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Effect of Trunk Muscles Strengthening on Hip Abductors Strength and Endurance in Young Adults

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ABSTRACT

Background: Hip abductors muscles are extremely important during several activities and its weakness can affect our daily life activities. **Objective:** This study aimed to investigate the effect of strengthening trunk muscles on Hip abductors strength and endurance in young adults.

Patients and methods: This study was conducted on 58 patients. They were assigned into 2 equal groups: **Group A** (Control group) consisted of 29 subjects received conventional hip abduction exercises from standing position against a theraband and **group B** (Study group) consisted of 29 subjects received the same hip abduction exercises plus a curl up exercise performed 3 days a week at October University for Modern Sciences and Art (MSA). **Results:** There was statistically significant differences in the mean values of maximum abductor isometric strength post-study between both groups (p= 0.038) in favor of group B, in the mean values of time of unilateral bridging test post-study between both groups (p= 0.046) in favor of group B and in the mean values of time of hip abductor endurance post-study between both groups (p= 0.005) in favor to group B.

Conclusion: Curl up exercise combined with hip abduction resisted exercise against an elastic band did a significant improvement regarding the maximum hip abductors isometric strength, and there was a significant difference in Hip abductors endurance compared to doing just hip abductors resisted exercise only. It's recommended to add curl up exercise in programs aimed to improve Hip abductors strength and endurance.

Keywords: Hip abductors strength, Trunk muscles, Curl up exercise.

INTRODUCTION

The primary hip abductor, gluteus medius, is one of the muscles that stabilizes the pelvis while walking [(1)]. Hip abductors were observed to be engaged during walking, particularly on the stance limb [(2)]. There is an anatomical relationship between the hip abductors and rectus abdominis, oblique abdominis and quadratus lumborum. Gluteus medius and gluteus minimus both take an origin from the pelvis while rectus abdominis, oblique abdominis and quadratus lumborum insert into it [(3)]. There is also an electromyographic relationship between gluteus medius, oblique internus and quadratus lumborum [(4)]. This shows a connection between trunk muscles and the hip abductors.

The isokinetic hip muscle strength was the subject of a systematic review in 2018, and the muscular torque was evaluated as a measure of this strength [(5)]. Researchers studied the impact of exercise on hip muscle strength and other factors in individuals with total hip arthroplasty, using hip abduction torque as a measure [(6)]. So, using the terms "torque" and "strength" interchangeably is reliable and valid.

Moderate-to-severe hip osteoarthritis may be detected by bilateral impairments in lower limb maximum strength, notably decreased knee extensor endurance, and poor functional performance [(7)]. Also, individuals that suffer more intense and chronic pain, have weaker and less durable hip abductor muscles [(8)]. Furthermore, a greater risk of injury is linked to decreased prone-bridge hold duration and abductor torque in soccer players [(9)].

Using a hand-held dynamometer to measure hip abduction strength is reliable [(10)]. Exercises like single-leg bridge, side-lying hip abduction with internal rotation, and isometric standing hip abduction are suggested to enhance hip abductor strength [(11)].

This aim of this study was to investigate the effect of rectus abdominis, quadratus lumborum, and oblique abdominis strengthening on hip abductors strength.

PATIENTS AND METHODS

This study was conducted on 58 patients. They were assigned into 2 equal groups: **Group A** (Control group) that consisted of 29 subjects received conventional hip abduction exercises from standing position against a theraband and **group B** (Study group) consisted of 29 subjects received the same hip abduction exercises plus a curl up exercise performed 3 days a week at October University for Modern Sciences and Art (MSA).

Sample size calculation: The sample size was calculated using the G*Power software (version 3.0.10). F-test MANOVA using within and between interaction effects was selected. Power is 0.80, α level of 0.05 and effect size of 0.42; two groups and number of measures 2, a generated sample size of at least 52 subjects. Adding 6

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subjects (10% as drop out), so total sample size was 58 subjects, 29 subjects in each group.

Inclusion criteria: Normal healthy subjects, age ranges from 18 to 25 years old, both genders and body mass index ranged from 18.5 to 29.9.

