

Rehabilitation Protocol Post Anterior Cruciate Ligament Injury: A Pragmatic Review

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Abstract: The Anterior cruciate ligament (ACL) injuries are extremely common among sports activities that involve excessive development of torsional and transitional forces within the knee joint. These types of ligament injuries often result in premature end to careers in sports. The treatment protocol post injury to the anterior cruciate ligament could be either operative or conservative. The main aim behind both the treatment protocol is to reach the best functional level for the patient and reducing the likelihood of new injuries or degenerative changes in the knee joint. The knowledge of healing processes and biomechanics for the knee joint post injury and reconstruction, together with physiological aspects on training effects is crucial for the formation of the rehabilitation protocol. The patients are allowed to return to light sports activities such as running 2–3 months post-surgery and to contact sports, which include cutting and jumping, post 6 months. In many cases, the decision is empirically based upon the rehabilitation protocol are adjusted to the time selected for returning to sports. This review study possesses criteria that should be fulfilled in order to allow the patient to return to sports. Surgery composed with rehabilitative protocol and sport specific exercises should result in development of functional stability of the knee joint. In addition to that adequate muscle strength and performance should be used as a critical criterion. Associative factors for instance social and psychological hindrances should also be accounted for, both during the rehabilitation and at the evaluation of the treatment.

Keywords: Anterior cruciate ligament, Degenerative, Reconstruction, Knee joint, Rehabilitation, Protocol, Stability.

I. INTRODUCTION

The yearly incidence of anterior cruciate ligament injuries has been accounted to 80,000 in the United States. In Germany 54% of football related injuries comprise ACL tear. Sports persons suffering from ACL injury often suffer long term complications for instance meniscal lesions, impairment of normal knee function, and arthrofibrosis [1-3]. These complications and the extended time loss from sport participation can be major setbacks for athletes. Elite and experienced players possess a greater risk of inflicting ACL injury. The incidence of injury is extremely high in the female counterparts in comparison to the male ones. The injury primarily results in static and functional instability that further results in differential motion patterns within the knee joint. Although several injury prevention programs have been designed and shown to reduce the injury rate to some extent, information is lacking about how and which components of these training programs are effective in modifying movement patterns or neuromuscular control during dynamic activities. Understanding the mechanisms of noncontact ACL injury may help us better design and focus our neuromuscular training programs to more effectively prevent at risk motions that may lead to ACL injury [4]. The Anterior cruciate ligament is considered to have two separate bands that wrap around each other. The anteriomedial band (AMB) and the posterolateral band (PLB) and each of them are named for their origins upon tibia. Management post ACL injury might involve an operation to replace the ruptured ligament with a graft in an attempt to reduce excessive anterior tibial translation in the sagittal plane. The main of the reconstructive management is to restore knee function to the best of level without any pain or developing degenerative changes correlated to the operation. Although the ACL reconstruction may not result in a completely normal knee, it may give the patient the chance to return to sporting activities, usually at a lower level than before [5-8]. The most common selection criteria include the patient's age, associated ligament and

meniscal injuries, functional and sporting demands on the knee and the patient's ability and training has been demonstrated in prospective willingness to participate in postoperative rehabilitation.

II. RATIONALE FOR THE MANAGEMENT POST ACL INJURY

The main rationale for management post ACL injury is to develop functional stability, reduce the chances of re-injury and to attain the optimal functional level at the knee joint. The formulated management protocol includes rehabilitation of both the injured and the un-injured knee, in addition to that the hip, trunk and associated group of muscles are required to be strengthened in order to stabilize the entire body and maintain the muscle integrity. The stability of the knee joint is majorly dependent upon the interplay between the passive structures of the dynamic system structures. The ACL stabilizes approximately 85% of the total anteriorly directed forces upon the tibia. Post ACL injury the sagittal transition forces within the knee joint increases [1-6]. The functional stability of the joint that is dependent upon the muscle, coordination and the proprioceptive components are hampered at a great extent. The muscle and the proprioceptive components experience the highest deficit during the ACL injury [9]. The Neuromuscular rehabilitation method primarily aims towards enhancing the nervous system's ability to generate fast and tactical muscle contractions, develop the co-ordination, balance and assisting in relearning motor patterns. The proprioceptive neuromuscular training also presents with excellent outcomes i.e. incidence of ACL injury is extremely low in sportsperson that undergo proprioceptive training. Numerous researches have been concluded to support the outcomes for instance Fleming et al found enhanced rehabilitative outcomes post ACL injury when PNF protocols were indulged in the rehabilitative stages [7-10].

