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The Relationship between Core Stability Performance and the Lower Extremities Static and Dynamic Balance Performance in Healthy Individuals: A Correlational Study

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Abstract: ***Background: Lumbar core stability performance is one of the function of the core muscles of the lumbar spine hence Lumbar spine dysfunction may lead to any alteration in the lower extremity functional performance including balance performance. Establishing a relation between the core stability and balance performance will provide a rationale to give core stability training for reducing balance deficit related injuries. Objective: To determine the correlation between the Core stability performance and the lower extremity static balance and dynamic balance performance in the healthy individuals. Methods: Sixty healthy active subjects (30 males And 30 females) were selected for this study on the basis of inclusion and exclusion criteria. Their Core stability performance was evaluated using prone plank test, side plank test, abdominal fatigue test and the lower extremity static balance performance using the Stork single limb balance test and the dynamic balance performance using SEBT. Data was analyzed using the Pearson correlation test. Results: Lower limb static balance performance was significantly correlated with that of the prone plank test ($p=2.2\times10^{-16}$, r=0.83), side plank test ($p=4.4\times10^{-10}$, r=0.70), abdominal fatigue test performance ($p=3.9\times10^{-8}$, r=0.63). And dynamic balance performance was significantly correlated with that of the prone plank test (p=0.009, r=0.33), side plank test (p=0.07, r=0.22), abdominal fatigue test performance (p=0.02, r=0.29). Conclusion: This study concludes that there is significant correlation of the lower extremity static and dynamic balance performance with that of the core stability.***

Keywords: Measuring tape, Core stability Tests, Balance, Stork balance test, Star excursion balance test

1. Introduction

Peoples now a day are including indoor and outdoor sports activities in their daily life routine. Outdoor sports and recreational sports participation is increasing at faster pace among adolescents. Consequently, along with an increase in the frequency or duration of recreational sports participation, there is a proportional increase in the incidence of activity induced musculoskeletal injury which acts as a true public health burden.[1]

Ankle sprains are among the most common injuries in the physically active population. The subjects with good balance score have nearly 7 times reduced risk of ankle sprain in comparison to people with poor balance.[2] Prime movers of trunk are Rectus Abdominis for flexion. Erector spinae, Latissimus Dorsi and Intrinsic Musculature of spine for extension. Quadratus Lumborum for lateral flexion. External oblique and internal oblique for rotation.

Core is associated with the body's center of gravity, which is over the region of the second sacral vertebrae groups and stability is associated with isometric and static strength.[3] Core stability is important to protect spine and surrounding musculature for injury in static movements and dynamic movement.[3]

The transversus abdominis, multifidus, internal and external oblique, rectus abdominis, erector spinae and diaphragm are the primary core muscles and Lattismus dorsi, gluteus maximus, trapezius are minor core muscles that help to stabilize the spine, pelvis and kinetic chain during functional movement.[4]

All motions are generated from the core and are translated to the extremities. During performance of sports skills, a stable core provides a foundation upon which the muscles of the upper and lower extremities can accelerate body segments and transfer force between distal and proximal body segments.[5,6,7] Core is centre of the functional kinetic chain providing the proximal stability for the distal mobility and function of limbs.[6]

Not only sporting and recreational activities require assessment of core stability and balance performance it is also necessary to assist the non recreational or an inactive sporting individuals as the weak core and the balance may be one of the cause for causing leading to injury or accidental trauma during ambulation and day to day leaving. Hence present study is aimed to determine the correlation among different tests of core stability and the lower limb static balance and dynamic balance performance in healthy individuals.

This study will provide an evidence of direct linkage between core stability performance and lower extremity static and dynamic balance performance. Also there will be data generation in regard to the aim of the current study.

2. Methodology

Type of study: Correlational study
Sampling method: Convenient sampling method
Sample size: 60 Subjects
Place of study: MIP College of physiotherapy, Latur
Duration of study: 6 months
Participation Criteria

Inclusion criteria
Healthy active individuals
Age: 19-25 yrs

Exclusion criteria
1) Any known systemic illness
2) Low back pain during last six months
3) History of Lower Limb or Spinal surgery
4) Participation in any training program for the core stability training, strength training, resistance training or balance training.

3. Material

Data collection sheet; plinth; stop watch; athletic tape.

Study Procedure
Permission from the Institutional Ethical Committee of the MIP college of physiotherapy was taken to conduct the study. Healthy active individuals who participates in the outdoor sports activity at least 30 minutes a day screened as per inclusion and exclusion criteria and willing to participate in the present study were selected. Consent form was taken from all these 60 participants.

