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INJURIES OF ANTERIOR CRUCIATE LIGAMENT – REVIEW

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Abstract: -

The anterior cruciate ligament is an important structure maintaining knee stability. ACL injuries are very commonly seen. They cause substantial effect in the younger population, mainly seen in sports injuries either by contact or non-contact mode, affects productivity and physical activity after injury, causes economic burden of surgeries and rehabilitation and postoperative complications. They fail to heal owing to various factors such as a low number of cells, poor vascularity, the inhibitory effect of synovial fluid. Newer approaches to surgeries are evolving to provide better treatment. Hence, a review will enrich the understanding of the pattern of ACL injuries and its application in novel ways of surgical repair.

Keywords: *Anterior cruciate ligament, Injuries, Biomechanism, Epidemiology, Healing, Failure of healing*

INTRODUCTION

The knee joint is the largest joint of the body. Also, beautifully complex in its structure. It is formed by femoral condyles, tibial condyles, and patella. It is classified as a complex joint and a modified synovial joint. The anterior cruciate ligament (ACL) is one of the ligaments in the knee joint. It is placed as "X" along with the posterior cruciate ligament. It arises from the anterior intercondylar area of the tibia and traverses posteriorly, laterally, and upwards to attach to the medial surface of the lateral femoral condyle. ACL has two bundles called anteromedial and posterolateral bundles, separated by a septum. ACL prevents hyperextension of the knee joint by limiting the anterior translation of the tibia over the femur and the posterior translation of the femur over the tibia. Also, it prevents excessive medial rotation of the tibia over the femur. ACL is supplied by the middle genicular artery and the middle genicular nerve. ACL is a very important ligament maintaining the stability of the knee joint. ACL complete tear can lead to a highly unstable knee joint, incapacitating the patient. An ACL injury is one of the most common knee injuries in the world.[1]

MATERIALS AND METHODS

Review is done using the search engine PubMed. Search terms used are anterior cruciate ligament, injuries, epidemiology, mechanism, histology, immunohistochemistry, surgeries, primary repair, reconstruction. Boolean operators AND, OR, NOT are used. Articles in the English language, mainly from the last 10 years were included. Articles related to human and animal studies were included.

REVIEW Epidemiology

1,20,000 ACL injuries per year are a case burden in the United States.[2,3] It constitutes 60% of sportsrelated knee injuries needing surgery.[4] Billion dollars approximately was the burden on the health care system for ACL reconstruction alone.[5] Another study showed a jaw-dropping 4 billion dollars burden approximately for rehabilitation to prevent osteoarthritis and 2 billion dollars for ACL reconstruction in long term.[6] In India, as per a 2014 study in PGI, Chandigarh, it is comprised 86.5% of knee injuries related to sports.[7] In a rural tertiary care hospital, road traffic accidents were seen to be the biggest culprit for ACL injuries.[8] The incidence of overall age groups is 68.6 per 1,00,000 person-years.[9] There are significant gender variations with males having higher incidence (81.7 vs 55.3 per 1,00,000 person-years). The highest incidence is in 19-25 years of age in males. In females, it is 14-18 years of age.[9]

Causes of ACL injuries

It is known worldwide as a very common sports-related injury.[1] They can be due to contact or non-contact mode. Non-contact is the most common mode constituting 70-84%.[10] Contact injuries can be again classified as direct contact and indirect contact. Direct contact implies impact to the knee, indirect contact implies impact to other body structures.[11] Most of the non-contact injuries occur when there is a sudden change in direction of motion, sudden deceleration while running, cutting manoeuvres combined with deceleration, landing after jumping, pivoting on a planted foot, sidestepping, single-leg landing.

In a study conducted on high school students playing different sports, it was noticed that volleyball and handball had maximum ACL injuries related to landing. Female soccer and basketball had cutting and stopping related ACL injuries.[11] In male soccer, direct contact injury of tucking the knee from behind contribute to 15% ACL injuries while remaining are cutting and stopping related.[12] Judo has mainly direct contact related ACL injuries.[11]

Mechanism of injury

The most common biomechanic variables involved are:

Increased abduction stress at the knee

It causes stretching of the anterior cruciate ligament, medial cruciate ligament, medial patellofemoral ligament. Repetitive loading of abduction stress is more dangerous than single large loading. Weak hip muscles cause increased adduction and internal rotation at the hip joint leading to knee abduction.[13] Increased hip abduction of the contralateral leg causes the force to act upon the lateral part of the knee joint leading to knee valgus and ACL injury.

