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THE EFFECT OF 8 WEEKS CORE STABILIZATION TRAINING PROGRAM ON BALANCE IN DEAF STUDENTS

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Abstract

Aim: The purpose of this study was to examine the effect of core stabilization training program of balance in deaf students. Twenty seven deaf male students were selected.

Methods: Subjects were divided randomly into two groups, training (TRN: n= 14) and control (CTL: n= 13). The static balance was measured with the Balance Error Estimate System (BESS) and the dynamic balance was measured with the Star Excursion Balance Test (SEBT). TRN group performed a core stabilization program for 8 weeks and three times per week. The post-test of BESS and SEBT was done for two groups afterward. Independent and dependent t-test used to analyze the data.

Results: The results indicated a significant difference in BESS and SEBT over 8 weeks in for the TRN group ($P \leq .05$). Also The results indicated significant differences in four excursions (medial, postromedial, posterior and postrolateral) for TRN group ($P \leq .05$).

Conclusion: Core stabilization training program may improve the static and dynamic balance and can be used with other training programs.

***Key words**: core stabilization training, balance, deaf, BESS, SEBT*

Introduction

Balance is an important component of daily activity and athletic performance [1]. Balance plays a curtail role in almost all sport events. Either in shooting which requires the least amount of movements, or dynamic sports such as gymnastics and wrestling, which require agility in conjunction with maximum balance, balance plays a critical role in success and failure [2]. Specialists believe in the important role of posture control and balance in doing tasks such sitting, standing and walking.

The core encompasses the lumbopelvic-hip complex (with 29 muscles of insertion) in which the center of gravity is located and where all movements begin [3]. Core stability is the motor control and muscular capacity of the lumbopelvic-hip complex. Normal function of the stabilizing system is to provide sufficient stability to the spine to match the instantaneously varying stability demands due to changes in spinal posture and static and dynamic loads [4]. Panjabi [4] proposes that spinal stabilization is dependent on the interplay between passive, active and neural control systems so that if deficit occurs in one of the systems, other systems will try to compensate the deficit. Core instability occurs if created deficit do not eliminate [4].

Studies showed the role of core stability on improving the athletic function and performance along with prevention of injury. Clarc [5] stated that the core function to maintain postural alignment and dynamic postural equilibrium during functional activities, which helps to avoid serial distortion patterns, thus improving athletic performance. Leetun [6] suggests that core stability is one of the factors related to lower extremity injury. Also core stabilization training is a main portion of rehabilitation programs in people with low back pain [7].

There is experimental evidence from studies that core stabilization exercise has beneficial effects on balance control [8]. These studies are done on athletes so that core stabilization training program is included in athletic movement. Also, there are different reports about type and time of training protocol. In this study we attempt to investigate the effect of core stabilization training on balance in people with imbalance problems. Regarding the role of vestibular system in maintaining balance, ears are taken in to account as the sensory-balance limbs. Some studies reported that compared to healthy people, deaf ones have less skills in balance and they rely on sight outputs in balanced tasks [9]. Therefore, the aim of this study is to assess the outcome of an eight weeks core stabilization training program on static and dynamic balance in deaf students.

Methods

Subject

Subjects were 27 high school male students (mean age: 17.47±1.03 yr, height: 170.5±5.05 cm and weight:

60/25± 6/21 kg) that all of them were deaf. Degree of hearing loss was obtained from records of audiometric testing. All of the subjects had either severe or profound hearing losses, greater than 75 dB [9]. Subjects signed an informed consent form and answered a demographic/injury history questionnaire, which was used to obtain background information from each subject. They were free of lower and upper extremity pathology, neurological and visual disorders, and none of them used medication and did not perform any core stabilization, strengthening and balance program within the past six months and they were matched in age and physical activity level.

Core stabilization training protocol

The subjects in the training group met three times per week on alternating days to perform the training program. The estimated time for completing the core stabilization training program was approximately 30 minutes per session. The training programs were administered and supervised by the principal investigator. This program consisted of three levels that subjects began at exercise level one and proceeded to the next level according to the protocol for that day. Level 1, included Static holds in stable environment; level 2, included dynamic movement in a stable environment; level 3, included dynamic movements in an unstable environment such as Swiss ball and resisted dynamic movement in an unstable environment. See core stability training program in this study (Table 1).

