Anterior Cruciate Ligament Repair : Evolving Trends

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Introduction

Once upon a time a patient with anterior cruciate ligament (ACL) tear led a relatively safe existence. It was a time when only a fall from a chariot or jousting horse, sent a gladiator or knight to early retirement because of an unstable knee. In today's world of motorcycle racing, soccer, increased fitness awareness and highly competitive sports, injury to ACL has assumed increasing importance from both the diagnostic as well as the therapeutic angle. In the past, damage to ACL was considered to be of little importance to the long term functions of the knee [1]. However, several studies have shown that the instability after rupture may lead to recurrent episodes of giving way, an increased risk of meniscal injury and premature degenerative changes [2,3].

Anatomy

The ACL is a crucial ligament of the knee. The development of the knee joint can be first detected at 4 weeks or 5 mm stage of the human embryo. The ACL itself appears as a condensation in the blastoma at about 6.5 weeks. It begins as a ventral ligament and gradually invaginates with the formation of the intercondylar space. It appears well before joint cavitations and remains extrasynovial at all times. With differentiation of femoral condyle, it migrates posteriorly. In its adult form, the anterior cruciate ligament averages about 4 cm in length and 1 cm in width. It is entirely intra-articular but is extra synovial within its synovial envelope. It is proximally attached to the posterior part of the intercondylar surface of the lateral femoral condyle in the form of an arc of a circle and on the tibial side inserted to a broader area, fitting into a depression slightly anterior and lateral to the tibial spine. It is divided into anteromedial and posterolateral bundles. The reciprocal relationship of the two bundles constitutes a four-bar linkage within the anatomy of this single ligament and provides for stability throughout the arc of knee joint motion.

Functions

It is the prime stabilizer of the knee and prevents forward displacement of the tibia on the femur. Its secondary functions are prevention of hyperextension and excessive internal rotation of tibia on femur. It also exercises restraint on valgus and varus stress in all degrees of flexion and fine tunes the screw home motion as the knee approaches terminal extension. If ACL is ruptured, the synchronous rolling and gliding movement of the knee disintegrates and knee becomes susceptible to attrition.

Mechanism of injury

The types of injury that most frequently damage ACL are those that cause excessive external rotation and valgus of the flexed knee or forcible hyperextension of the knee while tibia is in internal rotation. It can also be caused by complete dislocation of knee joint due to a direct posterior force against upper end of tibia or due to internal rotation of the tibia while knee is extended [4].

Biomechanical derangement

Loss of ACL unrivets one of the central struts of the crossed four-bar linkage kinematic system. The knee then becomes susceptible to attrition from unguided femoral motion. Excessive internal rotation exists in terminal extension. The lateral compartment, specifically the iliotibial band, is then stretched, which accentuates rotatory subluxation. Knee hyper extensibility stresses the doorstop effect of the meniscus as the femoral condyles repeatedly subluxate over the posterior horns, producing degenerative tears and further loss of stability. Thus, ACL incompetence initiates a process of intra-articular entopy of sorts that, with repetitive cyclic-loading, eventuates in cartilaginous degeneration and the ultimate state of joint degenerative arthritis.

Management

Mayo Robson did the first surgical repair for chronic instability due to ACL tear in 1885 at General Infirmary Leeds, England [5]. Thereafter, treatment of ACL

rupture evolved using iliotibial band, to hamstring tendons, to patellar tendons to synthetic grafts.

Isolated ruptures of ACL though uncommon, yet can result either because of its avulsion from bony attachment or tear in its mid substance. These acute injuries should be treated primarily by ACL repair with or without augmentation. Surgical methods of reconstructing the torn ACL can be divided into three broad categories; intra-articular reconstruction, extra-articular reconstruction and the combined extra-articular and intra-articular reconstruction using either autogenous material or synthetic material. There is no single best method to repair chronic knee laxity associated with ACL tear, the goal is to have a procedure that is effective and inexpensive. In the past, practically every structure about the knee has been used as substitute. Experience in the last one decade has shown that when properly used, intra-articular replacement can revascularize, and duplicate the ligament though not perfectly.

The gold standard is the use of bone-patellar tendon-bone graft, for intra-articular reconstruction of ACL [6] and platinum standard now a days is quadrupled hamstring tendon graft. It has less donor morbidity and fewer incidences of anterior knee pain and better rehabilitation in those who engage in sports [7].

In the recent years, arthroscopy has been the most significant advancement in the diagnosis and management of ACL injuries. Many patients who were earlier dumped into general diagnosis of internal derangement of knee (IDK) are now diagnosed accurately using arthroscopy. Arthroscopy aided reconstruction of ACL has also shown encouraging results. Patients undergoing arthroscopic aided reconstruction of ACL have shown better results as compared to open procedures [8].

In the future, assessment of knee ligament reconstruction techniques should look at long-term stability combined with low complication rates. Ease of revision surgery and low cost should also be taken into consideration, given the large annual volume of knee ligament reconstructions (50,000 in the United States alone) [9]. Whichever procedure is used, the outcome after reconstruction of ACL may be affected by associated damage to the collateral ligaments, the meniscus and the chondral surface which needs to be addressed at the time of initial procedure.

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