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TASK-ORIENTED PROGRESSIVE RESISTANCE TRAINING VERSUS PERTUBATION – BASED BALANCE TRAINING TO IMPROVE BAL- ANCE IN POST ACL RECONSTRUCTION

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ABSTRACT:

BACKGROUND: ACL injuries are common in physically active individuals, lead to pain, instability, and reduced function. Berg balance scale and 8 foot up and go test was used to assess balance in post ACL reconstruction population

PURPOSES: To find out the effect of task-oriented progressive resistance training versus perturbation-based balance training to improve balance in post ACL reconstruction

METHODOLOGY: 30 subjects who have undergone ACL reconstruction were selected from Sri Venkateshwaraa Medical College and Research Institute, Pondicherry, They were allocated and divided into two groups: group A (n = 15) task-oriented progressive resistance training and group B (n = 15) perturbation-based balance training for 6 week, The outcome measure (berg) balance scale and 8-foot up-and-go test) were measured in the pre- and post-test for a 6-week period.

RESULTS: Data analysis was done by unpaired 't' test and paired 't' test for the between-group and within-group analysis, respectively, The statistical analysis done with unpaired 't' test within Group A and Group B analysis shows significance ($p < 0.001$) Which shows that Group A must be significant than Group B, it have been concluded that Group A shows improvement balance in post ACL reconstruction population than Group B.

CONCLUSION: The study concluded that task-oriented, progressive resistance training (Group A) shows more significant when compared with perturbation based balance training (GROUP-B) in improving balance in post ACL reconstruction population.

KEYWORDS: Anterior cruciate ligament, balance training, post ACL reconstruction, resistance training.

INTRODUCTION

The interaction of multiple sensory, motor and integrative system is maintaining balance and functional task.⁽¹⁾ Functioning of these factors decline with age.⁽²⁾ The risk of falling increases in elderly people in certain age because the ability of maintaining balance declines as the age moves, and elderly people may also have a vestibular and cerebellar insufficiency causing poor balance. However, there are number of factors for risk of falling of elderly people with impaired balance. In specific, it is like that the foot problem has a decremental effect on mobility.⁽³⁾ In Biomechanics, Balance is an ability to maintain the center of gravity of a body within the base of support with minimal postural sway. Balance necessitates the simultaneous processing of inputs from many sensory systems, such as equilibrioception (from the vestibular system), vision, and the experience of pressure and proprioception (from the somatosensory system). The motor system is responsible for controlling the muscle motion involved in balancing. The sensory organs must perceive alterations in body position relative to the base, irrespective of whether the body or the base is in motion..⁽⁴⁾

The anterior cruciate ligament (ACL) is crucial for knee stability, preventing anterior tibial displacement. ACL injuries, common in physically active individuals, lead to pain, instability, and reduced function. ACL reconstruction, using tendon grafts, is the gold standard for restoring stability and function, promoting early return to activity and preventing complications like meniscus damage and osteoarthritis. Following surgical treatment, the tendon graft must undergo a remodeling process known as ligamentization, aiming to enhance its structural and biochemical resemblance to the native ACL⁽⁵⁾.

Literature reports a range of methods utilizing diverse sources for ACL reconstruction. This study examines the ACL's anatomical connections, biomechanical responses to noncontact injuries during sports, and the consequent impact on individuals' activity levels and overall health. Given the absence of self-healing and the severity of ACL injuries, surgical intervention is often necessary to restore an active lifestyle⁽⁶⁾. The review encompasses ligament anatomy, biomechanical forces in different knee positions, finite elemental analysis, and ACL graft options.

ACL injuries are most commonly observed in individuals aged 20-24 years. Males have a higher prevalence of ACL injuries generally, but female athletes are more prone to sports-specific injuries, with ratios ranging from 2:1 to 8:1. The data on ACL reconstruction patients reveals that Australia has a rate of 77.4 procedures per 100,000 individuals, the US has a rate of 52 procedures, New Zealand has a rate of 37 procedures, and Sweden has a rate of 32 procedures. This is a consequence of the increase in participation of individuals in this age bracket in sports and other forms of physical activities.⁽⁷⁾

Task Oriented Progressive Resistance Training provides goal-directed repetitive practice of motor task to improve functional abilities.⁽⁸⁾ The basic principle of task oriented progressive resistance training is indicated as “the best way to learn any task is to practice that particular task”.^(9,10) Task oriented progressive resistance training are more important for individuals gait, to improve muscle strength and co-ordination to inhibit altered changes in lower extremity soft tissues, to increase gait speed and to maximize motor performance skills and adapt daily life activities⁽¹¹⁾ and it provides neuroplastic changes in brain of stroke patients.⁽¹²⁾ Retention and generalization of the learned motor behavior will be improved through more practice of some important daily living activities.⁽¹³⁾

