ORIGINAL RESEARCH PAPER

Physiotherapy

RELATIONSHIP OF DYNAMIC BALANCE WITH LOWER EXTREMITY MUSCULAR STRENGTH AND ENDURANCE IN FOOTBALL PLAYERS

KEY WORDS: dynamic balance; Star Excursion Balance Test (SEBT); core endurance and lower limb endurance; isometric strength

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ABSTRACT

The aim of the study was to find a relationship of dynamic balance with muscular strength and endurance in football players. 50 football players (mean±SD, age 20.56±1.387 years, weight 56.68±8.408 kg, height 167.6±9.67 cm, BMI 20.1±1.7kg/m^2) performed the SEBT in anterior, anteriomedial, medial, posteriomedial, posterior, posteriolateral, lateral and anteriolateral directions bilaterally (% leg length), wall squat test bilaterally (seconds), McGill's anterior, posterior, and left and right plank core endurance tests (seconds), and bilateral isometric muscle strength of lower extremities. Pearson's correlation was used to find correlation of dynamic balance with isometric strength of lower limbs, dynamic balance with endurance of lower limbs, and dynamic balance with core endurance.

INTRODUCTION

Football is an admired sport but little is well-known regarding how dynamic balance is related with endurance and strength needed in serious field tasks in addition to technical skills with the ball. In football, multifarious skills are necessary comprising maintenance of balance while kicking, running, evading, and tackling as well as in changing direction (Larcom, 2013). Balance is the state in which all the forces operating on the body are balanced in a manner that the centre of mass is inside the stability limits, the margins of the base of support. One of the imperative constituents of motor skill progress is dynamic balance, which engages single limb control in order to complete functional tasks throughout the game of football (Butler, 2013).

Muscle strength is the quantifiable force exerted by a muscle or else a group of muscles to surmount a resistance in one maximal effort (O'Sullivan and Schmitz, 2007). Whenever a contact with the ball is made by a player, they not just balance on the contralateral leg but they furthermore coordinate their core along with limbs in a defined way to strike the ball in a desired direction (Dolan, 2013).

In past, various studies have reported the relationship of reduced strength, or else decreased muscle force, in addition to decreased balance (Hamilton, 2015). As balance is concerned, focus start in on the lower extremity joints and shift upwards as the lower joints affect and sometimes improve the movement of joints above. Lower limb strength has specific connection with football: the quadriceps, hamstrings and triceps surae are required to produce high forces for the activities like jumping, tackling, kicking, turning as well as changing the pace. In maintaining balance and control, the potential to protract strong contractions is also imperative.

Core musculature connects to as well as control the limbs so, core stability along with endurance are essential in any movement (Dolan, 2013). The basic techniques in the football like controlling the ball, running with the ball, passing the ball and shooting are performed with lower limbs thus lower limb musculature play a significant role in achieving success in these techniques and to play efficiently on the field.

Muscular strength, endurance and dynamic balance are the physical skills required in the game of football. Any disturbance in these skills while moving will further make a player prone to several injuries and decreases output during the game. Strength and endurance are essential co-determinants of football performance, as they are key features of physical capacity and main regulators of important football-specific tasks (Hoff and Helgerud, 2004).

Till date no satisfactory literature is available on the relationship of dynamic balance with lower extremity muscular strength, lower limb endurance and core endurance in football players. The purpose of this study was to investigate relationship of dynamic balance with muscular strength and endurance in football players.

METHODS

Fifty football players (20.56±1.387 years, 56.68±8.408 kg, 167.6±9.67 cm) participated in the study. Football players between the age group 18-25 years, with minimum 5 or more than 5 years of practise training, minimum 3 hours of practise per day, minimum 3 days of practise per week and a regular practising player were included in the study. Participants were excluded if having any neurological deficit or recreational player or players experiencing vestibular (e.g. vertigo) or visual problem (e.g. blind in one eye) or participant in structural training program or suffering from acute lower extremity injury at the time of testing.

The departmental research board approved all testing procedures. 23 male and 27 female participants signed a written consent prior to participation in this correlation survey study. All testing was performed in Sports field of the university and exercise therapy laboratory of the department. Star excursion balance test (SEBT) was used to assess dynamic balance (Bhat and Moiz, 2013), Endurance of lower limbs was measured by the wall squat test, McGill's tests were used to assess the core endurance of the participants, and Isometric muscle strength of both lower extremities was evaluated by using Cable tensiometer.

RESULTS

Table 1. Pearson correlation among significant muscle groups of lower extremities and Star Excursion Balance Test (SEBT).