Data Collection Procedure
All these 60 participants were evaluated as per data collection sheet which includes demographic data, static balance evaluation through stork balance single leg stance test and dynamic balance through star excursion balance test. Core muscle strength evaluation through prone plank test, side plank test, and abdominal fatigue test.

Prone plank test (Fig 7.1)
It selectively tests spinal extensor stabilizer's ability against flexion moment and has good test-retest ability.[8,9] Subjects from the prone lying positions will be required to maintain the whole body weight on the forearm and toes while lifting all intermediate segments off the plinth. The maximum duration for which they could maintain the position will be the performance of the test.[8,10]

Figure 7.1: Prone Plank Test.

Side plank test (Fig 7.2)
The test consisted of subject in side lying position on the firm mattress, with legs extended. Subjects will be instructed to support themselves lifting their hips off the mat to maintain a straight line over their full body length and support themselves on the elbow and their feet. The uninvolved arm will be held across the chest or simply rested on the lateral thigh of the upper extremity. The duration for which they could maintain the full straight position will be the performance of test.[8,11]

Figure 7.2: Side Plank Test.

Abdominal fatigue test (Fig 7.3)
It measures the endurance of the anterior abdominal wall by asking the person to hold a sit up position as long as they can. The subjects will require sitting on the test bench and placing the upper trunk against a support with an angle of 60^0 from the test bench. Both knee and hip will be flexed to 90^0. Both arms folded across the chest with the hands placed on the opposite shoulder and toes stabilized to the bed (either by manual support or by straps).The subjects is asked to maintain the body position while the supporting back support was withdrawn. The stopwatch is started at the moment, when the support is withdrawn. The stopwatch stopped when the upper body fell below the 60^0 position. Time duration between these two points will be recorded as the endurance holding score of the anterior abdominal muscle group.[8,11]

Figure 7.3: Abdominal Fatigue Test

Stork balance test (Fig 7.4)
This is used to measure static balance performance as subject is required to assume a single leg standing position on the testing limb and then commanded to raise his/her heel and maintain the balance on the ball of toes of foot for the maximum possible duration. The time duration between the assumption of the position and the loosing of the stable position will be taken as the score of the Stork balance test. In its measurement three trials are given for each leg and the time of the longest balance is recorded.[8,12,13]

Figure 7.4: Stork Balance Test

Star Excursion Balance Test (Fig 7.5)

Before the test is performed, there is a set up needed. Use 4 strips of athletic tape with a length of 6-8 foot. Then you should form a '+'. After this is done, use 4 strips of athletic tape of the same length but this time you are going to form an 'x'. It is important that all the different lines are separated from each other by an angle of 45°.[8,14]

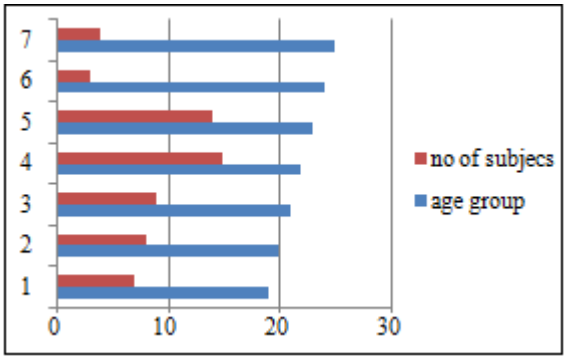
The goal of the SEBT is to maintain single leg stance on one leg while reaching as far as possible with the contra lateral leg .The person performing this test must maintain a base of support on one leg, while using the other leg to reach as far as possible in 8 different directions. This person (standing on his left leg for example) must reach in 8 different positions, once in every of the following directions: anterior, anteromedial, medial, poster medial, posterior, poster lateral, lateral and anterolateral.[14,15]

Figure 7.5: Star Excursion Balance Test

Statistical Analysis and Results

Table 8.1: Age wise distribution of study subjects.

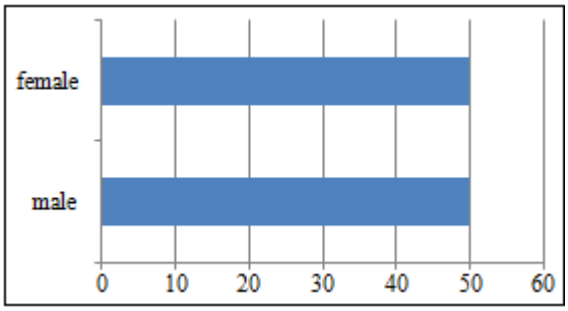
Sr. no.	*Age Group*	*No. of subjects*
1	19	7
2	20	8
3	21	9
4	22	15
5	23	14
6	24	3
7	25	4
Total		60



Graph: 8.1

Table 8.2 Gender wise distribution of study subjects.

