Invited lecture/Review

The role of the Concomitant Lesions in Determining Failure of Anterior Cruciate Ligament Reconstruction

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Abstract:
Anterior cruciate ligament (ACL) tear is one of the most common sport-related injuries and the request for ACL reconstructions is increasing nowadays. Unfortunately, ACL graft failures may occur in about 5.2% of cases. Unrecognized concomitant meniscus and ligamentous lesions are estimated to be responsive of about 15% of ACL reconstruction failures. Isolated ACL reconstruction in this setting may not be enough to properly restore knee stability. If not properly treated, such lesions may expose ACL graft to excessive stress, thus predisposing to failure. This article aims at highlighting the role of associated lesion in determining failure of ACL reconstruction, while also providing an evidence-based algorithm about proper management.

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1. List of abbreviations

ACL anterior cruciate ligament; ALL anterolateral ligament; MCL medial collateral ligament; PLC posterolateral corner; LMPR lateral meniscus posterior root.

2. Introduction

Anterior cruciate ligament (ACL) tear is one of the most common injuries in sports active population, involving about 3% of amateur athletes every year, and up to 15% of elite athletes per year (Mayer et al., 2015). Surgical reconstruction has always been supported by the international literature since conservative treatment was proved not to be capable of properly restoring knee kinematics and preventing osteoarthritis development (Noyes et al., 1983; Kessler et al., 2008; Hurd et al., 2008).

Despite the recent advances in surgical techniques, knee biomechanics knowledge and injury prevention programs, 10-to-15% of patients undergoing ACL reconstruction report unsatisfactory outcomes (Samitier et al., 2015). Two systematic reviews reported only 60% of amateur athletes (Ardern et al., 2014) and 83% of elite athletes (Lai et al., 2018) returned to their preinjury sport level after ACL reconstruction. Graft failure is claimed as the main determinants of outcomes. In a meta-analysis involving 1,272 elite athletes, the pooled failure rate was estimated in 5.2% (range 2.8% - 19.3%) (Lai et al., 2018), but this rate has been shown to grow up to 34.2% when including high-risk cohorts like younger athletes (Wiggins et al., 2016).

Graft failure after ACL reconstruction may be secondary to technical errors, biologic causes, or traumatic events (Vermeijden et al., 2020; Kamath et al., 2011). Unrecognized concomitant meniscus and ligamentous lesions are estimated to be responsive of about 15% of ACL reconstruction failures (Samitier et al., 2015). Isolated ACL reconstruction in this setting may not be enough to properly restore knee stability. If not properly treated, such lesions may expose ACL graft to excessive stress, thus predisposing to failure.

This article aims at highlighting the role of associated lesion in determining failure of ACL reconstruction, while also providing an evidence-based algorithm about proper management.

3. Anterolateral Ligament

The anterolateral ligament (ALL) is one of the most debated issues about this topic. High interest is fueled by the common finding of residual pivot-shift phenomenon after ACL reconstruction, which is estimated in up to 25% of cases regardless of the chosen graft (Sonnery-Cottet et al.,2017). Persisting rotational instability was shown to predispose to recurrent injuries and ACL failure (Kunze et al., 2021). Several biomechanical studies demonstrated a better restoration of anteroposterior and rotatory stability when an ALL reconstruction is combined to an ACL reconstruction, rather than performing an ACL reconstruction alone (Na et al., 2021). Such biomechanical findings also result in clinical evidence of reduced risk of graft failure.

A recent meta-analysis of 20 randomized and nonrandomized controlled trials found that the rate of graft failure was two-to-four times lower in the ACL/ALL group than in the isolated ACL reconstruction group, regardless the adopted technique or the surgical timing (Na et al., 2021). Therefore, international literature supports the ALL reconstruction in high-risk patients. Indications include patients with high-grade pivot shift, patients with concomitant Segond fractures and high-level athletes participating in pivoting sports and in ACL revision settings (Na et al., 2021).

