PTK
Physical Therapy Korea
https://doi.org/10.12674/ptk.2021.28.1.59
pISSN: 1225-8962 eISSN: 2287-982X
Phys Ther Korea. 2021;28(1):59-64

Original Article

Comparison of the Isometric Hip Flexors Strength in Supine Position in Subjects With and Without Weak Isometric Core Strength

In-Cheol Jeon, PT, PhD

Department of Physical Therapy, College of Life and Health Science, Research Institute for Basic Sciences, Hoseo University, Asan, Korea

Article Info
Received January 11, 2021
Revised January 14, 2021
Accepted January 14, 2021

Corresponding Author
In-Cheol Jeon
E-mail: jeon6984@hoseo.edu
https://orcid.org/0000-0002-6549-6866

Key Words
Isometric core strength
Isometric hip flexors strength
Supine position

Background: Hip flexor muscles are very important in the hip joint structure as a mover and stabilizer. In addition, isometric hip flexor strength in the supine position needs to be considered with isometric core strength (WICS) to measure a precise strength in a clinical way.

Objects: We compared isometric hip flexor strength in the supine position in subjects with and without WICS (between factors) and conditions with and without an external support (within factors).

Methods: A total of 34 subjects (16 with WICS, 18 without WICS) participated in this study. We used the double-bent leg-lowering test to divide the subjects in two groups according to the presence of WICS. Isometric hip flexor strength was evaluated in the supine position both with and without an external support condition. The two-way mixed analysis of variance was applied to identify significant differences between groups (with vs. without WICS: between factors) and conditions (with vs. without an external support: within factors). Statistical significance was set at $\alpha = 0.05$.

Results: In subjects with WICS, isometric hip flexor strength was greater with an external support than without it ($p = 0.0064$). In subjects without WICS, there were no significant differences in isometric hip flexor strength in the presence or absence of an external support ($p = 0.075$). The isometric hip flexor strength was significantly greater with an external support condition in particular in subjects with WICS.

Conclusion: The findings of this study reported that an external support condition in individuals with WICS may contribute to the improvement of isometric hip flexion strength in the supine position. Therefore, isometric core strength should be evaluated to distinguish the weakness between core region and hip flexors.

INTRODUCTION

Core strength is defined as an internal stabilization achieved by isometric contraction of lumbopelvic hip complex of the body [1]. This complex includes the abdominal structures, lumbopelvic region, hips, and proximal lower limbs [1]. The main function of this complex may create stabilization for the generation of motion and force in the distal joint [1,2]. Improved core strength may be helpful to manage lower back pain [3], improve body balance [4], and prevent musculoskeletal impairments [5,6]. Weakness and poor core strength may lead to injuries of the lower extremities and low back pain [5,7]. Therefore, core strength is important for rehabilitation of the lower extremities and athletic performance [8,9].

The iliopsoas, one of several hip flexor muscle group, contributes to lumbopelvic stabilization during active straight leg raising (ASLR). Thus, it is an important muscle group surrounding the hip joint [10]. The weakness of iliopsoas may result in uncontrolled movement in the lumbopelvic region [11] or anterior glide syndrome in the hip joint during ASLR [3]. Therefore, accurately assessing these compensatory mechanisms can be vital to interpreting and objectively evaluating hip flexor functions [12]. In previous study, the lumbopelvic compensation during ASLR was minimized by various methods including external compression belt in abdominal region [13] and pelvic rotatory control [14].

Among the hip muscle groups, isometric hip flexor strength has generally been assessed with subjects in the supine [15-17] and sitting positions [18]. Hip flexion in the supine position is a functional movement for assessing performance of the hip flexor muscles [15]. Sufficient isometric core strength in the supine position can contribute to improved hip flexor strength because the strength of distal extremity may need the proximal stability of the lumbopelvic region [3,11]. In addition, the lumbopelvic region can be stabilized either internally or externally [16]. An internal stabilization can be achieved by maintaining a body segment with isometric contraction of the adjacent muscles. An external stabilization can be achieved by manually maintaining a body segment with therapeutic straps, or the therapist's hands [16]. Non-elastic belts are also used to externally maintain the abdominal and lumbopelvic region while subjects performed hip flexion against resistance in the supine position [16]. Most of previous studies have been performed with various stabilizing methods in healthy subjects [10,16].

