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The importance of Anterolateral Ligament Repair in anterior cruciate ligament reconstruction – a review of the literature

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ABSTRACT

Rupture of the anterior cruciate ligament (ACL) is a common knee injury. While ACL reconstruction has historically been designed around isolated repair of the ACL, newer literature suggests that the role of anterolateral ligament (ALL) repair may have critical stability roles and improved surgical results. This study reviews the literature regarding anatomical and biomechanical contributions of the ALL and outcomes associated with concomitant ACL reconstruction and ALL repair. We performed a systematic review of 19 studies between 2013–2024 to provide insight into the role of the ALL and its use in reconstruction and surgery. The results demonstrate the presence of ALL lesions in 90% of ACL injuries, with concomitant ACL reconstruction and ALL repair improving knee rotational stability, decreasing graft failure rates, and improving patient-reported outcomes (PROs). Combined ACL reconstruction and ALL repair resulted in better functional outcomes, mainly presenting the majority of higher grades of rotational instability. In addition, this combined approach has a lower rate of re-rupture than isolated ACL reconstruction. However, the addition of ALL reconstruction does not impact return-to-sport time significantly. Further studies are needed to ascertain the optimal surgical procedure and establish clear guidelines for patient selection.

Keywords: Anterolateral ligament, anterior cruciate ligament, surgery, reconstruction, repair, ACL, ALL

1. INTRODUCTION

ACL (anterior cruciate ligament) rupture is one of the most frequently occurring knee injuries and is particularly common among athletes and the active population (Filbay and Grindem, 2019). While the focus of ACL reconstruction has traditionally been on isolated ACL repair, recent literature has encouraged us to consider the role of the anterolateral ligament (ALL) as a potential player in knee stability post-surgery. The anatomy of the anterolateral ligament (ALL) of the knee was described in detail in 2013. Until then, a name for the structure itself had not been well-established (although it does appear in some scientific literature). Proximal and posterior to the lateral femoral epicondyle is the origin of ALL, whose fibers run via its insertion located on the proximal aspect of the tibia between the tip of the fibular head and Gerdy's tubercle distal to the lateral tibial plateau (Claes et al., 2013). Though the role of the ALL is still a matter of contention in the scientific debate, most studies have justified its significant role in stabilizing the knee against tibial internal rotation (Lee et al., 2020). The ALL injury itself could potentially contribute to chronic instability and unsatisfactory functional results following ACL reconstruction.

2. METHODS

We performed a comprehensive review of literature using PubMed and Google Scholar to identify relevant literature with a focus on articles published between January 2013 and January 2024. Search terms were "anatomy of anterolateral ligament", "biomechanics of anterolateral ligament", "ACL reconstruction", "ALL repair", "anterolateral ligament and ACL surgery", "combined ACL and ALL reconstruction". We found nineteen relevant studies, encompassing biomechanical studies, clinical trials, and systematic reviews. We excluded articles that did not specifically describe ALL structure and function or that did not report on a clinical or biomechanical outcome relevant to ALL repair. Studies with the highest level of evidence (RCTs, prospective cohort studies, and meta-analyses) were extracted and analyzed. We evaluated articles for conclusions about ALL function in knee stability, its relationship with patterns of ACL injury, and the results of ACL reconstruction with concomitant ALL repair.

3. RESULTS AND DISCUSSION

Radiologic and clinical studies have demonstrated that 90% of ALL lesions affect individuals with ACL tears (Monaco et al., 2021). Claes described the anterolateral ligament in detail in 2013. Since then, scientists explored multiple methods for its repair with studies assessing its role in knee biomechanics and its reconstruction with ACL injury. Among these methods, we find extra-articular tenodesis (LET) based on the iliotibial band and anterolateral reconstruction using hamstring tendons (Fayard et al., 2021). Some proposed focus on ACL instability and rotational control, such as combined ACL repair with ALL internal brace augmentation. This surgical technique is invaluable in patients with both an ACL tear and an ALL injury since ACL injuries are associated with a risk of instability in rotation. The procedure is beneficial for people particularly susceptible to rotational instability after an ACL tear (Hopper et al., 2020).

Surgical techniques comparison

Knee stability evaluated with the pivot-shift and Lachman tests was better with ACL reconstruction with anterolateral augmentation than isolated ACL reconstruction (Lai et al., 2023). This enhanced strategy can be helpful for those potentially at risk of experiencing rotational instability, such as high-demand athletes who regularly perform cutting, pivoting, and other dynamic activities. The dual procedure not only addresses the ACL but also the anterolateral structures. This technique improves knee stability and decreases reinjury rates, making it the ideal alternative for patients desiring knee high performance.

Despite these considerations, several studies have recently suggested that ACL reconstruction with anterolateral ligament (ALL) reconstruction may be more beneficial than other forms of augmentation. For example, some studies report that the ACL-ALL reconstruction strategy has a faster recovery process and a better return to pre-injury levels of sports activity levels compared to ACL reconstructive surgery plus lateral extra-articular tenodesis (LET) (Ferretti et al., 2023). This more rapid functional recovery may be particularly valuable for athletes hoping to minimize time spent out of competition while obtaining adequate knee stabilization.