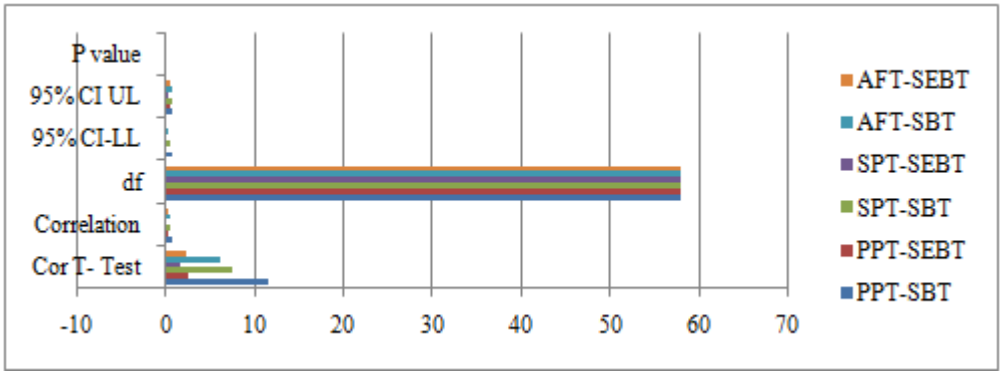
Sr. No.	*Gender*	*No.*	*Percentage*
1.	Male	30	50
2.	Female	30	50
Total		60	100



Graph 8.2

Table 8.3: Distribution of Scores Obtained by the Subjects.

Sr.no.	*Variables*	*Cor t-test*	*Correlation*	*df*	*95% CI-LL*	*95% CI UL*	*P value*
1.	PPT – SBT	11.656	0.8371536	58	0.7406777	0.8998035	2.2e-16
2.	PPT-SEBT	2.6847	0.3324626	58	0.08577945	0.54073796	0.009449
3.	SPT-SBT	7.4893	0.7011598	58	0.5441093	0.8107390	4.412e-10
4.	SPT-SEBT	1.7822	0.227853	58	0.02767277	0.45542779	0.07996
5.	AFT-SBT	6.3244	0.6388657	58	0.4594795	0.7681743	3.955e-08
6.	AFT-SEBT	2.3332	0.2929311	58	0.04214097	0.50899550	0.02312



Graph: 8.3

4. Results

A total number of 60 individuals were selected these participants were evaluated as per data collection sheet which includes demographic data, assessment of core stability by using prone plank test, side plank test, abdominal fatigue test and assessment of static balance by using stork balance test and dynamic balance by using star excursion balance test.

Data collection was taken for statistical analysis and was carried out for evaluation of the relation of core stability with lower limb static and dynamic balance.

60 out of 60 individuals enrolled in study were included for final analysis. As per table no.8.1 age group of participants enrolled between 19 to 25 year.

As per table no.8.2 which show gender wise distribution of study subjects. It shows that there were 30males and 30 females enrolled in present study i.e 50% of male and 50% of female.

As per the values of Table no. 8.3 between PPT and SBT with $p=2.2\times10^{-16}$ and r=0.83, PPT and SEBT p=0.009 and r=0.33, SPT and SBT with $p=4.4\times10^{-10}$ and r=0.70, SPT and SEBT with p=0.07 and r=0.22, AFT and SBT p= 3.9×10^{-8} and r=0.63, AFT and SEBT with p=0.02 and r=0.29 suggest that there is strong positive correlation between the Prone plank test (PPT) and Stork Balance Teat(SBT), Side Plank Test (SPT) and Stork Balance Teat (SBT) and Abdominal Fatigue Test (AFT) and Stork Balance Test (SBT).

And there is strong correlation between the Prone Plank Test (PPT) And Star Excursion Balance test (SBT), Side Plank Test (SPT) and Star Excursion Balance test (SEBT), Abdominal Fatigue Test (AFT) and Star Excursion Balance Test (SEBT).

