Science Arena Publications
Speciality Journal of Sport Sciences
Available online at www.sciarena.com
2016, Vol, 1 (1): 24-34

The impact of rebound therapy on postural control of hearing-impaired people

Marzieh Ghavaminejad [1] , Gholam Ali . Ghasemi [2]
1. Graduate student , sport pathology group and remedial motions , sport sciences college , Esfahan Azad university , Esfahan unit (khorasgan), Esfahan, Iran;
Email address of responsible writer Ghavaminejad@yahoo.com
2. Associate Professor, Sport pathology group and remedial motions, sport sciences college, Esfahan university, Esfahan, Iran

Abstract: Researchers and clinicians have considered rebound therapy exercise as a new training method that causes mechanical stimulation of the neuromuscular system. With regard to the relationship between neuromuscular system performance and balance as integral part of everyday sport activities, the aim of this study was to examine the impact of rebound therapy on postural control of hearing-impaired people. In this study, 32 hearing-impaired students with mean and standard deviation (Age: 16.22 ± 1.641 years, weight: 52,88 ± 10.070 kg, height: 158.09 ± 7.239 cm) were voluntarily participated in this study and were randomly divided into two groups: control (n = 16) and experimental (n = 16) groups .Before applying training program, static and dynamic balance was measured using stork balance test and balance Y test. Experimental group performed rebound exercises that involved aerobic, strength, resilience, and safe jumping in eight weeks and three sessions per week for 30 to 45 minutes. After the end of the period, two experimental and control groups underwent post-test. ANOVA test was used for duplicate data to analyze the data. The findings showed that rebound therapy exercises have significant effect in three directions (anterior, posterior internal, posterior-external) of dynamic balance test and stork balance test. According to the findings of the study, rebound exercises can be recommended to improve postural control and improvement of the balance hearing-impaired people.
Key words: rebound therapy exercises, postural control (static and dynamic balance)