Despite these benefits, there is much research about the best augmentation procedure. Some prefer LET over ALL reconstruction, based on ALL reconstruction downsides. More specifically, critics claim ALL reconstruction has the potential to over-constrain the lateral joint, resulting in insufficient motion about the knee or symptoms of discomfort. Furthermore, some authors note that ALL

reconstruction may not confer any significant mechanical advantage in overcoming rotational forces and should be considered based on clinical conditions (Mathew et al., 2018).

Re-rupture rate

The rupture of graft is a critical complication after anterior cruciate ligament (ACL) reconstruction, with up to 18% of high-risk patients developing this complication (Webster and Feller, 2016). Therefore, concomitant anterolateral ligament (ALL) reconstruction with anterior cruciate ligament (ACL) reconstruction may decrease the risk factor of graft failure and re-rupture for individuals who have sustained ACLIs. Such a combined approach appears advantageous for patients demonstrating high-grade pivot shift, a clinical measure of rotational knee instability (Hopper et al., 2020). Moreover, the dual surgical intervention may provide advantages for patients with particularly significant rotational instability, as the ALL reconstruction addresses the unique structural instability that may not be sufficient by ACL reconstruction alone.

This technique intends to protect the knee and minimize the chances of injury or failure of the graft, particularly in patients with higher-than-average rotational forces or instabilities of the knee. Evidence from cohorts with at least 2 years follow-up following surgery demonstrates the use of hamstring tendon-based anterior cruciate ligament reconstruction in combination with anterolateral ligament reconstruction decreases the revision rate by a factor of 3.1 when compared to isolated hamstring tendon-based ACL reconstruction and by 2.5 times when compared to isolated bone-patellar tendon-bone based ACL reconstruction. The graft failure rate in patients undergoing ACL reconstruction with ALL reconstruction was 4.13% (Sonnery-Cottet et al., 2017).

Patient-reported outcomes (pros)

Patient-reported outcomes (PROs) are essential in the evaluation of the effectiveness of surgical procedures such as anterolateral ligament (ALL) and anterior cruciate ligament (ACL) reconstructions from the perspective of patients. Such tools yield vital information about a patient's symptoms, functional disability, and quality of life after surgery that better reflect a patient's recovery experiance than clinical or imaging-based measures alone. The patient-reported outcome indicators include knee function, pain level, ability to return to activities or return to sport. Patient-reported outcome measures (PROMs), such as the International Knee Documentation Committee (IKDC) Score, the Knee Injury and Osteoarthritis Outcome Score (KOOS), the Tegner Activity Scale, and the Lysholm Knee Score are used frequently (Berk et al., 2023).

Patients with a combined procedure demonstrated a significantly more significant improvement in objective knee scoring lists than those undergoing isolated ACL reconstruction in follow-up assessments performed over two years after surgery. In all these cases, the patients showed a significant decrease in pivot shift test ratings, Na et al., (2021) enhanced results on KT-1000, and more excellent scores on IKDC and Lysholm tests Saithna et al., (2021) In the five studies using the subjective IKDC score, three demonstrated statistically higher scores at a minimum 2-year follow-up for patients undergoing combined ACL and ALL reconstruction compared to isolated ACL reconstruction (Littlefield et al., 2021).

Surgical residual instability

Residual rotatory instability of the knee persists for many years following successful anterior cruciate ligament (ACL) reconstruction in many patients. This problem is especially noticeable in those demonstratin a prominent pivot shift, a clinical sign of rotational instability. Despite stabilizing the knee by preventing anterior translation (tibia forward relative to the femur), the ACL alone does not control the rotational forces acting on the joint. Consequently, isolated ACL reconstruction may inadequately address this challenging biomechanical problem. To provide more excellent rotatory stability, an anterolateral extra-articular tenodesis (LET) is added to the surgical reconstruction of the ACL. This alternative approach treats ACL-deficient knees to increase the rotatory stability of the knee that is insufficient in the solitary ACL.

However, extensive research has shown no significant improvement when adding LET to ACL reconstruction compared to using ACL alone when measured with standard clinical parameters like the Lachman test or instrumented arthrometer testing. These mobility tools focus on anterior translation, whose stability effectively supports an ACL reconstruction. A previous biomechanical study has reported that adding of LET significantly decreases the magnitude and incidence of the pivot shift phenomenon despite no additional anterior stability. This finding highlights the importance of LET in enhancing rotational stability and explicitly targeting the biomechanical impairments contributing to pivot shift, independent of its effects on stability in the anterior direction (Mao et al., 2021).

