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Research Article

Hip Adductor, Abductor Muscles Strength, and Performance in Participants with and without Low Back Pain

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ABSTRACT

Introduction: Weakness of hip muscles is common in individuals with chronic non-specific low back pain (CNSLBP). Also, hip joint performance can be influenced by the weakness of hip muscles. This study aimed to compare the strength and performance of hip adductor and abductor muscles between subjects with and without CNSLBP and to investigate their association with disability level.

Materials and Methods: This case-control study included 41 participants with CNSLBP and 41 healthy participants. The strength of hip abductor and adductor muscles were measured using a dynamometer and their performance was assessed using the one-leg hop test. The disability level in the CNSLBP group was assessed using the oswestry disability index (ODI). Data were analyzed using an independent sample t test and Pearson correlation coefficient.

Results: No significant differences were observed between groups for hip muscle strength. One-leg hop test scores of the left lower extremity in the lateral direction were significantly higher in the CNSLBP group compared to the control group. Also, no significant relationships were observed between the total score of ODI and hip muscle strength or performance in the CNSLBP group.

Conclusion: It's recommended that evaluation and exercise therapy of participants with CNSLBP be performed during functional performance tasks.

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1. Introduction

Chronic non-specific low back pain (CNSLBP) is a common musculoskeletal disorder [1]. This term is used when the etiology of the pain is unknown. Although the etiology of CNSLBP has not been fully understood, some possible risk factors include trunk and hip muscle strength [2-4]. Hip muscles are essential for maintaining dynamic alignment and biomechanics of the trunk area and hip joint [3, 4]. Also, the hip muscles assist in the segmental stability of the lumbar area [5]. Previous studies have shown that gluteus medius muscle weakness contributes to the development of low back pain (LBP) [3, 4]. Both abductor and adductor muscle groups play a vital role in pelvic stability [6, 7], and any imbalance between these muscles could make a compensatory lumbar lateral bending, which may result in LBP [7, 8]. Most previous studies have focused on hip abductor muscle strength and have not assessed the role of hip adductor muscles. The findings of previous studies revealed an increase in hip adductor muscle strength, following lower leg injuries, to compensate for the weakness of the hip abductor [9, 10]. However, regarding CNSLBP, few studies have considered the hip adductor muscle strength [7]. Therefore, changes in the strength of hip adductor muscles in participants with CNSLBP are not clear. Furthermore, hip joint and lower limb performance can be strongly influenced by the weakness of hip muscles [11].

The functional performance test subjectively measures hip muscle strength and is commonly used to assess hip muscle function in participants with knee injuries [12-14]. Several studies have assessed hip muscle performance in LBP participants using clinical tests [15-17]. Clinical tests do not assess the overall functional ability [18]. Using functional performance tests to assess hip muscle strength in participants with LBP can be beneficial for "screening or monitoring low back disorders" [19].

LBP is also a common cause of disability [20, 21]. The level of disability may affect the performance of participants with LBP. High disability has been associated with lower levels of physical activity in CNSLBP [22]. To date, no study has examined both adductor and abductor muscles strength and performance and their relation to disability in participants with CNSLBP. Also, it is important to compare the participants with CNSLBP with a control group to ensure the detection of impairment. This study aimed to compare the strength and performance of the hip adductor and abductor muscles between participants with and without CNSLBP and to determine whether hip muscle strength and performance are correlated with the level of disability.

2. Materials and Methods

Design

This was a cross-sectional case-control study conducted from November 2019 to June 2020 and reported according to strengthen the reporting of observational studies in epidemiology (STROBE) [23].

Participants

The sample size was calculated using G×Power software version 3.1.9.4. According to the results of Kendall et al.' study, it was found that the sample size of 41 participants in each group would be sufficient to compare the hip muscle strength between groups [24] (effect size d=0.66; α=0.05; power=0.8). Forty-one participants with CNSLBP (17 men, 24 women) and 41 without CNSLBP (17 men, 24 women) participated in this study (Table 1). Participants with CNSLBP were recruited via advertising in orthopedic and physical therapy clinics of the Iran University of Medical Sciences (IUMS). The participants in the control group were recruited from the IUMS staff and students. Each participant signed informed consent before enrollment in the study. The study was approved by the Ethics Committee of IUMS (Ethic number: IR.IUMS.REC.1397.628).

The participants were included in the CNSLBP group if they reported the following items, including age between 20 to 45 years, CNSLBP diagnosed by an orthopedic surgeon, at least two episodes of LBP symptoms in the last year that lasted at least two consecutive days [25], pain intensity between 0 and 30 mm (mild pain, during rest) on the visual analog scale (VAS), on the testing day [4, 5, 7, 25].

