

ASSESSMENT OF FUNCTIONAL PERFORMANCE OF LOWER EXTREMITY AND EFFECT OF LEG DOMINANCE ON THE SAME IN YOUNG ASYMPTOMATIC INDIVIDUALS

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ABSTRACT

Background: Functional Performance is one's ability to participate and move through different planes of movement in safe and timely manner without functional limitations. Square hop test, type of Functional Performance test aims to measure neuromuscular coordination by placing combined frontal and rotational stress on the lower extremity. Sedentary population may develop significant bilateral asymmetry in lower limbs due to constant overload on the jumping leg depending upon different kind of daily activities. Clinicians often use functional performance test (FPT) in lower extremity rehabilitation without taking limb dominance into consideration.

Objectives: To determine time taken to complete square hop test in young asymptomatic individuals and to observe the effect of dominance on square hop test.

Method: Study Design- Observational, Cross sectional study 60 healthy, asymptomatic individuals between 18-25 years were selected using systematic sampling. Time taken to complete the square hop test was noted, first with dominant leg followed by non-dominant leg with a rest pause of 4 minutes. Two trials of each leg were noted and mean time taken by both dominant and non-dominant leg was used for statistical analysis.

Results: There was significant statistical difference in time taken for performing Square hop test between dominant and non-dominant legs (5.11 ± 14.06) using Unpaired t test ($p < 0.05$). Again moderate (0.31) clinical difference in time taken to complete the test using Cohen et al Phenomenon of effect size.

Conclusion: we found that the subjects performed the test for more time on the dominant leg as compared to the non-dominant leg and observed that leg dominance had an effect on performance of square hop test.

KEY WORDS: Functional Performance Test, Square hop test, Leg Dominance, Effect Size.

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INTRODUCTION

Functional performance is a part of everyday life, whether for the professional athletes, the industrial worker, the homemaker, or anyone else. It is one's ability to participate at the desired

level in sport, an occupation, or recreation or to return to participation in safe and timely manner without functional limitations and also one's ability to move through different planes of movement. Successful performance often

requires multiple skill and this multiple skills are required to be assessed and quantified so the clinicians may use tests to assess functional performance of an individual. These tests or series of tests helps to determine performance abilities or functional limitations [1].

Functional performance test (FPT) or series of tests can be determined using functional performance outcome measures like time taken to complete the test, number of jumps covered, distance covered [2-4]. Scores on functional performance tests should help to predict the level of activity to which individual can perform or to which the individual can safely return without pain or swelling. It also provides justification whether further rehabilitation or care is needed or not [1].

Normally, after injury, there is brief period of physical impairment. It is during this period that the more classical objective measures of physical function are evaluated, such as range of motion, anthropometry, muscle strength, reflexes and joint integrity. But, although these clinical examination measures are important, they do not appear to correlate directly with actual functional performance. Hence, there is need to assess functional performance.

Hop testing has been used as a practical, performance based outcome measure that reflects the integrated effect of neuromuscular control, strength (force-generating capacity), and confidence in the limb [5].

Square hop test has been developed and used by the physical therapists in clinical practice, and it is a measure of the dynamic postural balance, coordination and strength of the thigh and calf muscles [7,10].

Unlike other hop tests, square hop test aims to measure neuromuscular coordination in the lower extremity, the ability to make small, fast movements and changes of direction and to accommodate on terrain by placing combined frontal and rotational stress on the lower extremity [7,8]. So this test correlates with the actual performance required in daily activities. Limited number of studies using square hop test as functional performance test are done. So, the purpose of our study was to determine the time (seconds) to complete square hop test in young

asymptomatic individuals.

The concept of leg dominance is important in clinical settings but it is often ignored in clinical practice. Clinicians often use functional performance test (FPT) in lower extremity rehabilitation without taking limb dominance into consideration. It is also evident from the study done by Gabbard and Hart (1996) which states that although an individual can use both sides reasonably well, one hemisphere generally overrides the other with respect to preferential use and skill [9].

It is highly apparent in the upper extremity that the dominant arm is usually stronger and more versatile which is usually ignored by the clinicians in case of lower extremity. In sedentary population, they may develop significant bilateral asymmetry in lower limbs due to constant overload on the jumping leg depending upon different kind of daily activities [11]. Thus, determining the role of leg dominance on functional performance test would be valuable to the clinician and researcher for assessment and rehabilitation purpose.

Thus, the need of our study was to determine the time taken to complete the square hop test and to observe the effect of dominance on performance of the square hop test.

MATERIALS AND METHODS

Participants: 60 healthy young, asymptomatic individuals were selected using systematic sampling. Inclusion criteria- Normal healthy individuals between 18-25 yrs of age and Body Mass Index (BMI) of 18.5 to 24.9 kg/m² [12]. Exclusion criteria- Any musculoskeletal problems or neurological disorders, currently undergoing any rehabilitation program, Individuals undergoing any physical training or sports, recent surgery. The study was approved by the Institutional Ethical Review Board .All the subjects were informed about the aim, the method of the study and protection of their rights. Informed written consent was taken from all subjects who participated in the study.