A Perturbation based Balance training program that improves ability to execute effect change in support reactions could potentially has a profound effect in reducing risk of falling. Both in place and change in support strategies are necessary for the postural stability. These change in support reactions are the only defense against large balance perturbations ⁽¹⁴⁾ and are common responses to smaller perturbations.^(15,16) Additionally, instability is not confined to one plane, so it must able to control movement in variety of contexts. In order to maintain stability and preserve trunk mass inside the base of support, the patient must actively move his weight forward, backward, and side to side. In order to prevent falling, the subject must abduct his arms and legs. Having coordinated movement techniques is crucial for preserving equilibrium.⁽¹⁷⁾

The Berg Balance Scale (BBS) is most commonly used in clinical practice by Physiotherapist; it is developed as a clinical measure of functional balance specifically for use with older adults. Among Ontario physical therapist committed in geriatrics, the BBS and the TUG are the most commonly used measures of functional performance. The 14 tasks that the BBS assesses are graduated, which offers safety during the assessment process and can help with treatment planning. Numerous patient populations have provided strong evidence of the BBS's psychometric qualities. ^(15,16,17)

A popular test used in practice and research to evaluate mobility and fall risk is the Timed Up and Go Test (TUG). The benefit of TUG is that it requires little time and is simple to execute.⁽³⁴⁾ For healthy, high-functioning older adults, the TUG is not helpful; it works better for less healthy, lower-functioning older adults.⁽¹⁸⁾ This study will find the optimal Balance exercise protocol which will be safe and comfortable to ACL reconstruction population prevent from fall. Hence this study compare the two most relevant exercises, Task Oriented Progressive Resistance Training and Perturbation based Balance Training to improve Balance.

METHOD OF COLLECTION OF DATA

The study was designed as a comparative investigation conducted at Sri Venkateshwaraa medical college hospital & research centre, puducherry. The study population comprised young adults aged between 25 to 40 years who exhibited balance impairment. A total of 30 subjects were included in the study, with a duration spanning six months. Data collection focused specifically on male subjects with balance impairment. Two primary tools were utilized for assessment: the Berg Balance Scale and the 8-Foot Timed Up and Go Test. These tools were chosen to comprehensively evaluate the balance capabilities of the participants over the course of the study. Moreover, all participants needed to demonstrate the ability to follow commands effectively, ensuring their cooperation throughout the duration of the study. Participants with specific characteristics were excluded. Individuals with neurological disorders impacting lower limb function were excluded, as were those with lower limb deformities. Participants who had undergone recent lower limb fracture or surgery with severe limitations in passive range of motion (PROM) at the lower extremity were not included in the study. By excluding individuals with these conditions, the study aimed to focus on a cohort of participants without confounding factors that could significantly impact the assessment of balance impairment.

OUTCOME MEASURES

The study employed two primary outcome measures to evaluate balance impairment. The first was the 8-Foot Up & Go Test, assessing mobility, balance, and gait speed by timing participants as they rose from a chair, walked 8 feet, turned, and returned. The second measure was the Berg Balance Scale, consisting of 14 tasks assessing various aspects of balance performance. These measures provided comprehensive insights into participants' balance capabilities, aiding in the assessment of impairment throughout the study.

METHODOLOGY

Thirty subjects were assigned to two groups. All subjects included in the study provided informed consent prior to participation. Instructions regarding the techniques to be performed were given to each subject. Prior to the treatment and at the end of 6 weeks of treatment, assessments

were conducted using the 8-foot timed up and go test and the Berg balance scale. A total of 30 subjects were evenly divided into two groups: Group A (n=15) and Group B (n=15). Group A underwent Task-Oriented Progressive Resistance Training, while Group B participated in Perturbation-based Balance Training.

PROCEDURE

TASK ORIENTED PROGRESSIVE RESISTANCE TRAINING

The participants were provided with a six-week task-oriented progressive resistance training program administered in one-on-one therapy sessions, with weekly advancements as outlined below:

WEEK 1: Starting from a standing position, participants reached for objects held by the therapist beyond arm's length in various directions without advancing their steps. The exercise lasted for 5 minutes with appropriate intervals, increasing repetitions every 5 minutes to enhance lower limb loading and muscle activation.

