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Comparison of Static Balance in Different Athletes

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KEYWORDS Body Sway. Center of Pressure. Sway Path. Sports.Static Balance

ABSTRACT The purpose of this study was to analyze the differences in static balance during dominant and non-dominant one legged stance among athletes of different sports. The right-footed subjects of four groups; tennis (TEN), n=20; soccer (SOC), n=20; basketball (BSK), n=20; volleyball (VLB) n=20. The foot scan platform and foots can software were used for plantar pressure measurements during the Flamingo test. The software gave an image and quantified data of Centre of pressure (COP) and Sway path. The sway path was the average covered distance (surface) by COP during the 60 seconds test. The tennis players showed the best static balance of all groups on both leg ($p < 0.05$). No other significant differences were observed within groups. Further research needs to develop static balance of athletes in dominant and non-dominant leg.

INTRODUCTION

Balance is an indispensable motor skill, chiefly based on muscular synergies, which minimize the displacement of the center of pressure (COP) while maintaining upright stance, proper orientation, and adequate locomotion (Winearls 1972). It is actively controlled by the central nervous system, which processes the afferent visual, otolithic, and somatosensorial information (Lepers et al. 1997).

The maintenance of balance, static or dynamic, is an essential requirement for Excelling in sports like soccer, basketball, and gymnastics (Gerbino 2007). Davlin (2004) felt that any sport discipline induced specific postural adaptations, which were associated with the muscles involved and loads required to execute the specific movement. It has been demonstrated that sport training improved postural capacities, enhancing the ability to use proprioceptive information (somatosensory and otolithic) (Bringoux 2000). Golomer et al. (1999) advocated that professional dancers, when deprived of vision, were more able than sedentary subjects to use proprioception information to compensate for body sway. Two different studies (Paillard and Noe 2006; Paillardet al. 2006) demonstrated that, in soccer, the higher the level of competition, the more stable the posture and the less the visual information required for postural maintenance. Matsuda et al. (2008) examining COP sway characteristics of both legs during 60-sec static one-legged stance in athletes from different sports, showed demonstrated that soccer players had a better one-legged stance than swimmers, basketball players, and sedentary subjects. Moreover, none of the four groups presented laterality in their COP sway during the one-legged stance (Rahnama et al. 2005). Most soccer players prefer to use the dominant leg for kicking the ball to be more accurate and the non-dominant leg to support body weight. In fact, many drills performed (shooting, passing, heading and stopping) are executed in a few seconds whilst standing on one leg that normally is not the another factor may depend on the difference that soccer dominant leg. Although, the main cause for the high accident rate in soccer is physical contact with the opponent, soccer activity creates between the dominant and non-dominant leg; in fact, analyses of risk factors in elite soccer players informs that soccer has a high injury rate and that contact and overuse injuries predominantly occurs to the dominant leg (Ekstrand and Gillquist 1983; Faude et al. 2006). It is investigated the one-legged standing balance in volleyball, basketball, tennis, soccer players, who make strong use of their antigravity muscles during training.

Equilibrium of the body is the resultant of muscle, tendon and ligament working in the lower body and torso. Thus, the evaluation of balance is a measurement of physical fitness. By the Flamingo balance test has been a test item of the Euro fit test battery used to evaluate balance. An individual tries to keep his balance on one foot on a narrow pole. The number of times that

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a person loses his balance and has to place his other foot in 60 seconds is a record of balance. For a more correct measurement and evaluation of balance and stability more substantial quantitative data is needed. By the test has no such concrete data was produced yet. By performing the flamingo test on the foot scan plate, foot pressure distribution data (COP and Sway path) can be linked to balance and stability of the body. This data gives an objective and quantified image of balance and stability. By measuring the pressure under the foot, more than only stability in the foot and ankle will be measured. Unbalance of the body can be caused by many factors like ankle, knee or hip instability. When a person can't keep his body in balance during the flamingo test, foot scan images will show a larger sway path. A larger sway path, or a larger surface covered by the COP, means less balance or stability of the body. In contrast, a stabile body will show a very small surface covered by the COP.

The purpose of this study was to examine static balance of both dominant and non-dominant legs during 60-sec one-legged stance in tennis, volleyball, soccer, and basketball players. It was hypothesized that tennis players would display higher static balance.

MATERIAL AND METHODS

To evaluate the static balance during dominant and non-dominant one legged stance, we analyzed the COP sway path data of subjects standing on either right or left leg, respectively. The Flamingo test was used by a footscan® plate system (RsScan nv., 2m x 0.4m, 16384 sensors, 500 Hz, dynamic calibration with footscan® plate system).

In this study, 80 healthy male subjects were enrolled: 20 tennis players (TEN), 20 soccer players (SOC), 20 basketball players (BSK), and 20 volleyball players (VLB) (see Table 1). The TEN, SOC, BSK, and VLB groups played in the Turkish league. The criteria were: performance level (at least third division of the Turkish leagues), and dominant leg (only the right-footed subjects were included). Before the study, none of the subjects reported any injury. All subjects provided written informed consent prior to participation in the study. The Flamingo balance test was performed on the foot scan platform. The subject lifted one leg and tried to maintain body balance on the other leg for 60 seconds. This can be done barefooted. The test was performed twice, once for the left foot and once for the right foot. The mean height and body weight of BSK group were significantly higher than in SOC, VLB, and TEN groups ($p< .05$) (See Table 1).