However, no studies of isometric hip flexor strength in the supine position have been performed in subjects with and without weak isometric core strength (WICS). This study investigated isometric hip flexor strength in the supine position in subjects with and without WICS in the presence or absence of an external support. We hypothesized that the isometric hip flexors strength with an external support in the supine position would be improved in subjects with WICS compared to subjects without WICS.

The findings of this study may provide insights regarding clinical techniques that can be used to test isometric hip flexor strength with considering WICS.

MATERIALS AND METHODS

1. Subjects

A total of 34 subjects were recruited for this study (16 subjects with WICS and 18 subjects without WICS). The general characteristics for the subjects were summarized in Table 1. G*Power (ver. 3.1.2; Franz Faul, University of Kiel, Kiel, Germany) was used to determine the sample size based on a pilot study of five participants. A pilot study was performed to investigate the independent variables such as hip flexor strength in the supine position. The sample size was calculated with a power (0.80), an alpha (0.05), and an effect size (0.94). The sample size for the study was required seventeen participants. Inclusion criteria were no limitations in hip flexion range of motion and no impairments of the hip joint or lumbopelvic region. Exclusion criteria were a history with surgery in the hip joint and lumbopelvic region with neuromuscular or musculoskeletal aspects within the previous 3 years as well as pain in any part of the body during tasks. The experimental protocols were explained to all subjects in detail, who provided written informed consent and ethical principles of the Declaration of Helsinki (No. 1041849-201603-BM-015-01).

Table 1. General characteristics of the subjects (N = 34)

Variable	With WICS (n = 16)	Without WICS (n = 18)	p-value
Age (y)	43.6 ± 17.1	44.2 ± 15.6	> 0.05
Height (cm)	173.2 ± 8.4	175.2 ± 9.3	> 0.05
Weight (kg)	70.4 ± 6.9	72.6 ± 7.8	> 0.05

Values are presented as mean ± standard deviation. WICS, weak isometric core strength.

2. Measurement of Isometric Hip Flexor Strength

The isometric maximal voluntary contraction strength of the hip flexor muscles was measured by using a tensiometer (Smart KEMA Pulling Sensor; Factorial Holdings, Seoul, Korea). The strap of the pulling sensor was positioned at 10% of the femur length from the patella. To minimize regional differences, the same region on the skin was marked with a straight line [19]. The strap length was adjusted to ensure that each hip angle reached 90° in the supine position. Then each task was repeated using the same procedure after 2 minutes of rest. All examiners were familiarized with pulling sensor before actual measurements began [19]. The tensiometer consisted of a force-detecting system with measurement forces of up to 100 kg, 0.1 kg accuracy, and 0.1 kg resolution. Before any measurements were made, all subjects warmed up with submaximal-speed jogging for 5 minutes to prevent discomfort or pain during exercises [20].

Each subject was familiarized with 90° hip flexion in the supine position both with and without an external support. The examiner supervised each subject during all exercises. This measurement was randomized within each test session.

All subjects assumed a supine position on the table. Subjects were asked to perform hip flexion without an external support; for the same task with an external support, a non-elastic belt was applied to subjects' abdominal and lumbopelvic regions to provide external stability in the lumbopelvic region [16,19]. During measurements, the knees of tested limbs performed 90° hip flexion, and the knees of non-tested limbs were straightened at rest on a table during isometric maximal voluntary contraction [19]. The duration of contractions was approximately 5 seconds. Measurements were made three times, with 2 minutes of rest time between trials to prevent fatigue. The maximal strength with the tensiometer (in kg) was recorded.

3. A Test for WICS

The double-bent leg-lowering test was used according to the recommendation of Comerford and Mottram [11,19], to classify subjects with and without WICS. A pressure biofeedback unit (PBU) was positioned on the lumbopelvic region. Subjects were asked to assumed a crook-lying position. The pressure of PBU was adjusted to 40 mmHg. The Subject was asked to maintain the PBU at 40 ± 10 mmHg, without holding their breath, while moving their legs. They were asked to maintain PBU at 40 mmHg with hip flexion at 90° for 5 seconds and with the heels held immediately above the table for 5 seconds [19]. Specifically, they were asked to dissociate movement through the range of bilateral hip flexion from 90° to 45° while maintaining PBU pressure. Individuals who could maintain the PBU pressure below ±10 mmHg were included in the group of subjects without WICS [19]. Subjects with WICS were defined as those who exhibited a pressure difference ±10 mmHg in the lumbopelvic region [11,19].