WEEK 2: Participants sat upright and practiced standing up from a low chair, with the exercise continuing for 5 minutes. Progression involved raising the chair height and increasing repetitions every 5 minutes to strengthen lower limb extensor muscles.

WEEK 3: Standing, participants stepped forward and backward onto blocks of varying heights without displacing them, for 5 minutes with intervals. Progression included increasing repetitions every 5 minutes to enhance lower limb muscle strength.

WEEK 4: From a standing position, participants sidestepped onto blocks of different heights without displacing them. The exercise lasted for 5 minutes with adequate rest, progressing by increasing repetitions every 5 minutes to strengthen lower limb muscles.

WEEK 5: Standing, participants stepped forward onto small steps, progressing to stools of varying heights over 5 minutes with intervals. Progression involved increasing repetitions every 5 minutes to bolster lower limb muscles.

WEEK 6: Participants performed heel raises to 45 degrees and lowered on a stable surface for 5 minutes with intervals. Progression included increasing repetitions every 5 minutes to strengthen plantar flexor muscles.

PROGRESSION:

Verbal feedback and instructions were provided to enhance performance. Progression was achieved by increasing repetitions, advancing exercise complexity such as reaching distance in standing, and elevating chair and block height

PERTURBATION BASED BALANCE TRAINING

The perturbation-based balance training is structured into two phases:

Phase 1: This phase focuses on training on unstable surfaces for the initial three weeks.

Phase 2: Transitioning to the wobble board occurs during the fourth to sixth weeks of training.

Phase 1: On a stable base, participants begin seated on a couch where manual perturbation is applied. Over three weeks, progression involves transitioning from seated to standing positions while experiencing manual perturbations. These perturbations, administered by the therapist, target the shoulder, trunk, and waist regions, initially in forward and backward directions while seated, then progressing to standing. Perturbations also extend to sideways movements while seated, gradually advancing to standing. Each session consists of 5 minutes of perturbations with 10-second breaks between sets.

Phase 2: Participants stand on the wobble board unsupported, with therapist assistance if needed. The board provides perturbations in various directions (forward, backward, and sideways). Sessions last 5 minutes with appropriate intervals totaling 30 minutes. Progression involves adjusting the wobble board's direction and tilt intensity. These modifications aim to enhance balance and stability progressively throughout the training period.

STATISTICAL ANALYSIS

In this study, pre and post interventional differences within the two groups were analyzed using paired t test and between the two groups were analyzed using unpaired t test for each of the

outcome measures. Statistical significance was set at $p < 0.0001$.

BETWEEN THE GROUP ANALYSIS OF BERG BALANCE SCALE

	Mean	SD	t-value	p-value
GROUP A	9.13	1.684	1.849	<0.05
GROUP B	8	1.558		

Showing the pre and post-test values of group A&B:(unpaired t-test values)

- The “p” value of BBS is <0.05 considered significant.
- The “t” value of BBS is 1.849 with 29 degrees of freedom.