Data

The foot scan platform and foot scan software were used for plantar pressure measurements during this Flamingo test. The software gave an image and quantified data of Centre of pressure (COP) and Sway path. The sway path was the average covered distance (surface) by COP during the 60 seconds test plus and minus one standard deviation. This data enclosed 68.27% of the normal distribution graph. The foot scan software also gave average sway path data every 10 seconds (Fig. 1).

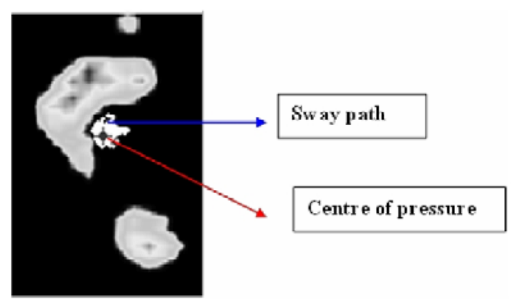

Fig. 1. Pressure under the foot during flamingo balance test. The total distance is the traveled way off COP.

Statistical Analysis

To evaluate and analyze the differences among groups and within group, dependent

Table 1: Demographics of the athletes

	Basketball	*Soccer*	*Tennis*	*Volleyball*	*P*
Age(years)	22.4 ± 2.4	24.5 ± 3.2	20.2 ± 2.3	22.3 ± 2.1	-
Height (cm)	185 ± 5.1	172 ± 4.9	170 ± 2.4	176.5 ± 4.3	< .05
Body weight (kg)	85.4 ± 8.7	74.5 ± 7.5	68.7 ± 2.5	70.5 ± 5.2	< .05

P<.05

variables between groups (COP sway path) were analyzed by general linear model analysis of variance (ANOVA) considering leg. If a significant difference was detected during ANOVA analysis, this was further evaluated by Bonferroni post hoc analysis. The Kruskal-Wallis test was used for the differences between the groups. Mann-Whitney U test was used analyze differences between the groups. The level of significance was set at $p < .05$. Values were expressed as mean ±SD. All statistical analyses were performed by using the IBM SPSS 20 (Chicago IBM Corp.) evaluation software.

RESULTS

To evaluate the static balance during dominant and non-dominant one leg stance, it was analyzed that the COP sway path data of subjects standing on the right and left leg, respectively. All groups, standing on the left leg and right leg, during the 60 second Flamingo test (see Table 2), the COP sway path, mean, the tennis players were the best score of the groups (right foot 511.18±2011mm, left foot 1285.02± 2060.1 mm).

Standing on the left leg2 and left leg3 sway path of BSK, VLB,TEN, SOC players were significantly different than the left leg1, left leg4, left leg5 and left leg6 sway path in 10 sec. time interval ($p < .05$),but standing on the right leg sway path in 10 sec. time interval were not significantly different (Left Leg2=.042 and Left Leg3=.024) (see Table 3).The difference of standing on the left leg2 and left leg3 sway path measures were not found between the BSK and the VLB players (See Table 4).The difference of standing on the left leg2 and left leg3 sway path measures were not found between the BSK and the SOC players (See Table 5)

DISCUSSION

The researcher observed that all groups, during right leg or left leg stance, had higher COP sway path measures basketball than other sports. The COP sway path, mean, were the best score in the tennis players during the 60 second flamingo test. Because a tennis player needs to be able start and accelerate from a stationary position, make a series of movements to cover the court then decelerate to strike the ball using static or dynamic balance, as a result of making a powerful stroke the player will be out of bal-

Table 2: Sway path score of athletes

		0-10 sec	*11-20 sec.*	*21-30 sec.*	*31-40 sec.*	*41-50 sec.*	*51-60 sec.*	*Total(mm)*
Basketball	Right foot	832.5±483.52	623.37±440.7	685.87±333.88	625.25±407.19	448.375± 221.69	548± 311.33	3763.37± 1893.73
	Left foot	824.25±833.73	557.75±308.81	540.12±414.73	563±412.1	459.87± 291.34	367.12± 178.77	3312.12± 2161.57
Soccer	Right foot	576.66±499.79	323.88±119.90	418.88±371.59	359.44±207.03	469± 581.86	462.11± 459.93	2610± 2024.25
	Left foot	486.66±550.06	415.66±384.93	317.44±241.65	456±416.49	381.33± 331.54	428± 459.28	2485.11± 2203.41
Tennis	Right foot	240.94±452.2	86.25±292.4	229.44±395.9	141.68±303.6	112.45± 250.3	165.95± 316.6	511.18± 2011
	Left foot	293.53±394.3	165.97±280.2	195.84±345.7	102.04±306.4	127.47± 290.6	540.86± 442.9	1285.02± 2060.1
Volleyball	Right foot	669.57±502.86	520.57±391.86	490.07±501.15	419.85±280.19	413.28± 235.18	444.92± 225.88	2958.28± 1557.27
	Left foot	509±361.91	314.78±200.67	299.92±193.31	449.28±618.52	369± 297.62	311.35± 233.87	2253.35± 1510.46