4. Medial Collateral Ligament

Medial collateral ligament (MCL) injury is quite often associated to ACL tears (Grant et al., 2012), as a result of the typical valgus stress trauma determining ACL lesion. ACL and MCL play a synergistic role in maintaining anteromedial knee stability (Wierer et al., 2021). Several cadaveric studies demonstrated that ACL strain is increased after sectioning MCL, when applying a valgus stress or an intra-rotation movement of the tibia (Wierer et al.,2021; Battaglia et al., 2009). In addition, combined MCL and ACL sectioning increases anterior knee laxity greater than isolated ACL sectioning (Mains et al., 1977). Despite these findings, the treatment of combined ACL and MCL tears is still controversial. Most authors support the conservative management of the MCL injury, especially in acute settings and low-grade injuries (Grant et al., 2012; Bollier and Smith, 2014). A "wait and see" approach is recommended by some authors also in high-grade MCL tears (Grant et al., 2012). However, a recent study from the Swedish National Knee Ligament Registry highlighted a higher risk of ACL revision in patients with ACL reconstruction and non-surgically treated MCL injuries compared to isolated ACL reconstructions. When a repair or reconstruction of concomitant MCL injuries was performed, this risk was comparable to isolated ACL reconstructions (Svantesson et al., 2019). These findings encourage the authors supporting early MCL repair or reconstruction (DeLong and Watermann, 2015) because ACL insufficiency might adversely affect the MCL process healing (Woo et al., 1990). On the other hand, delayed ACL reconstructions have been related to better functional outcomes with earlier motion recovery (Mook et al., 2009). MCL surgical treatment should be considered in patients with severe valgus alignment, entrapment over the pes anserinus tendon (Stener-like lesion), large bony avulsions and persistent instability after ACL reconstruction (DeLong and Watermann, 2015; Mook et al., 2009)

5. Posterolateral Corner

The posterolateral corner (PLC) of the knee is another important issue of academic interest, because of an evolving appreciation for its biomechanical relationship with the ACL function. PLC injuries are commonly associated to cruciate ligaments tears, occurring in isolation in only 28% of cases (Dean and LaPrade, 2020). Specifically, 7.4% - 13.9% of patients with ACL injury have a concomitant PLC injury (LaPrade et al., 2007). Biomechanical data demonstrated a significant increase in force on the ACL in PLC-deficient knee, when applying a varus moment or a combined varus-internal rotation moment to the knee joint (LaPrade et al., 1999; Plaweski et al., 2005), as well as during simulated gait and squatting (Kang et al., 2019). In addition, Plaweski et al. (2005) found that an ACL reconstruction was not enough to prevent varus and external rotation displacement in the setting of ACL-PLC deficient knee; a return to native kinematics was achieved only after adding a reconstruction of PLC static structures. Despite such promises, the role of PLC on the risk of ACL failure has not been adequately investigated. In one registry study, a concomitant PLC injury would appear to not affect the risk of ACL failure, whatever the treatment is (Svantesson et al., 2019). However, this analysis was impaired by the small size of the study groups, which limits the relevance of such findings.

6. Menisci

The biomechanical role of the menisci on knee stability must not be overlooked. The medial and lateral menisci act as secondary restraints for anterior and rotatory tibial displacement (Musahl et al., 2010; Grassi et al., 2019; Hoshino et al., 2020) Meniscus repair would seem to restore knee stability comparable to ACL-reconstructed knees with intact menisci (Hoshino et al., 2020). These findings also apply to meniscus posterior root lesions (MPRL) (Zheng et al., 2020; Samuelsen et al., 2020) Lateral MPRLs (Figure 2) were reported to increase anterior tibial subluxation of the lateral compartment in patients with ACL injuries (Zheng et al., 2020). Similarly, medial MPRLs were found to significantly increase ACL graft loads over the intact state, while root repair restored the function of the medial meniscus as a secondary stabilizer (Samuelsen et al., 2020). Finally, a ramp lesion in an ACL-deficient knee has also been shown to increase anterior tibial translation and external rotational laxities (Stephen et al., 2016; Naendrup et al., 2019). This aberrant laxity cannot be

completely restored after ACL reconstruction alone but with combined posterior meniscocapsular repair (Naendrup et al., 2019). Nevertheless, there is poor clinical evidence regarding increased risk of graft failure following meniscal loss. Only one study identified medial or lateral meniscus deficiency as significant factor for predicting graft failure (Parkinson et al., 2017), since several other studies did not detect significant difference between isolated ACL reconstruction and ACL reconstruction combined with medial and/or lateral meniscectomy (Young et al., 2021; Akada et al., 2019). However, the fundamental role of the meniscus in preserving joint function and preventing osteoarthritis development is well known. Furthermore, meniscectomy has been clearly recognized as a risk factor for delayed return to sport (Akada et al., 2019) and career shortening in athletes (Akada et al., 2019; Neyret et al., 1993; Brophy et al., 2009). As a result, meniscus repair should be considered even in athletes.

7. Conclusion

Associated lesions to ACL tear play a non-secondary role in determining graft failure after ACL reconstruction. Careful preoperative evaluation as well as proper management of such lesions is fundamental to not expose ACL graft to excessive stress, thus minimizing the risk of failure.

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

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