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Operative Techniques in
Orthopaedics

Repair of the Anterolateral Structures in the Acutely Injured Anterior Cruciate Ligament

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Repair of the acutely injured anterolateral complex is a surgical procedure justified by biomechanical studies, surgical findings, and clinical results. In a lack of specific radiological protocols able to reliably detect such injuries, indications are still related to the degree of pivot test, as evaluated preoperatively under anesthesia (explosive pivot shift). Repair techniques, to be always performed along with an anterior cruciate ligament reconstruction, are simple procedures strictly related to the type of injury. In type I and II tears, when a clear stretching is encountered (limited to the anterolateral capsule and ligament or extended toward the posterolateral capsule), repair consists of retensioning the capsule by means of plicating it with simple stitches. In type III tears, when a complete rupture of the capsule is found, an end-to-end suture is performed, possibly reproducing native tension. In type IV tears (bony avulsion, Segond fracture), repair is performed using periosteal stitches, suture anchors, or cancellous bone screws, according to the size of the fragment. In selected cases of generalized hyperlaxity or when a severely damaged tissue is found, augmentation with fascia lata or other autologous or allogenic grafts could be considered. Old prejudices about the possible complications of extra-articular procedures associated with intra-articular anterior cruciate ligament reconstructions for overconstraint, reduced range of motion, and higher rate of degenerative osteoarthritis seem to be overtaken, when modern surgical and rehabilitative procedure are used.

KEYWORDS knee, ACL, anterolateral complex

Introduction

First attempts to surgically treat anterior cruciate ligament (ACL) tears date back to the early 1900s, when some pioneers of knee surgery proposed rough techniques to both repair or reconstruct the torn ACL.[1] However, it was only in the mid-1960s, when the disabling phenomenon of the pivot shift and the pivot-shift test were described as a sign of rotatory instability as a consequence of ACL insufficiency, that the modern ACL surgery actually began.[2] Nowadays, ACL reconstruction is one of the most performed surgical procedures, which is aimed to stabilize the knee and to eliminate the pivot shift, with a success rate ranging from 80%-95%.[3,4] The advent of arthroscopy and arthroscopic-assisted reconstructions also contributed to more precise and less invasive procedures leading to further improving functional outcomes. At the same time, the approach to surgical treatment of ACL-deficient knee also changed. In fact, since the early 1980s, when ACL reconstructions were performed in an open fashion, the treatment of ACL insufficiency was not strictly limited to intra-articular reconstruction but often included repair or reconstruction of secondary restraints (anterolateral capsular structures) whose role was considered crucial in the pivot-shift phenomenon.[2] In fact, the strict relationship between the ACL and anterolateral structures in controlling tibial rotation and rotatory stability, much earlier postulated by the French radiologist Paul Segond,[5] had been demonstrated by several distinguished knee surgeons of the past century.[6,7] Therefore, since the 1980s the treatment of ACL-deficient knees often included isolated extra-articular reconstructions or, more often, along with intra-articular ACL reconstructions. However, because of the inability of isolated extra-articular

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reconstructions to fully stabilize the knee and an unacceptable increased morbidity of combined reconstructions, the extra-articular reconstructions were almost completely abandoned by the end of the 1980s.[8] Moreover, as the surgeons became more confident with arthroscopy and related techniques leading to a more proper and anatomical reconstruction of the ACL, procedures eventually shifted from combined intra-articular or extra-articular reconstructions to isolated intra-articular reconstructions. However, despite significant advances in surgical reconstruction techniques, including a detailed, almost haunting, aim to surgically replicate ACL anatomy and function, a certain degree of rotatory instability, as revealed by a persistent pivot shift, is often reported. For these reasons, repair and reconstruction of secondary restraints, whose role in rotatory instability in ACL-deficient knees has been recently redocumented,[9] have been reconsidered[10] in view of the reduced morbidity provided by modern arthroscopic techniques for intra-articular reconstructions and postoperative rehabilitation. In this article, we will deal with diagnosis, indications, and surgical treatment of injuries of secondary restraints of the lateral compartment of the knee occurring along with acute ACL tears.

