

Efficacy of Mechanoreceptor Rehabilitation on Sensorimotor Recovery by Reducing Visual Dependence in a Patient after ACL Reconstruction Surgery

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Abstract

Background:-Anterior cruciate ligament (ACL) injuries usually result in impaired proprioception, muscle weakness, and decreased functional performance even after operative reconstruction.

Case description:-This case study explores the effect of mechanoreceptor-based rehabilitation with Grade 2 ACL tear in 35 years old male patient after ACL reconstruction surgery.

Intervention: The intervention comprised traditional physiotherapy supplemented with a rehabilitation program of proprioceptive training, balance, progressive strengthening and sensorimotor retraining to progressively reduce reliance on visual cues to complete tasks. Lysholm knee score showed improvement from 30 to 68 post therapy indicating the necessary improvements in knee range of motion, muscular power, gait pattern, functional activities and overall knee function.

Conclusion: These results indicate that mechanoreceptor rehabilitation may improve functional outcomes and sensorimotor recovery after ACL surgery, particularly by decreasing visual dependence.

Background: ACL injury means injury to anterior cruciate ligament of knee which causes excessive anterior translation of tibia on femur because anterior cruciate ligament connects femur to tibia & if torn it causes anterior instability in knee. It is among the most common and serious of knee injuries, particularly among athletes. Female athletes are 2.4 to 9.5 times more likely to sustain ACL injury than male athletes due to various risk factors including anatomical risk factors which includes greater joint rotational laxity, increased valgus stress at knee due to increased Q angle, less muscle mass per body weight, greater joint hyperextension, physiological risk factors in females have estrogen & progesterone sites in ACL cells. It may have proposed that level of these hormones may have deleterious effect on tensile strength of ACL or contraction of quadriceps muscle rather than hamstring in females.

ACL begins from medial side of lateral condyle of femur & posterior side of intercondylar notch of femur & attaches to center of eminentia of tibial plateau. The ACL ligament consists of two major bundle fibers, namely the anteromedial and posterolateral bundles. When the knee is in extension the posterolateral bundles are taut and the anteromedial bundle is moderately lax. There is some variability in the femoral origin of anteromedial & posterolateral bundles. The anteromedial bundle originates high and deep in the notch on the femur proximally and anteriorly (at 90° flexion of the knee) and the posterolateral bundle originates distally and posteriorly on the femur. The mechanoreceptors of the intact anterior cruciate ligament are involved in the functional stability of the knee joint.

ACL functions as the vital restraint against anterior displacement of shinbone on femur. This character however belongs to either the anteromedial bundles or posterolateral bundles, depending on knee flexion angle. In addition to its essential restraint against anterior shear, the ACL may act as secondary restraint against either valgus or varus motions at the knee. With valgus loading, the length of both bands of ACL increases as knee flexion increases. Given the potential of individual muscles to either increase or decrease loads on ACL, it is not surprising that co-contraction of multiple muscle groups at the knee can influence strain of ACL. For eg., if quadriceps is weak, it increases more strain on ACL.

Aim:

To promote sensorimotor recovery in patients after ACL reconstruction surgery by reducing visual dependency.

Scope:

We can promote the knee's functional stability with the help of mechanoreceptor rehabilitation, and that also reduces the chances of an ACL injury recurrence driven on by instability and a psychological fear of activity.

Objective:

1. Reducing visual reliance.
2. Regaining stability in the knee
3. Improving sensorimotor control & proprioception
4. Increase range of movement
5. Reducing pain
6. Strengthening of quadriceps muscle
7. Promote functional activities & postural control

Case Description:-

A 35-year-old male patient presented to the rehabilitation department with a Grade 2 tear of the ACL after ACL reconstruction surgery. He had a fall from a scooter. There was no previous history of injury or surgical procedure. During assessment, the patient had swelling and redness around the knee, decreased knee bending, pain around the patella, weakness and atrophy of the quadriceps muscle, irregular movement patterns in the knee, and occasional knee locking. During examination, I performed the Anterior Drawer Test and Lachman Test to check for ACL injury. I found around few mm of forward tibial movement in the affected knee as compared to the normal knee, which indicated a Grade II ACL tear. The MRI findings further supported the same result. The effect of the injury on the patient's daily activities was evaluated by me using the Lysholm Knee Scoring Scale. He needed a cane to support himself because of his limp. He also said that his knee would often feel like it was going to give way and sometimes lock up on him when he was walking. Pain and swelling were present even after walking a short distance. The patient was unable to climb stairs properly & could not sit in a kneebend position. Before starting rehabilitation, I assessed the patient's Lysholm score as 30, which showed severe difficulty in functional activities & independent walking. During gait assessment, I observed a limping gait pattern. I also assessed the power of quadriceps & hamstring muscles using manual muscle testing. Both muscle groups had grade 1 strength & quadriceps muscle atrophy was also seen. This altered sensory control may gradually lead to

visual dependency, decreased sensorimotor efficacy & decreased psychological assurance in the stability of knee.