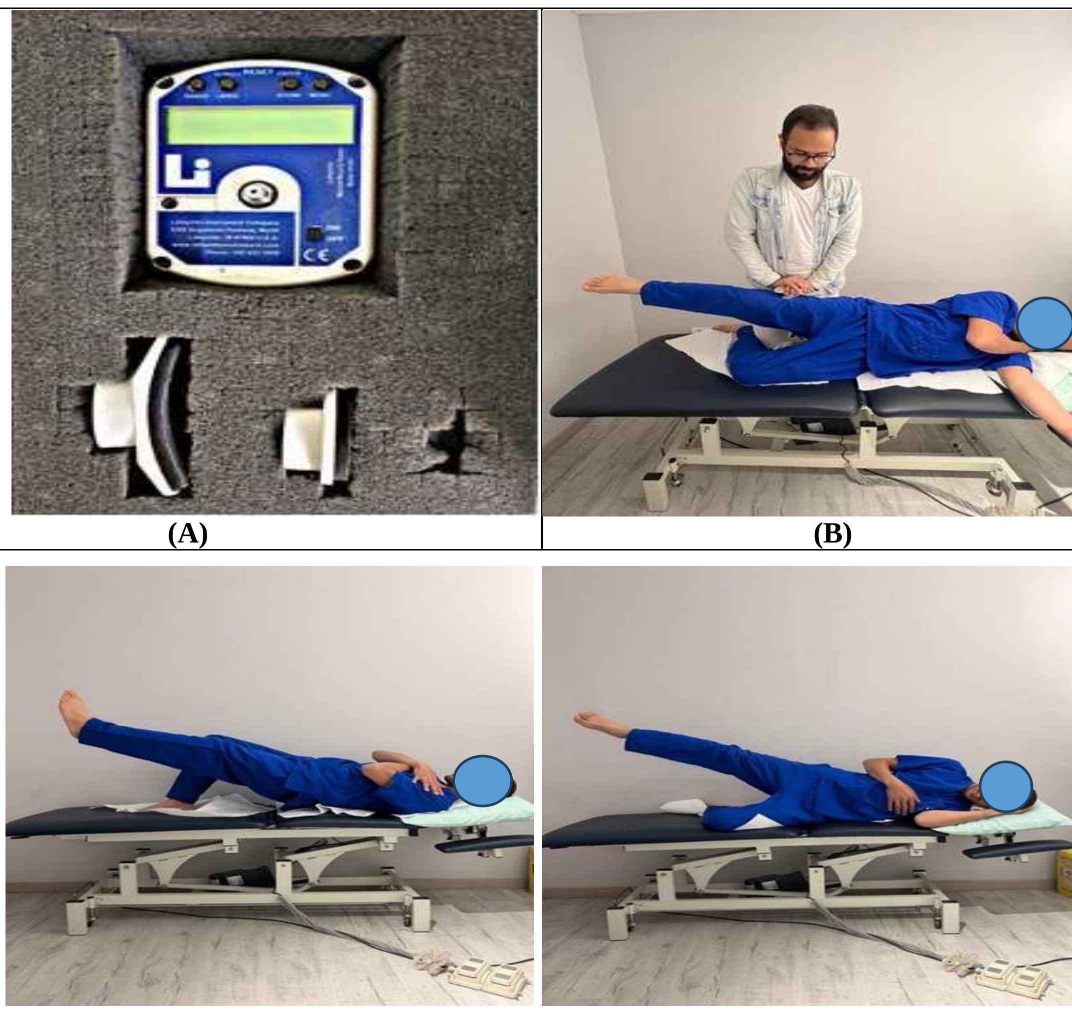
Exclusion criteria: Patients who had pain symptoms in hip, knee, ankle and spine for at least one month before the study, who had history of hip surgery, pregnancy, mental disorders that affect perception or the performance of the tested lower limb and trunk muscles, who had deformity affecting the performance of the procedure on the lower limbs or trunk muscles, having leg length discrepancy and smokers.

Materials:

Hand held dynamometer: A hand held dynamometer from Lafayette Instrument Company, model 01163 was used to measure the hip abduction maximal isometric strength from side lying position (12).

Endurance testing: Gluteus medius abduction and gluteus medius bridging endurance tests were used to measure gluteus medius endurance (13).