5. Disscussion

The purpose of present study was to find out the relationship between core stability and lower limb static and dynamic balance in healthy individuals. The results revealed that there is a significant correlation between Prone plank test, Side plank test and Abdominal fatigue test the assessed components of core stability and lower limb static balance measured with Stork Balance Test (SBT) and dynamic balance with Star Excursion Balance Test (SEBT) moreover in a study done by Anoop Aggarwal and et al (2010) of the relationship between core stability performance and the lower extremities static balance performance in recreationally active individuals found correlation between Prone Plank Test (PPT) with Stork Balance Test (SBT) with p value 0.05[1] whereas in current study it is found to be strong correlation with p value 2.2×10^{-16}.

Correlation between Side plank test and Stork Balance Test found to be not significant with p values 0.86 whereas in the current study shows strong correlation with p value 4.4×10^{-10}. Correlation between Abdominal fatigue test and Stork Balance Test there is no significant correlation with p value 0.27 whereas in current study p value is 3.9×10^{-8} which is strongly correlated.

A total number of 60 active healthy individuals involved in this study. These participants were evaluated as per data collection sheet which included demographic data assessment of core stability by using Prone Plank test (PPT), Side Plank Test (SPT) and Abdominal Fatigue Test (AFT) and lower limb static balance with Stork Balance Test (SBT) and dynamic balance with Star Excursion Balance Test (SEBT) were checked.

In our study total number of 60 participants, male (30) and female (30) in age group 21.8 ± 3. The study done by Anoop Aggarawal et.al (2010) included 40 subjects.[8]

In the study done by Anoop Aggarawal et al (2010) Prone plank, side plank, abdominal fatigue test Modified Beiring Sorensen Test, Sharmans core stability test for core stability, stork balance test for static lower limb balance were performed. They found significant correlation of the lower extremity balance performance with that of the core stability. Present study is similar to the above study.[8]

The study done by Melanie Berscheitetal included 30 recreationally active healthy individuals and side plank, Balance error Score System and star excursion balance test were performed and found that there is no significant correlation between core stability and static and dynamic lower limb balance.[16]

Kayvan Baban et al (2015) found that the Core stability has an important role in lower extremity injuries and strengthening of core stabilizer muscle can use to prevent the lower extremity injuries.[17]

In the study done by Tarik ozmen (2016) trunk flexion test, side bridge and SEBT were performed. They found that there is no significant correlation core stability and lower limb dynamic balance with p value ≥ 0.05.[18]

Sarvin Salar (2014) found significant correlation between core stability and lower limb static balance with p value 0.001.[19]

EMG study done by Arti Kaushik (2013) found strong negative correlation between measures of core stability and components of modified (SEBT) with p value of <0.001.[20]

In the study done by Rachel Leitz (2015) core stability test and dominant leg stance test for lower limb static balance was performed. They found there is significant relationship between core stability and lower limb static balance with p value 0.061.[21]

Nicol Kahle (2009) found that there is effect of core stabilization training on lower limb balance in young healthy adults.[22]

Susen Christine Ashdown (2013) found there is weak correlation between core stabilization, lower limb lower limb balance and athlete performance.[23]

Whereas in present study there is strong correlation between PPT and SBT with $p=2.2\times10^{-16}$ and r=0.83, PPT and SEBT p=0.009 and r=0.33, SPT and SBT with $p=4.4\times10^{-10}$ and r=0.70, SPT and SEBT with p=0.07 and r=0.22, AFT and SBT with $p= 3.9\times10^{-8}$ and r=0.63, AFT and SEBT with p=0.02 and r=0.29.

This pattern of correlation reveals that the static balance performance and dynamic balance performance of lower limb is significantly correlated with the performance of prone plank test, side plank test and abdominal fatigue test.

6. Conclusion

After statistical analysis this study concludes that there is significant correlation between the core stability and lower extremity static and dynamic balance in healthy individuals.

7. Limitation and Suggestion

7.1 Limitation

In present study the only relation between core stability and lower limb static and dynamic balance was evaluated in single cessation. A Specific core strengthening programme and balance training was not performed for the individuals in the study. The scope for future studies to assess the core strength, balance assessment to be followed by core strengthening and balance improvement training on a large sample size with respect to the generalized population, community dwelling or any other recreationally participating active individuals. As core strengthening and balance improvement can prevent various day to day as well as sporting injuries of the lower limb.

7.2 Suggestion

1) Further study may include core strengthening programme, pre strengthening and post strengthening evaluation of the core strength and lower limb static and dynamic balance.
2) Further study could be carried out with large inclusive and exclusive criteria.
3) Further studies can be done with respect to recreational and sports activities.

8. Source of Funding

Nil.

9. Conflict of Interest

There is no conflict of interest.

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