Original Research Article **Ailled sciences**

International Journal of Pharma and Bio Sciences

ISSN 0975-6299

EFFECTIVENESS OF PERTURBATION TRAINING ON CONTRALATERAL KNEE JOINT TO IMPROVE STABILITY IN ANTERIOR CRUCIATE LIGAMENT DEFICIENT KNEE JOINT

R MANJULA*[1], A PAHINIAN [2], G PREMKUMARI [3]

[1]Physiotherapist, KMC Hospital, Karaikal
[2]Principal, Sri Venkateshwaraa College of Physiotherapy, Pondicherry
[3]Associate Professor, Sri Venkateshwaraa College of Physiotherapy, Pondicherry

ABSTRACT

Loss of stability is a very common problem in Anterior Cruciate Ligament Deficient (ACLD) knee. To evaluate the effectiveness of Perturbation training on ACLD knee joint and Contralateral knee joint compared with Perturbation training on the ACLD knee joint alone. Patients were randomized into two groups using a Pre/Post-test experimental design. On the day 0 and 28th (i.e. pre and post treatment)patients were administered Non-Weight Bearing proprioception questionnaire and Weight Bearing Postural Sway on single leg stance were completed using validated outcome measures. Both group were performed Perturbation training protocol for 10 sessions (2-3session per weeks) on ACLD knee joint additionally only one group performed Perturbation training on the Contralateral knee also. Chi-Square test was used to compare the Non-Weight Bearing proprioception questionnaire. Paired t-test and unpaired t-test were used to compare the Postural Sway on single leg stance with eyes open followed by eyes closed. The data showed that with the use of 10 sessions of Perturbation training protocol there is a significant difference between the post values of Postural Sway on single leg stance between group A and group B but more improvement was seen in group B i.e. significant difference inreduction of postural sway. The data of this study showed that there was non-significant difference between post values of Non-Weight Bearing proprioception questionnaire between group A and group B. This study concluded that the Perturbation training on the ACLD knee along with the contralateral kneejoint improve the Stability in ACLD knee and also improve the postural stability hence it reduces the risk of fall and re-occurrence of injury.

KEYWORDS: ***ACL injury, proprioception, contralateral limb perturbation training, Lord's sway meter, Non-Operative ACL Rehabilitation Protocol***

R MANJULA*
Physiotherapist, KMC Hospital, Karaikal

***Corresponding Author**

Received on: 24.11.2016
Revised and Accepted on : 06-02-2017
DOI: http://dx.doi.org/10.22376/ijpbs.2017.8.2.b72-77

INTRODUCTION

Proprioception is defined as the "cumulative neural input to the CNS from mechanoreceptors in the joint capsule, ligaments, muscles, tendons and skin".[1] There is loss of both stability and proprioception in the knee following an injury to the anterior cruciate ligament (ACL).[2] The afferent nerves are responsible for proprioception arise from the ligaments, capsules surrounding muscles and skin,[3] activating muscle contraction, which may be assumed to help stabilize the joint. [4] Injuries, including ACL tears, are likely to disrupt this process. Spinal motor neuron receives afferent information from both ipsilateral and contralateral limbs.[5] In the cerebral motor cortex cross-connections between contralateral limbs contribute to concurrent learned responses.[6] This phenomenon has been exploited in the rehabilitation of patients with a head injury, in whom training the opposite limb to improve the function in the weaker limb limbs.[5] Disruptions of the afferent input from a knee with ACL injury theoretically affect the contralateral limb. The altered afferent information from the peri-articular receptors in the injured limb affected the functioning of the muscle spindles in the contralateral limb, thereby altering the sense of stability in the contralateral limb.[7] Proprioceptive training of an ACL-injured limb has been seen to improve stability, even though the reflex arc and the mechanical stability are lost.[8] This is probably as a result of the effect on the supracotical processing of the feedback impulses. Similarly, it may be possible for proprioceptive training in the opposite limb to improve the stability in the affected limb.[9] Considering the results of the extensive literature search carried out for this review indicated an obvious paucity of research concerning the use of proprioceptive training on the contralateral knee joint. Hence the purpose of the study is to find out the appropriate interventions for the ACLD knee joint.

