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ORIGINAL ARTICLE

Comparison of Dynamic Balance in Collegiate Field Hockey and Football Players Using Star Excursion Balance Test

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- A Concept / Design
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Abstract

Purpose: **The preliminary study aimed to compare dynamic balance between collegiate athletes competing or training in football and hockey using star excursion balance test.**

Methods: **A total thirty university level players, football (n=15) and field hockey (n=15) were participated in the study. Dynamic balance was assessed by using star excursion balance test. The testing grid consists of 8 lines each 120 cm in length extending from a common point at 45º increments. The subjects were instructed to maintain a stable single leg stance with the test leg with shoes off and to reach for maximal distance with the other leg in each of the 8 directions. A pencil was used to point and read the distance to which each subject's foot reached. The normalized leg reach distances in each direction were summed for both limbs and the total sum of the mean of summed normalized distances of both limbs were calculated.**

Results: **There was no significant difference in all the directions of star excursion balance test scores in both the groups. Additionally, composite reach distances of both groups also found non-significant (*P*=0.5). However, the posterior (*P*=0.05) and lateral (*P*=0.03) normalized reach distances were significantly more in field hockey players.**

Conclusion: **Field hockey players and football players did not differ in terms of dynamic balance.**

Key Words: Field Hockey; Football; Postural Balance; Star Excursion Balance Test

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INTRODUCTION

Dynamic balance is considered as an ability to maintain stable position while performing a task [1]. Dynamic balance is desirable in sports that require stability while athlete is moving and quickly reacting to changing circumstances. Balance is maintained by the vestibular, visual and somatosensory system along with centre of gravity and centre of mass. A player may face perturbations against his dynamically balanced position either by the opponent or by the player themselves while changing directions to avoid an opposing player or while passing or kicking a ball. These perturbations are large and need strong stabilization [2].

Balance ability has a significant effect on athletic performance [3]. Athletes have presented with superior balance ability compared to non athletes; suggesting that sports participation improves balance [4-9]. Athletic training stimulates neurosensory pathways which improve balance and proprioception [6,7]. Poor balance ability has been associated with an increased risk of ankle injury in a number of sports [10].

There are various methods to assess dynamic balance [3] and star excursion balance test (SEBT) is one of the reliable and feasible methods to assess dynamic balance as it challenges a person's ability to maintain a stable base of support simultaneously performing reach movement [5,11] SEBT has been found to be a predictive measure of lower extremity injury in high school basketball players. [12] It is found to be a reliable measure to assess dynamic balance [12-16].

On field, athletes are always exposed to the situations where the balance is dynamically challenged while performing movements like walking, running, stepping and jumping [17]. Balance is essential for football players during most aspects of games [18]. They are required to maintain single leg balance while shooting accurately, dribbling and passing the ball [19].

Field hockey, like football is a highly dynamic activity [20]. Being a highly dynamic activity, field hockey also demands good dynamic balance.

A hockey player is usually moving or running while performing a skill and has to seek a point of balance in relation to the ball. A well balanced position is essential in learning to play attack role, to dribble quickly in any direction, pass or shoot the ball in any direction as well as to receive the ball from any direction [21].

Comparison of dynamic balance in football had been established in relation to other sports. A number of studies have found that football has a higher dynamic balance than other sports [3,4,8]. No study has compared dynamic balance in field hockey players with other sports. There is a necessity to identify whether the dynamic balance in a hockey player is similar or different to football players. Therefore, this study has been designed to investigate comparison between field hockey and football players. We hypothesized that dynamic balance in a collegiate field hockey player would be different from football players. Estimation of dynamic balance in both sport activities will give a perception of whether the sport's demand in field hockey and football influences the balance ability and also will help in predicting risk factors in lower extremity injuries as well as athletic performance in both sports.