4. Procedures

The unilateral maximal isometric strength of the hip flexor muscles was quantified in the supine position with the preferred leg, both with and without an external support [21]. The isometric strength measurement for the preferred side was identified as the tested hip side in subjects with and without WICS.

5. Data Analysis

The one-sample Kolmogorov–Smirnov test was used to determine whether the measurement data had a normal distribution. The isometric strength of the hip flexors was compared with two-way mixed analysis of variance between the two groups (with vs. without WICS: a between factor) for hip flexion (with vs. without an external support: a within factor). Statistical significance was set at $\alpha = 0.05$. If a significant interaction was confirmed between an external support or groups, simple effects were determined with the Bonferroni correction ($\alpha = 0.05/4 = 0.0125$). To assess effect size of an external support according to each group, we calculate the Cohen d using mean ± standard deviation for the hip flexor strength with and without an external support. Cohen's d values > 0.8 reported a strong effect, > 0.4–≤ 0.8 indicated a moderate effect, and ≤ 0.4 was rated as weak effect [6-8]. SPSS for Windows (ver. 18.0; IBM Co., Armonk, NY, USA) was used for statistical analyses.

RESULTS

A significant interaction effect was observed between an external support (with vs. without an external support) and WICS (with vs. without WICS) ($F = 37.89$, $p = 0.0038$). Therefore, the Bonferroni correction was used to compare simple effects.

In subjects with WICS, isometric hip flexor strength in the

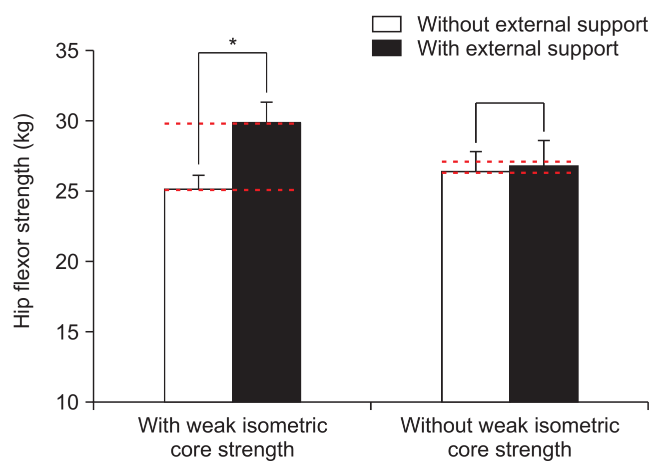

Figure 1. Comparison of the difference in hip flexor muscle strength between groups with and without weak isometric core strength and conditions with and without an external support. The error bar represents the difference of hip flexor strength according to external support. *$p_{adjust} < 0.01$.

Table 2. The hip flexor strength in the group with and without WICS

Variable	Without external support (kg)	With external support (kg)	Changing values of strength (kg)	t value	p-value	Effect size
With WICS	25.16 ± 6.13 (23.13–28.60)	29.89 ± 7.48 (26.38–32.78)	4.73 ± 1.35	–5.581	0.0064*	0.87
Without WICS	26.42 ± 7.05 (24.37–28.12)	26.92 ± 6.82 (23.10–28.64)	0.5 ± 0.23	–1.927	0.075	0.16

Values are presented as mean ± standard deviation (95% confidence interval). WICS, weak isometric core strength. *$p_{adjust} < 0.01$.

supine position was significantly greater with an external support than without it (Table 2, Figure 1). In subjects without WICS, no statistically significant differences were found in isometric hip flexor strength regardless of an external support (Table 2, Figure 1).

DISCUSSION

Isometric hip flexor strength can be helpful to treat chronic lower back pain and improve the performance of the hip joint [5,7,15,22]. However, in most clinical settings, it is not commonly considered with WICS. Moreover, a lack of consideration regarding WICS may result in inappropriate training of target muscles in subjects with WICS [3]. This study compared isometric hip flexor strength in the supine position in subjects with and without WICS.

Our study demonstrates that in subjects with WICS, isometric hip flexor strength was significantly greater with an external support than without it (18.80% difference in strength). In addition, in subjects without WICS, isometric hip flexor strength was not significantly different regardless of an external support (1.90% difference). Greater isometric strength of the hip flexors was observed in subjects with WICS in particular with an external support as the hypothesis of this study indicated. This finding implies that improved isometric core strength with an external support during hip flexion improves the strength of the hip flexors in the supine position.