Table 1. *Core stabilization training program*

First level
Hollowing abdominal in supine position
Hollowing abdominal in prone position
Hollowing abdominal in quadruped position
Hollowing abdominal in supine position with curling foot
Hollowing abdominal in prone position with curling foot
Side bridging
Second level
Bridging with hollowing abdominal
Pelvic bridging
Squat with Swiss Ball
Dying bug with hollowing abdominal
Seated on Swiss Ball with hollowing abdominal
Third level
Pelvic bridge with Swiss ball
Bird dog
Twist on Swiss ball
Bird dog exercise on Swiss ball
Diagonal curls on Swiss ball
Side bridging with arising one leg

Balance test

Static balance was tested using the Balance Error Scoring System (BESS) and dynamic balance was tested by Star Excursion Balance Test (SEBT). The BESS involved 3 stance positions each on the stable and unstable surface. The 3 stance positions were double-leg stance with feet together, single-leg stance on test limb with contralateral knee in approximately 90° of flexion, and tandem stance with the foot of the test limb in line and anterior to the foot of the contralateral limb (the heel of the test foot touching the toes of the back foot). Each position was held with eyes closed and hands on hip for 20 seconds in duration, and scoring was determined by recording of errors: (1) opening eyes; (2) lifting hands from hip; (3) touchdown of non-stance feet; (4) step, hop or other movement of the stance foot or feet; (5) lifting forefoot or heel; (6) moving hip into more than 30° of flexion or abduction; and (7) remaining out of position for longer than 5 seconds (Fig. 1) [10].

Fig. 1. *Subject performing Balance Error Scoring System test. (The 3 stance positions involve double-leg stance with feet together, single-leg stance on test limb with contralateral knee in approximately 90° of flexion, and tandem stance with the foot of the test limb in line).*

The SEBT involved a taped star pattern with eight excursions each at 45 degrees from each other, on an even floor surface. Subjects placed their non-dominant foot on the middle of the star pattern, while their dominant foot reached as far as possible to each of the eight excursions (anterior excursion, anteromedial excursion, medial excursion, posteromedial excursion, posterior excursion, posterolateral excursion, lateral excursion, anterolateral excursion) while maintaining a single leg stance while reaching with the opposite leg to touch as far as possible along a chosen excursion. They touched the farthest point possible, and as light as possible, along a chosen excursion with the most distal part of their reach foot. Subjects were then instructed to return to a bilateral stance while maintaining their balance. A practice session of 6 times in each excursion followed by a one minute rest and then the measured average of three trials for each excursion was recorded as the subject's dynamic balance scores. Trials were discarded and repeated if the reach foot was used

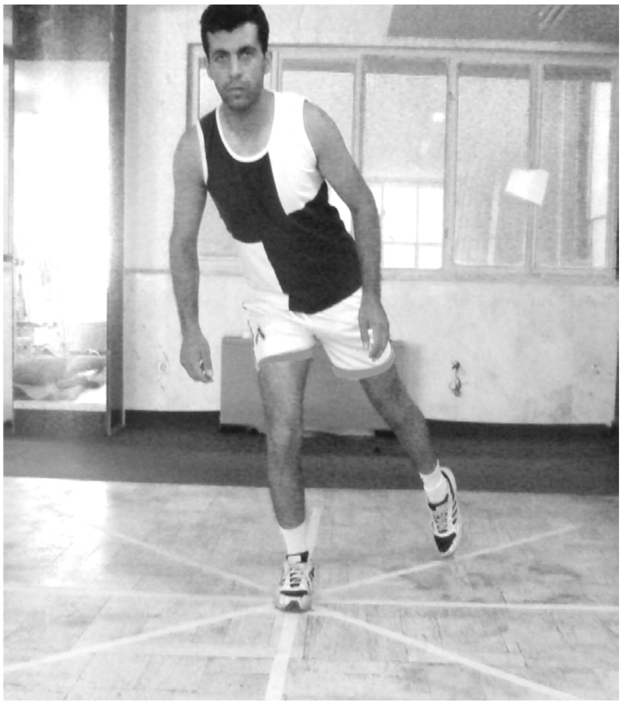

Fig. 2. *Subject performing Star Excursion Balance Test into postrolateral direction*

to provide considerable support when touching the ground, the stance foot was lifted from the center of the star grid or if the subject was unable to maintain balance throughout each excursion (Fig. 2). Additionally, the leg length of the subject's dominant extremity was used to normalize their dynamic balance scores (excursion length/leg length x 100) for a percentage of an excursion distance in relation to the subject's leg length) and used for data analysis [11].

