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Comparison of Balance and Muscle Strength between Dominant and Non-dominant Legs in Adults

The purpose of this paper was to investigate the comparison of balance and muscle strength between dominant and non-dominant legs in adults. Thirty adults in their 20s participated in this study. The dominant and non-dominant legs were selected based on the dominant hands of the target. The subject's muscle strength of legs was measured with Nicholas MMT, and the balance was measured with BIO-Rescue. We compared the dominant and non-dominant legs based on the results. The result, indicated no statistical difference on balance and muscle strength between dominant and non-dominant legs(p>.05). The results of this study will be helpful in setting the effective treatment direction and treatment level, and in controlling posture, balance and motor function.

Key words: *Dominant leg, Non-Dominant Leg; Muscle strength; Balance*

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INTRODUCTION

In organs that exist on both sides of the human body, one side usually shows dominance, and this phenomenon is apparent in the hands, feet, and eyes [1]. For most adults, muscle activity is dominant on either the left or right side, and the opposite side has a much lower muscle tone.

Almost everyone has a dominant hand, even those who use both hands equally, but dominant and non-dominant hands are usually divided by tasks, depending on which side is more actively used [2, 3].

In sports that require mainly lower extremity movement, such as running, cycling, and soccer, balanced movement of the left and right legs is very important. In a study examining individuals playing soccer, both the kinematic and epidemiological factors were significantly different when using the dominant leg than when using the non-dominant leg [4, 5, 6]. In other words, even in sports that use each side equally, a performance difference exists between the dominant leg and non-dominant leg [7].

Balance requires the interaction of senses, including proprioceptive sensation, visual input, involvement of the vestibular system, and so on. The vestibular system changes the tone of the extensors and antigravity muscles, and the visual system keeps the head in an appropriate position for movement and environmental changes [8]. If even one of these factors is defective, balance becomes difficult to maintain, risk of falling increases, and functional activity becomes limited [9]. Additionally, damage to the balance regulation system causes stability impairment, abnormal posture control, and reaction time delay, and pain can interfere with balance by distorting normal signals from the muscle and sensory systems [10]. Balance control problems can lead to asymmetrical or abnormal postures and detrimental changes in soft tissue [11]. Muscle strength is the maximum force muscles can generate through voluntary effort [12] and is influenced by many factors, such as gender, age, measurement position, and contraction type [13]. Minimal muscle strength is an essential element in the consideration of activities of daily living because having strong muscles makes

movements more stable [14].

Previous studies have presented conflicting results about dominant and non-dominant muscle strength, and many of these studies were limited to examining functional aspects of the arms and legs rather than physical functions. To address this discrepancy, the current study aimed to investigate the differences in strength and balance abilities in the dominant and non-dominant legs in adults.

SUBJECTS AND METHODS

Subjects and Study period

This study was conducted on 30 adults in their 20s who do not have orthopedic, neurosurgical, and balance disorders. This experiment was conducted from August 1, 2018 to August 30, 2018. The included subjects understood the study's purpose and process and agreed to participate. The selection criteria for the study subjects are as follows [15]. Subjects who had vestibular problems, reported dizziness, or had difficulty with standing balance due to pain or injury were excluded from the experiment. The general characteristics of the subjects are shown in Table 1. The subjects were consisted of 7 male subjects and 23 female subjects.

Table 1. General characteristic of the subjects (M±SD)

General characteristic	M±SD
Age (yrs)	22.90±0.29
Height (cm)	164.06±1.33
Weight (kg)	58.60±1.99
Sex (F/M)	7/23

M±SD: mean ± standard deviation

Measuring equipment

Nicholas Manual Muscle Test

Nicholas MMT(Lafayette Instrument, USA) was used to compare the strengths of the dominant legs and non-dominant legs of the subject(Fig. 1). The measuring method is to place the measuring instrument in the muscle to be measured, and when the resistance is given, the muscle power is represented by a number.

Fig. 1. Nicholas manual muscle test

Bio-Rescue

BIO-Rescue(Rmingenierie, Rodez, France), a balance ability measurement and training program, was used to compare the balance capability of the dominant and non-dominant leg(Fig. 2). The subject's foot was placed on the BIO-rescue's line and the frontal point was parted in the wall. The pressure of foot in weight bearing side is evaluated through the BIO-Rescue.

Fig. 2. BIO-Resucue

Measuring method

Muscle strength measurement

To compare the strengths of the dominant and non-dominant legs, the strength of both knee flexion and knee extension was measured. The dominant and non-dominant criteria are based on the hand being used. The subject was placed on the bed and the measuring instrument was placed in front of the tibia while subject was instructed to extend knee to measure the quadriceps muscle. At this time, resistance was given for 3 seconds in the opposite direction of the

knee extension to measure muscle strength(Fig. 3). To measure the hamstring muscle, the knee was flexed after placing the instrument on the back of calf. Resistance was given in the opposite direction to bending to measure muscle strength.