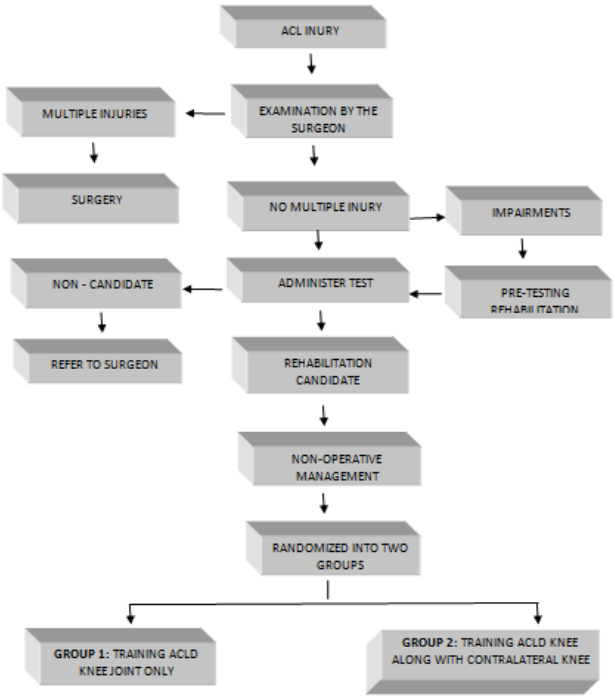
METHODS

Preparing the patient for testing

Testing is usually performed within1-4 weeks after the initial injury, therefore, joint effusion and pain, limitations in knee joint motion, and quadriceps femoris weakness must be resolved before testing. Patients may participate in a pretesting rehabilitation program until these impairments are resolved. The criteria used to determine readiness for testing include the following: (1) no evidence of joint effusion (2) full passive knee range of motion (3) full extension during a straight leg raise on the involved limb (4) quadriceps femoris maximum voluntary contraction force on the involved limb equivalent to 75% of that the uninvolved limb (5) tolerance for single-leg hopping on the involved limb without pain.

Test Procedures and Criteria for patient selection

The patient selection process included 4 tests administered in the following order: (1) single, cross over, triple and timed hop test 80% or more of the uninjured limb (2) Knee outcome survey activities of daily living scale score of 80% or more (3) Global rating of knee function of 60% or more (4) no more than 1 episode of giving way. The subjects were excluded if they had any chronic disease such as Diabetes mellitus, peripheral neuropathy or vestibular dysfunction that could compromise proprioception, if there is associated ligamentous injury in same or opposite knee, presence of any deformity, unable to do single-leg hopping on the involved limb without pain, timed hop test 79% or less of the uninjured limb, Knee outcome survey activities of daily living scale score of 79% or less, Global rating of knee function of 59% or less, not more than 1 episode of giving way.[10] Patient selecting criteria was mentioned in the following (flow chart 1).



Flow Chart 1
Patient Selection Algorithm for Non-Operative Rehabilitation[10]

INTERVENTION

Patients were randomly assigned to one of the two treatment groups

Group A - received non-operative ACL rehabilitation addition of Perturbation training protocol to the ACLD knee only. Group B - received non-operative ACL rehabilitation addition of Perturbation training protocol to the ACLD knee and contralateral knee joint. On the day 0 and 28th (i.e. pre and post treatment) patients were administered Non-Weight Bearing (NWB) proprioception questionnaire i.e., Joint Position Sense (JPS) and Joint Movement Sense (JMS) and Weight Bearing (WB) proprioception was assessment by Lords Sway Meter.

