

EFFECTS OF LEG DOMINANCE ON THE SINGLE LEG HOP FUNCTIONAL TEST IN NON-INJURED ADULTS

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The purpose of this study was to determine the effects of leg dominance on the single leg hop (SLH) functional test used in ACL rehabilitation. Twenty-two subjects performed four manipulative, and two standing balance tests to determine leg dominance; and three trials of a standing broad jump and the single leg hop test on both lower limbs. Ground reaction forces were measured using two force platforms (AMTI) and the distance jumped were recorded. *T*-tests for dependent measure (SPSS) were used to determine difference between dominant and non-dominant limb. Subjects were able to significantly jump farther, produce more vertical and horizontal ground reaction forces when using the dominant leg, except when they jumped from both legs. Clinicians should take in consideration the effects of leg dominance on the single leg hop test results.

KEY WORDS: jumping, forces, ACL, rehabilitation.

INTRODUCTION: The concept of leg dominance is important in clinical settings. Hop testing is frequently used in clinics as a performance outcome that reflects neuromuscular control, strength, and limb stability, in addition, it is easy to administer and requires minimal equipment (Reid, Birmingham, Stratford, & Alcock, 2007). Most clinical studies compare the non-surgery leg to the surgery leg without taking in consideration limb dominance. Determining leg dominance is not as simple and create an inconvenience of when analyzing differences between limbs and it is often determined in different ways: by right- and left-hand preference (Barber, Noyes, Mangine, McCloskey, & Hartman, 1990), which leg the subjects prefer to kick a ball with (Greenberger & Paterno, 1995), by jump preference (Nyland, Shapiro, Stine, Horn, & Ireland, 1994), or by stance preference when kicking a ball (Nyland Shapiro, Caborn, Nitz, Malone, 1997). Several studies (Gentry & Gabbard, 1995; Spry, Zebas, & Visser, 1993; Whittington and Richards, 1987) support the notion that humans are generally right-footed for mobilization tasks but left-footed for tasks requiring postural stabilization. Velotta, Weyer, Ramirez, Winstead, & Bahamonde (2011) tested leg preference of subjects on different types of tasks. When the task was manipulative in nature such as kicking a ball, most subjects used the right leg (most people are right-side preference) but when the task involved stabilization such as standing on one leg, more than 50% of the subjects used the left leg to perform the task. Spry et al., 1993 also found similar results with respect to the tasks and found no relationship between lower extremity dominance and isokinetic measures at knee and hip. More recently, studies have found significant leg difference between dominant and non-dominant leg strength measured by the hamstring-quadriceps (H:Q) ratio and recommended the adjustment of clinical tests based on leg dominance (Lanshammar & Ribom, 2011; Kong & Burns, 2010).

Clinicians often use isokinetic strength exercises and single leg hop test in lower extremity rehabilitation; these test scores are used as criterion to determine the progression and the suitability of the patient to return to sport participation (Reid, et.al., 2007; Petschnig, Baron, Albrecht, 1998; DeCarlo & Sell, 1997). It has been suggested (Shelbourne, Klootwyk, & DeCarlo, 1995), that once the anterior cruciate ligament (ACL) reconstructed extremity achieves 70% of the strength of the non-injured leg, the patient may be allowed to engage in sport-specific activities. Such criterion might be a valid standard assuming no strength or motor control differences exist between limbs prior to injury which might be dependent on leg dominance. The purpose of this research is to measure the effects of leg dominance on the scores of the kinetics during landing in a SLH. Our hypothesis was that leg dominance will affect the distance jump and force generation during the SLH.

