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Original Article

Measuring hip flexor and extensor strengths across various postures using a fixed belt

Takashi Yoshizawa, RPT, PhD[1)*], Kentarou Higashi, RPT, MS[1)], Tomohiko Katou[1)]

[1)] *Department of Physical Therapy, Yachiyo Rehabilitation College: 11-1-30 Yachiyodaikita, Yachiyo City, Chiba 276-0031, Japan*

Abstract. [Purpose] The purpose of this study was to evaluate hip flexor and extensor strength due to differences in posture measurement. [Subjects and Methods] Healthy adults (26 males and 24 females) were enrolled. Using a hand-held dynamometer, hip flexor and extensor strengths were measured in various postures and in a basic posture (sitting posture and hip/knee joint flexed 90°) according to the Manual Muscle Testing procedure. While calculating intraclass correlation coefficients by measurement, hip flexor and extensor strengths were compared in males and females for every posture. [Results] Intraclass correlation coefficients were greater than 0.7 in every measurement. There was no significant difference in hip flexor and extensor strengths in both males and females. Furthermore, there was a significant difference in right and left hip flexor strengths and in left hip extensor strength. [Conclusion] Hip flexor and extensor strengths can be simply and easily measured using a hand-held dynamometer.

Key words: Hip flexor and extensor strength, Basic posture, MMT posture

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INTRODUCTION

In physiotherapy, there are many cases in which measuring muscular strength is necessary. Generally, as a method to measure a patient's muscular strength, the Manual Muscle Testing (MMT) method is used[1)]. MMT is suitable for understanding approximate muscular strength, but the evaluation becomes subjective. Therefore, in recent years, instruments for muscular strength measurements have been increasingly used[1)]. Among muscular measuring instruments, the hand-held dynamometer (HHD), which has superior portability and can simply measure muscular strength[2)], has been used increasingly[1)]. Despite these advantages, when fixation of the measured area is not sufficient or extensive muscular strength is to be measured, it is possible that the HHD is unreliable[3)]. Therefore, it has been reported that, while measuring muscular strength by HHD, usage of a fixed belt is recommended. In doing so, the reliability also increases[4)]. Furthermore, as a position, MMT measures joint function by moving muscles to a final range of motion[5)]. Conversely, in measuring leg muscles, the HHD often measures on a condition that the joint is not moved from a sitting posture[4)]. Specifically, in the case of hip flexor strengths, we measure flexion at the hip joint when the hip/knee joint are flexed at 90° and in a sitting posture. These dual measurements can be used to increase the reliability of measurement.

In kinesiology treatment for patients who have a difficulty in standing or walking, the quadriceps muscle, which works to extend the leg at the knee, is often assessed using the Open Kinetic Chain[6)]. In motion behavior in the Close Kinetic Chain, such as standing motion, leg extension torque as a whole leg, wherein hip/knee/leg joint activity are compounded, is required[7)]. Therefore, it is thought to be useful to measure not only knee extension strengths, but also hip flexor and extensor strengths. In research concerning hip flexor and extensor strengths, Kato et al.[8)] have reported that they were measured with and without a belt, using HHD. Furthermore, the use of a belt resulted in highly reproducible results. However, while the use of the belt improves data reliability, it inconveniences the clinician that makes use of the HHD. For this reason, the use of

*Corresponding author. Takashi Yoshizawa (E-mail: t.yoshizawa@yachiyo-reha.jp)

HHD requires muscular strength measurement that does not require fixation with a belt. Hip flexor strengths measurement using HHD is generally conducted in a sitting posture and with a hip/knee joint flexed at 90°[8]. Furthermore, hip extensor strengths measurement is often conducted either in the prone position with the hip/knee joint extended to 0°, or in the dorsal position with the hip joint flexed to 30°[8, 9]. In this study, to retain convenience of measuring with HHD, we measured hip flexor and extensor strengths in the sitting posture and hip joint flexed 90° (basic posture). In measuring MMT, we measured hip flexor strength in the sitting posture with maximal hip joint flexion, and hip extensor strength in the prone position with maximal hip joint extension (MMT posture).