Resuming sport and day-to-day life after surgery

Recent studies suggest no significant difference in return to sports between patients who undergo ACL reconstruction with versus without lateral extra-articular tenodesis (LET). The return to sports is also similar, whether or not adding LET to the specific surgical procedure. Patients undergoing isolated ACL reconstruction (ACL → 324) and ACL with LET (ACL + LET → 195) equally belong to both groups. The functional results (Marx Activity Rating Scale) at the baseline and the 24th-month follow-up were comparable in both groups of patients. Before surgery, the median activity level was almost maximum in both groups. At 24 months post-surgery, both groups of patients had returned to activity levels close to their pre-injury levels, with little difference between groups.

The incorporation of an ALL reconstruction with an ACL repair fails to affect the return to pre-injury levels of activity or return to competitive sports (Getgood et al., 2020). Although some scientists theorized that knee stability is beneficial (especially for managing rotational instability), the addition of ALL reconstruction did not yield more favorable sports recovery or return of competition outcomes than ACL reconstruction alone. These data imply that even though ALL reconstruction may have some knee stability benefits, it does not provide any additional value in the recovery of the patient's sports and return to the pre-injury level of competition. Other surgical factors as well as the type of pre-existence of related BLC can be influential (Coquard et al., 2022; Gonnachon et al., 2024).

However, in recent years, recent knee surgery research has focused on repairing the anterolateral ligament (ALL), which may improve outcomes when performed along with the reconstruction of the anterior cruciate ligament (ACL). Several studies have shown that combining these techniques leads to improved knee stability, specifically rotational control, as well as lower rates of graft re-rupture. Moreover, some evidence from PROs suggests that dual surgery may be favorable regarding symptom control, functional status, and quality of life. The ALL repair provides better control over lateral forces and helps restore the biomechanical balance of the knee, which is important for long-term knee health. Even though the results appear promising, some key areas require further studies to determine the path forward for future research.

A significant issue is the absence of universally accepted method for repairing an ALL. Although some approaches have been suggested, none are widely used. Therefore, studies are urgently needed to assess the optimal surgical techniques. Furthermore, since the ALL repair is a new addition compared to standard knee surgery, more biological and clinical evidence is required to evaluate the long-term impact of this combined approach on knee-confined function and stability. Another central area of active investigation is determining which patients will benefit most from ALL reconstruction. Although the method has potential, it does not apply to all ACL injuries. Age, activity level of the patient, and any pre-existing conditions such as meniscal tears or osteoarthritis are important to help inform the criteria for selecting candidates for concomitant ACL and ALL repair.

The extent of rotational instability (clinical pivot shift) is key in assessing the need for ALL reconstruction. In patients with mild or no rotational instability, only the repair of the ALL may not show advantages and thus generate the need for more precise selection criteria. Furthermore, there remains no uniformity regarding the indications for ALL reconstruction. However, it remains uncertain whether the purported effect of ACL repair on the ALL is meaningful in patient populations that differ from those studied. Not all ACL injuries coexist with ALL tears or instability, and the extent to which ALL injury contributes to knee dysfunction varies between patients.

Therefore, further investigation is needed to determine whether ALL reconstruction is globally helpful for ACL-injured patients or only in select subgroups of patients, such as those with high-grade pivot shift or significant rotational instability. Also, studies should help to understand whether the function of the ALL varies depending on the type of ACL injury, which may play a role in the decision of whether to include ALL repair during ACL reconstruction surgery (Table 1).

Table 1 Type of operation and surgical outcomes

Aspect	Isolated ACL reconstruction	ACLR+ ALLR/LET
Objective Clinical Tests at least two years after surgery	More patients with pivot-shift grade 2 or 3 which indicates knee instability	Less patients with pivot-shift grade 2 or 3 which indicates knee instability
Re-rupture rate	Up to 18% of high-risk patients especially those demonstrating	4.13 % on average

	high-grade pivot shift test result	
Patient- reported outcomes (PROs) at least two years after surgery	Lower subjective clinical scores including Lysholm Score, Tegner Activility Scale, Subjective IKDC	Higher subjective clinical scores including Lysholm Score, Tegner Activility Scale, Subjective IKDC
Level of sports acitivity at least two years after surgery measured by Marx Activity Rating Scale	Similar	Similar
Objective IKDC	Marginally worse scores	Marginally better scores

4. CONCLUSIONS

Research demonstrated significant improvements in outcomes with improved rotational stability, lower graft failure rates, and improved patient-reported outcomes with the addition of ACL reconstruction with ALL surgical repair. This method has benefits for patients with significant rotational instability that ACL reconstruction alone may not guarantee. Scientists did not establish a specific method for ALL reconstruction and additional investigations are necessary to induce optimal surgical practices and improve patient protocoling.

It should help determine who benefits most from the combined procedure based on factors like activity level and degree of instability. Although ALL reconstruction does increase knee stability, it does not meaningfully expedite return-to-sport times or pre-injury activity levels. Overall, ACL and ALL reconstruction enhances knee stability, but additional studies are necessary to standardize the technique, determine ideal candidates, and evaluate long-term outcomes.

Author's Contributions

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Ethical approval

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Informed consent

Not applicable.

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Conflict of interest

The authors declare that there is no conflict of interests.

Data and materials availability

All data associated with this study are present in the paperDół formularza

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