The control group was matched with the CNSLBP participants in terms of age, sex, weight, height, and body mass index. The inclusion criteria for the healthy control group included age between 20 to 45 years, not having pain in the low back during the last six months. The following exclusion criteria for both groups included pregnancy, leg length discrepancy, neurologic diseases (e.g. Multiple Sclerosis, Parkinson), history of surgery in the low back during the last 1 year, history of disk herniation in the low back, history of trauma in the spine during the last 1 year, rheumatoid arthritis, scoliosis, radicular pain, excessive genu varus or genu valgus [3-5, 7]. All tests were performed by one experienced physiotherapist. There was no dropout and all participants completed the study.

Outcome measures

Hip adductor and abductor muscles strength

The hip abductor and adductor muscle strength were assessed using a hand-held dynamometer (made in US, MINFIX, 2017). The dynamometer is a simple and easily applicable measurement device that is acceptably reliable for measuring lower limb muscle strength in most cases [26, 27]. Before the measurement, participants were trained to perform maximal isometric contractions of the hip abductor and adductor muscles to ensure that the tests were done correctly.

The dynamometer was calibrated before the study, based on the manufacturer's instructions. Abductor and adductor muscles' strength was examined in the side-lying position described by Kendall et al. [8]. The participants were instructed to hold their arms at their sides in a relaxed position. The hip abductor muscle strength was assessed in a side-lying position with a pillow between the legs to maintain the normal position of the hip joints (Figure 1A). The dynamometer was located 5 cm above the lateral condyle of the femur. The adductor muscle strength was measured in the same position and the participants were asked to extend the knee while keeping the natural hip position (Figure 1B). In this test, the dynamometer was held under the table and the connecting sling was located 5 cm above the medial condyle of the femur. During the assessment, the participants were allowed to hold the edge of the table if they needed. Then, the values of the abductor and adductor hip muscle strength were normalized with the participants' weight, using Equation 1 [28]:

1. *The strength normalization=([strength [N]/weight [N]]×100)*

The participants were asked to perform a maximal contraction for each trial. Each contraction was held for 5s and was repeated three times. The mean value of three maximal contractions was used for data analysis [29, 30]. To minimize the influence of fatigue, participants rested for 30s after each repetition and 2 minutes after each trial. Participants received verbal encouragement to achieve maximum contraction.

Hip adductor and abductor muscles performance

One-leg hop test was used to assess the performance of the hip adductor and abductor muscles. This test is a valid and reliable measure [31] that is usually used to assess the dynamic and functional performance of hip muscles [32, 33].To perform the one-leg hop test, a line was determined on the floor. The participants were asked to stand on one foot and hoped to the maximum distance in the medial or lateral direction as far as possible and land on the same foot. During the test, the participants were asked not to place their contralateral feet on the ground, but they could use their hands to hold their balance [32]. They were asked to maintain their balance at least 5s after landing. The distance was measured with a tape. The values of the one-leg hop test were normalized to the height as using Equation 2 [31]:

2. *The distance normalization=(distance of hopping [cm]/height [cm])×100*

Participants performed three repetitions for each direction with 30s recovery period between repetitions. The mean value of the repetitions was used for further analysis. A 3-minute break was considered before hopping to another side.

Disability

In this study, disability level was assessed in the CNSLBP group using the Persian version of the oswestry disability index (ODI) [34]. ODI is a ten-item questionnaire that measures the intensity of back pain during nine different activities of daily living, such as personal care, lifting, walking, sitting, standing, sleeping, sex life, social life, and traveling [35]. Each item is scored between 0 to 5 and higher scores indicate more disability. The raw scores were multiplied by 2 and then were transformed into percentages, with higher percentages representing more pain and difficulty [35, 36]. The Persian version of ODI has demonstrated acceptable reliability and validity in individuals with LBP [34].

Procedure

Demographic data were collected for both groups. All participants in the CNSLBP group were asked to complete the ODI. After filling out the questionnaires, the participants performed the standardized warm-up exercises for 10 minutes that included 5 minutes of jogging, side steps, cross-steps, and 5 minutes of stretching exercises [37]. Then, the strength of the hip adductor and abductor muscles was measured for each subject, on both

A) Hip abductors

B) Hip adductors

Figure 1. Hip muscles strength test

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sides. The tests were performed randomly using closed pockets. Closed pockets contained four assessment orders, including left hip adductor muscles testing, right hip adductor muscles testing, left hip abductor muscles testing, and right hip abductor muscles testing. When this part was completed, the participants were instructed to perform a one-leg hop test in both medial and lateral directions [32]. All measurements were performed in one day. Both groups were examined by one examiner blinded to the groups.