METHODS AND SUBJECTS

Subjects:

Total thirty healthy collegiate students; 15 field hockey and 15 football players, mean age 21years (range between 18-25 years), university level players from Jamia Millia Islamia, India, participated in the study. Participants had to be competing in only one sport for the previous 2-3 years. Subjects should not be involved in any balance training program apart from their typical sports training and should be free from lower extremity injury for at least 6 months prior to testing. Participants were excluded if they had a vestibular problem (vertigo), visual problem, history of concussion 12 weeks before the study, current history of hip, knee and ankle surgery, current or undergoing treatment of inner ear, sinus, upper respiratory tract infection.

Ethical clearance has been taken from University Ethical Board. The participants were informed about the procedure thoroughly and informed consent was signed by them. Study design was two groups comparative, quasi experimental, retrospective design. Independent variable included sports activity while dependent variable dynamic balance measured using SEBT.

Procedure:

The procedure included assessment of dynamic balance and leg length. Dynamic balance was assessed by using star excursion balance test. The testing grid consists of 8 lines each 120 cm in length extending from a common point at 45º increments and was formed using a protractor and a 3-inch wide adhesive tape or adhesive placed on firm floor. The 8 lines positioned on grid are labeled according to the direction of excursion relative to the stance leg: Anterolateral (AL), anterior (A), anteromedial (AM), medial (M), posteromedial (PM), posterior (P), posterolateral (PL) and Lateral. Limb length was measured to normalize excursion distance [11] and was measured by measuring tape. The distance between anterior superior iliac spine to medial malleolus was used.

Protocol:

The protocol described by Gribble and Hertel [11] was followed to measure dynamic balance using star excursion balance test. The subjects were instructed to maintain a stable single leg stance with the test leg while shoes were off and to reach for maximal distance with the other leg in each of the 8 directions. A verbal and visual demonstration of the testing procedure was given to each participant. Then subjects were made to place the foot of their stance leg in the middle of the SEBT and were instructed to make a light touch on the tapes aligned in different directions with the most distal part of the reaching leg while looking over the point of contact of the reaching leg with tape without using the reach leg for support. If it is determined that the reach leg has been used for support or stable base of support has been compromised, the trial was repeated. For the trial to be successful hands had to remain on the hips and the foot of stance leg should not move from its original position and the heel of stance leg should be in contact with ground. The leg tested and order of reach direction was randomly selected before testing and a 5 sec. rest with a 2 feet stance was given between reach attempts.

Subjects were allowed to practice reaching 4 times in each of the 8 directions [22] After a 5 minute rest period; subjects performed three trials in each of 8 directions. These three trials were performed for each limb. Subjects were instructed to reach behind the stance leg when performing trials in the posterior directions. Visual cues were removed from the testing area to help reduce visual and auditory influences. Marks at regular intervals (1cm) were set on the tape [23]; a pencil was used to point and read the distance to which each subject's foot reached.

To measure leg length, the participant was made to lie on a plinth; a mark was placed using a marker on the participant's most inferior aspect of each anterior superior iliac spine and on the most distal portion of medial malleolus. The subject was asked to lift hips off the plinth and return them to starting position. The examiner passively straightens the legs to equalize the pelvis. The subject's limb length was measured in centimeters from the anterior superior iliac spine to the most distal portion of the medial malleolus with a cloth tape measure.

Data analysis:

The average of three distance (cm) scores was taken for each direction over the three trials and was normalized to leg length. [Reach distance/ leg length X 100 = percentage of leg length]. The normalized distances in each direction were summed for both limbs and the total sum of the mean of summed normalized distances of both limbs were calculated Data analysis was performed using Scientific Package for Social Sciences (version 16, Chicago, IL.USA). The descriptive variables are expressed as the mean$\pm$standard deviation (Table 1). The main outcome measure, normalized composite reach distances between two groups (i.e. hockey players and football players) were analyzed and compared using Leven's t-test to examine the differences. Statistical significance between groups

Fig. 1: Star excursion balance test

Fig. 2: Anterior reach direction of SEBT for left stance leg

Table 1: Demographic Characteristics of Subjects

Variable	Field Hockey (n=15) Mean (SD)	Football (n=15) Mean (SD)	P. value
Age (years)	21.20 (1.61)	20.93 (1.71)	0.7
Weight (Kg)	62.76 (7.18)	65.66 (7.61)	0.3
Height (meters)	1.68 (0.07)	1.73 (0.06)	0.07
Body Mass Index (kg/m^2)	22.05 (1.37)	21.83 (1.57)	0.7
Right Limb Length (cm)	88.50 (3.90)	92.37 (4.80)	0.02
Left Limb Length (cm)	88.76 (4.09)	92.63 (4.80)	0.02

SD: Standard Deviation

was evaluated using independent t-test and statistical significance was assumed at $P<0.05$.

