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Original Article:

Effect of Dynamic Platform Lateral Step-Up versus Stable Platform Lateral Step-Up Weight Bearing Exercise in Hip Abductor Strengthening on Healthy Male Volunteers - Randomized Clinical Trial

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Abstract: Objective & Background: To determine the effect of the dynamic platform lateral step-up and stable platform lateral step-up weight bearing standing exercise in strengthening of hip abductor. Many researchers have reported that strengthening of hip muscles as important component especially hip abductors in lower extremity rehabilitation program. **Study Design:** Single blinded randomized comparative clinical trial. **Methodology:** Sixty five healthy college going male subjects (Age group of 18 – 24 years) volunteered for this study. They were randomly assigned to one of the 2 groups. One group received the dynamic platform lateral step-up and the other received stable platform lateral step-up weight bearing standing exercise. The strength measurements were recorded using hand held dynamometer. **Results:** The results indicate that both groups had a positive effect on the outcome measures. The strength of hip abductors in dynamic platform group improved from a mean value (SD) of 19.47(3.59) to 26.93(3.19) and in stable platform group from 19.07(2.32) to 22.67(2.46). Significant difference is also observed between the two groups at p value .05. **Conclusion:** The study shows that dynamic platform lateral step-up exercise is more beneficial than stable platform lateral step-up weight bearing standing exercise in improving hip abductor muscle strength.

Key Words: Hip Strength; Hip Abduction; Strengthening Exercises; Dynamic Platform

Introduction:

Muscle strength is a broad term that refers to the ability of contractile tissue to produce tension and a resultant force based on the demands placed upon the muscle.(1) Muscular strength is an important factor in determining the effectiveness of the work done.(2,3)

The gluteus medius is described as a strong abductor and medial rotator of the hip joint. During the stance phase of gait, the gluteus medius is supported to prevent the sagging of the pelvis on the unsupported side. The action of the gluteus minimus is said to be similar to that of gluteus medius. (4) Neumann and colleagues (5-7) reported that electromyography (EMG) activity of hip abductors during the stance phase of walking increases when carrying a load in the hand contralateral to the given hip abductors.

Hip muscle weakness is frequently found following hip injury, orthopaedic surgeries around the hip and degenerative joint disorders. Hip muscle weakness could lead to patellofemoral malalignment and development of patellofemoral pain.(8-10) Hip abductor weakness is also reported in long distance runners with Illio Tibial Band syndrome.(11) Delayed hip abductor muscle firing patterns were found in subjects with ankle hypermobility.(12)

Therapeutic exercise is one of the must important interventions used by rehabilitation professionals. Physiotherapists routinely prescribe hip abduction strengthening exercises for patients who have sustained Hip injury or others who have undergone total hip arthroplasty.(13)

Physiotherapists use many variations of hip abductor strengthening exercises in the rehabilitation process. Many clinicians use a standard side lying hip abduction exercise.(11,14,15) Other common methods of strengthening hip abductor muscles include weight bearing exercises (13) such as pelvic drop, weight bearing hip abduction and weight bearing with flexion abduction of contra lateral hip and non weight bearing exercises (13) such as side lying hip abduction, non weight bearing standing hip abduction and non weight bearing standing flexed hip abduction.

Many clinicians usually concentrate on hip abductor strengthening by open kinematic chain exercises. This study focuses on strength improvements of Hip abductor muscles over stable and unstable platform. Till now no randomized clinical trial was done to find the effectiveness of hip abductor strengthening using dynamic platform. So this study intends to compare the effect of weight bearing hip abduction exercise on a stable platform and dynamic platform lateral step-up in improving the strength of hip abductors.

Methods:

Subjects:

Prior to participation in the study, the subjects were explained in detail about the testing procedures and associated risks and

benefits specific to the study and they acknowledged their participation by signing an informed consent. The subjects were then randomly divided into 2 treatment groups, dynamic platform (wobble board) (DP) or stable platform (SP). Randomization was performed by using sealed envelope containing a slip of paper indicating group assignment as either DP or SP. The subjects were assigned a number and recorded on all data collection forms and were blinded from the assessor. Subjects with no lower extremity dysfunction and who can safely perform a single leg stance on each lower extremity were included in the study. Females and individuals with history of significant lower extremity injury or surgery of lower extremity in the preceding year, acute illness, residual pain or disability, Cardio vascular symptoms, neuromuscular diseases and conditions in which strength testing is contra-indicated were excluded from the study. The study was approved by Institutional Review Board.