Concerning hip flexor and extensor strengths, there are no previous studies that compare measurement results in the basic and MMT posture. Therefore, in this study, we studied the relationship between both male and female patients.

SUBJECTS AND METHODS

We enrolled 50 healthy adults who had no problem in the lower extremity (26 males/average age 24.6 ± 5.6 years old, 24 females/average age 23.4 ± 6.9 years old). Prior to participating, we explained the research purpose, measurement method, our system for managing results, and the results of the study. We further ensured patients that we would not disclose identifying information and that we would discard data after the conclusion of our research. Then, subjects provided written consent and were included in this study. Furthermore, this study was conducted after obtaining approval from Ethic Committee of Yachiyo Rehabilitation College (Approval No.Y16014).

Any muscular strength measurements employed the HHD (μTas: Anima Corporation). Muscular strength-to-body weight ratio (N/ kg) was calculated based on measurement results. Hip flexor and extensor strength measurement in the basic posture was conducted in the sitting posture with the hip/knee joint flexed to 90°. In the sitting posture, hands were put in the position of both armpits to stabilize the trunk. In the basic posture state, while applying the HHD sensor on the front and back side of most distal part of thigh, we measured strength by continuing maximal voluntary contraction for approximately seconds. Hip flexor strength measurement in the MMT posture was conducted in the sitting posture with maximal hip joint flexion and the knee joint in a natural dropping position. Hip extensor strength was measured in the prone position with maximal hip joint extension and the knee joint flexed to 90°.We stabilized the trunk in the sitting posture, at the location of the HHD's sensor for the duration of voluntary contraction, which was the same as in the basic posture.

Measurement in the basic posture and the MMT posture were respectively performed three times and the average value was calculated. Then, the subject rested for 5 minutes between each measurement. We began the measurement in either the basic posture or MMT posture based upon random assignment. The latter measurement was conducted in two days within seven days from the earlier measurement. We calculated the intraclass correlation coefficients (ICC) for each measurement. Next, hip flexor and extensor strengths between male and female were investigated using independent t-test. Hip flexor and extensor strengths in basic posture and MMT posture were respectively investigated in male and female subjects using a paired t-test. SPSS Statistics V22.0 was used for statistical analyses, with $p<0.05$ being assumed as significant.

RESULTS

Hip flexor and extensor strengths in male and female subjects in either the basic or MMT posture are shown in Tables 1 and 2. The ICC (1.3) for each measurement is shown Tables 1 and 2. Hip flexor and extensor strengths between male and female subjects exhibited no difference between postures. For both male and female subjects, there was a significant difference in right and left hip flexor strength and left hip extensor strength in basic and MMT postures (Tables 1 and 2).

Table 1. Mean, standard deviation and ICC of hip flexor and extensor strength in the males

		Basic posture		MMT posture			Significant difference of basic posture and MMT posture
		mean ± standard deviation	ICC		mean ± standard deviation	ICC	
Hip flexor (N/kg)	(Right)	4.1 ± 0.6	0.83	(Right)	2.8 ± 0.5	0.86	**
	(Left)	3.8 ± 0.6	0.87	(Left)	2.8 ± 0.4	0.86	**
Hip extensor (N/kg)	(Right)	3.5 ± 1.2	0.94	(Right)	3.1 ± 0.5	0.83	
	(Left)	3.7 ± 1.2	0.96	(Left)	3.0 ± 0.4	0.79	*