Procedure

At the orientation meeting, subjects were explained the purpose of this study, training protocol and balance test. The participant's dominant leg was noted and measured, as determined as the leg that would normally be used to kick a soccer ball [11]. Subjects were categorized randomly into two groups, training (TRN: n=14) and control (CTL: n=13). Training group performed a core stabilization training program for eight weeks. The control group did not perform any of the training exercises. Subjects did balance tests one week prior to the beginning of the core stabilization training program (pre-test) and one week after the conclusion of the core stabilization training program (post-test). An independent t test was conducted to compare pretest and posttest between groups. In addition, a depended t test used to compare pretest and posttest in each group. The experiment wise alpha level was set at $P<.05$. For SEBT, Bonferroni corrections were utilized, resulting in an adjusted significance level of $P< .006$ (see note in Table 4).

Results

Table 2 shows Mean and Standard Deviation of the general characteristics of subjects in training and control groups.

Table 3 shows Mean and Standard Deviation of post test and post test of BESS in training and control groups. No Significant differences were found between groups in pretest of static ($P>0.05$) and dynamic balance ($P>0.006$).

The results indicated a significant difference was found between pretest and posttest of static balance for training group ($P\leq0.05$) which was not significant in control group ($P>0.05$) (table 3).

Table 3. *Pre and post Test Data for the Balance Error Scoring System*

Table 4 showed a Significant difference between pretest and posttest of dynamic balance for training group ($P<0.006$) while in control group it was not significant ($P>0.006$). The results showed that no significant difference for pretest of BESS ($P>0.05$) and all excursions of SEBT ($P>0.006$). A significant difference was found between groups for posttest of BESS (t = 2.468, P = 0.021). Significant differences between groups was found in medial excursion (t = 2.212, P =

Table 2. *General Characteristics of Subjects*

Group	Age (yrs) Mean ± SD	Height (cm) Mean ± SD	Weight (kg) Mean ± SD
TRN	17.32±2.3	169.67±6.3	59.45±7.5
CTL	17.14±1.45	171.33±5.8	61.05±6.4

Table 3. *Pre and post Test Data for the Balance Error Scoring System*

Variable	Group	Pre-test Mean ± SD	Post-test Mean ± SD	t	*P*-value
BESS	TRN	13.5±1.78	10±2.24	4.446	0.001*
	CTL	13.38±1.38	12.31±1.51	3.818	0.560

* Significance at the 0.05 level ($P<0.05$)

Table 4. *Descriptive Statistics for the Pre and post Test Data for the Star Excursion Balance Test*

excursion	group	pretest Mean ± SD	posttest Mean ± SD	t	*P*-value
Anterior	TRN	105.81±25.82	109.97±12.54*	3.768	0.002
	CTL	105.45±8.02	106.22±9.21	1.143	0.276
Anteromedial	TRN	105.46±5.94	108.40±8.34*	3.920	0.002
	CTL	103.09±9.93	103.69±7.1	0.962	0.355
Medial	TRN	100.59±6.34	105.59±7.50*	3.672	0.003
	CTL	98.49±9.31	99.94±13.69	2.548	0.26
Posteromedial	TRN	94.33±5.18	101.35±11.44*	4.521	0.001
	CTL	93.55±11.62	94.46±8.30	1.670	0.121
Posterior	TRN	92.30±9.44	100.91±14.21*	5.188	0.000
	CTL	90.95±13.01	92.33±10.45	0.893	0.389
Posterolateral	TRN	90.78±8.87	97.89±9.87*	3.738	0.003
	CTL	85.02±10.87	86.54±9.61	3.049	0.10
Lateral	TRN	87.90±7.51	98.09±7.49*	4.692	0.000
	CTL	84.05±9.79	85.95±12.21	1.532	0.151
Anterolateral	TRN	88.55±12.49	94.87±15.23*	1.890	0.002
	CTL	89.05±12.20	89.04±8.74	0.018	0.944

Note. Scores adhere to a Bonferroni correction level of significance of $P < 0.006$ (0.05 divided by number of reaching directions, 8). *$P < 0.006$.

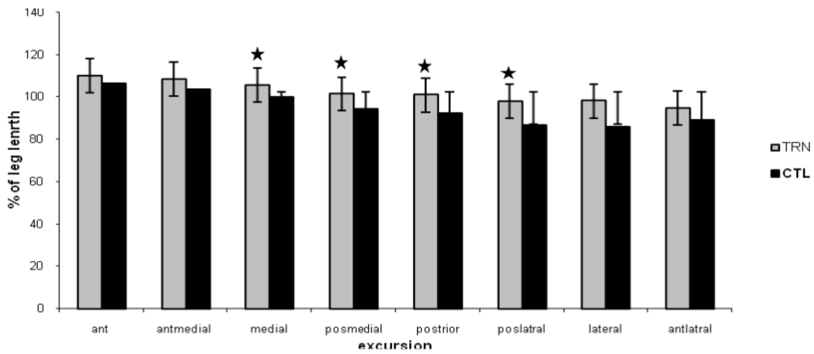

Fig. 3. *Star excursion balance Test (SEBT) value. ★ Indicates that there are significant different between training and control group*

0.004), posteromedial excursion (t = 1.946, $P = 0.005$), posterior excursion (t = 2.228, $P = 0.002$) and posterolateral excursion (t = 3.367, $P = 0.003$) (Figure 3).

