Biomechanical Proof for the Existence of the Anterolateral Ligament

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KEYWORDS

• Anterolateral ligament • Knee • Biomechanics • Rotational instability

KEY POINTS

- Awareness of the contribution of the anterolateral knee for rotational stability has reemerged in the literature.
- Improved understanding of the anatomy has led to an expansion of the literature on the biomechanics of the anterolateral knee, including the participation of the anterolateral ligament, as well as the iliotibial band, including the deep (Kaplan) fibers and the capsuloosseous layer.
- The anterolateral ligament (ALL) resists tibial internal rotation at increased knee flexion angles, with a minimal role in anteroposterior stability.
- The contribution of other anterolateral structures has received less recent attention in the literature.
- Combined anatomic anterior cruciate ligament reconstruction (ACLR) and ALL reconstruction reduces tibial internal rotation compared with isolated ACLR with ALL deficiency, although may be associated with overconstraint.

INTRODUCTION

Although anterior cruciate ligament (ACL) reconstruction is one of the most common knee procedures, with more than 200,000 performed annually in the United States,[1,2] rotational instability persists in up to 25% of patients.[3] In patients with rotational laxity, tunnel positioning has often been deemed satisfactory, suggesting that successful treatment of these patients may be dependent on more than this factor alone. Several extra-articular techniques have emerged in the past 50 years to address rotational

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laxity in the setting of an ACL tear, primarily relying on augmenting or reconstructing the anterolateral structures of the knee. However, concerns of knee overconstraint with reconstruction of extra-articular structures have been raised, as overconstraint has been demonstrated in several biomechanical studies, and may lead to accelerated degenerative changes or ACL graft failure.[4–7]

Historically, the existence of an isolated ACL tear was infrequent and it was suspected that there were likely concomitant injuries to extra-articular stabilizing structures. Specifically, the anterolateral structures may be injured concomitantly with the ACL tear. For example, Helito and colleagues[8] evaluated the prevalence of anterolateral ligament (ALL) injury in 88 knees with an ACL tear and an identifiable ALL; 33 patients had imaging findings consistent with an injury to the ALL. Similar associated injury patterns also have been reported for the iliotibial band (ITB).[9] Failing to recognize these injuries at the time of ACL reconstruction may result in residual rotational laxity (pivot shift), a scenario that can potentially compromise the ACL graft. In fact, it has been suggested that an ALL reconstruction may be indicated in patients with chronic ACL tears, as well as those with a high-grade pivot shift.[10]

Recent studies have identified several structures likely to play a role in rotational stability, including the ALL,[11] the ITB,[12] and the lateral meniscus posterior root.[13] Much of the recent literature has focused on the anatomy and biomechanics of the ALL, and several reconstruction techniques have been described. The roles of key anterolateral knee structures are reviewed, with a specific emphasis on the anterolateral ligament, to improve the understanding of the influence of the anterolateral knee on rotational stability.

NOMENCLATURE AND ANATOMIC CONSIDERATIONS

A leading cause for an incomplete understanding of the biomechanical role of anterolateral knee structures is the inconsistency in anatomic descriptions and nomenclature. No consensus exists currently, as several investigators have provided different anatomic and functional descriptions, and heterogeneity in nomenclature has persisted.

In 1879, Segond[14] described an avulsion fracture of the proximal aspect of the anterolateral tibia that was subsequently reported to be associated with ACL injuries.[15,16] Additionally, he reported the existence of a structure that was associated with these lesions, which according to his description, was a pearly band extending in an oblique fashion from the femur inserting into the avulsed tibial bone. Interestingly, this description coincides with a capsular thickening of what Hughston and colleagues[17–19] termed the "mid-third lateral capsular ligament"[9] and also the anterior oblique band of the lateral collateral ligament described by Johnson.[20] Furthermore, Terry and colleagues,[18] in 1986, reported that the deep, capsulo-osseous and superficial layers of the iliotibial tract functioned as an "anterolateral ligament of the knee." Additionally, in 2007 Vieira and colleagues[21] reported that the capsulo-osseous layer acts as a "true" anterolateral ligament. Later, in 2013, Claes[22] described a reportedly distinct anatomic structure with well-defined anatomic attachments, which he termed "the anterolateral ligament of the knee." This more recent change in terminology was likely engendered by strong lay press-driven research studies, which validated the role of the ALL in anterior and rotational stability about the knee.[23]

BIOMECHANICAL ROLE OF KEY ANTEROLATERAL STRUCTURES

Several anterolateral knee structures likely contribute to restraining internal rotation, including the ALL, the superficial layer of the ITB, the ITB deep (Kaplan) fibers, the