Fig. 3. Muscle strength measurement for quadriceps muscle

Balance ability measure

The subjects were randomly placed in the dominant and non-dominant legs, allowing the second toes to line up on the indicated guide line of the BIO-rescue(Fig. 4). The posture sway of the subject can be analyzed by measuring the area, the length, the speed of COP by Bio-rescue. The balance was measured by looking at the front, eye opening and holding the other leg for 15 seconds [16].

Fig. 4. Static and Dynamic one leg standing balance

Analysis

All data were subjected to a normality test, statistical analysis was performed using SPSS 18.0 for Window. Statistical significance was $\alpha=.05$. Independent t-test was performed to see the change of muscle strength and balance ability in dominant leg and non-dominant leg.

RESULTS

Comparison of muscle strength between dominant and non-dominant legs

For comparing the strength between dominant leg and non-dominant leg, the muscle strength of the flexion and extension was measured. There was no significant difference in flexion and extension ($p<.05$)(Table 2).

Table 2. Comparison of muscle strength between dominant and non-dominant legs (M±SD) (unit : N)

	Dominant leg	Non-dominant leg	p
Knee flexion	15.53±3.91	14.77±3.37	0.42
Knee extension	20.18±6.90	18.93±6.70	0.48

* $p<.05$

Comparison of static balance ability between dominant leg and non-dominant leg.

For comparing the static balance ability between dominant leg and non-dominant leg, the area of COP and length of COP, Speed of COP was measured. Although there was no significant difference in all results ($p<.05$), the non-dominant side showed higher value than the dominant side in all balance ability (Table 3).

Table 3. Comparison of static balance between dominant and non-dominant legs (M±SD)

Time of occurrence	Dominant leg	Non-dominant leg	p
Area of COP (unit : mm2)	403.73±296.99	491.07±362.66	0.31
Length of COP (unit : cm)	29.68±8.93	32.92±14.41	0.30
Speed of COP (unit : cm/s)	1.84±0.53	2.02±0.82	0.32

*p<.05
Area of COP : area of center of pressure
Length of COP : length of center of pressure
Speed of COP : speed of center of pressure
M±SD : mean±standard deviation

DISCUSSION

The purpose of this study was to investigate the differences in strength and balance ability of dominant and non-dominant legs in adults.

Cetin [17] reported that there were no significant differences in the use of muscle strength between the dominant and non-dominant legs in cross-country skiers. Ryu et al. [18] found a significant difference in grip power between the non-dominant and dominant hand, but they did not find a difference in grip strength according to growth. In this study, when comparing the strength of knee flexion and extension in adults, the dominant leg was stronger than the non-dominant leg, but this result was not significant. These results are consistent with the results of previous studies and are thought to be caused by having balanced development in the two legs.

The balance test can be divided into two parts: static balance and dynamic balance. Static balance is the ability to stand without posture sway by maintaining the center of mass within the base of support. Dynamic balance refers to the ability to balance when there is movement in the support surface or shaking from an outside source [19]. A previous study found a significantly higher balance index when individuals were standing on the dominant leg; in other words, balance ability increased when people were supported by the dominant foot. In this study, we used static balance evaluation to measure the surface area, distance of pressure center movement, and average velocity of pressure center movement [20]. We compared the balance ability between dominant leg and non-dominant leg, and we found that the balance index of the non-dominant leg was higher than that of the dominant leg. The reason for the difference between the previous study results and the current results is that this study provided balance assistance through visual feedback. Additionally, our study used measurements from stable surface, whereas previous studies used measurements from unstable support surfaces. These results also suggest that the dominant leg has more influence on posture control while on unstable support surfaces than while on stable support surfaces. However, further studies are needed to better understand the relationship between the dominant leg and the non-dominant leg while on various supporting surfaces.

Regarding muscle strength, we found no significant difference in knee flexion and extension strength between the dominant leg and non-dominant leg. However, the dominant leg showed greater overall leg strength than the non-dominant leg. Regarding balance ability, stability was slightly better when participants were supported by their dominant leg. This finding may have occurred because the dominant leg was stronger and had better motor control ability than the non-dominant leg. We conclude that there is no significant difference in balance and strength between the dominant and non-dominant leg.

CONCLUSION

In this study, we compared the balance and strength of dominant and non-dominant legs in 30 adults(23 female, 7 male). The results showed that both knee flexion and extension muscle strength were higher for the non-dominant side when compared with the dominant side, but this difference was not statistically significant. Regarding balance, the non-dominant side showed increased balance ability when compared with the dominant side, but this difference was not significant. Thus, we conclude that, in adults, both legs can be used as dominant or non-dominant legs for balance and strength training, but the dominant leg is considered to be advantageous in tasks requiring high exercise control ability.

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