Muscle group	Reaching direction	r value	p value
Right Hip Flexors	Left anterior	- 0.397	0.004
Right Hip Extensors	Left anterior	-0.429	0.002
	Left anteriolateral	-0.417	0.003
	Right anteriolateral	-0.405	0.003
Right Hip Abductors	Left anterior	-0.547	0.000
	Left anteriolateral	-0.489	0.000
	Right anteriolateral	-0.458	0.001
Left Hip Flexors	Left anterior	- 0.421	0.002
Left Hip Extensors	Left anterior	-0.406	0.003
	Left anteriolateral	-0.412	0.003
	Right anteriolateral	-0.438	0.001
Left Hip Abductors	Left anterior	-0.482	0.000
	Left anteriolateral	-0.414	0.003
	Right anteriolateral	-0.404	0.004

Right knee Flexors	Left anterior	- 0.441	0.001
Left knee Flexors	Left anterior	- 0.405	0.003
Right Ankle Dorsiflexors	Left anterior	-0.481	0.000
	Left anteriolateral	-0.427	0.002
Left Ankle Dorsiflexors	Left anterior	-0.510	0.000
	Left anteriolateral	-0.478	0.000
	Right anteriolateral	-0.435	0.002
Right Ankle Plantarflexors	Left anterior	-0.513	0.000
	Left anteriolateral	-0.423	0.002
Left Ankle Plantarflexors	Left anterior	-0.483	0.000
	Left anteriolateral	-0.414	0.003

Table 2. Pearson correlation among left reach excursion on SEBT and left lateral McGill's core endurance test.

Left reaching Directions	r value p value	Left lateral plank test
Posteriomedial direction	r p	0.417 0.003

DISCUSSION

The primary findings of this study include significant relationships between: 1) isometric muscle strength of lower limbs and dynamic balance 2) core endurance and dynamic balance. In this study, it was found that sum isometric strength of right and sum isometric strength of left lower limb do not have a significant correlation with dynamic balance. Even the sum isometric strength of hip, sum isometric strength of knee and sum isometric strength of ankle of both lower limbs was not found to have a significant relationship with dynamic balance. Chtara et al. (2016) found that dynamic balance is related to muscle strength of lower limbs, in disagreement to the result of present study. They used Y-balance test for evaluating dynamic balance which has only 3 reach directions unlike 8 reach directions of SEBT. Indeed, Coughlan et al. (2012) reported that a subject may use diverse postural-control strategies to complete the tasks on both Y-balance test and SEBT, tools for assessing dynamic balance. So, it can be considered that the tool used by Chtara et al. did not comprised all the postural control strategies that may have been included in SEBT. Nevertheless, it was interesting to observe that the single muscle group strength was significantly correlated with some of the components of dynamic balance such as the isometric muscle strength of right hip flexors, extensors and abductors with left anterior reach direction; isometric muscle strength of right hip extensors and abductors with left anteriolateral reach direction; isometric muscle strength of right hip extensors and abductors with right anteriolateral direction; isometric muscle strength of left hip extensors and abductors with right anteriolateral reach direction; isometric muscle strength of left hip flexors, extensors and abductors with left anterior reach direction; left hip extensors and abductors with left anteriolateral reach direction; isometric muscle strength of left knee flexors and right knee flexors with left anterior reach direction; left ankle dorsiflexors with right anteriolateral, left anterior and left anteriolateral reach direction, left ankle plantarflexors with left anterior, anteriolateral reach directions, right ankle dorsiflexors with left anterior and anteriolateral reach directions and right ankle plantarflexors with left anterior and anteriolateral reach directions($p<0.005$). The studies which are in agreement to the results of the present study, Ambegaonkar et al. (2014); Hubbard et al. (2007); Evans (2011); Iwamoto (2009) who reported that single muscle group strength of hip, knee and ankle has correlation with dynamic balance. Ambegaonkar et al., 2014 found that isometric strength of the hip flexors, extensors, and abductors was positively correlated with SEBT scores. Hubbard et al., (2007) reported that hip abductor and hip extensor strength was positively correlated with dynamic balance. Evans, (2011) reported moderate correlation between ankle dorsiflexors and dynamic balance but weak correlation between ankle plantarflexors and dynamic balance in female collegiate athletes. Iwamoto (2009) proved that there exist a positive moderate correlation of hip abductor muscle strength and dynamic balance in healthy athletes. In the present study, no correlation was found between hip external rotators isometric muscle strength and dynamic balance which shows disagreement with the result of Ness et al. (2016) who found an increase in strength of hip external rotators of dominant limb was associated with improved lower extremity dynamic balance on the same limb for the anterior reach direction of SEBT. In the latter study, handheld dynamometer was used to measure isometric muscle strength unlike the present study in which cable tensiometer was used to assess isometric muscle strength and this could be the possible reason for the difference in results.