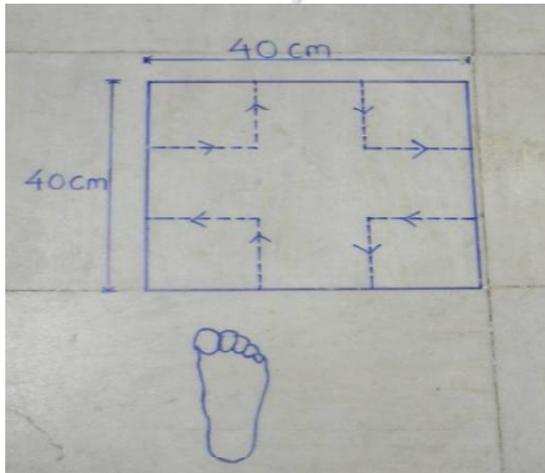
Methodology: 5 minutes of warm up was given within Borg Rating Scale of Perceived Exertion of 11 or 12 i.e. light. Warm up exercises included were 10 repetitions each of lunges, power jump, calf stretching, hamstring stretching [16].

Dominance of leg was noted by asking the subjects to kick a ball kept in front of them [6,7].

Figure 1 shows the outline of square hop test, 40 -40cm square was marked on the floor using marker pen with tape [5].

Directions were also marked on the square using arrow marks.

Fig. 1: depicting outline of square hop test.



Subjects were given the demonstration of the test and the instructions to be followed during the test. The inter test reliability was $r = 0.94$ and the intra test reliability was $r = 0.74$ for square hop test.

Starting outside of the square, the subjects were instructed to hop in and out of the square with constant speed as long as possible till they feel fatigue in the limb or lose balance. With the right limb, subject hopped in a clockwise direction and with the left limb in a counter clockwise direction. In this way, the subject had to jump as follows: first forward into the square, then sideways to the left out of the square, then sideways to the right into the square, and then forwards out of the square and backwards into the square again; thereafter sideways to the right out of the square, and then sideways to the left into the square and finally backwards out of the square to the starting position. One repetition consisted hopping in and out of the tape out-line completely around the square back to the starting point [1,4,5].

The subjects were told to continue as many such repetitions as long as possible in this pattern till they feel fatigue in legs or lose balance and the time was recorded in seconds. Time (seconds) to complete one trial was recorded.

After completing one trial, subjects were given a rest of 4 minutes and were allowed to start over again for second trial with the same leg. After this, subject performed the same test with the non - dominant leg twice. Time taken by dominant and non dominant legs of 60 subjects was noted down.

Statistical Analysis:

Mean time was analysed for both the legs and was used for statistical analysis.

The data was initially tested for normal distribution using the one sample Kolmogorov Smirnov test for Normality. Since the data was normally distributed, parametric test was used

The comparison in mean time (seconds) taken to perform square hop test between dominant and non dominant leg was analyzed using paired t test.

RESULTS

The result of paired t test shows that there is a significant difference in time taken for performing functional test between dominant and non dominant legs. ($P < 0.05$). The table 1 shows the difference in mean and standard deviation of time (seconds) taken by dominant leg and non dominant leg for performing square hop test taking limb dominance into consideration. It was seen that mean \pm SD for the dominant leg was 49.78 ± 15.07 seconds and non dominant leg was 44.67 ± 16.51 seconds in 60 subjects.

In assessing the importance of significant results, Effect Size as proposed by Cohen (1988), is an important tool in reporting and interpreting effectiveness of our study. It is the measure of strength of the phenomenon i.e. the relationship between the two variables i.e. dominant and non-dominant leg performance. [14] It quantifies the size of the difference between two groups, and may therefore be said to be a true measure of the significance of the difference. It complements p values.

Effect Size (ES), as proposed by Cohen, is estimated by the difference in means between the two groups divided by the standard deviation of the control group (in our case non dominant group).

Table 1: Mean and Standard deviation of time (seconds) taken by Dominant and Non dominant leg.

Time (seconds)	Mean	Standard deviation	significance
Dominant leg	44.67	15.07	0.007
Non dominant leg	49.78	16.51	

Table 2: Calculation of effect size using Cohen's formula.

Time (secs)	Dominant leg	Non dominant leg
Mean	49.78	44.67
Difference in mean	5.11	
Standard deviation	16.51	
Effect size	0.31	
Significance	Moderate	

As seen in Table 2, after calculating effect size from the readings, our study falls in group of moderate clinical significance (0.31). Thus, our study is not only statistically highly significant but also clinically significant at moderate level.