Lords sway meter

Sherrington found that sway measurement obtained with sway meter are strongly correlated with measurements obtained from a force plate i.e.) with movement of center of pressure. Duration of each trail 30 seconds. During each trail the subject was not given any feedback. 5-10 sec rest periods after each trail but he/she were not allowed to move the feet away from the foot markings (duration 6-7 minutes). Totally six trails, first three with eyes opened next three with eyes closed. The measurements are taken in centimeter (cm). Postural Sway on single leg stance was measured using the Lord's sway (i.e., Anterior Sway, Posterior Sway, Right lateral Sway, and Left Lateral Sway) with eyes open followed by eyes closed.[11] The protocol of the study was of 10 sessions 2-3 per week which included 'Group-A' with a total of 20 patients who were under the non-operative rehabilitation protocol (Table 1) and perturbation training to the injured limb only (Table 2) 'Group-B' with total of 20 patients who were all under the rehabilitation protocol to the injured as well as to the contralateral limb.

Data Analysis

All the data were analyzed using the statistical tests which were performed using SPSS 15.00 software package. Chi-Square test was used to compare the Non-Weight Bearing (NWB) proprioception questionnaire between the groups on day 0 and 28th day. Paired t-test and unpaired t-test were used to compare the Postural Sway on single leg stance at 4 directions (i.e., Anterior Sway, Posterior Sway, Right lateral Sway, and Left Lateral Sway) with eyes open followed by eyes closed within the group and between the groups respectively on day 0 and 28th day.

Table 1
Non-Operative Rehabilitation Protocol [12]

Levels ofNeuromuscular Control	Elements	Rehabilitation Techniques	Afferent/Efferent characteristics
Higher Brain control Centre A)Conscious level	Proprioception & Kinesthesia	Joint Re-positioning, Functional range of motion, Axial loading, Closed Kinematic Chain exercises	Peripheral receptor sensitivity, Facilitate afferent pathways
B)Unconscious level	Proprioception & Kinesthesia	Distraction technique into exercise, Single leg balance toes,	Peripheral receptor sensitivity, Facilitate afferent pathways
Brainstem control level	Dynamic Stability	Closed Kinematic Chain exercises, High repetition/low resistance, Eccentric loading, Stretch-shortening exercises, Balance training	Agonist/antagonist co-activation, Muscle activation rate and amplitude, Peripheral receptor sensitivity, Muscle stiffness
Spinal level	Reactive neuromuscular control	Reaction to joint perturbations, Stretch-shortening exercises, Plyometrics, Balance re-acquisition	Reflex facilitation, Muscle activation rate and amplitude
	Functional motor	Sport-specific drills	Arthrokinematics

Exercises based on Neuro-Muscular Principles.

Table 2
Guidelines for progression of perturbation training[11]

Perturbation technique	Milestones	Activities
Roller board translations	Initial treatment sessions Controlled balance with double limb support Controlled balance with single limb support in parallel bar	Double limb support perturbations Progress to single limb perturbation in parallel bar Progress to single limb support without parallel bar
Tilt board perturbations	Initial treatment sessions Controlled balance with double limb support Controlled balance with single limb support	Double limb perturbations Progress to single limb perturbations Add functional task performance during perturbations
Roller board and stationaryplatform perturbations	Initial treatment session Match therapist forces without excessive movement of the roller board Match therapist forces in diagonal stance without excessive forces of the roller board	Perform perturbation in straddle star position Progress to diagonal stance perturbations Add functional task performance during perturbations

Types of Perturbation Techniques

RESULTS

A total number of 40 subjects participated in this study. Group A includes 20 subjects and Group B includes 20 subject. Non-Weight Bearing (NWB) proprioception questionnaire i.e., Joint Position Sense (JPS) and Joint Movement Sense (JMS). The mean difference between the (NWB) Group A [JPS = .08; JMS = 0.3] where as in Group B [JPS = 0.7 JMS = 0.3] viewed as figure 1.