Methods: After assigned the consent form, patients were asked to go in a side lying position on a medical bed to assess their maximal hip abductors isometric strength of the dominant lower limb using a handheld dynamometer, then the contralateral hip and knee were slightly flexed at about 30 degrees of flexion each, this was to make the participants more stable and comfortable during the measurement and they were not being permitted to use their hand for trunk stabilization (12, 14), the dynamometer was placed in the middle between hip and knee joints. Three trials were done for each subject for familiarization then three actual test trials were recorded with a highlight on the maximal hip abductor isometric strength, then we measured the hip abductors endurance using abduction endurance test from side lying position and unilateral bridging endurance from supine position (Figure 1).



(A) (B)

(C) (D)

Figure (1): (A) Handheld dynamometer from Lafayette Instrument Company, model 01163, **(B)** Hip abductor strength measurement using a hand-held dynamometer, **(C)** Gluteus medius bridging endurance test and **(D)** Gluteus medius abduction endurance test .

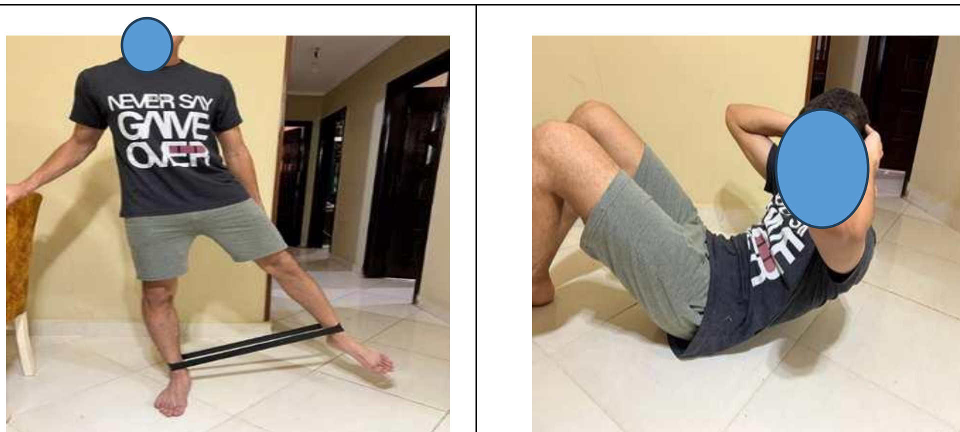
In Hip abduction endurance test: The participant laid on his side in a side lying position on the treatment table with his back erect and slightly touching the wall, the limb on the top was the tested limb and its hip and knee joints were in 0 degrees of flexion and rotation so the limb was straight, the bottom lower limb was in slight hip and knee flexion, and the sole of the foot was rested on the opposing wall, the hand on the top was placed on the top of iliac crest and the bottom hand should be in a relaxed position, the head is positioned on a standard pillow with the spine in the normal erect position. The top lower limb was passively elevated in abduction to 30, an inclinometer was used to make sure of the angle. Then, the tester withdrew his hand and asked the patient to maintain the position as long as he can. It was allowed to instruct the subject to maintain the right position with no motivational words. The subjects may not be told or seen the time passed during the test until it was finished. The test would end if the subject lose over 25% of the 30-degree height for more than three seconds or the testing limb collapsed.

For unilateral bridging test: The participant with his arms crossed across his torso, the subject was hook lying. The knee of the tested limb was flexed to 135° or as close to that angle as possible. Approximately shoulder-width separates the ankles. They were shod. The participant holds the non-tested extremity's thigh parallel to the tested extremity's thigh while extending the non-tested extremity's knee to 0° of flexion. The subject was told to actively extend the hip of the tested extremity to 0° of flexion, or as close to this position as is physically feasible. The patient was told to keep the hip at 0° of flexion for as long as they can. During testing, the tester was permitted to prompt the subject to reposition themselves correctly; however, no encouragement words were allowed. Until the test was over, the examiner keeps an eye on the subject's location and the subject was not informed of or given access to the passing time. The test was over when the pelvis touches the testing surface or when the tester notices an estimated loss of height of more than 25% of the beginning position for more than three seconds. It keeps track of the duration until task failure. The subject would reach the maximum for 3 trials with 10 minutes' rest between each trial [13].