RESULTS

The demographic data is shown in Table 1. Both the groups were similar in age, weight, height and their body mass index. However, in right and left limb length there was a minute difference of 3cm between the groups which was found to be statistically significant. There were no significant difference in scores for composite reach distances for hockey players and football players ($P>0.05$).

There were no significant differences in normalized anterior, anteromedial, medial, posteromedial, posterolateral, anterolateral reach distances between field hockey and football players (Table 2). There was a significant difference in normalized posterior reach distances for field hockey and football ($P=0.05$). Also there was a significant difference in normalized lateral reach distances for field hockey and football ($P=0.03$). There was no significant difference for right normalized reach distances for field hockey and football ($P>0.05$). There was no significant difference for left normalized reach distances for field hockey and football ($P>0.05$).

The normalized reach score for the hockey group were 5.95 higher than the football group (table 3) but it was statistically non-significant ($P=0.5$).

DISCUSSION

This study compared dynamic balance in male collegiate field hockey players and football players using star excursion balance test (SEBT). The result demonstrated that field hockey players had similar

Table 2: Comparison of other variables between the games

Directions	Normalized reach distance: Field hockey Mean (SD)	Normalized reach distance: Football Mean (SD)	Independent t test: t	Independent t test: P. value
Anterior	84.97 (6.52)	87.02 (6.15)	-0.885	0.4
Anteromedial	93.99 (5.55)	94.99 (3.66)	-0.578	0.6
Medial	100.82 (6.61)	103.56 (6.44)	-1.14	0.3
Posteromedial	108.07 (5.82)	106.21 (4.73)	0.961	0.3
Posterior	110.77 (4.22)	107.51 (4.48)	2.046	0.05
Posterolateral	103.64 (5.95)	101.58 (6.27)	0.920	0.4
Lateral	94.09 (5.59)	89.38 (5.85)	2.251	0.03
Anterolateral	77.55 (4.59)	78.54 (7.78)	-0.423	0.7
Composite reach distance $^{\alpha}$	774.23 (20.58)	768.92 (21.66)	0.696	0.5

α= normalized composite reach distance i.e ∑ of %leg length; SD: Standard Deviation

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Table 3: Comparison of total normalized reach distances of right and left leg in between the games

Limb	Field hockey Mean (SD)	Football Mean (SD)	t *	*P*. value
Right	770.87 (19.77)	764.92 (26.19)	0.702	0.5
Left	778.45 (27.39)	773.15 (22.14)	0.583	0.6

* Independent t-test; SD: Standard Deviation

dynamic balance as compared to football players. However, posterior and lateral reach distance scores of SEBT were more in field hockey players than football players. In previous studies, football players have demonstrated dynamic balance ability superior or equal to gymnasts and higher static unipedal balance ability than basketball players, swimmers and non athletes [3,8,9]. Since there is no published work reporting the study of dynamic balance of field hockey players, the present study for the first time profiled dynamic balance in collegiate field hockey players andcompared this with that of compared football players as their balance ability with respect to other athletes and non athletes has been already established.

Correct balance is imperative for both football and field hockey players as football players require to maintain single limb balance while performing many tasks like shooting accurately, dribbling and passing the ball [19]. Consequently, football players are expected to have better unipedal stability than athletes in other sports [9]. Although field hockey players use their upper extremity for dribbling, passing and shooting the ball using their hockey stick, proper balance of head, feet and hand with the stick is necessary to be maintained to perform these quick and skilful movements. It is required for a player to seek a point of balance in relation to the ball with every technique [21].