Statistical analysis

All the variables in the present study were analyzed using the SPSS Statistics v. 24. The distribution of the data was assessed using Kolmogorov-Smirnov test. All variables had a normal distribution. Independent sample t-tests were used to compare the mean values of the anthropometric data and dependent variables (hip muscles strength and distance of hopping during the one-leg hop test) among the two groups. Also, Pearson correlation coefficient was used to assess correlations between the strength and performance of hip abductor and adductor muscles and the level of disability. Correlations were classified as “little or no” (r<0.25), “fair to moderate” (r= 0.26 to 0.49), “moderate to good” (r=0.5 to 0.74) or “good to excellent” (r>0.75) [38]. The significance level was set at P<0.05.

3. Results

A total of 41 participants with CNSLBP and 41 healthy participants participated in this study. Table 1 presents the characteristics of the participants. No missing data existed in our data analysis. No significant differences were found in baseline characteristics between the two groups (P>0.05) (Table 1). Most of the participants in the CNSLBP group reported minimal disability according to ODI (Table 1).

Table 1. Demographic characteristics of the sample

Variables	Mean±SD/No. (%)		P
	Control Group (n=41)	CNSLBP Group (n=41)	
Age (y)	27.63±6.54	28.44±6.20	0.56
Sex (female)	24(58.5)	24(58.5)	0.58
Weight (kg)	63.70±9.07	67.43±10.11	0.08
Height (cm)	167±7.2	170±7.8	0.14
BMI (kg/m²)	22.62±2.89	23.22±2.72	0.33
ODI score	NA	18.73±8.96	Na

BMI: Body Mass Index; CNSLBP: Chronic Non-Specific Low Back Pain; ODI: Oswestry Disability Index.

The results of the independent t test showed no significant differences between groups for the hip abductor and adductor muscle strength on both sides (P>0.05) (Table 2). The values of the one-leg hop test in the lateral direction were significantly higher in the left lower limb of the control group (P<0.05) (Table 2). However, no differences were observed between groups for one-leg hop test values of the right lower extremity (in both directions) or right lower extremity in the medial direction (P>0.05). Table 3 presents the results of the correlation analysis. The correlation coefficient between the normalized values of the strength of hip abductor and adductor muscles; normalized values of the distance of one-leg hop and the scores of the ODI questionnaire were not significant (r<0.25).

4. Discussion

The purpose of the current study was to compare the strength and performance of hip abductor and adductor muscles between the participants with and without CNSLBP. The results showed no significant differences in the strength of hip abductor and adductor muscles among the groups. The results also showed higher scores for the hip abductor and adductor muscles performance in the left lower limb of the control group (in the lateral direction) compared to the CNSLBP. Disability level in participants with CNSLBP was neither associated with the strength of hip abductor and adductor muscles nor with their performance.

Table 2. Comparing the results of the hip muscles' strength and one-leg hop test between groups (n=41)

Variables	Mean±SD		Mean Difference	95% CI of the Mean Difference	P	Effect Size
	Control	CNSLBP				
Right hip ABD strength	17.69±4.41	15.85±4.59	1.83±0.99	-0.14, 3.81	0.69	0.40
Right hip ADD strength	18.12±7.69	18.58±8.48	-0.46±1.78	-4.02, 3.10	0.79	0.05
Left hip ABD strength	17.20±4.31	15.56±4.88	1.64±1.01	-0.38, 3.66	0.11	0.35
Left hip ADD strength	18.39±6.86	17.48±7.02	0.91±1.53	-2.14, 3.96	0.55	0.13
Lateral hop of the right leg	31.31±5.43	29.95±4.75	1.35±1.12	-0.88, 3.60	0.23	0.26
Medial hop of the right leg	30.62±6.06	29.62±4.57	0.99±1.18	-1.36, 3.35	0.40	0.18
Lateral hop of the left leg	32.39±5.99	29.43±5.30	2.95±1.24	0.46, 5.43	0.02*	0.52
Medial hop of the left leg	31.58±5.02	29.88±5.28	1.69±1.13	-0.57, 3.92	0.14	0.33

ABD: Abduction; ADD: Adduction; CNSLBP: Chronic Non-Specific Low Back Pain. *P<0.05.

Table 3. Correlational analysis of the hip muscle strength and performance with disability level in CNSLBP group

Variables	Correlation (r) with ODI Score	P
Right hip ABD strength	-0.11	0.35
Right hip ADD strength	-0.17	0.27
Left hip ABD strength	-0.14	0.34
Left hip ADD strength	-0.05	0.70
Lateral hop of the right leg	-0.08	0.59
Medial hop of the right leg	-0.12	0.42
Lateral hop of the left leg	-0.03	0.83
Medial hop of the left leg	-0.25	0.10