Reduced knee flexion during injury

Quadriceps contraction causes this during single-leg landing, to prevent falling.[14] Weak hamstrings lead to contracted quadriceps which causes hip flexion and reduced knee flexion leading to ACL injury. Hip and knee joints in extension put the maximal load on ligaments, the static supporters rather than muscles and tendons.

Increased quadriceps activation and gluteus maximus activation lead to the extension of the knee and hip joints. Decreased hamstrings activation and decreased gastrocnemius activation causes reduced knee flexion.

Grades of injury

There are three grades of ACL injury. Grade I is a peri-ligamentous injury, involving microscopic tears and results in mere stretching of the ACL. No instability is seen with this grade. Grade II is rarely seen. It involves a partial tear of the ACL. Some knee instability is observed. Grade III is very commonly encountered. It involves a complete tear of the ACL into two remnants. The knee joint is very unstable.

Healing

The healing of ACL injury is known to be poor. Murray et al observed the histology of ruptured ACL and described four phases. The inflammatory phase lasting for 3 weeks showed disruption of epiligament and synovium,

giving a mop-end appearance. The epiligamentous repair phase, lasting from 3 to 8 weeks, showed epiligament and synovium growing over injured edges having a smooth, mushroom-like appearance. The proliferation phase lasting from 8 to 50 weeks showed the maximum density of cells and blood vessels. The remodelling phase lasting from 50 to 100 weeks showed a low density of blood vessels and cells.[15]

Failure of healing

Causes of failure of healing

ACL tear does not undergo healing easily[16]. Multiple explanations were put forward when compared to medial collateral ligament (MCL) healing.[17] Synovial fluid produces an inhibitory effect on blood clot formation[18] and the proliferation of fibroblasts. Fibroblasts are significantly less on the epiligament of ACL than MCL. Collagen I, V, III are less in ACL than MCL.[17] Nitric oxide is of higher levels in ACL which inhibit collagen synthesis. Vascularity of MCL is good on epiligament with some vessels supplying midsubstance. Whereas ACL has vascularity only on epiligament with almost no vascularity for supplying midsubstance. Bray et al observed in rabbits that MCL shows 8-fold response in blood flow and 6 fold response in the vascular index to hemitransection whereas ACL hemi–transection showed no increase in blood flow and only 2 fold response in the vascular index.[19]

Repair techniques

There is a higher failure rate of a primary ACL repair.[16] Therefore, the ACL is removed, and a graft is placed instead. Bone-patellar tendon-bone grafts and hamstring grafts are commonly used. However, graft reconstruction still leads to a higher incidence of post-operative osteoarthritis within two decades.[20] And remnant preservation had a better clinical outcome than the standard technique of reconstruction.[21] This led to a search for better approaches. Dynamic intraligamentary stabilization is an approach in which intraligamentary braid is strengthened on the femoral side with cortical button, tibial side with spring in a screw,[22] internal brace ligament augmentation using ultra braid sutures and endo button,[23] suture anchor primary ACL repair, bridge enhanced ACL repair is an approach using implant made of protein which is resorbable with autologous blood in between the two torn ends.[24] Biologically augmented ACL repair is an upcoming approach to overcome this osteoarthritis and as well give a similar biomechanical outcome.[25,26]

CONCLUSION

ACL injuries are very common. They seldom heal without intervention. Interventions also cause postoperative osteoarthritis. A recent surge of research in this area is seen to circumvent this obstacle and have a better postoperative outcome.

New classification: ACL injuries can be classified based on the cause of injury as sports-related and non-sports related, mode of injury as contact and non-contact, grade of injury as a microscopic tear (I), partial tear (II) and complete tear (III). A new classification comprising the above components may aid in the line of management. Sports-related may demand quick improvement by surgery. Complete tears need surgical management.

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