Procedure:

The tester is a senior physiotherapist with more than 10 years of clinical experience and had evaluated the strength of more than 800 patients using dynamometers. The tester was blinded to the subject's group allocation and the strength of the subjects was recorded on a form using the serial number of the subjects and were stored in a secure place. The post test values were also tested in the same fashion and the data were later utilized by the authors for analysis. Baseline Hydraulic Hand-Held Dynamometer (FEI, Irvington, NY) was used in the study. The dynamometer was calibrated by the manufacturer prior to the study and was also checked by using known weights. The hand-held dynamometers are found to have good test-retest reliability (16,17) and can be used for measuring the hip abduction strength.(18,19) The test- retest reliability of hand held dynamometer muscle testing in the lower extremity is good with interclass correlation coefficient (ICC) of 0.68 to 0.79, (20) 0.95 to 0.99 (21) and 0.84 to 0.91.(22) Subjects were tested in a gravity minimized supine position with a hand-held Dynamometer attached to a stationary device stabilized at the side of examination couch. This type of anchoring station has been found to be highly reliable in the measurement of hip girdle strength and has been used in previous studies. (18,23) A study on reliability of dynamometer attached on to anchoring station reported a ICC of 0.94 to 0.98 for hip abductor and extensor strength testing.(24) Soft foam was placed on the handle of the Hand Held Dynamometer to provide comfort to the subjects during the participation. (24) Right lower extremity was chosen for evaluation and data collection for all subjects. Subjects were positioned so that the dynamometer was 5 cm proximal to the lateral femoral condyle (knee joint line) of the right limb.(23) The same placement was used for every subject during pre and post-tests.

To stabilize the pelvis, a belt was placed across the participant's anterior superior iliac spines and around the table during the testing procedure. (18,23) Care was taken not to allow the subjects to rotate the pelvis or perform internal rotation, external rotation or flexion at the hip. Use of upper extremities to stabilize the trunk was permitted. Maximum effort was used to perform a "Make Test" (13,16) in which subject exerted a maximal isometric force against the dynamometer for five seconds on each of the pre-test and post-test. Proper explanations were given by the tester. The subjects received two practice sessions. The strength measurements were recorded the next day. Three trials were taken. Rests of two minutes were given between the trials to avoid fatigue.

Intervention:

In dynamic platform (wobble board) lateral step-up group (DP), subjects stood with both lower extremities shoulder width apart then they performed a lateral step-up on the centre of a 20" wobble board (height of the half sphere beneath the board is one and half inch) and maintained the pelvis in level. Balancing on the wobble board the subjects were instructed to lift the contra lateral lower extremity from the ground and abducts the leg up to 25˚.(13) Then the subject returns back to starting position and repeats the exercise for 15 repetitions over 3 sets. In stable platform lateral step-up weight bearing standing exercise group (SP), the subjects did a lateral step up on a 11 cm platform on their right lower extremity and maintained the pelvis in level and then were instructed to lift the contra lateral extremity from the ground and to abduct to 25˚.(7,13)

In the both procedures, the subjects returned back to their starting position and repeated the exercise for 15 counts over 3 sets. Approximately 3% of body mass was added above the ankle on the contra lateral side (13) for enhancing ipsilateral hip abductor recruitment.(7,13) The subjects practiced their respective exercise to familiarize themselves with task until they demonstrated proficiency. Subjects generally required 8 to 10 practice repetitions for respective exercise. The frequency of exercises was three sessions a week for six weeks.

The subjects were asked not to indulge in any sports activity or other exercise program during the duration of the study. At the end of the sixth week the post-test dynamometric values were collected.

Statistical Analysis:

Prior to data analysis, strength measurements, recorded in kg, were normalized to body weight for each subject. Statistical analyses were done using Statistical Package for Social sciences, Version 17 for windows (SPSS-17). Changes within the group if any significant were analyzed using paired t-test and the differences between the groups were analyzed by independent t-test. The alpha level for all analyses was set at .05.

