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Postural Control of The Elite Deaf Football Players

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Abstract

Objectives: Childhood hearing impairment is a common chronic condition that may have a major impact on postural control. The aim of this study was to determine the postural control of the elite deaf football players and compare normal-hearing football players and sedentary deaf controls. Eighteen deaf football players, ten deaf sedentary controls, ten normal-hearing sedentary controls were included in study.

Methods: Postural stability was assessed both on bilateral stance and on single-limb stance with Biodex-Balance System on static surface, in eyes-open condition. Limits of stability testing were performed on bilateral stance.

Results: Statistically significant results were found in medial-lateral index (MLI) score of dominant and non-dominant legs among three groups respectively (p=0.027, p=0.045). In limits of stability testing significant differences were found for overall direction (p=0.008) and right direction (p=0.017) among three groups. There was a significant difference in MLI score of non-dominant leg (p=0.012) and in right direction of limits of stability test (p=0.016) between deaf athletes and deaf controls. Also there were significant differences found in MLI score of dominant legs (p=0.023) and overall (p<0.001) and right (p=0.008) direction of limits of stability test between deaf controls and healthy controls.

Introduction

Postural stability is defined, as the ability to maintain or control equilibrium in relation to the base of support to prevent falls and complete desired movements (Horak, 1987). It requires complex intermingled physiologic mechanisms involving the cognitive, motor, cerebellar, vestibular, and proprioceptive systems (Woollacott et al., 2002). Damage to cochlear systems causes balance deficits because of the anatomic and functional relationship

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of cochlear and vestibular systems (Rine et al., 2000). So that, deafness causes delayed motor development (Rine et al., 2000; Rine et al., 2004) and sensory organization deficits accompany to vestibular dysfunction in this population (Rine et al., 2004). Postural balance deficits are compensated by visual and somatosensory mechanisms in deaf population (Gheysen et al., 2008). However it was stated that this compensation does not equalize the postural control of deaf people with normal-hearing people (Brunt et al., 1982; Carlson, 1972; Siegel et al., 1991; Rajendran et al., 2012; Kluenter et al., 2009).

According to literature, postural control of deaf children improves up to 7 to 14 years and then plateaus, however remains inferior to normal-hearing children (Brunt et al., 1982; Carlson, 1972; Siegel et al., 1991; Rajendran et al., 2012). Deaf children have more difficulties than normal children while doing balance-related activities (Gheysen, 2008). Also deaf adults have been showed poor postural control in comparison to normal-hearing adults (Kluenter et al., 2009). Vestibular-specific neuromuscular training (Rajendran et al., 2009) and regular exercise (Effgen, 1981; Fotiadou, et al., 2002) was shown to have some benefits on balance.

Balance of deaf sportsmen was investigated in one study (Eliöz, 2013). In that study (Eliöz, 2013) a timed-flamingo balance test was used to assess balance abilities. They found balance ability of the deaf football players is better than deaf sedentaries. However a comprehensive analysis of balance was not done. The aim of this study was to compare the postural control of the elite deaf football players with sedentary deaf controls and sedentary healthy controls on both bilateral and unilateral stance and to compare limits of stability scores of elite deaf football players with sedentary deaf controls and sedentary healthy controls.

Methods

Eighteen deaf football players, ten deaf sedentary controls, ten normal-hearing sedentary controls were included in study. Each subject provided written informed consent before participating. Inclusion criteria were not having any systemic, orthopaedic or neurological disease; not having any lower extremity injury since past one year. Demographic data were obtained before assessments.

Assessments: Postural stability was assessed both on bilateral stance and on single-limb stance with Biodex-Balance System on static surface, in eyes-open condition. Subjects stood on bilateral stance while knees were extended and arms were crossed on contralateral shoulders and then were asked to stand in this position for 20 seconds. Test was done 3 times and average score was recorded. For single-limb postural stability assessment, the same procedure was repeated on single limb. It was made in 3 directions [overall (OSI), anterior-posterior (API) and medial-lateral (MLI)]. The order of testing was randomized. All assessments were done by the same expert. A high number indicates a lot of motion, which means the subject had difficulty to maintain his balance.

"Limits of stability" testing was performed on bilateral stance. Subjects were asked to shift their centre of mass in anterior, anterolateral, antero-medial, posterior, posterolateral, posteromedial, medial and lateral directions. Test was done 3 times and average score was recorded.

Statistical analyses were performed using the SPSS software version 15.0. The variables were assessed using Kolmogorov-Smirnov test to determine whether or not they are normally distributed. Due to low number of subjects and non-normally distribution of the variables Kruskal-Wallis tests were conducted to analyse the differences between three groups, and Mann-Whitney U test was used to analyse the differences between two groups. The Mann-Whitney U test was performed to test the significance of pairwise differences using Bonferroni correction to adjust for multiple comparisons. An overall %5 type-1 error level was used to infer statistical significance.

Results

Eighteen deaf football players, ten deaf sedentary controls, ten normal-hearing sedentary controls were included in study.

Table 1. Demographic profile of the subjects.

Parameters	Deaf football players	Deaf controls	Healthy controls
	Mean±SD	Mean±SD	Mean±SD
Age (years)	27,17±4,64	17,90±0,88	21,20±2,86
Height (cm)	177,17±4,23	170,20±8,68	173,86±5,18
Body weight (kg)	73,06±6,17	66,35±19,17	67,41±9,81
Body mass index (kg/m^2)	23,26±1,59	22,67±5,15	22,33±3,40

Hearing loss values of deaf football players and deaf athletes were given in Table 2. No differences were found in hearing loss values between deaf football players and deaf controls ($p>0.05$).