Discussion

The purpose of this study was to examine the effect of core stabilization training program on static and dynamic balance in deaf students. Results showed that core stabilization training improved both of static and dynamic balance in deaf students. There was significant difference in posteromedial, posterior, posterolateral and medial for training group. The findings of this study was consistent with results of studies like Carpes et al. [12], Petrofsky et al. [13] and Cosio-Lima et al. [14], who noted that core stabilization training results in improving the balance but was not consistent with Piegaro [15], Swaney & Hess [16] and Lewarchick et al. [17]. Although there were some basic similarities in their findings, the subject population and design of the studies were different. In the Piegaro's study [15] 39 healthy subjects were divided into four groups (core, core/balance, balance training, and a control group), whereas the present study worked on deaf students. Swaney and Hess [16] used healthy subjects for their control group and swimmers, while Lewarchick et al. [17] used healthy controls and football athletes. Since there is no universally accepted standard for core stabilization training program, it is not known what type, frequency or duration of exercises should be prescribed. Piegaro [15] conducted a four weeks program in which the specified training programs were conducted two times a week for four weeks, instead of three times a week for five weeks. Swaney and Hess [16] did a nine-week program, and Lewarchick did a seven weeks program. Also, Piegaro, Lewarchick and Swaney used laboratory methods for assessing the balance such as Biodex Stability System while here the functional test was applied. Furthermore, in more previous studies was focused on contraction and strengthening of global muscles, but in this study was tried to strength deep and local muscles of core in training program.

Gribble [18] and Hertel et al. [19] noted posterior, postromedial and medial reach directions were the easiest directions to reach but anterior, anterolateral and lateral reach directions were the most difficult ones. It is surprising that in this study, core stabilization training had the greatest improvement for the easiest reach directions while had the least improvement for other directions. Hertel et al. [19] found the SEBT requires neuromuscular control through proper joint positioning and strength from the surrounding musculature, throughout the test.

Contraction of core stability muscles before initiation of limb movements, which is the feedforward posture reaction from neuromuscular system, shows that voluntary movement of the upper extremity is preceded by postural movements occurring in the lower extremity (pelvis, hips and trunk) that contributes to general dynamic organization of balance and inhibits postural disturbances. Core stabilization training program leads to sequencing the anticipatory activity and then reduces early perturbations of the center of gravity, which is a benefit for the individuals who need to remain in constant postural control [20].

It is important to train movements and not muscles, so that everything works together. Training movements integrates and improves the function of the neuromuscular system in postural control [8]. Furthermore the core is important because it is the anatomical location in the body where the center of gravity is located and movements stem from, therefore it seems strengthening of muscles of core causes the improvement of neuromuscular system and decrease of center of gravity displacement and sway [5]. Core stabilization training improves neuromuscular system efficiency which leads to optimal arthrokinematics in the lumbopelvic-hip complex during functional kinetic chain movements, optimal acceleration, deceleration, optimal muscular balance and provides proximal stability for efficient lower extremity movements [20]. This effects lead to optimal function and lower extremity muscles strength, that can eliminate produced torque during reaching in SEBT. Consequently Subjects can obtain more reach distance in SEBT. In this study, the applied training protocol was so that subjects performed their task on unstable surface such as Swiss ball, and this challenged their balance.

Results of our study showed no significant difference in anterior, anteromedial, lateral and anterolateral. It seems that core stabilization training had fewer effects on neuromuscular system control and muscles strengthening in these directions. One reason for this may be that these directions appeared to be the most difficult ones. Hodges and Richardson [21] suggested making sure that the proper contractions occurred during the core stabilization training program which was paramount for determining the amount of neuromuscular control that would be contributing to the SEBT for optimum effects. However, our study did not implement any invasive techniques for measuring muscle activation. Only subject feedback and visual observation by the principle investigator served as the assessment of core activation, it is possible that subjects during core stabilization training were not able to contract stability muscles well. In conclusion, core stabilization training may be used to enhance dynamic balance in deaf students and is applied in the clinical setting.

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