The postural control system also depends on reaction time[24]. Volleyball and football players are found to have quicker reaction time than non athletes [25,26] whereas Bhanot and Sidhu [27] found that Indian field hockey players have faster visual and auditory reaction time of hand and feet than Indian Volleyball players. Therefore, the faster reaction time in field hockey players than the athletes of other sports could be one of the supporting factors for better dynamic balance performance.

Sports participation or sports training has an effect on balance ability which has been demonstrated earlier. Athletes have presented with greater balance abilities than non athletes [4-9]. Long term athletic training augments neurosensory pathways and stimulates cutaneous nerve receptors or mechanoreceptors in the muscles, ligaments and joint capsule of knee and ankle joint as demonstrated by improved balance and proprioception [6,7]. Football players have demonstrated better balance ability than non athletes [5,8,9]. Therefore, the established effects of long term athletic training on balance and proprioception could be one of the rationales for the greater dynamic balance performance of football and field hockey players on SEBT.

Difference in balance ability among athletes of different sports had been studied earlier [4,8,9,28,29]. Vuillerme et al [28] suggested that difference in stability among athletes can be due to varying sensitivity of sensory system in athletes. Probably, field hockey players and football players may be having equal sensitivity of sensory system as they displayed similarity in their dynamic balance performance. Bressel et al [4] also found difference in dynamic balance in collegiate female basketball players with collegiate female gymnasts and football players. There was no difference in dynamic balance among gymnasts and football players suggesting that some sensorimotor challenges may be common in these two sports or it may be SEBT were not sensitive enough to pick up the differences. This could also be the justification for similar SEBT scores of field hockey player and football players that either the both the sport may be having some common sensorimotor challenges as both are highly dynamic activities or SEBT is not sensitive enough to find out the differences.

Considering difference in balance ability in various athletes of different sport activity, [3,4,8,9,28,29] it has been found that balance ability in gymnasts is superior to athletes of other sports [8,28]. But in a previous study done by Bressel et al [4], the football players displayed similar static and dynamic balance as compared to gymnasts and superior dynamic balance than basketball players. In other studies, it has been found that balance ability of football players have equal bipedal dynamic balance as compared to swimmers and superior unipedal static balance ability than basketball and swimmers [8].

Both football and field hockey are the highly dynamic sport activities [20]. It has been found that football and field hockey players (field games) are faster than volleyball and basketball players (court games) [30]. Kansal et al [31] studied intrasportive differences in maximum oxygen uptake and body composition of Indian players in field hockey and football and found that intrasportive differences in physique and physiological status of football and hockey players in different categories of players namely forwards, halves, backs and goalkeepers of the two games have almost the same comparative physique as for lean body mass, body weight and aerobic power are concerned. Also forward have greater VO2 max/ kg/min and percentage lean body mass in both the games followed by halves, backs and goal keepers.

Football players displayed superior balance than other athletes of different sports as well as non athletes [4,5,8,9]. Only Bressel et al [4] used eight directions of SEBT to compare dynamic balance in female collegiate football players with gymnasts and basketball players. Our SEBT scores for male football players were more (Mean ± SD = 768.92±21.66) than reported by them (Mean ± SEM = 756±14.0) on female collegiate football players. The differences in the SEBT scores may be due to neuromuscular differences among male and female athletes. Female athletes have decreased potential for dynamic stabilization of the knee joint along with strength imbalances as compared to male [32]. Also; it has been found that male football players showed higher gluteus medius EMG activity than female football players while performing a forward jump single landing task [33]. However, Gribble and Hertel, [11] reported no gender difference following normalization of excursion distance to leg length. The similar scores of SEBT in between male and female in their study may be because of fewer differences in neuromuscular characteristics as the subjects were not trained athletes. The SEBT scores of field hockey players were more difficult to compare as no study regarding dynamic balance in field hockey has been done. Although balance abilities in various athletes have been compared in many studies, [3,4,8,9,26,27] our study extends this knowledge to field hockey players. There is no difference in dynamic balance between field hockey players and football players, consequently, field hockey players also have superior dynamic balance score on SEBT (Mean±SD = 774.23 ±20.58) when compared to the score of basketball players (Mean±SEM=704±14). Therefore, it is postulated that if the dynamic balance of field hockey player is similar to football players; it is understandable that the balance ability in field hockey players would be better than non athletes and athletes of different sport.