METHODS: Twenty two healthy college-aged (21.5 ± 1.9 y; 172.7 ± 10.6 cm; 78.1 ± 13.1 kg) subjects (nine males and 13 females) with no lower extremity surgery or injury were recruited and provided informed consent to participate in the study. Each subject was asked to perform commonly used test to determine leg dominance (Velotta et al, 2011). In the manipulative tests, the subjects were asked to kick a ball, step on a bug, write a word with the foot, and take a step forward. For the two balance tests, the subjects were asked to stand on one leg and to stand still on two legs on AMTI force platforms for period of 100 seconds. Each subjects performed three jump trials from the force plates with each foot wholly placed on a separate force plate under the following conditions: double-limb jump and single-limb jump with the dominant and non-dominant lower limb. The ground reaction forces generated during takeoff were measured at 1000 Hz using two multi component force plates (AMTI) and jump distances were recorded. *T*-tests ($p \leq 0.05$) for dependent groups were used to determine the differences between-limb (dominant and non-dominant leg) on the following variables: distance jumped, peak vertical and horizontal ground reaction forces generated during the SLH and double-limb jump.

RESULTS: During the SLH, statistically significant between-limb differences in the distance jumped were observed, with dominant leg jumping further than the non-dominant leg (Table 1). There were also significant differences in the vertical and horizontal GRF generated during the SLH. Nevertheless, when the subjects jumped with both legs, there were no statistically significant differences between-limbs in the vertical GRF but, there were significant differences in the horizontal GRF, with dominant leg generating a greater force.

Table 1: Dependent variables mean and standard deviations.

Variable	Dominant Leg	Non-Dominant Leg	Sig
SLH Distance (cm)	163.2 \pm 33.9	153.8 \pm 32.1	**
SLH Vertical GRF (%BW)	1.87 \pm 0.22	1.70 \pm 0.19	**
SLH Horizontal Forward GRF (%BW)	0.54 \pm 0.10	0.42 \pm 0.12	**
SLJ Vertical GRF (%BW)	1.12 \pm 0.17	1.13 \pm 0.13	
SLJ Horizontal Forward GRF (%BW)	0.39 \pm 0.09	0.35 \pm 0.09	*

Significant * $p < .05$, ** $p < .01$.

DISCUSSION: The SLH is a common test used in clinical settings and its score use to compare the injured with the non-injured leg without taking in consideration leg dominance. Our results showed the leg dominance has a significant influence on the distance jumped and on the forces the subjects are able to generate (Table 1). A criterion score of 70% of the distance jumped of the non-injured leg is often used to determine if a patient can return to normal competition. For example, if a patient injured leg is the dominant leg, the non-injured leg is often used as a standard for comparison. Our study showed that in the population tested there is 10% difference in the distance jumped, an 11% difference in the vertical GRF and 29% difference in the horizontal GRF generated by the subjects. Our results seem to indicate that the main reason for the differences in the distance jumped is the inability of the subjects to generate sufficient horizontal GRF to propel them forward. Although several studies (Gentry & Gabbard, 1995; Spry et al., 1993; Whittington & Richards, 1987) support the notion that humans are generally right-footed for mobilization tasks but left-footed for tasks requiring postural stabilization, the SLH require both conditions.

A 70% score on a dominant leg translates into 60% of the non-dominant leg score, which could lead to a patient returning to competition without the strength needed and risk re-injuring the leg. Chow & Tillman, (2005) found even larger leg discrepancies between the dominant and non-dominant leg of soccer players, which could lead larger differences in the SLH scores for competitive athletes. More recently the notion of leg strength discrepancies associate with limb dominance, as measure with H:Q ratio have been supported by the studies of Lanshammar & Ribom (2011) and Kong & Burns (2010). An assumption is made that the uninvolved leg is normal. This might not be true in an individual who has recently undergone a knee surgery due to muscle inhibition of both legs after acute ACL injury (Chmielewski, Stackhouse, & Snyder-Mackler, 2004).

CONCLUSION: The concept of leg dominance is important in clinical settings and it is often ignored. Clinicians use isokinetic strength exercises and SLH tests in lower extremity rehabilitation; these test scores are used as criterion to determine the progression and the suitability of the patient to return to sport participation. Such criterion might be a valid standard assuming no strength differences exist between limbs prior to injury which might be dependent on leg dominance. Our study show significant difference in the tests scores when subjects performed the SLH with the dominant leg. It is recommended that when the injured leg is the dominant leg that the score of the non-dominant leg be adjusted to account for possible difference in strength and performance.

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