Table 2. Hearing loss values of deaf football players and deaf controls.

Parameters	Deaf football players			Deaf controls		
	Min.	Max.	Mean±SD	Min.	Max.	Mean±SD
Right hear hearing loss (dB)	15.00	115.00	70.11±23.58	30.00	76.00	60.00±13.55
Left hear hearing loss (dB)	45.00	120.00	77.06±20.32	30.00	82.00	61.50±15.15

SD: Standard deviation. Min: Minimum. Max: Maximum

Descriptive values of postural stability assessment were given in Table 3 and descriptive values of limits of stability assessment were given in Table 4. Statistically significant results were found in MLI score of dominant and non-dominant legs among three groups respectively (p=0.027, p=0.045). In limits of stability testing significant differences were found for overall direction (p=0.008) and right direction (p=0.017) among three groups. Post-hoc pairwise comparisons' results showed that there is a significant difference in MLI score of non-dominant leg (p=0.012) (Table 3) and in right direction of limits of stability test (p=0.016) (Table 4) between deaf athletes and deaf controls. Additionally significant differences were found in MLI score of dominant legs (p=0.023) (Table 3) and overall (p<0.001) (Table 4) and right (p=0.008) (Table 4) direction of limits of stability test between deaf controls and healthy controls.

Table 3. Descriptive values of postural stability assessment.

Parameters	Deaf football players Mean±SD	Deaf sedentary controls Mean±SD	Healthy controls Mean±SD
Bilateral stance			
OSI	0.48±0.18	0.60±0.33	0.58±0.12
API	0.37±0.12	0.48±0.33	0.49±0.09
MLI	0.21±0.17	0.26±0.13	0.24±0.17
Stance on dominant leg			
OSI	10.20±0.48	10.32±0.60	0.94±0.27
API	0.83±0.5	0.77±0.37	0.72±0.20
MLI	0.52±0.19	0.88±0.45*	0.43±0.22*
Stance on nondominant leg			
OSI	10.10±0.26	10.55±0.68	10.24±0.47
API	0.75±0.23	0.96±0.48	0.91±0.38
MLI	0.54±0.29*	0.99±0.50*	0.63±0.40

*Significant difference was found between groups (p<0.05). SD: Standard deviation.

Table 4. Descriptive values of limits of stability assessment.

Limits of stability assessment	Deaf football players	Deaf sedentary controls	Healthy controls
	Mean±SD	Mean±SD	Mean±SD
Overall	49.22±15.07	44.00±11.96*	61.67±8.50*
Forward	67.06±18.45	53.00±20.15	65.22±19.09
Backward	62.22±24.64	57.90±16.69	66.00±19.07
Right	62.39±18.11*	45.20±11.54*¥	65.89±15.67¥
Left	57.94±23.12	45.70±15.20	67.33±15.30
Forward-right	59.89±16.43	60.60±13.34	69.22±14.11
Forward-left	61.44±16.77	55.20±14.25	68.00±12.27
Backward-right	51.00±20.29	40.90±15.08	59.11±12.48
Backward-left	56.06±18.93	50.90±16.71	64.67±11.39

*,¥ Significant difference was found between groups. SD: Standard deviation.

Discussion

This study was done to investigate compare the balance abilities of deaf football players, deaf and healthy sedentaries. We found that deaf football players balance abilities were better than deaf sedentaries in some parameters. No difference was found between deaf football players and healthy sedentaries.

Eliöz et al. (2013) investigated the differences of balance among hearing-impaired football players, healthy football players and hearing-impaired sedentary people by flamingo balance test. They found that deaf football players have better balance ability than deaf sedentaries. The results of our research were in consistent with Eliöz et al.'s study (Eliöz, 2013). However, in this study a detailed analysis of postural stability was conducted. In postural stability test on bilateral stance we found no difference among three groups. The reason might be the requirement of less postural sway on bilateral stance than unilateral stance (Hazime, 2012) and all groups achieved this task similarly.

Postural balance is fundamental in allowing us to perform tasks and maintain daily life. In other words, postural stability has been defined as the ability to maintain an upright posture within the base of support (Lee, et al., 2007) and is considered to be an important indicator of musculoskeletal health and physical performance. Balance can be defined as the ability to return the centre of mass within the base of support to maintain body stability against perturbation (Alexandrov, et al., 2005). Decreased ability to maintain balance was seen in deaf sedentary people when compared with healthy sedentary people in MLI score of dominant leg's postural stability test and in LOS test in overall and right directions.

Additionally decreased ability of maintaining balance was seen in deaf sedentaries when compared with deaf football players in terms of postural stability of non-dominant leg (MLI score) and in right direction of LOS test. It can be seen that decreased balance abilities of deaf people are seen in medio-lateral direction in single limb stance postural stability test and in LOS test. Balance impairments of deaf people were linked to the function of the vestibular system because of the close anatomic relationship of the vestibular and cochlear systems (De Kegel et al., 2012; Shinjo et al., 2007). In patients with vestibular loss, maintaining balance was seen to be more difficult in medio-lateral direction than antero-posterior direction, (Mbongo et al., 2005; Mbongo et al., 2007) thus our results are in consistent with these studies and supported the literature.

Based on the findings of the present study, it can be suggested that deaf children should be oriented to the appropriate sports and physical activity to advance in their postural control.

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