INTRODUCTION

Hearing-impaired people problems are often considered merely from communicative aspect. Communicative problem is the main defect caused by hearing loss, but hearing loss is also associated with other health issues. In this regard, balance deficit with damage to sensory integration and motor development is one of the defects seen in hearing-impaired people (1). According to the general system theory, the sensory systems that include the vestibular system of the inner ear, visual sense, and somatosensory sense play an important role in maintaining physical stability and balance. Damage to parts of the cochlear-atrial nerve not only causes sensorineural hearing loss, but also due to damage to vestibular branch of this nerve, it might be associated with balance problems, and this is a reason why about 40% of deaf people are faced with the problem of balance (2). In various studies, the balance deficit in hearing-impaired people compared to normal people has been discussed. Moresh (1963) compared the vestibular performance of hearing-impaired people and normal people at high school level. He observed that hearing-impaired people compared to normal people showed weaker performance (3). Gill (1990) compared the static and dynamic balance of hearing-impaired children and normal children and concluded that hearing-impaired children have less dynamic balance compared to normal people, but there was no significant difference between them in terms of static balance (1). Balance is one of the integral parts of all the daily activities and a key part for performance of athletes (4). For postural control, the person should maintain his body in space and produce appropriate force to maintain or correct the position of his body, which it requires a complex relationship between the sensory, musculoskeletal, nervous systems (5). To stand, central and peripheral components of nervous system act in interaction with each other in an appropriate way, and muscles and nervous system processes peripheral data, and they selects the most appropriate muscle response for postural control (6). Balance in a closed kinetic chain is maintained and it is impaired as result of dysfunction in sending afferent sensory information or dysfunction in mechanical strength and power of each joint or lower limb structures (7). In addition, the lowest part of this chain is the foot that provides small range of reliance level for maintaining the balance. Therefore, it is logical that its small biomechanical changes to affect the balance control (8). During the daily activities and properly performing of sports skills, maintaining the postural status of the body is essential and its measurement in laboratory clinical environment is used as a tool to assess sustainability and neuromuscular control in healthy people and patient people (9). The control of postural status has been defined as controlling and maintaining the body status in space to achieve sustainability and the orientation of body (10). The control of postural status of body can be classified as maintaining a situation with minimal motion (static balance), maintaining a situation while the level of reliance is displaced (semi-dynamic balance) and maintaining the stability reliance level while a described motion is implemented (dynamic balance) category (11, 12). In this regard, maintaining static postural status can be defined as a functional task without getting involved of a part of the reliance level (13) observed in most of skills such as backhand hit in tennis or shoot in football. This type of control of the postural status of the body is maintained using data collected by the mechanical receptors found in the inferior limbs, trunk, and combination of visual, vestibular, and sensory-motor data in order to create the appropriate motor responses to control the status of the center of mass in the range of reliance level (12). Some studies have been conducted on rebound therapy as a training method which its main component is rebounder (mini trampoline) (14). Many of the studies have reported the positive effects of rebound therapy on human body in physical therapy and therapeutic environments. Rebounds therapy exercises are among the plyometric exercises, which include jumping up and down, landing on two feet, landing on one foot, and diverse movements of the shoulders, arms, hands, torso, thighs, knees and feet (14). Although trampoline is used since 1950 in various trainings, the concept of rebound therapy was defined and used by Anderson et al for the first time in 1970, while working on children with physical and learning disabilities (15-16). Lawrence (2004) introduced mini-trampoline as a safe and useful means for practicing all parts of the body, by combining the principles of jumping exercise and plyometric exercises, providing health and safety framework for all ages and with all levels of ability to achieve the benefits of health. They believe that rebound therapy exercises performing using simple jumping exercises on trampolines body fat reduces, legs, thighs, abdomen, arms and hips are strengthened, and agility increases, and muscles become powerful (18-17). In rehabilitation environments, rebound therapy used in training and rehabilitation programs, since rebound therapy has been considered as positive practice to increase muscle strength, vertical jump, balance of body, mechanical functionality of the bones, bone mineral density, as well as raising levels of health, and even injury recovery (20-19). Smith and Cook (2007) named advantages of this method as muscle stretching change, relaxation, stimulating balance reactions, status mechanism and facilitating the movement of the movements. They believed that this type of exercises stimulate the paths related to cardiovascular and respiratory functions. Therefore, the use of trampolines in rebounds therapy increases the awareness of patients with neurological disorders and it increases cardiovascular and respiratory function and activates movements during sensory systems stimulation (21-15). It has been proven experimentally that the gravitational forces of the jump in rebounds therapy help lymph flow. In addition, any physical activity, especially low-impact activities such as jumping, is useful in rebound therapy, since lymphatic system requires muscle contraction to return to liquid lymph around the body (18). According to Smith and Cook (1990), rebound therapy can improve balance and coordination (21). According to what was said above, assessing the balance situation of hearing-impaired people plays major role to be aware of the type of potential disruption and providing required consulting to them and their families in the field of environmental and recreational experiences. Therefore, the aim of this study was to examine the effect of rebound exercises on controlling the postural control of hearing-impaired people.

Methodology

This study is a quasi-experimental study in which the effect of rebound therapy exercises on postural control was measured through pre-test and post-test. Subjects of study included 32 female hearing - impaired students less than 30 dB with mean and SD (Age: 16.22 ± 1.641 years, weight: 52.88 ± 10.070 kg, height: 158.09 ± 7.239 cm). In all sports, the ability to maintain body balance and stability in a balanced status are very important, especially in sports such as basketball, gymnastics, martial arts and maintaining a body position without additional movement is a great privilege, and obtaining a balanced status is an essential (23-22). Hence, subjects of the study who were studying in Mir high school of Isfahan city were selected using available sampling, and they randomly divided into two groups: control (n = 16) experimental (n = 16) groups.

Balance Y test: This test is based on the test adopted from stars balance test that Gribble considers it as a valid test for the evaluation of dynamic balance. In this test, three directions (anterior, posterior-internal, and posterior-external) are placed in the form of Y and at angles of 135, 135 and 90 degrees relative to each other. In order to run this test, the actual length of the leg, from anterior-upper iliac spine to inner ankle is measured (26-25-24). After explaining the implementation of test by tester, each participant practiced the test four to learn its procedure. In addition, before starting the test, dominant leg of subjects was determined so that if the right foot is dominant, test to be done in counter clockwise way (Figure 1) (26-25-24).