There are two potential explanations for the contribution of WICS to differences in isometric hip flexor strength based on an external support. First, biomechanical elements may be at play. Proximal stability during lower extremity exercise can facilitate interactions of the iliopsoas and rectus femoris muscles with the spine and pelvis [23,24]. In this study, the abdominal and lumbopelvic regions were externally stabilized with nonelastic belts while subjects with and without WICS performed isometric hip flexion against resistance. Note that in subjects with WICS, this external support may have contributed to the improvement of WICS, resulting in sufficient proximal stability for isometric hip flexor strength. By contrast, no significant differences in isometric hip flexor strength were found regardless of an external support, because subjects without WICS may already have sufficient core strength against resistance. Therefore, the external support may have improved WICS by fixing the lumbopelvic region during the hip flexion task in this study.

Second, the relationship between length and tension may explain the finding regarding the contribution of WICS to differences in isometric hip flexor strength. The hip flexors are important muscles because they have various roles in the hip joint [10,15]. In the supine position, they counterbalance both the pelvis and femur head against resistance. However, in subjects with WICS, who exhibit insufficient isometric core strength, the compensated anterior tilting of the pelvis during hip flexion against resistance in the supine position led to a lengthening of the abdominal core stabilizing muscles. This may have led to difficulty co-contracting both synergistic abdominal and hip flexor muscles. The external support may minimize anterior tilting of the pelvis against resistance during hip flexion in the supine position, thus aiding in optimization of the length-tension relationship of abdominal core strength during hip flexion. This relationship can provide sufficient proximal stability of the lumbopelvic region for isometric hip flexor strength against resistance. Therefore, isometric core strength may influence on isometric hip flexor strength in the supine position, in particular in subjects with WICS.

In a previous study, the task was performed in the supine position to investigate the stabilizing effects of the iliopsoas during ASLR [12]. Jeon et al. showed that the iliopsoas thickness was greater in a group without uncontrolled lumbopelvic rotation than in a group with uncontrolled lumbopelvic rotation during ASLR [12]. The sufficient isometric core strength provided by various stabilizing muscles (e.g., transverse abdominal, internal oblique, and iliopsoas) may be related to improved isometric hip flexor strength in the supine position. Although the previous study could not be directly compared to our findings, this study showed similar results in that WICS affected hip flexor performance in the supine position. Therefore, in clinical setting, the sufficient core strength can be necessary to improve isometric hip flexion strength in the supine position in subjects with WICS. In addition, the assessment for isometric core strength can be recommended to distinguish the possible reasons between isometric muscle weakness in core and hip joint regions. The hip flexor training with isometric core strengthening may be recommended as an effective method for activating the hip flexor muscles [12].

This study has several limitations. First, surface EMG was not used for muscle activation during hip flexion because the nonelastic bands used for an external support in this study concealed the attachment site and caused the cross-talk. Therefore, further studies are needed to investigate by surface EMG contractions of lumbopelvic muscles during hip flexion in the supine position. Second, because healthy subjects participated in current study, the findings cannot be generalized to different age groups or patients with lower back pain. Further studies are needed to compare isometric hip flexor strength between elder generation and patients with lower back pain. Third, not all hip flexor muscles (e.g., tensor fascia lata and rectus femoris) were fully investigated. Finally, the hip flexor strength measurement was not selective method of the iliopsoas.

CONCLUSIONS

In subjects with WICS, isometric hip flexor strength was better with an external support than without it. Isometric core strength externally stabilized with non-elastic belts may contribute to improved isometric hip flexor strength in the supine position in particular in subjects with WICS. Therefore, the evaluation of WICS can be necessary to distinguish the weakness between core region and hip flexors.

ACKNOWLEDGEMENTS

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIT) (No. 2017R1C1B5076172).