ABD: Abduction; ADD: Adduction; ODI: Oswestry Disability Index

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Investigations comparing hip abductor muscle strength in participants with and without CNSLBP have reported inconsistent findings. Some studies failed to demonstrate any significant difference in the hip abductor muscle strength between participants with and without CNSLBP [39-41]. However, weakness of hip abductor muscles in participants with LBP has been reported in several studies [3, 4, 24, 42]. Also, the association between hip adductor muscle strength and the occurrence of LBP was revealed in a study [7]. The reason for this inconsistency may be due to various testing methods, pain levels in participants with LBP, and differences in participants' age. In the current study, participants with a pain level of less than 3 on the Visual Analog Scale (VAS) were recruited as the CNSLBP group, while most previous studies included participants with higher pain levels or no limitation for the pain level [3, 24, 42]. According to the literature, the level of pain is a crucial factor affecting the muscle's strength [43]. It has been proposed that pain may decrease the strength of voluntary contraction in all muscles [43]. Since the participants in the CNSLBP group had lower pain levels, they may have been able to produce a similar strength level as the control group. Also, participants in our study and studies that found no differences in the hip abductor muscles strength between participants with and without CNSLBP [39-41] were younger than participants in the other studies that reported weakness of hip abductor muscles in participants with LBP [3, 4, 24, 42]. It seems that age can affect the results of hip abductor and adductor muscle strength [44].

The other aim of this study was to compare hip adductor and abductor muscle performance between participants with and without CNSLBP. The findings showed no significant differences between groups in the scores of the one-leg hop test of right lower limbs. Only one-leg hop of the left lower extremity in the lateral direction showed a significant difference among the groups. Based on previous studies, several factors, such as the effects of the dominant side, strength reduction, and electromyographic (EMG) characteristics, including the level of activity, time to activate, and time to peak activation may influence the hip muscle performance in individuals with LBP [45]. The difference between right- and left-side results may be due to the effects of the dominant side. All participants in this study were right dominant. The literature reported the weakness of the non-dominant side muscles and asymmetry in motion between the dominant and non-dominant lower limbs in participants with chronic LBP [46, 47]. In the current study, no differences were observed between groups for hip abductor and adductor muscle strength. However, one-leg hop is a functional performance test and assesses the association between multiple trunk joints, lower limb segments, and muscles that are active during this test [48, 49]. Therefore, the differences in one-leg hop scores of the left lower limb (in the lateral direction) between groups may be due to the weakness of other segments of muscles on the non-dominant side, which was not examined in this study. The use of EMG would be helpful in future studies to evaluate the trunk and lower limb muscles' performance during a one-leg hop test.

Our results also showed that muscles' strength and one-leg hop test scores were not significantly correlated with ODI scores. A moderate and negative relationship between physical activity and disability in participants with chronic LBP was reported in a systematic review and meta-analysis study [22]. The relationship between muscle strength, performance, and disability in participants with CNSLBP depends on many factors such as measurement method, the level of pain, and the level of disability [22]. In the present study, the participants in the CNSLBP group had a low level of disability. Also, compared to the studies that reported a significant relationship between disability and performance/ muscle strength, the mean age of the participants in our study was lower which can affect the results.

According to the results of our study, young participants with CNSLBP did not show weakness in hip abductor and adductor muscles compared to the control group. However, a significant difference was observed in hip abductor and adductor muscle performance (on the left side, lateral direction) among groups. The clinical implications of these findings may emphasize prescribing exercise therapy during functional performance tasks rather than enhancing muscle strength.

5. Conclusion

The findings of the current study showed that the strength of hip abductor and adductor muscles did not differ between participants with and without CNSLBP and was not correlated with disability level. The performance of hip abductor and adductor muscles was higher in the left lower extremity of the control group (in the lateral direction) and was not correlated with disability level. It seems that the participants' age, their mild pain level, and low disability level, have affected the results. According to the findings, it is recommended that evaluation and exercise therapy of participants with CNSLBP be performed during functional performance tasks. Further studies investigating older participants with CNSLBP and higher levels of back pain and disability can help develop a better insight into this field.

There are some limitations to this study. The participants were young and had mild pain during the testing procedure. Also, the participants with CNSLBP had a low disability level; therefore the results cannot be generalized to the older CNSLBP population with severe pain intensity or high disability levels.

Ethical Considerations

Compliance with ethical guidelines

The study was approved by the Ethics Committee of Iran University of Medical Sciences (IUMS) (Code: IR.IUMS.REC.1397.628).

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Authors' contributions

Conceptualization, research design: Shabnam Shah Ali, Soheyl Jamalipour; Data collection: Soheyl Jamalipour, Javad Abdolhamidi, Saman Salehi; Analysis, interpretation: Shabnam ShahAli; Writing the article, final approval of the article: All authors; Critical revision of the article: Shabnam ShahAli, Soheyl Jamalipour.

Conflict of interest

The authors declared no conflict of interests.

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