Results:

A total of 110 subjects were screened for the study (Figure-1). Forty five of these were excluded due to the following reasons: 26 did not meet the inclusion criteria and 19 were not interested to participate. Sixty five subjects were then randomly assigned to receive Wobble board lateral step-up exercise (n=33) or Stable Platform Lateral step-up standing exercise group (n= 32). Of the 65 subjects, three subjects were not evaluable (1 subject in DP group and 2 subjects in SP group). Two subjects one in each group were not interested in continuing the exercises and one subject in SP group was lost as he moved out of the city. The analyses was made using the remaining subjects of DP group (n=32) and SP group (n=30). All the 65 subjects were men, and the mean (SD) age was 21.08 (1.65) years. Table 1 summarizes their baseline characteristics (age, body weight and hip abductor muscle strength)

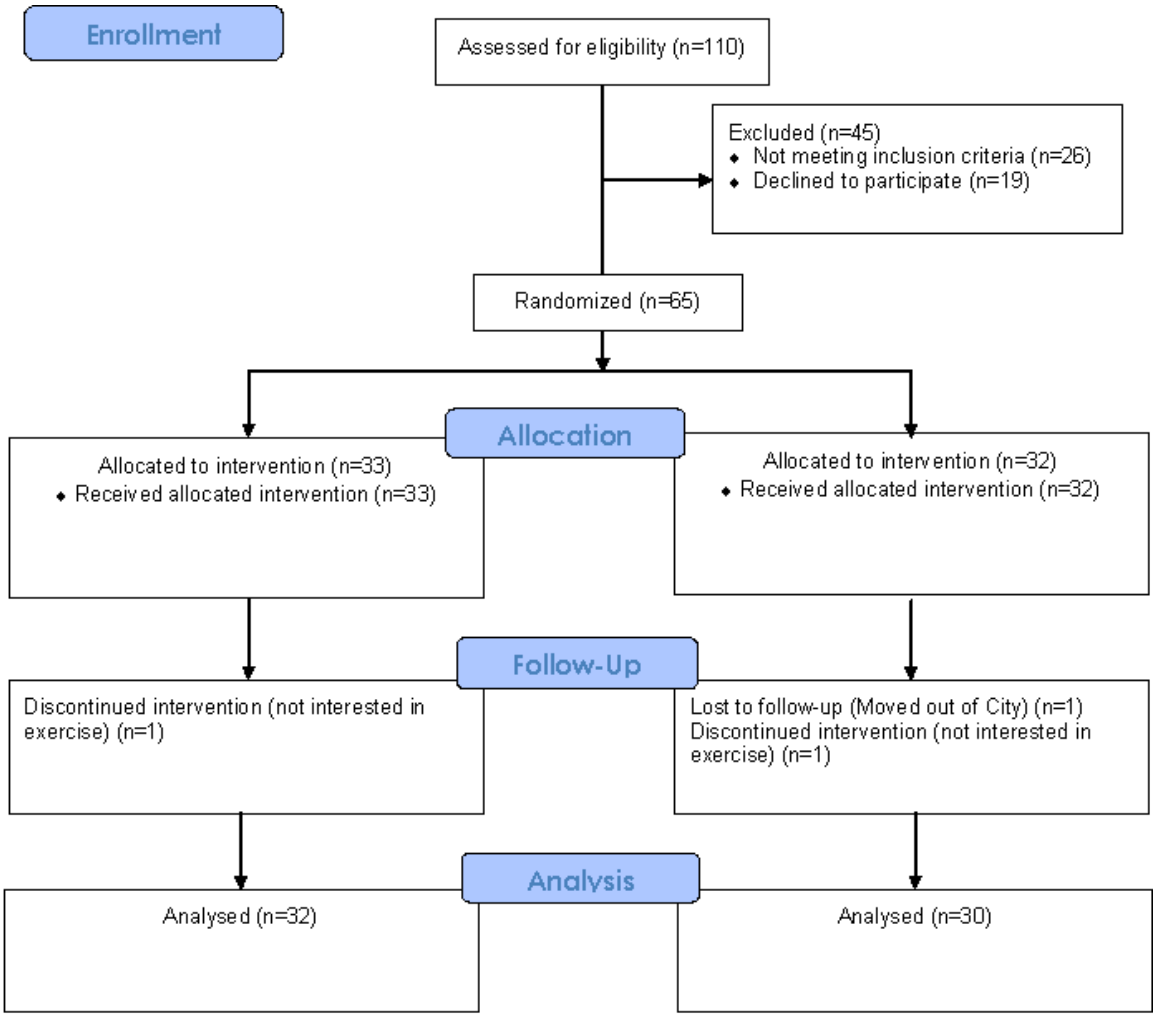

Figure 1: CONSORT 2010 Flow Diagram of randomized clinical trial: number of participants screened, randomized, and retained and analyses.