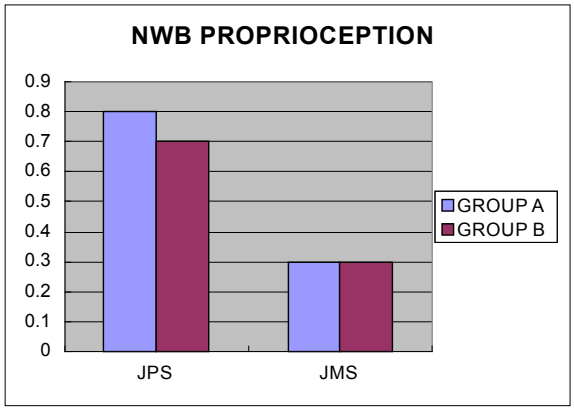


Figure 1
Mean difference between two groups JPS & JMS

The resulted "p" value accept the null hypothesis, it denotes that both groups are Independent variable and there is a significant difference .Weight bearing (WB) assessment using Postural Sway on single leg stance was measured using the Lord's sway.The mean difference of (WB) in eyes opened condition sway readings are mentioned at Table 3 and it viewed as figure 2 whereas the mean difference of (WB) in eyes closed condition sway readings are mentioned at Table 4 and it viewed as figure 3.

Table 3
The mean difference of (WB) in eyes opened condition

EYES OPEN CONDITION	ANTERIOR SWAY	POSTERIOR SWAY	RIGHT LATERAL SWAY	LEFT LATERAL SWAY
GROUP A	0.02cm	0.04cm	0.04cm	0.03cm
GROUP B	0.08cm	0.08cm	0.09cm	0.10cm

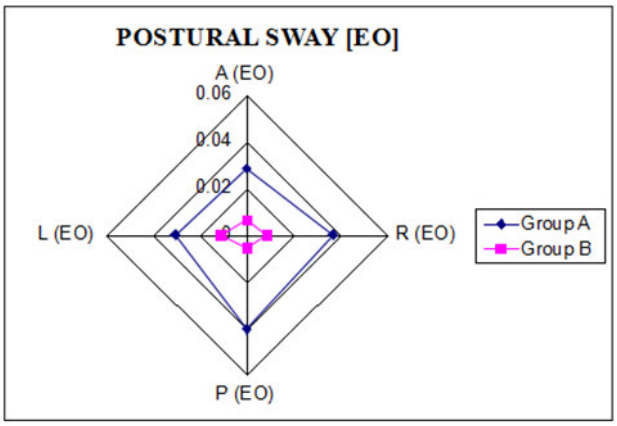
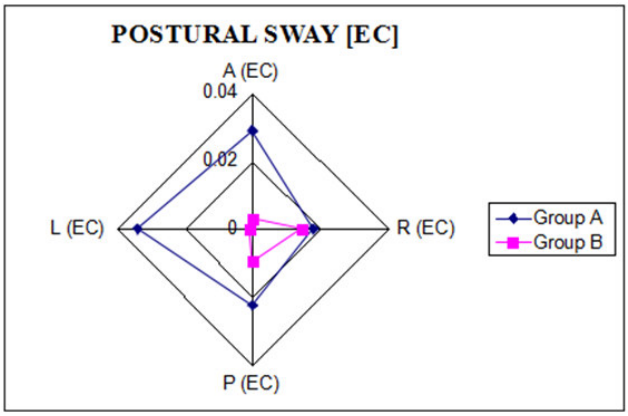


Figure 2
Mean difference between two groups postural sway in single limb stance in Lord's Sway meter in Eyes Open

Table 4
The mean difference of (WB) in eyes closed condition

EYES CLOSED CONDITION	ANTERIOR SWAY	POSTERIOR SWAY	RIGHT LATERAL SWAY	LEFT LATERAL SWAY
GROUP A	0.02cm	0.01cm	0.02cm	0.03cm
GROUP B	0.08cm	0.08cm	0.09cm	0.09cm



After the statistically analyzed the Un-paired "t" test showed that there is significant difference between these two groups (Group A & Group B

Figure 3

Mean difference between two groups postural sway in single limb stance in Lord's Sway meter in Eyes Closed