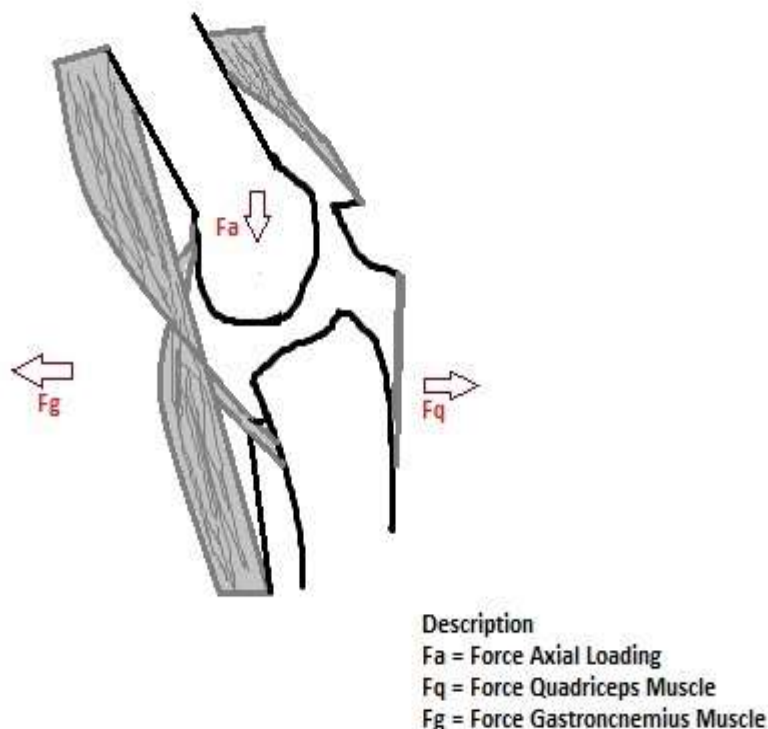


Figure 1.0 Axial loading upon the knee joint results in anterior transition of the tibia on the other hand the contraction of gastrocnemius and quadriceps result in stabilizing the knee joint i.e. to prevent the tibial transition

III. MUSCLE ACTIONS AND EFFECTS

Quadriceps muscle's contraction results in knee extension and its strength correspond to a positive prognosis post an ACL reconstruction surgery. The muscles contraction causes tibial transition in between approximately 0-70 degrees of flexion. On the other hand a research conducted by Higuchi et al concluded that strong gastrocnemius muscle component plays an important role in assisting the rehabilitation protocol post ACL reconstruction.

As the Gastrocnemius contracts it results in anterior transition of tibia by holding and pulling the femur backwards by exerting posteriorly directed shear forces upon the femur. Gastrocnemius also acts as an accessory muscle in assisting the

flexion at knee joint and further increasing the joint compression [9-14]. Hamstring muscles contract to primarily to produce flexion movement at knee joint. They are considered to be the most important muscle in accordance with the quadriceps group of muscle to maintain the knee joint stability and integrity. The muscle contractions increase the joint compressive forces and exerts posterior shear forces to pull the tibia backwards at angles of flexion around 20-25 degrees [13].

One of the most important elements of rehabilitative protocol's component includes closed kinetic chain (CKC) exercises. These exercises are considered to be extremely safe and research conducted by Keays et al have concluded that CKC exercises indeed provide exceptional results in managing ACL injury.

A CKC exercise for the lower limbs involves simultaneous co-contractions of the lower limb muscles, but without any change in length. This type of exercise protocol does not necessarily reduce the anteriorly forces acting upon the tibia. CKC exercises effectively mimics the weight bearing that is effective in providing the necessary proprioceptive training and reducing the transiting movements. An evidence based study conducted by Li et al. concluded that the total tibial transition during the weight bearing exercises for instance squatting etc. was considerably reduced to approximately 20-55% as the tibia was stipulated anteriorly throughout the range. He also concluded a decrease in anterior posterior tibial motions, during the weight bearing. Also, as a result of posterior tilting of the tibial plateau, the acting gravitational forces during the weight bearing results in development and exertion of posteriorly directed shear force upon the femur and hence maintaining the anterior position of the tibia [12-18].

A research conducted by Alice et al. comparing rehabilitative approaches between CKC exercises alone and CKC and Open kinetic chain exercises (OKC) stated negligible or extremely minor differences in tibial transitions.