Table-1: Baseline demographics, Body weight and Outcome measure of participants

Variable	Dynamic platform lateral step-up exercise group (DP) n=33	Stable Platform Lateral step-up exercise group (SP) n=32	t	p
Age	21.12 (1.63)	21.03 (1.69)	.492	.624
Body weight	59.10 (3.69)	58.66 (3.52)	.218	.828
Hip abductor Muscle strength	19.41(3.55)	18.95 (2.29)	.612	.543

Table-2: Comparison of pre and post intervention values of DP group and SP group

Groups	n	Mean (Std. Deviation)	t	p
DP_Pre	32	19.47 (3.59)	-41.080	.000
DP_Post	32	26.93 (3.19)		
SP_Pre	30	19.07 (2.32)	-23.790	.000
SP_Post	30	22.67 (2.46)		

Analyses of pre and post intervention data were done only for the subjects who have completed the study. Table 2 shows the paired t test values for both groups i.e. comparison of pre and post intervention values of hip abductor muscle strength within group. Out of 33 subjects assigned in DP group only 32 completed the study. The p value < 0.001 shows there is statistically significant improvement in hip abductor muscle strength in DP group. In SP group 32 subjects were assigned and 30 have completed the study. The p value < 0.001 shows there is statistically significant improvement in hip abductor muscle strength in SP group. Independent t test was used to find out any significant difference in post intervention values between the groups.

Table-3: Comparison of hip abductor muscle strength after intervention

Groups	n	Mean (Std. Deviation)	t	p
DP	32	26.93 (3.19)	5.858	.000
SP	30	22.67 (2.46)		

Table 3 shows the independent t test value of hip abductor muscle strength of both groups after intervention. P value < 0.001 shows that there is statistically significant difference between both groups after intervention with increased strength in DP group than SP group. No adverse events were noted during the course of the study.

Discussion:

This study compared the effects of two techniques on improving hip abductor muscle strength using dynamic platform Lateral Step-up and stable platform lateral Step-up Exercise. Among 65 subjects 33 subjects received dynamic platform Lateral Step-up and other 32 received the stable platform lateral step-up exercise. Exercises are commonly used weight bearing exercises for the lower extremity.

Nawoczenski and Neumann have defined internal torque as the effect of a force tending to move a body segment about a joint's

axis of rotation (25) with its magnitude dependent on the applied external torque. In this program the external torque produced by gravity on head, arms, trunk and contra lateral lower extremity (approximately 84% of body mass) contracted by internal forces of gluteus musculature.(13)

Exercise in weight bearing generates very high torque for hip abductor muscle than non weight bearing hip abductor exercises. Exercise program emphasizing weight bearing and postural stability resulted in a significant improvement in muscle strength, postural stability and self perceived function in patients four to twelve months after total hip arthroplasty.(26) Exercises to increase hip abduction strength is beneficial in rehabilitation of patients with ankle sprains.(27) Hence exercise in weight bearing would be more beneficial in gluteal muscle strengthening and rehabilitation.

Lateral step-ups on unstable platform (wobble board) have not been described in literature. This study focused on strength improvements due to unstable platform lateral step-ups. In this study the group exercises with dynamic platform (wobble board) lateral step-up improved better than stable platform lateral step-up. This may be attributed to inducing neuromuscular adaptations of stretch reflex, elasticity of the muscle and sensory system of the joint. (28) Weight bearing exercises induce co-contraction of agonist and antagonist muscle synchrony in maintaining joint stability by increased joint compression. Wobble board lateral step-up may have enhanced sensory motor training of the hip abductor muscle in contribution to improved muscle performance.

The study noted that there is significant improvement in the strength of abductor in the both groups. This may be due to specific training of hip abductor muscle due to body weight resistance in lateral step-up exercises. Clinically, many studies reveal that these exercises are very helpful in late – phase of exercise program in conditions like total hip arthroplasty, post traumatic immobilization, ankle sprains, iliotibial band friction syndrome, patellofemoral pain and also in training of athletes in sporting activities, like basket ball, soccer, etc.

The strength measurements were recorded in Kilograms instead of torque and were normalized to body weight for each subject. Although the subjects had similar baseline characteristics for age, sex, weight and participation in sports and other recreational activities, no control was exercised over the possible differences in leg length of the subjects. Therefore, a bias could have resulted due to the difference in the moment arm between the groups.

This study states that exercises are effective in strengthening hip abductors and wobble board lateral step-up exercise may be incorporated in rehabilitation program for improving the strength of hip abductor muscle. A similar study can be done among the females and especially geriatric population for whom hip abductor strengthening is important following hip arthroplasty or other degenerative joint diseases. A future study can acknowledge the height of the subjects. A similar study is also needed to determine the effect of other modes of hip abductor strengthening exercises.

Conclusion:

This present study suggests that dynamic platform lateral step-up exercise is effective in improving the muscle strength of hip abductor than the stable platform lateral step-up exercise.

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