DISCUSSION

This study was aimed to find out the Effectiveness of Perturbation training on the contralateral knee joint to improve the stability of the ACL deficient knee joint. Many studies stated that the Proprioception was reduced in the patient with ACL deficient knee. In this study, 50 patients were taken with unilateral ACL injury without any concomitant multiple ligament injury were included in this study. 43 out of these were categorized as rehabilitation candidate and 7 remaining subjects were into non-candidate based on their administer test score. In these 40 patients out of 43were able to return to premorbid levels of activity and complete the season successfully. High level physical activity is defined as regular participating in sport and recreational activity.[11] The proprioception was measured in both NWB & WB positions of the limb. In Non-Weight Bearing the Proprioception was assessed by using JPS & JMS, in which knee flexion should be 45 degree was chosen as a starting position for measurements because mid-range angles of knee flexion 30-60 degree have been used frequently measurements. Since several studies indicate that proprioception in the knee is more sensitive in the end range of extension, further studies will have to include angles of knee flexion between 0 – 20 degree.[13] Measurement of the movement sense alone doesn't seem to be suitable for evaluation of proprioceptive loss in the ACL deficient knee. Hence here both the joint movement as well as position sense was included. The Proprioception in WB was measured using Lord's Sway meter.There is a difference between the measurements of proprioception in NWB & WB. Because in NWB knee re-positioning procedures has the greatest potential for revealing the proprioceptive status to the knee joint because it doesn't involve any movements, resistance or weight bearing of its own or through adjacent joints. The examiner slowly and passively move the knee to and from the target position, there is also likelihood that the subjects device cues from these movements to assist in locating test positions. During weight bearing procedures there was a greater potential for standing subjects to use movements cues because of proprioceptors of all joint working together to improve stability.[14] Proper muscular rehabilitation can improve performance of the individual with a torn ACL. The pattern of muscle loss in subjects with torn ACL found that Quadriceps atrophy has found with averaged 10% of the control leg, while the hamstring loss was only 4%. These changes were present one year after injury and did not alter thereafter.[15] The female athletes are more prone to ACL injury but not male, because core stability predicted the risk of injury.[16] Altered afferent information from peri-articular receptors in injured limb affect the function of muscle spindle in contralateral limb. Proprioceptive training of ACL injured limb will improve the stability but there is a loss of mechanical stability due to the effect on supra-cortical processing of feedback. Since proprioceptive training of opposite limb improve the stability of the affected limb.[9] After statistically analyzed the mean difference of post values of intervention group showed much significant than the control group. This implies that there is decreased postural sway found in ACL deficient knee after giving proper training to the contralateral limb. In cross limb hypothesis it have been stated that while training the contralateral limb that produces variable decreased postural sway and increased joint proprioceptors.

CONCLUSION

This study concluded that Perturbation training on the ACL deficient knee along with the contralateral knee joint improve the Mechanical Stability in ACL deficient knee and also improve the Postural Stability; hence it reduces the risk of fall & re-occurrence of the injury. It may be concluded that ACLD patient the sway was more in eye closed condition than eye opened condition and lateral sway were predominately higher than the anterior and posterior sway

ACKNOWLEDGEMENT

I thank Dr. J. Mohanakrishnan, Phd., Physical Therapist, Department of Ortho Surgery, PMRC, JIMPER, Puducherry for his support in our research.

CONFLICT OF INTEREST

Conflict of interest declared none.