Implementation of only CKC exercises in the rehabilitative protocol is not sufficient enough for strengthening up the whole quadriceps component. Deficit in the strength of the quadriceps component post the ACL reconstruction is extremely common and it is highly recommended to indulge a quadriceps strengthening protocol within the rehabilitation program. Berry et al. emphasized the combined implementation of both the CKC and the OKC training protocols as according to her research conclusion it stated better rehabilitative outcomes than in comparison to only CKC implementation.

IV. ACL GRAFT HEALING

A repaired graft when subjected to control loading facilitates ligamentous healing, but when the graft is subjected to excessive loading it can disrupt the graft healing as a result of excessive stretch.

The graft undergoes necrosis and revascularization post ACL reconstruction. Rougraff and Shelbourne found that 3 to 8 weeks post-surgery only 30% of a human graft biopsy showed necrosis. A few of the histological and the mechanical properties of various grafts remain similar, but the graft biomechanics varies significantly from person to person. In addition to that it has been found in a research conducted by Morrissey et al. that the anterior tibial transition increases significantly post ACL reconstruction in a few subjects. Rise in anterior tibial transition can be attributed to weak structural and biomechanical properties of the graft.

V. REHABILITATION PROTOCOLS

Dramatic changes in the duration and protocols for rehabilitation post ACL have occurred. In the past conservative rehabilitation included limitation of range of motion, delayed weight bearing and it took approximately 8-10 months for full weight bearing and 9 months to 1 year to return to sports [6, 15-19]. On the other hand the rehabilitation protocols followed today include immediate weight bearing and ROM training and approximate time duration to return to sports is approximately 4-6 months. Savita et al. concluded that the duration of rehabilitation post ACL can be significantly reduced if the sports person is ideally motivated by the physical therapist [20].

VI. RANGE OF MOTION

Majority of researches conducted support immediate training of range of motion. Initiation of such protocols eliminates the adverse effects upon the graft stiffness and ultimately enhances the knee strength. It also is helpful in enhancing the graft healing process which in turn would enhance the rehabilitative phase post ACL injury [17, 21]. Cristian et al. suggested the use of restrictive bracing in the early phases of rehabilitation so as to limit the anterior posterior transitions within the knee joint [21-23].

VII. WEIGHT BEARING

The reviewed manuscripts suggested immediate weight bearing post-surgery. Tyler et al. compared immediate weight bearing with the weight bearing initiated post 2 weeks of surgery and concluded no significant difference in knee laxity within the groups during a 7 month follow up, although approximately 40% of patients had a difference of 3mm or more in difference in sagittal transitions between the legs [22-29].

VIII. RETURNING TO LIGHT AND CONTACT SPORTS

It is an extremely empirical decision to permit an individual to return to sports activities. On the other hand permitting an individual to attend an unrestricted activity might cause adverse effects upon the graft. Glasgow et al. found no significant difference in the sagittal transitions or graft failure in a group returning to sports activities before 6 months compared with the group returning after 6 months from surgery [15, 30]. Shelbourne and Nitz were the first to discover accelerated rehabilitation with return to sports activities between 4-6 months [22-24]. Östenberg et al reported that out of 50 athletes who underwent ACL reconstruction, 40% returned to pre-injury sports activity after 4 months, 40% returned between 4-6 months and the remaining 20% between 6-8 months. Particularly 9 football players returned to play an official game post 4 months of surgery [26-30].

Majority of the reviewed studies followed the protocol where the subject was allowed to return to mild sports activities for instance jogging, running etc. 2-3 months post-surgery and to contact sports 6 months post-surgery. The stability of the knee joint is extremely important, although sagittal transitions measured when the patient is resting do not correlate with the outcome or the participating restrictions [7, 8, 31-32].

IX. CONCLUSION

The modern trend for the rehabilitation protocol post ACL reconstruction revolves around the accelerated training programs. In addition to that an early return to sports activities is also accounted for. The primary aim of the reconstruction surgery remains to enhance the stability. Also sagittal transitions are also increased even after the ACL reconstruction procedures and they are not correlated to knee function or a return to sports. Motivation when combined with the therapeutic rehabilitative protocol enhances the prognosis and the chances of early return of the person to sports activities.

X. RECOMMENDATIONS FOR FUTURE RESEARCH

The future research on the ACL rehabilitation process should attempt to develop the most viable and efficient biomechanical rehabilitative procedure. It should be efficient enough to enhance the graft healing and reduce the rehabilitative duration [33]. Research should be conducted to determine indulgence of new exercise procedures that can reduce the time duration to return to unrestricted sports activities [34].

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