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

REFERENCES

1. **Rivera CE.** Core and lumbopelvic stabilization in runners. Phys Med Rehabil Clin N Am 2016;27(1):319-37.
2. **Akuthota V, Nadler SF.** Core strengthening. Arch Phys Med Rehabil 2004;85(3 Suppl 1):S86-92.
3. **Sahrmann SA.** Diagnosis and treatment of movement impairment syndromes. St. Louis: Mosby; 2002;234-9.
4. **Ekstrom RA, Donatelli RA, Carp KC.** Electromyographic analysis of core trunk, hip, and thigh muscles during 9 rehabilitation exercises. J Orthop Sports Phys Ther 2007;37(12):754-62.
5. **Leetun DT, Ireland ML, Willson JD, Ballantyne BT, Davis IM.** Core stability measures as risk factors for lower extremity injury in athletes. Med Sci Sports Exerc 2004;36(6):926-34.
6. **Tyler TF, Nicholas SJ, Campbell RJ, Donellan S, McHugh MP.** The effectiveness of a preseason exercise program to prevent adductor muscle strains in professional ice hockey players. Am J Sports Med 2002;30(5):680-3.
7. **Leinonen V, Kankaanpää M, Airaksinen O, Hänninen O.** Back and hip extensor activities during trunk flexion/extension: effects of low back pain and rehabilitation. Arch Phys Med Rehabil 2000;81(1):32-7.
8. **Sever O, Zorba E.** Comparison of effect of static and dynamic core exercises on speed and agility performance in soccer players. Isokinet Exerc Sci 2018;26(1):29-36.
9. **Yoon TL, Kim KS, Cynn HS.** Comparison of the knee valgus angle, leg muscle activity, and vastus medialis oblique/vastus lateralis ratio during a single leg squat on flat and declined surfaces in individuals with patellofemoral pain syndrome. Isokinet Exerc Sci 2016;24(4):341-7.
10. **Hu H, Meijer OG, van Dieën JH, Hodges PW, Bruijn SM, Strijers RL, et al.** Is the psoas a hip flexor in the active straight leg raise? Eur Spine J 2011;20(5):759-65.
11. **Comerford M, Mottram S.** Kinetic control: the management of uncontrolled movement. Chatswood: Churchill Livingstone; 2012.
12. **Jeon IC, Kwon OY, Weon JH, Choung SD, Hwang UJ.** Comparison of psoas major muscle thickness measured by sonography during active straight leg raising in subjects with and without uncontrolled lumbopelvic rotation. Man Ther 2016;21:165-9.
13. **Mens JM, Damen L, Snijders CJ, Stam HJ.** The mechanical effect of a pelvic belt in patients with pregnancy-related pelvic pain. Clin Biomech (Bristol, Avon) 2006;21(2):122-7.
14. **Lee D.** The pelvic girdle: an approach to the examination and treatment of the lumbopelvic-hip region. 3rd ed. Edinburgh: Churchill Livingstone; 2004;198-209.
15. **de Groot M, Pool-Goudzwaard AL, Spoor CW, Snijders CJ.** The active straight leg raising test (ASLR) in pregnant women: differences in muscle activity and force between patients and healthy subjects. Man Ther 2008;13(1):68-74.
16. **Park KH, Ha SM, Kim SJ, Park KN, Kwon OY, Oh JS.** Effects of the pelvic rotatory control method on abdominal muscle activity and the pelvic rotation during active straight leg raising.

Man Ther 2013;18(3):220-4.

17. **Kisner C, Colby LA, Borstad J.** Therapeutic exercise: foundations and techniques. 7th ed. Philadelphia: F.A. Davis Company; 2018;284-98.
18. **Kendall FP, McCreary EK, Provance PG, Rodgers MM, Romani WA.** Muscles testing and function. 5th ed. Baltimore: Williams & Wilkins; 2005;312-29.
19. **Jeon IC.** Influence of the condition with and without external support on the strength of hip flexor in supine in subjects without core stabilization. J Korean Phys Ther 2020;32(6): 335-40.
20. **Jeon IC.** Comparison of test-retest measurement reliability of iliopsoas strength between break and make test in subjects with lumbar extension syndrome. J Musculoskelet Sci Technol 2019;3(2):54-8.
21. **Lee W.** Effects of the abdominal hollowing and abdominal bracing maneuvers on the pelvic rotation angle during leg movement. J Musculoskelet Sci Technol 2020;4(2):70-5.
22. **Workman JC, Docherty D, Parfrey KC, Behm DG.** Influence of pelvis position on the activation of abdominal and hip flexor muscles. J Strength Cond Res 2008;22(5):1563-9.
23. **Huxel Bliven KC, Anderson BE.** Core stability training for injury prevention. Sports Health 2013;5(6):514-22.
24. **Kibler WB, Press J, Sciascia A.** The role of core stability in athletic function. Sports Med 2006;36(3):189-98.