REFERENCES

1. Beard DJ, Kyberd PJ, Fergusson CM, Dodd CA. Proprioception after rupture of ACL. An objective indication of the need of the surgery. J Bone Joint Surg Br. 1993 Mar; 7(2):311-315.
2. Barrett DS. Proprioception and function after anterior cruciate reconstruction. J Bone Joint Surg Br. 1993 Sep; 73(5):833-837.
3. Grigg P, Hoffman AH. Properties of Ruffini afferents revealed by stress analysis of isolated sections of cat knee capsule. J Neurophysiol. 1982 Jan; 47(1):41-54.
4. Schultz RA, Miller DC, Kerr CS, Micheli L. Mechanoreceptors in human cruciate ligaments: a histological study. J Bone Joint Surg Am. 1984 Sep; 66(7):1072-6.
5. Cuadrado ML, Egido JA, González-Gutiérrez JL, Varela-De-Seijas E.Bihemispheric contribution to motor recovery after stroke: A longitudinal study with trans-cranial Doppler ultrasonography. Cerebrovasc Dis. 1999 Nov-Dec; 9(6):337-44
6. Michael Lee, Mark R Hinder, Simon C Gandevia, and Timothy J Carroll. The ipsilateral motor cortex contributes to cross-limb transfer of performance gains after ballistic motor practice. J Physiol. 2010 Jan 1; 588(1):201–212.
7. Roberts D, Friden T, Stomberg A, Lindstrand A, Moritz U. Bilateral Proprioception defects in patients with a unilateral ACL reconstruction. A comparison between patients and healthy individuals. J Orthop Res. 2000 Jul; 18(4):565-57.
8. Cooper RL, Taylor NF, Feller JA. Asystemic review of the effect of the Proprioception and Balance Exercises on people with an injured or Reconstructed ACL. Research in Sports Medicine. 2005 Apr-Jun; 13(2):163-178.
9. Arockiaraj J, Korula RJ, Oommen AT, Devasahayam S, Wankhar S, Velkumar S, Poonnoose PM. Proprioceptive changes in the contralateral knee joint following anterior cruciate injury. Bone Joint J. 2003 Feb; 95-B(2):188–91.
10. G. Kelley Fitzgerald, PhD, PT, OCS, Michael J. Axe, MD, Lynn Snyder-Mackler, ScD, PT. Proposed practice Guidelines for Non-operative Anterior Cruciate Ligament Rehabilitation of Physically Active Individuals. Journal of Orthopaedic & Sports Physical Therapy. 2000 Apr; 30(4):194-203.
11. Sivakumar Ramachandran, Roopa Yegnaswamy. Measurement of Postural Sway with a Sway Meter- an Analysis. J Phys Ther. 2011; 2(2):46-53.
12. C. Buz Swanik, Scott M. Lephard, Frank P. Giannantonio, Freddie H.Fu. Reestablishing proprioception and Neuromuscular control in ACL-injured patients. Journal of Sport rehabilitation. 1997; 6:182-206.
13. Pap G, Machner A, Nebelung W, Awiszus F. Detailed analysis of proprioception in normal and ACL deficient knees. J Bone Joint Surg Br. 1999 Sep; 81(5):764–768.
14. Madhavi V Lokhande, Jaimala Shetye Amita Mehta Medha V Deo. Assessment of Knee joint proprioception in Weight bearing and Non-Weight bearing positions in Normal Subjects. Journal of Krishnan Institute of Medical Sciences Unversity. 2013 Jul-Dec; 2(2): 94-101.
15. Corrigan JP, Cashman WF, Brady MP. Proprioception in the cruciate deficient knee. J Bone Joint Surg Br. 1992 Mar; 74 (2):247-50.
16. Mandelbaum BR, Silvers HJ, Watanabe DS, Knarr JF, Thomas SD, Griffin LY, Kirkendall DT, Garrett W Jr. Effectiveness of Neuromuscular and Proprioceptive training program in preventing ACL injury in female athletes. Am J Sports Med. 2005 Jul; 33(7): 1003-1010.

Reviewers of this article

J. Mohanakrishnan, Ph.D

Physiotherapist, Department of Orthosurgery,
JIPMER, Pondichery-6, India

Prof. Srawan Kumar G.Y

Associate Professor,Nalanda Institute of Pharmaceutical Sciences, Sattenapalli, Guntur, Andrapradesh, India

Prof.Dr.K.Suriaprabha

Asst. Editor , International Journal of Pharma and Bio sciences.

Prof.P.Muthuprasanna

Managing Editor , International Journal of Pharma and Bio sciences.

We sincerely thank the above reviewers for peer reviewing the manuscript