*p<0.05, **p<0.01

DISCUSSION

In this study, we investigated the relationship between hip flexor and extensor strengths due to posture difference between male and female subjects. ICC (1.3) in each measurement of this research was 0.79–0.94. Since it becomes supportive evidence for demonstration, reliability is important for data measurement[10]. Furthermore, since ICC is used as one of the indices of reliability[11], a ICC value of 0.7 or more was used to assume reliability[12]. Therefore, we think that hip flexor and extensor strength measurements in both the basic posture and MMT posture that were conducted in this research are reliable. As stated, there is concern with measuring hip extensor strength in the MMT posture since the prone position is usually required. For example, in the event of a pelvic fracture, grave arrhythmia, or low blood pressure condition, a prone position is contraindicated[13]. In cases of such as these, basic posture is useful. We think that the physical burden or risk is less if measuring hip flexor strength in the sitting posture. Furthermore, clinically evaluating muscular strength at the bedside is important. In providing feedback concerning treatment progress or determining the curative effect for patients, it is important that data measurement is as reliable as possible. As a result of this study, not only in the MMT posture but also in the basic posture, it is believed that there is no interference in hip flexor and extensor strength measurements using HHD without a fixed belt. Furthermore, the basic posture is easy for physical therapist to understand and give instructions concerning measurements in patients. Therefore, we think it is simple and easy to measure hip flexor and extensor strengths.

There was no specific difference between male and female subject's hip flexor and extensor strength in any posture. Naturally, absolute muscular strength difference between male and female subjects is large[14], but when considering relative muscular strength to weight ratio, there is hardly any difference between male and female subjects[15]. Furthermore, in this study, there was almost no difference in hip flexor and extensor strengths between male and female subjects, which supports results from Holloway et al[15].

Furthermore, when studying hip flexor and extensor strengths per posture, there were specific differences in right and left hip flexor strengths and left hip extensor strength for both male and female subjects. Specifically, muscular strength in the basic posture was greater than in MMT posture. Regarding differences between the basic posture and MMT posture, body position and posture (hip/knee joint angle) are discussed. We think that the difference in body position and hip/knee joint angle results in the difference in muscular length around the hip joint and affects the muscular strength, which was generated from the relationship between length and tension[16]. Jiroumaru et al.[17] have stated that generated extension torque at 0° of hip joint flexion is greater than at 60° of flexion. This was believed to be due to muscles around the hip joint, including the iliopsoas muscle, having been stretched. Furthermore, Iraha et al.[18] considered the effect on hip joint extensor strength, which is provided by the hip joint position. Furthermore, muscular strengths were clearly found in the difference in hip joint intermediate position and in extended position. In other words, they have stated that when hip joint position is in extended position, it resulted that muscular strength generated with most difficulty. This was believed to be due to the gluteus maximus muscle, when in the intermediate position, was stretched greater than the hip joint in the extended position and muscular strength generated more easily with concentric contractions. In this study, we observed the same results. Concerning right hip extension strength, there was no difference in posture. When compared to MMT posture, the rate of muscular strength increases when in the basic posture was approximately 10–20% lower than the measurement of the left one. We believe this is due to the difference in right and left muscle flexibility. Endo et al.[19] compared the flexibility of the right and left muscles around hip joints. In doing so, researchers found that the flexibility of the left hip joint might be lower. Furthermore, Kawamoto et al.[20] have indicated that there is a difference in muscles around the right and left hip joints in healthy adults. Due to a combination of various factors, we believe that there was no difference in muscular strengths. This can be studied in future investigations.

Since all subjects were healthy adults, our study is limited to its application to adults with various conditions. In the future, we would like to study elderly or postoperative patients using a similar research design.

Table 2. Mean, standard deviation and ICC of hip flexor and extensor strength in the females

		Basic posture			MMT posture		Significant difference of basic posture and MMT posture
		mean ± standard deviation	ICC		mean ± standard deviation	ICC	
Hip flexor (n/kg)	(Right)	3.8 ± 0.8	0.88	(Right)	2.4 ± 0.6	0.94	**
	(Left)	3.4 ± 0.8	0.86	(Left)	2.2 ± 0.6	0.92	**
Hip extensor (n/kg)	(Right)	3.4 ± 1.0	0.91	(Right)	3.2 ± 0.6	0.85	
	(Left)	3.6 ± 1.2	0.93	(Left)	2.8 ± 0.8	0.85	**

**$p<0.01$

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