Intervention:

Group (A): Performed a conventional hip abduction exercise from standing position against a Theraband for 10-12 repositions, three days per week [15]. **Group (B):** Performed the same hip abduction exercise plus a curl up exercise for 3 days a week, four weeks were allotted for instruction. Under the guidance of a therapist, the volunteers worked out three times per week every other day. Exercises involving curl-ups were performed during every training practice. The exercise involved bending the trunk while lying on one's back with the knees bent, keeping the lumbar area of the spinal column in contact with the ground. Participants did 10 repetitions in a set during the first training week, 20 repetitions during the second, 30 repetitions during the third, and 40 repetitions during the fourth. The number of sets that each son performed the exercise in was noted by the tester. Each training exercise was carried out until the participant's muscles began to burn. Stretching exercises were also included at the end of each practice [16]. After 4 weeks of training, the participants were measured for their hip abductors strength from side lying position using a handheld dynamometer [12]. Also, the hip abductor endurance was determined using abduction endurance and unilateral bridging endurance [13] (Figure 2).

Ethical approval: The study was approved by The Ethical Committee of Faculty of Physical Therapy, October University for Modern Sciences and Arts (number P.T.REC/012/004988). Informed consents were obtained from all patients. The study adhered to the Code of Ethics of the World Medical Association, specifically the Declaration of Helsinki, for research involving human subjects.



(A) (B)

Figure 2: (A): Hip abductor exercise against resistance, **(B):** Curl up exercise.

Statistical analysis

Descriptive data were expressed as mean ± SD. Unpaired t-test and Chi square were used to compare between subjects' characteristics of the two groups. Shapiro-Wilk and Kolmogorov-Smirnov tests were used for testing normality of data distribution. MANOVA was performed to compare within and between groups' effects for measured variables (Maximum hip abductor isometric strength, unilateral bridging and hip abductor endurance). Statistical package for the social sciences computer program (version 20 for Windows; SPSS Inc., Chicago, Illinois, USA) was used for data analysis. *P* less than or equal to 0.05 was considered significant.

RESULTS

There was no statistically significant difference between thetwo groups as regards age, BMI and dominance (Table 1).

Table (1): Demographic data of subjects of both groups

Demographic data	Group A	Group B	t-value	p-value
Age (years)	19.3±1.9	19.2±1.7	0.217	0.829
BMI (kg/m^2)	22±1.6	22.4±1.8	-0.853	0.397
Dominance	N (%)	N (%)		
Right	28 (96.6%)	28 (96.6%)	χ^2= 0	1
Left	1 (3.4%)	1 (3.4%)		

Data was expressed as mean ± standard deviation, χ^2: chi square, p- value: significance.

MANOVA was conducted to investigate the effect of treatment on the measured variables. There was significant interaction effect of (treatment * time) (p=0.001), Also there was a significant main effect of time (p=0.001) and of treatment (p = 0.040) (Table 2).

Table (2): MANOVA table for the effect of treatment on the measured variables

Interaction effect (treatment * time)	p- value	η2
F = 9.97	*p = 0.001**	*0.357*
Effect of time		
F = 358	*p = 0.001**	*0.952*
Effect of treatment		
F = 2.96	*p = 0.040**	*0.141*

F value: Mixed MANOVA F value, p value: Probability value, *: Significant.

Between groups comparison: There was statistically significant difference in the mean values of maximum abductor isometric strength post-study between both groups (p= 0.038) in favor of group B, in the mean values of time of unilateral bridging test post-study between both groups (p= 0.046) in favor of group B and in the mean values of time of hip abductor endurance post-study between both groups (p= 0.005) in favor of group B (Table 3).

Table (3): Mean ± SD of measured variables pre and post study of both groups.

Measured variables	Group A Mean ± SD	Group B Mean ± SD	f-value	P-value	η2
Max abductor isometric strength (Lb)					
Pre-study	19 ± 3.2	20.4 ± 2.8	3.35	0.072	0.056
Post-study	21.1 ± 3.7	23 ± 3.3	4.5	0.038*	0.075
% of change	11%	12.7%			
P-value	0.001*	0.001*			
Unilateral bridging (sec)					
Pre-study	59.5 ± 24	67.8 ± 27	1.5	0.223	0.026
Post-study	71.9 ± 29	90.3 ± 38	4.1	0.046*	0.069
% of change	20.8%	33.2%			
P-value	0.001*	0.001*			
Hip abductor endurance (sec)					
Pre-study	95 ± 28	108 ± 29	2.9	0.093	0.050
Post-study	19.6 ± 33	148.8 ± 42	8.4	0.005*	0.131
% of change	25.9%	37.8%			
P-value	0.001*	0.001*			

SD: standard deviation, *: significant, η^2: partial eta square.