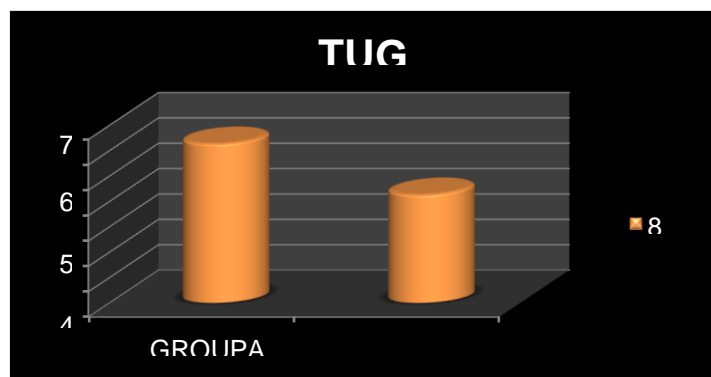
BETWEEN THE GROUP ANALYSIS OF 8 FOOT TIMED UP AND GO TEST

	Mean	SD	t-value	p-value
GROUP A	6.27	1.868	3.53	0.001
GROUP B	4.26	1.031		

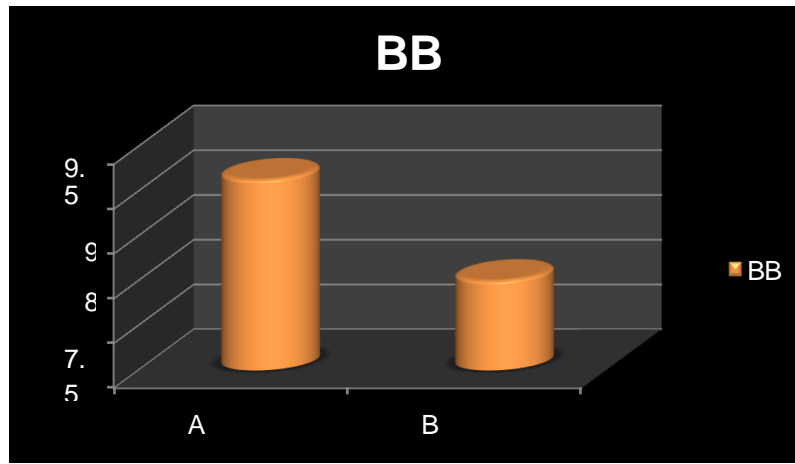
Showing the pre and posttest values of both Group A &B (unpaired t test-values)

- The “p” value of 8 TUG <0.001 considered more significant.
- The “t” value of 8 TUG is 3.53 with 29 degrees of freedom.

BETWEEN THE GROUP ANALYSIS OF PRE AND POST-TEST VALUES FOR 8TUG



BETWEEN THE GROUP ANALYSIS OF PRE AND POST-TEST VALUES FOR BERG BALANCE SCALE



RESULTS

Between the group analysis of Group A & B, The mean and SD for the 8 TUG pre and post test values is 6.27 ± 1.868 and 4.26 ± 1.031 respectively. The mean and SD for BBS pre and post test values is 9.13 ± 1.684 and 8 ± 1.558 respectively. The statistical analysis done with unpaired “t” test within the group A and B analysis shows significance ($p < 0.001$). Between group analysis with BBS and 8 TUG in both groups shows that group A is more significant than group B after statistically analyzed, it has been there is increase in the balance in group A (task oriented progressive resistance training) than group B (perturbation based balance training) Which shows that group A must be significant than group B, it have been concluded that group A shows improved balance in post ACL reconstruction with 8 TUG and BBS than group B.

DISCUSSION

This study was selected for the purpose of finding the effectiveness of Task Oriented Progressive Resistance Training versus Perturbation based Balance Training for post ACL reconstruction people with balance impairment and it shows that there is a significant difference in statistical analysis with p value (0.001) between group A and B.

Similarly the study done by **Rahul shaik et al**, has conducted a study on 30 patients with chronic

stroke, one group is given strength training and another is given task oriented strength training. The results of this study have revealed that there is no significant change noticed in both groups with regards to parameters such as quadriceps ($p=0.0657$), dorsiflexors strength ($p=0.0657$), step length (0.2413), stride length ($p=0.6798$) and cadence($p=0.1403$). The results indicated no significant difference in gait parameters between groups and the strength improvement is more in Task Oriented strength training group.

Task oriented strength training is useful in improving motor unit recruitment and motor learning (the development of neuro-motor patterns of co-ordination between agonist and antagonist muscles through practice of a skill) may have contributed to some degree. This training will improve the strength in antigravity muscles so that it helps in maintaining the stability.

Increase in hip extension in late stance phase may be functionally important because these changes are associated with moving the trunk forward over the stance foot, thus providing the hip flexors with better mechanical advantage to generate power to pull-off the limb, resulting in a large contra lateral step length and an increase in speed.⁽¹⁸⁾

Mansfield et al, has conducted a research in a large urban hospital. Thirty community dwelling older adults were participated. Perturbation based balance training led to greater reductions in frequency of multistep reactions and foot collisions that were significant for surface translations. PBT is an proven intervention to recover the ability of ACL reconstruction people to fall preventions⁽²⁰⁾.

In this study, statistical values shows that Task Oriented Progressive Resistance Training is significant with probability value of > 0.001 when compared to Perturbation based Balance Training with significant value of >0.05 . Statistical value shows that probability value is 0.001-0.0026. In this study we can conclude Task Oriented Progressive Resistance Training was effective to improving Balance in ACL reconstruction population.

Hence it founds, that the Task Oriented Progressive Resistance Training is more significant than the Perturbation based Balance Training in improving balance in post ACL reconstruction population.

CONCLUSION

This study conclude that the Task Oriented Progressive Resistance Training (group A) shows more significant when compared with Perturbation Based Balance Training (group B) in improving balance in post ACL reconstruction population. Only male with post ACL reconstruction were selected in this study. Age group was kept wide due to unavailability of sample size in old age home. The study analyzed only the short term benefits with respect to balance only. We recommend that further study can done with inclusion of equal number of male and female with consideration of level of activity.

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