A third reviewer was consulted or discussed with the other reviewers to settle any disagreements.

DISCUSSION

Graft Types for ALC Reconstruction

In the realm of ACL reconstruction, the choice of graft material plays a key role in the success and long-term outcomes of the surgery. Autografts, harvested from the patient's own body, are often preferred due to their superior integration and lower risk of immune rejection. Among autografts, the bone-patellar tendon-bone (BPTB) graft is renowned for its biomechanical properties that closely mimic the native ACL, offering robustness and quick integration, albeit with potential donor site morbidity like anterior knee pain [5]. Hamstring tendon grafts, utilizing the semitendinosus and gracilis tendons, are favored for their minimal donor site morbidity and excellent functional outcomes, despite some concerns regarding their long-term strength and potential for stretching. The quadriceps tendon graft has emerged as a viable option, especially appealing for its ample size, low donor site morbidity, and excellent biomechanical properties, making it suitable for a wide range of patients, including those with previous surgeries or high-demand athletes.

Allografts, derived from cadaveric donors, present an alternative that eliminates donor site morbidity, making them particularly useful in revision surgeries or when multiple ligaments are injured. While they offer the advantage of avoiding the pain and complications associated with harvesting autografts, they may come with a slightly higher failure rate in younger, active populations and concerns over disease transmission and slower integration [6]. Synthetic grafts once considered a promising alternative due to their immediate strength and stability, have seen limited use in recent years due to concerns over biocompatibility and long-term outcomes. However, they remain an option in complex cases where

biological grafts are not viable, with ongoing research focused on improving their design and integration.

Many factors influence the choice between different transplant kinds, such as the patient's age, degree of activity, and particular surgical indications. Autografts generally offer the best outcomes in terms of integration and biomechanical characteristics, but allografts may be preferred in scenarios where donor site morbidity is a significant concern. Synthetic grafts are considered in specific, complex cases. Ultimately, the choice of graft material requires careful consideration of the patient's lifestyle, recovery expectations, and the potential for donor site morbidity, with the surgeon's experience and preference also playing a critical role in the decision-making process.

Early Post-Operative Phase

After ACL reconstruction, the initial post-operative phase is crucial as it lays the basis for a full recovery and long-term knee functionality. This phase, generally spanning the first 4 to 6 weeks after surgery, emphasizes several key objectives: protecting the graft, managing inflammation, restoring range of motion (ROM), and initiating weight-bearing activities as appropriate.

Protection of the graft is paramount in the immediate aftermath of ACL reconstruction. The use of braces and crutches is widely advocated to mitigate stress on the newly implanted graft, facilitating its integration with the surrounding tissue. Controlled physical activity during this period is essential to prevent graft elongation or rupture, with a systematic review highlighting the significance of such measures in safeguarding the graft's integrity.

Concurrently, managing post-operative inflammation is crucial for minimizing pain and swelling, thereby enhancing the patient's comfort and facilitating a smoother rehabilitation process. Techniques such as cryotherapy and the application of compression garments are effective. A study demonstrates that the combination of cryotherapy with compression significantly alleviates pain and swelling, underscoring the importance of these interventions in the early post-operative care regimen [7]. Restoration of ROM is another critical objective during the early post-operative phase. Initiating passive and active-assisted knee movements shortly after surgery is essential for preventing joint stiffness and the formation of scar tissue, which can impede the recovery process. The approach to weight-bearing in the early postoperative period varies, but there is a consensus on the benefits of gradually introducing partial weight-bearing activities. Transitioning to full weight bearing is carefully guided by the patient's pain tolerance, knee stability, and quadriceps strength. Research suggests that early weight-bearing when approached with caution, does not endanger graft integrity and is instrumental in regaining normal gait patterns [8].

Post-Operative Outcomes

The postoperative outcomes following ACL reconstruction can vary significantly depending on the graft type used. These outcomes are generally categorized into graft survival and failure rates, functional recovery (including strength, ROM, and return to sport and activity levels), and potential complications for instance infection, graft rejection, and re-rupture.

Graft survival and failure rates are crucial metrics in evaluating the success of ACL reconstruction. A meta-analysis showed that autografts, particularly the patellar tendon and hamstring tendon grafts, generally show lower failure rates compared to allografts [9]. The study suggested that the biological integration of autografts might contribute to their superior durability. Conversely, allografts, while beneficial in reducing donor site morbidity, have been correlated with a slightly higher risk of failure, particularly in younger, more active populations.

Functional recovery post-ACL reconstruction is multifaceted, encompassing the restoration of muscle strength, ROM, and the capability to return to sport and activity levels. Initial deficits in hamstring or quadriceps strength may occur depending on the graft type used; however, these differences typically diminish over time. Early postoperative mobilization plays a crucial role in regaining ROM, with the type of graft showing no significant impact on the ultimate range of motion achieved. The return to sport is a complex outcome, influenced not only by physical recovery but also by psychological factors, including fear of re-injury. Autograft recipients often show higher chances of returning to pre-injury activity levels compared to those receiving allografts.