Uniqueness:

A characteristic of this condition is the increased dependence on visual inputs for balance in the patient after an ACL injury or surgery. The sensory adaptation demonstrates how the proprioceptive deficits associated with ACL affect balance and stability.

Intervention:

For reducing visual dependency, restoring knee stability, and improving sensorimotor control:

1. Eyes closed during training:

Training with eyes closed includes exercises such as standing on a step, shifting weight, doing mini squats, and standing on one leg to reduce dependence on visual input. Such training promotes the central nervous system to rely more on vestibular, proprioceptive and knee joint sensory cues for stability maintenance. Also neuromuscular control gets better.

2. Training on uneven surfaces with restricted vision:

We decreased visual input by making him move his head and look at things other than his lower limbs, and included balance exercises on unstable surfaces such as foam surfaces, wobble boards, and therapeutic trampolines. Due to the unstable surfaces, the body had to constantly adapt joint position, which in turn increased sensory stimulation in the knee mechanoreceptor. In these exercises, pressure on the knee joint through stimulation of the surrounding muscles improved sensory input signals and also improved motor response, contributing to the maintenance of overall joint stability.

3. Dual task sensorimotor training:

Throughout this training, I asked the patient to do tasks like counting backwards and responding to spoken instructions or sounds. As a result, the patient's ocular surveillance and excessive attention to lower limbs during movement were lessened. The training improved mechanoreceptor-based modulation of automatic postural control responses by diverting the patient's attention from the knee to other tasks.

- For increasing range of motion: Heel slides (wall slides in the first phase and stationary cycling in the later phases) were used to increase knee flexion range. Heel prop exercises and quadriceps setting exercises were used in the first phase to improve knee extension, and long arc quadriceps workouts were added subsequently.
- For pain relief: Following surgery, the PRICE protocol reduced joint stiffness and swelling in addition to helping to reduce pain.
- To strengthen the quadriceps muscle: To strengthen the quadriceps muscle, isometric workouts were incorporated in the first phase. To increase quadriceps strength, banded long arc quadriceps movements were incorporated into the latter progression phase.
- To enhance functional activities:

The first focus was on sit-to-stand and gait training to improve functional activities. Mini squats, stair climbing, and lunges were included throughout the advancement phase to enhance everyday living activities.

Results:

After 1 month, when assessed, this treatment had a valuable impact on the sensorimotor recovery of pa-

tients by reducing visual dependency. It helps in improving knee stability, enhances joint position sense without the requirement to look at the joint, improves balance, increases range of movement of the knee, and helps prevent atrophy of the quadriceps muscle. The table below shows the patient's condition before and after mechanoreceptor rehabilitation aimed at reducing visual dependency.

Before Mechanoreceptor Rehabilitation	After Mechanoreceptor Rehabilitation
Lysholm scale score 30/100	Lysholm scale score 68/100
Knee flexion ROM 30 degree	Knee flexion ROM 70 degree
Grade 1 strength in quadriceps and hamstrings	Grade 3 strength in quadriceps and hamstrings
Patient was unable to climb stairs properly	Patient is able to climb 8 to 10 stairs at a time without any support
Limping gait was observed while walking	At present the patient has a normal gait pattern
Knee was very unstable initially during any kind of movement	Patient has dynamic stability

Discussion

Previous studies on mechanoreceptor rehabilitation by reducing visual dependence have mainly focused on improving proprioception of knee joint. On the other hand, the present case study demonstrated that improved proprioception was not only obtained but knee's sensorimotor response, joint stability and functional performance are also improved. While previous studies have mainly focused on proprioception as a single outcome this case study highlights the potential benefits of this intervention in various aspects of knee function.

Conclusion

The patient demonstrated significant progress with less reliance on vision after mechanoreceptor therapy. Knee stability, proprioception, balance, muscle strength, and gait pattern all improved during the course of treatment. The patient was able to carry out functional tasks more easily and confidently. This case study indicates that this strategy may be helpful in knee rehabilitation following ACL reconstruction surgery, enhancing both the functional and psychological elements of knee recovery.

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