Table 3: Right and left leg of the data of the Kruskal-Wallis Test Results

Left foot	$L_{1\ 0\text{-}10\ sec}$	$L_{2\ 11\text{-}20\ sec}$	$L_{3\ 21\text{-}30\ sec}$	$L_{4\ 31\text{-}40\ sec}$	$L_{5\ 41\text{-}50\ sec}$	$L_{6\ 51\text{-}60\ sec}$	L_{Total}
Chi-square	4.086	8.223	9.436	4.146	3.847	2.812	7.084
Df	3	3	3	3	3	3	3
Asymp. Sig.	.252	.042*	.024*	.246	.278	.421	.069
Right foot	$R_{1\ 0\text{-}10\ sec}$	$R_{2\ 11\text{-}20\ sec}$	$R_{3\ 21\text{-}30\ sec}$	$R_{4\ 31\text{-}40\ sec}$	$R_{5\ 41\text{-}50\ sec}$	$R_{6\ 51\text{-}60\ sec}$	R_{Total}
Chi-square	4.150	3.288	5.303	5.095	3.959	4.637	4.233
Df	3	3	3	3	3	3	3
Asymp. Sig.	.246	.349	.151	.165	.266	.200	.237

Kruskal Wallis Test
Grouping Variable: Sports
* $p<.05$ (L_2 and L_3)

ance and will need to recover balance and change direction to prepare for the next stroke. A player will use a series of patterns of movements.

Standing on the left leg2 and left leg3 sway path were significant differences among all players than on the left leg1, left leg4, left5, left leg6 sway path in 10 second time interval.

The difference of standing on the left leg2 and left leg3 sway path measures were found between the BSK , the SOC players, and the BSK , the VLB players respectively. The BSK, the SOC and the VLB players have better standing balance on non- dominant leg. Paillard et al. (2006) conducted a study to evaluate the postural performance and strategy in the unipedal stance of soccer players and observed that balance of subjects standing on the non-dominant leg for 25 sec. was better in the subjects who were trained daily than in subjects who were trained biweekly. Matsuda et al. (2008) did not observe any laterality difference in soccer players during 60-sec one-legged standing balance, because, in our opinion, the acquisition time is longer than the duration time of a soccer drill. In the current study the results obtained from a 10-sec one-legged standing balance test showed that soccer players also had a better standing balance on the non-dominant leg, probably as a consequence of many hours of soccer practice during which they maintain standing balance for a few seconds on the non-dominant leg for kicking the ball with the dominant foot to have more precision (Hertel 2002). The soccer players prefer to kick with the dominant leg because they have better control or because they have better standing balance on the non-dominant leg; the higher incidence injury rate in the dominant leg may be influenced by the different ability to maintain standing balance between the dominant and the non-dominant leg (Ekstrand and Gillquist 1983). Tdid not observe significant differences within SOC, VLB, BSK players. The VLB group showed lower COP sway path results standing on the non-dominant leg than on the dominant one, while the BKS group had similar results on both legs. Basketball players should have many opportunities to use both legs during sport practices, which may have minimized any difference in balance ability between the legs; these results confirm the Matsuda et al. (2008) data. Volleyball players have to make various-jumps during a game, Therefore, they should have a better balance standing on non-dominant legs.

Table 4: For L2 and L3 value "Volleyball X Basketball" binary comparison (Mann-Whitney U)

	L2	*L3*
Mann-Whitney U	22.500	26.500
Wilcoxon W	142.500	146.500
Z	-2.684	-2.445
Asymp. Sig. (2-tailed)	.007	.014
Exact Sig. [2*(1-tailed Sig.)]	.005(a)	.012(a)

Not corrected for ties.
Grouping Variable: Sports

Table 5: For L2 and L3 value "Soccer X Basketball" binary comparison (Mann-Whitney U)

	L2	*L3*
Mann-Whitney U	14.000	7.000
Wilcoxon W	50.000	43.000
Z	-2.117	-2.791
Asymp. Sig. (2-tailed)	.034	.005
Exact Sig. [2*(1-tailed Sig.)]	.036(a)	.004(a)

Not corrected for ties.
Grouping Variable: Sports

CONCLUSION

The results of present study show that tennis players have better standing balance than others during unipedal stance (non-dominant leg). The repeated tennis drills, executed by tennis players in unipedal stance with the left leg used as the pivot, should modify proprioceptive factors and/or neuromuscular control and/or strength and stiffness generated around the joints and tendons of the non-dominant leg.

RECOMMENDATIONS

Further research is necessary to investigate which of these factors positively affect the static balance on the dominant and non-dominant leg.

LIMITATIONS

The inclusion criteria was being healthy (no serious orthopedic problems, neurological problems, etc.) for players. All players have right foot dominant leg.

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