DISCUSSION

The hip joint, which serves as the body's main connection between the trunk and the lower limbs, plays a significant role in the generation and transfer of forces during both everyday activities and sports endeavors. Because of the remarkable level of inherent bony stability this joint possesses, variations in osseous structure have a substantial impact on the biomechanical characteristics of the human hip. Due to the possibility of injury or other chronic pathologic processes, the physical pressures imposed on the hip joint during athletic activities have potential significance for the diagnosis and surgical treatment of structural hip disorders [17].

When performing exercises to raise the hip abductor torque in the affected limb, it is crucial to consider hip discomfort. Hip pain may inhibit the effort and contraction of muscles [18]. That's why in this study, other ways that may help designing the treatment plan for patients suffering from hip problems were introduced.

In several investigations on the impact of weak hip abductors, it was found that the strength of the gluteus medius significantly affects the loading of the hip and knee joints. The research also indicates that hip abductor weakness affects the peak contact force of the knee more so than hip and ankle joint strength [19]. Hip abductor muscle strength was decreased in osteoarthritis patients compared to unaffected limb and healthy controls [20].

Moreover, there is a connection between the hip and trunk muscles. **Aly and coworkers** **[21]** concluded that performing various trunk muscle exercises greatly boosted the strength of the hip flexor, hip extensor, hip adductor, and trunk flexor, but not the hip abductor.

The results of this study showed that the control group (A) had an increased maximum hip abductors isometric strength by 11% while the test group (B) increment of maximum hip abductors isometric strength was 12.7%. This results showed a statistical significant difference, which contradict with the study of **Aly *et al.*** **[21]** as they concluded that there was no change in Hip abductors strength after doing trunk muscles exercises. This contradiction may be due to the measurement tool as in this study we used a hand held dynamometer while they used isokinetic. Although, the results obtained from hand held dynamometer were valid and reliable compared to isokinetic in case of using belt during the measurement with hand held dynamometer **[22]**, one of the limitations we didn't use the hand held dynamometer with belt which may cause this statistical significant difference **[23]**.

Regarding hip abductors muscles endurance, there was a clear significant difference between both groups in the favor of group (B). Group (B) was better than group (A) by 12.4% and 11.9% in unilateral bridging test and hip abductors endurance test respectively. This may be due to the indirect attachment between gluteus medius and trunk muscles through thoraco-lumbar fascia **[24]**.

On the other hand, biomechanically a relationship between trunk muscles and hip abductors as they both can prevent the pelvis from dropping during gait through the line of action of hip abductors, which in this case runs from the muscles origins to its insertions creating a torque **[25]**, Quadratus lumborum action is hip hiking **[26]**, which acts also to prevent the pelvis from dropping. This may explain why hip abduction endurance was increased in this study. Additionally, according to research by **Hu *et al.*** **[27]**, the transverse abdominus, oblique internus, and oblique externus were all engaged at various gait speeds **[27]** which may explain the improved strength and endurance in both hip abduction endurance test and unilateral bridging test.

CONCLUSION

The findings of this study elicited that curl up exercise combined with hip abduction resisted exercise against an elastic band did a significant improvement regarding the maximum hip abductors isometric strength. Also, there was a significant difference in hip abductors endurance compared to doing just hip abductors resisted exercise only. So it is recommended to add curl up exercise in programs aiming to improve hip abductors strength and endurance.

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- **Conflict of interest:** No declaration of interest.

- **Authors Contributions:** Ahmed S. Abdel latif: Idea, design data collecting and processing, data analysis and interpretation, literature review and writing. Nevin A. Abdel Raoof: design, supervision, data interpretation and critical review. Olfat A. Diab: design, supervision, data interpretation and critical review.
- **Explanations:** None.

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