Anatomy

Any surgical reconstruction techniques cannot leave out of consideration the anatomy of structures it aims to repair. In fact, besides a generic description of the articular capsule, none of the classic textbooks of anatomy report a description of ligaments or other significant structures on the anterolateral aspect of the knee resembling or possibly functioning as a ligament. To find a description of such structures, we must refer to specialized knee surgery publications. Following the first description of a "pearly resistant fibrous band" at the anterolateral aspect of the human knee made by Segond in 1879,[5] other authors reported on a thickening of the anterolateral capsule actually acting as a ligament appointed to control internal tibial rotation. In their milestone article on knee ligament instability, Hughston et al[6] reported on anterolateral instability because of a combined injury of the ACL and the middle-third capsular ligament, described as attached proximally to the lateral epicondyle and distally at the tibial joint margin, which would provide a major support for the knee at around 30° of flexion. Later, Werner Mueller[7] named this structure "the anterolateral femuro tibial ligament", a structure he considered as a deep portion of the iliotibial tract inserting to the intermuscular septum proximal to the lateral collateral ligament on the femoral condyle, containing fibers inserting on Gerdy tubercle. Claes et al[11] should be credited for the most recent and popular anatomical study of the anterolateral capsule where they identified a constant structure that becomes tense with internal tibial rotation, which they named anterolateral ligament (ALL). The origin of the ALL was situated at the prominence of the lateral femoral epicondyle and the insertion approximately midway between Gerdy tubercle and tip of fibular head. Later, Dodds et al[12] described the origin of the ALL slight proximal and posterior to the lateral epicondyle. All these authors agreed with the role of controlling internal tibial rotation of this structure. Other authors,[13,14] in accordance with surgical findings, recognized that control of internal tibial rotation is provided by a wider area of the anterolateral capsule extending far anterior and posterior to the ALL as described by Claes et al, introducing the term *anterolateral complex*. Nowadays, with the lack of a definitive and precise description of all lateral structures (including the lateral meniscus) involved in controlling internal tibial rotation and the pivot-shift phenomenon, we will refer to it as to the anterolateral complex rather than to the ALL.

Physiopathology and Surgical Findings

Many studies showed that the anterolateral complex acts in conjunction with the ACL in controlling internal tibial rotation and has a significant role for the pivot-shift phenomenon.[6,7,15-19] Moreover, some very interesting and sophisticated studies using video analysis of sports-related injuries, documented that in most cases, even when a true valgus external rotation seems to occur, a sudden earlier internal rotation stress is applied to the joint, before the knee eventually collapses in valgus external rotation.[20,21] The results of these studies could explain how the anterolateral complex is often injured in most cases of ACL injuries, mainly being a result of a pivot shift like mechanism of valgus and internal tibial rotation. We should also consider that injury of the anterolateral complex could happen along with the first injury or is a result of progressive stretching chronically ACL-deficient knees. In fact, the prevalence of acute injuries of the anterolateral complex occurring along with ACL tears has been reported to range from 90%-100% of cases.[6,14,22,23] In our experience, a steady exposure of the anterolateral capsule allowed us to document anterolateral complex injuries in 90% of cases of apparently isolated ACL tears.[14] These lesions could be classified as follows:

Type I: Multilevel rupture in which individual layers are torn at different levels with macroscopic hemorrhage involving the area of the ALL and extended to the anterolateral capsule only (Fig. 2A).

Type II: Multilevel rupture in which individual layers are torn at different levels with macroscopic hemorrhage extended from the area of the ALL and capsule to the posterolateral corner (Fig. 3A).

Type III: Complete transverse tear involving the area of the ALL near its insertion to the lateral tibial plateau (always distal to the lateral meniscus) (Fig. 4A).

Type IV: Bony avulsion (Segond fracture) (Fig. 5A).

One of the most important issues concerning the treatment of acute anterolateral complex injuries is related to the outcome of these injuries, whether they have a potential for a spontaneous healing and which actually need to be surgically treated.

Diagnosis and Indications

Radiologists, urged by orthopedists, only recently got awareness of the importance of the anterolateral complex and