SEBT is more dependent on neuromuscular characteristics such as lower extremity coordination, flexibility and strength[12]. The stance leg requires ankle dorsiflexion, knee flexion and hip flexion range of motion and adequate strength, proprioception and neuromuscular control to perform these reaching tasks[19]. The EMG activity of supporting limb during kicking action revealed that gluteus medius, gluteus maximus and vastus medialis were more active in some phases of kicking action [34]. The EMG study of stance limb while performing SEBT also revealed that activity of gluteus medius was more when performing reaching movements in anterior and medial directions while gluteus maximus and vastus medialis were more active in all three i.e. anterior, medial and posteromedial directions [35]. The use of these muscles in kicking action as well as performing SEBT can be the one of the reason for better performance of football players on SEBT. However, EMG study on muscle activity while performing SEBT included only 3 of 8 directions that were anterior, medial and posteromedial and only three muscles, gluteus medius, gluteus maximus and vastus medialis were quantified. There is no study to quantify more muscles of lower extremity and in all directions of SEBT and also to quantify muscle actions while performing different field hockey strokes, otherwise, it would have been easier to understand the role of particular muscles responsible for maintaining balance and for better performance of field hockey players on SEBT.

Thorpe and Ebersole [5] found that posterior reach direction of SEBT is correlated with hip extensor strength in football players. As field hockey players have shown identical dynamic balance to football players, it can be assumed that the normalized posterior reach distance is more in field hockey players than football players because of differences in hip extensor strength in between both the groups. We could not find the reason for increased lateral reach distance in field hockey players. Further EMG or individual muscle testing responsible for lateral excursion is required to understand the differences.

The results of our study demonstrate that the requirement of dynamic balance in field hockey is superior to other sports because of its highly dynamic nature like football. Field hockey players are also required to have better strength, range of motion, proprioception, neuromuscular control as well as sensorimotor function for better balance ability as well as athletic performance.

Many studies have proved that balance can be used as a predictor of injury risk factors [10,12,36-39]. It was found that athletes with poor balance or decreased balance were more prone to ankle injuries. All these studies suggest that pre-season balance assessment has been proved helpful in predicting risk factors for ankle injuries. However, in all these studies balance was assessed using different balance tests and equipment while Plisky et al [12] used SEBT to find out association of SEBT reach distances with risk of lower extremity injury in high school basketball players and found that the players with an anterior right/left reach distance difference greater than 4cm were 2.5 times more likely to sustain a lower extremity injury suggesting that components of the SEBT are more reliable and more sensitive test to predict injury risk factors in lower extremity and SEBT can be incorporated into pre participation physical examination to identify increased risk of lower extremity injury in basketball players. SEBT scores for field hockey players and football players in our study can provide normative values to predict the risk factors for lower extremity injuries in both the collegiate field hockey as well as football players.

Although this research has reached its aim, there were some unavoidable limitations. First because of the time limit, this research was conducted only on a small size of sample who were university football or hockey players. Therefore, generalizing the results for all football and hockey players with caution, the study should have involved more athletes at different levels. Second, the athletes overloaded practice session, to some extent, might affect the results of dynamic stability. Finally, the time consuming process might discourage participants' interest and motivation in joining to the study. Further studies should include larger sample size including various levels of players and using the more objective modern techniques of measuring dynamic balance such as a force-plate technology measure of dynamic postural stability.

CONCLUSION

Collegiate field hockey players did not differ with football players in terms of dynamic balance as measured by Star excursion balance test. The result suggesting that field hockey players also require superior balance like football players for better athletic performance and to prevent lower extremity injuries. SEBT scores for collegiate field hockey and football players can be used as normative scores to incorporate into pre participation physical examination to identify risk of injury in collegiate field hockey and football players.

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Conflict of interests: None

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