DISCUSSION

The purpose of our study was to determine time taken by both the legs to complete square hop test and to find the effect of limb dominance on the performance of the test. 60 subjects participated in the study and they performed the test first with the dominant leg. Time required to complete the test was determined. Then, we studied the effect of dominance on the performance by comparing time difference between dominant and non-dominant legs. From the above findings, we say that dominant leg could perform for longer time than non dominant leg in square hop test. This can be attributed to study done by George Mavromatis et al (1998) who stated that improved performance in hop test by dominant leg could be due to more effective activation of legs muscles which might have been produced because of more frequent execution of vertical hops with the dominant leg during daily activities [15]. This indicates that limb dominance did have an effect on functional performance testing which consisted of square hop test. A study done by Rafael Bahamonde et al (2012) found significant difference between dominant and non dominant limbs on functional performance testing [16].

Thus, there exists asymmetry between bilateral limbs in young, asymptomatic individuals. This asymmetry may in turn affect the performance of the individual during functional hop testing (square hop test). The probable reason may be overreliance of the dominant limb in daily activities, which can decrease the non dominant extremity's ability to absorb large forces associated with daily activities [17].

This test depends upon factors like dynamic stability, muscle endurance and muscle strength. The effect of dominance on this above factors may be the probable reason for performance difference between dominant and non dominant legs in our test.

Dynamic stability refers to the ability of a joint's dynamic stabilizers to brace a joint during movement. It requires proper coordination, proprioception and stiffness in joints to stabilize the joint at various positions [11]. Ross et al in his study also concluded that the kicking leg (dominant leg) has superior thigh muscle strength, better proprioception and greater knee flexion ROM [18]. Colby et al also showed a significant difference in stabilization time between dominant and non dominant legs [19]. Muscular endurance is a physical characteristic challenging adequate dynamic stability at times when fatigue begins to influence performance. In our study, subjects had to perform the test as long as possible till they felt fatigue or lost balance. In square hop test, the subject had to move in different planes of movement. During this test, there occurs continuous eccentric and concentric contraction in hip, knee and ankle musculature giving rise to fatigue [20]. Rozzi et al. define fatigue as an inability to reproduce force outputs during repeated bouts of muscle contraction [21].

This supports our finding from the study done by Demura et al (2001) who showed that lateral dominance (i.e. the preferred use and superior performance of one side of the body as compared to the other side) was noted across muscular endurance and power exertion [22]. Physical performance and risk of injury have been related to functional asymmetries of the lower extremity. This difference in performance of lower limb due to limb dominance in young asymptomatic individuals can be a cause for increased risk of

injury during daily activities due to favoring the stronger, or dominant side, of the body [23]. This finding is consistent with the discovery that asymmetry and poor alignment leads to increased energy expenditure and decreased muscular efficiency, which ultimately leads to increased stress and fatigue [24]. The fatigue may have set up much faster in non-dominant leg than dominant leg, which could have resulted in non dominant leg performing less than dominant leg in square hop test.

The muscle strength is an important factor contributing to dynamic stability and overall muscle performance [11]. Biarticular muscles of lower limb play an important role in transferring of power from proximal to distal joints during single leg hopping [15]. Studies revealed that during this push off phase, biceps femoris is activated more in dominant leg than non-dominant leg [24]. This difference in activation pattern of biceps femoris between dominant and non-dominant leg during this phase could have resulted in difference in performance on square hop test.

Bobbert & van Ingen Schenau (1996) also concluded that vastus medialis and rectus femoris shows greater activity in dominant leg during hopping [25].

Our findings can also be supported by the study done on strength and fatigability testing on dominant and non-dominant legs which concluded that hip abductors on dominant leg are stronger than non-dominant [25,26]. Fatigue of hip abductors of non-dominant leg leads to increase valgus moment of knee further increasing stress on medial aspect of knee putting medial hamstrings under stress. This, in turn causing early loss of balance in square hop test by the non-dominant leg resulting in less time taken by non-dominant leg to perform the test. Apart from the above factors playing role in performance difference in dominant and non-dominant leg, several authors have proposed theories on an innate origin of preference leading to asymmetry. Limb preference in activities of daily living and athletics may be influenced by innate origins involving prenatal posture, evolution, and neurospinal architecture.

The author Dimond (1993) discussed the role of

asymmetrical motor output behavior in cerebral hemispheres and suggested limb preference based on the side that performs better [27].

The concept of leg dominance is important in clinical settings. Square hop testing can be used in clinics as a performance outcome that reflects neuromuscular control, strength, and limb stability [16]. In addition, it is easy to administer and requires minimal equipment. Thus, the findings of our study i.e. the difference obtained in time between dominant and non dominant leg shows not only high statistical difference but also needs to be weighed in terms of its clinical value. Clinical value was assessed using effect size which also showed moderate significance.

CONCLUSION

From our study we conclude that the subjects performed the test for longer time on the dominant leg as compared to the non-dominant leg and we observed that leg dominance had an effect on performance of square hop test. Limitation of our study was the factors (dynamic stability, muscle endurance, muscle strength) contributing to this difference between dominant and non-dominant leg was not assessed individually in our study which could have strengthened the results of our study further. In young asymptomatic individuals, further research is required to establish normal lower limb symmetry index for this square hop test. This would help to determine lower limb symmetry ranges that could be used for reference when evaluating the patients with ankle or knee instability and its association with dominance.

Conflicts of interest: None

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