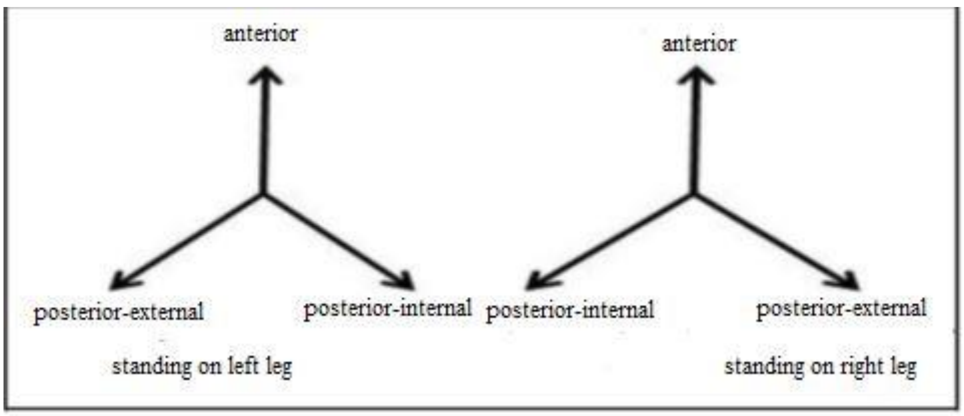

Figure 1- general view of dynamic balance test

The subjects with the dominant leg (single leg) were placed at the center of the star, and until they make no mistake, (leg does not move from center of the stars, does not rely on the leg performing the access action, or the person does not fall), he moved toward in line with the current line. Then, he backed to normal status on two legs. The distance of free leg contact place to center is the access distance. Each of the subjects performed each of the directions three times, and finally their mean was calculate, and it was divided into length of the leg (by CM) and multiplied by number 100 so that the access to be obtained by percentage of the leg length size (27).

Stork balance test: this test involves a constant position in which the subject stands on a flat surface without shoes. He lays hands on hips. Then, he puts the non-anchor leg (dominant leg) adjacent to knee of the anchor leg (non-dominant leg). Subjects practice this situation for a certain period. Then, he lifts the hill to establish the balance on his fingers. The time that subjects lift the hill from ground, chronometer starts working. The length of time that subject can maintain this status is considered as privilege and when he does an error, chronometer stops. Errors in this test include lifting hands from the thighs, swinging anchor leg in any direction, separation of non-anchor leg from the knee and touching the ground by the heel of the anchor leg (Figure 2) (28-29).

Figure 2- view of Stork balance test

In order to apply rebound therapy exercises, the standard protocol defined by Grubel (2006) was used. This exercise protocol includes safe jump, aerobic jump, strength jumps, resistance jumps, which experimental group performed these exercises at eight weeks, three sessions per week for 30 to 45 minutes.

Table 1. Training programs rebounds experimental group

Table 1- the program of rebound exercises in experimental group

Sessions	Movements	Minute
First week	Organizational and physical readiness (Changing clothes, observing hygiene and safety tips, slow walking, stretching and stationary movements)	10
	Movements related to be familiar with the device (such as standing, walking, etc.)	25
	Return to initial position (Walking, stretching, dressing, collect belongings)	5
Second week	Organizational and physical readiness (Changing clothes, observing hygiene and safety tips, slow walking, stretching and stationary movements)	10
	Movements in a sitting position	25
	Return to initial position (Walking, stretching, dressing, collect belongings)	5
Third week	Organizational and physical readiness (Changing clothes, observing hygiene and safety tips, slow walking, stretching and stationary movements)	10
	Movements in a sitting and interstitial position	25
	Return to initial position (Walking, stretching, dressing, collect belongings)	5
Fourth week	Organizational and physical readiness (Changing clothes, observing hygiene and safety tips, slow walking, stretching and stationary movements)	10
	Movements in standing position in elementary form	25
	Return to initial position (Walking, stretching, dressing, collect belongings)	5
Fifth week	Organizational and physical readiness (Changing clothes, observing hygiene and safety tips, slow walking, stretching and stationary movements)	10
	Jerking and jumping movements	30
	Return to initial position (Walking, stretching, dressing, collect belongings)	5
Sixth week	Organizational and physical readiness (Changing clothes, observing hygiene and safety tips, slow walking, stretching and stationary movements)	10

	Jerky and jumping movements with high intensity	30
	Return to initial position (Walking, stretching, dressing, collect belongings)	5
Seventh week	Organizational and physical readiness (Changing clothes, observing hygiene and safety tips, slow walking, stretching and stationary movements)	10
	Jerky and jumping movements	30
	Return to initial position (Walking, stretching, dressing, collect belongings)	5
Eighth week	Organizational and physical readiness (Changing clothes, observing hygiene and safety tips, slow walking, stretching and stationary movements)	10
	Jerky and jumping movements	30
	Return to initial position (Walking, stretching, dressing, collect belongings)	5

A day before the rebound therapy exercises, two groups subjects underwent pre-test after 10 minutes warm up (slow walking, stretching the muscles of the hamstring, quadriceps, the muscles of the gluteal, twin, soleus). In the next day, the experimental group subjects after a 10-minute warm-up (stretching) started rebound therapy exercises. This issue caused that they can use their feet bones better during the program. After the end of the exercises period, two groups of experimental and control underwent post-test. In order to summarize and classify data, descriptive statistics in the form of mean average and standard deviation were used. Analysis of variance for duplicate data in SPSS version 19 software was used for the analysis of data and the significant level in all analyses was considered 0.05.