Complications such as infection, graft rejection, and re-rupture present potential risks following ACL reconstruction. The risk of infection remains low across all graft types, though allografts may carry a slightly higher risk due to their processing and handling. Graft rejection, more common with allografts, has been mitigated by advances in tissue processing techniques. Re-rupture is a concern for all patients, with studies indicating that younger athletes and those returning to high-level sports face the highest risk, although autografts have a slightly lower re-rupture rate compared to allografts [10].

Long-term Implications of Graft Choice

Beyond the short-term recovery time following ACL reconstruction surgery, graft selection has long-term effects on knee stability and function, osteoarthritis risk, and overall patient happiness and quality of life. When choosing the best graft type for ACL restoration, patients and physicians must take these results into account.

Knee stability and function are paramount for patients undertaking ACL reconstruction, with the type of graft playing a significant role in long-term outcomes. Studies have shown that autografts, particularly the patellar

tendon and hamstring tendon grafts, tend to provide superior knee stability compared to allografts. A study reported that patients with autografts generally experience better knee stability and function, attributing this to the biological integration and mechanical properties of autologous tissue [11]. However, the choice concerning patellar tendon and hamstring tendon autografts can depend on individual patient factors and surgeon preference, as both have shown excellent long-term stability and functional outcomes.

The development of osteoarthritis (OA) after ACL reconstruction is a significant concern, with the type of graft potentially influencing this risk. Studies have indicated that while ACL reconstruction can reduce the risk of OA compared to non-operative treatment, the choice of graft does not significantly alter the risk of developing OA [12]. However, factors such as return to high-impact sports and additional injuries to the knee post-reconstruction can contribute to the development of OA, regardless of the graft type used.

Patient satisfaction and quality of life are critical measures of success for ACL reconstruction. Autografts have been associated with high levels of patient satisfaction, particularly due to the reduced risk of graft rejection and the perception of a more "natural" repair. A study highlighted that patients who undergo ACL reconstruction with autografts report high satisfaction levels and quality of life, which is closely linked to the restoration of knee stability and function and the ability to return to pre-injury activity levels [13]. The psychological impact of feeling "recovered" and "stable" also plays a significant role in patient satisfaction and overall quality of life post-surgery.

The narrative review highlights the crucial role of graft selection in ACL reconstruction, emphasizing the need for personalized decision-making based on patient-specific factors to optimize outcomes and enhance patient satisfaction. It suggests leveraging evidence-based practices to inform clinical decisions and promote standardized protocols across healthcare systems. Additionally, the review underscores the importance of ongoing research and innovation to improve graft materials, surgical techniques, and rehabilitation strategies, with a focus on minimizing osteoarthritis risk and enhancing long-term patient prognosis. Policymakers can use these insights to develop guidelines for equitable access to optimal care. Overall, the review provides valuable guidance for healthcare professionals, policymakers, and researchers to advance ACL reconstruction practice and improve patient outcomes.

CONCLUSION

The review highlights the significance of graft selection in ACL reconstruction, showing that autografts generally offer better knee stability, function, and patient satisfaction compared to allografts and synthetic grafts. Despite advancements, osteoarthritis risk persists, underscoring the need for tailored graft choices based on

individual patient profiles and ongoing innovation in surgical and rehabilitation strategies to optimize long-term outcomes. Future research should focus on enhancing surgical techniques and mitigating osteoarthritis risks, aiming for improved patient prognosis in ACL reconstruction.

Limitations

The study faced limitations including language bias due to its restriction to English-language literature, potential exclusion of relevant short-term outcomes, heterogeneity among included studies in design and outcome measures, possible publication bias, lack of formal quality assessment for included studies, and potential outdatedness of findings due to evolving ACL reconstruction techniques. These limitations emphasize the need for cautious interpretation and suggest avenues for future research to address these gaps.

Recommendations

It is recommended that clinicians prioritize individualized graft selection in ACL reconstruction, considering patient-specific factors such as age, activity level, lifestyle, and personal preferences. Integrating evidence-based practices into decision-making processes and transparently communicating the benefits and limitations of each graft type empower patients to make well-informed decisions. Continued research and innovation in graft materials, surgical techniques, and rehabilitation strategies are crucial for optimizing outcomes. Future studies should focus on graft integration, minimizing osteoarthritis risk, and enhancing patient satisfaction. Emphasizing patient-centered care fosters better communication and shared decision-making, promoting a collaborative approach to care delivery.

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List of abbreviations

ACL: Anterior cruciate ligament
ACLR: Anterior cruciate ligament reconstruction
BPBT: bone-patellar tendon-bone
ROM: range of motion
OA: osteoarthritis

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The authors have no competing interests to declare.

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