From this result we can conclude that on reaching to different directions on SEBT, strength of single group of muscles are more important that a whole group of muscles. Indeed, strengthening single muscle group would be of more worth than strengthening a muscle group or all muscles of lower limb together. And according to the result of the present study, it can be considered that a football player uses hip flexors, extensors and abductors, knee flexors and ankle dorsiflexors more for maintaining balance in action.

The endurance of lower limbs was analyzed to find relationship with dynamic balance and there was no significant correlation found in the results. Balance is the condition in which a person balances all the forces acting on the body such that his center of mass is contained by the limits of stability, within the margins of the base of support (O'Sullivan and Schmitz, 2007). This balancing of the body, to keep center of mass within base of support, requires various adjustments of the body segments brought about by contraction of different muscles, together with muscles of the lower limbs.

This could be the possible explanation why the present study was able to establish a significant relationship of dynamic balance with isometric muscle strength of single muscle group of lower limbs and not with lower limb muscle endurance.

Another finding of the present study highlighted that there exists a significant positive correlation between left lateral plank test and left limb excursion in posteriomedial direction with 'r' being 0.417. Abdi and Sadeghi, (2013); Sandrey and Mitzel (2013); Tse et al. (2005) are in agreement to the result of the present study that there exist a relationship between dynamic balance and core endurance. Abdi and Sadeghi, (2013) conducted a study to find the effect of eight-week core stability training program on the dynamic balance in young elite footballers and their results findings proved a high level of significance in progress of dynamic balance in the medial-lateral, anterior-posterior and vertical directions and dynamic postural stability of the entire was proved. Likewise a study conducted by Sandrey and Mitzel (2013) determined the results of a 6-week core-stabilization training program for high school track and field athletes on dynamic balance in addition to core endurance. And it was established that after the 6-wk core-stabilization-training program, measures of the SEBT, abdominal fatigue test, back extensor test, and side bridge test progressed. Tse et al, 2005 performed a research with players having an average of 1 year of rowing experience from university rowing clubs. The back extensor test plus anterior flexor test was performed at 60° were used to study the effects of an 8-week core endurance- training program using 20 players and results showed advanced selected core endurance parameters in healthy young men. In the present study, the correlation of core endurance with dynamic balance was found for posteriomedial direction in left lateral plank test. To the best knowledge of researcher, there is no study that confirms disagreement to the result of the present study.

From this result it can be believed that in the game of football, maintaining balance during changing directions quickly throughout the match of 90 minutes requires ample of core endurance. Core musculature coordinates with lower extremity muscles to bring about coordination while kicking, tacking the ball and also to balance even on the narrowest base of support when player kicks the ball while running.

The relatively small sample size is one of the limitation of this study. Still, to the researchers' knowledge, this is the first combined correlation study of dynamic balance with lower limb isometric muscle strength, lower limb endurance and core endurance in football players. The subjects participating in the study were not blinded to the value displayed on the cable tensiometer used for assessing isometric muscle strength of lower limbs. Any inadequate force exerted by the players may have affected the results. While assessing core endurance any slight movement of the body in anterior or posterior direction in McGill's core endurance tests may have been missed while recording the hold timing of the players in a particular test position. In SEBT, while being focused on monitoring stance foot movement, simultaneously marking reaching distance was nearly impossible.

Clinical implications

Superior strength of lower limb group muscles is associated to the better performance on SEBT in various directions. Increase in single muscle group strength of lower limbs will increase dynamic balance plus increase in endurance of core muscles will also increase dynamic balance and vice-versa. This can decrease the chances of injuries in football by improved single muscle group strength, greater core endurance and enhanced balancing abilities on the field. Also, improving dynamic balance, core endurance and strengthening of single group muscles of lower limbs can be included in the rehabilitation of players off the field, from any past lower limb injury.

Conclusions

The results of the present study revealed that dynamic balance is significantly correlated with the single muscle group isometric strength of hip flexors, extensors and abductors, knee flexors, as well as ankle dorsiflexors and plantarflexors. Dynamic balance was also found significantly related with left lateral plank in McGill's core endurance test. Adding strength training of single muscle group of lower limbs in training program will help in improving dynamic balance deficits in football players. By increasing core endurance dynamic balance will improve and vice-versa. The significance of dynamic balance with single muscle group isometric strength and core endurance can be considered in future studies, in prevention of injuries and in rehabilitating a player from injury of lower limbs.

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