Results

Demographic information on age, height, weight of the subjects is given in Table 2. Demographic characteristics indicated no significant differences between the experimental and control groups in any of the variables. Therefore, experimental and control groups can be considered homogeneous at the beginning of the study.

Table 2. Demographic characteristics of subjects

factor	n	Group	mean ± SD	T	p
Age	32	rebound	15/56±1/31	-2/436	0/436
		Control	16/88±1/70		
Height	32	rebound	155/94±6/51	-1/739	0/422
		Control	160/25±7.47		
Weight	32	rebound	49/87±6/22	-1/739	0/109
		Control	55/88±12/31		

p= significance level *significance at the level of 0.05

According to information shown in Table 3, the mean record of static balance in pre-test in both of the experimental and control groups was respectively 7.43 and 14.83 seconds, and it was 32.43 and 3.5 seconds in post-test, respectively. The mean of these differences was statistically significant (F=16.030 and P=0.001). In other words, inter-group differences between different research groups during two stages of test taking were matched (P<5%). In Figure 3, we see that the slope of the line in the experimental group is more than that in the control group. This means that there is significant interaction between the two groups (F=53.643 and P=0.001). In other words, by separately considering of score changes in each of the two groups, internal changes pattern significantly differs between the two groups. Inter-group comparison showed significant progress or regress in total scores of two groups (F=7.622 and P=0.001).

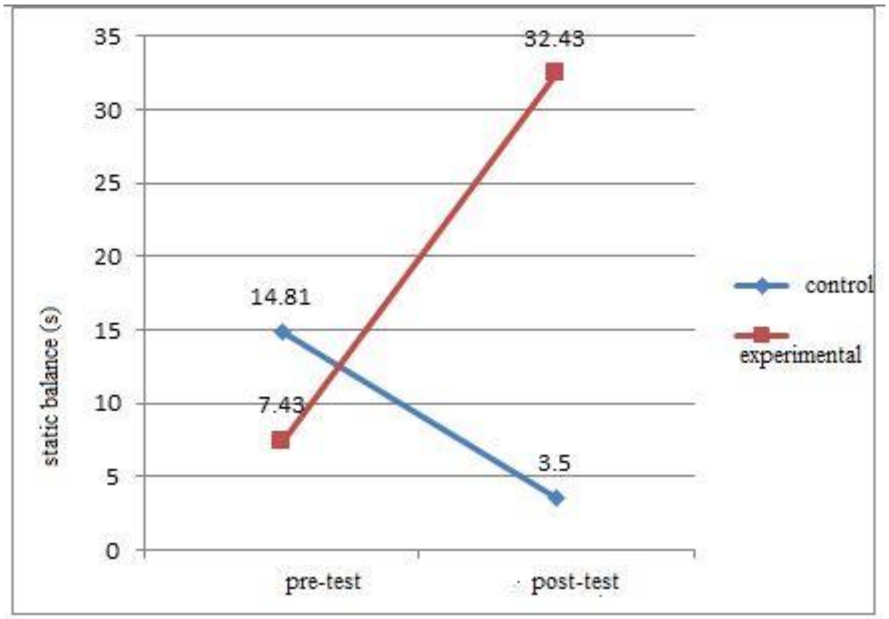

Figure 3- linear diagram of static balance test

The mean record of dynamic balance in anterior part in pre-test in two experimental and control groups was respectively 101.64 and 73.71 steps, and it was 115.84 and 72.04 steps in post-test, respectively. The mean of these differences was statistically significant (F=6.532 and P=0.001). In other words, inter-group differences between different research groups during two stages of test taking were matched (P<5%). In Figure 4, we see that the slope of the line in the experimental group is more than that in the control group. This means that there is significant interaction between the two groups (F=88.367 and P=0.001). In other words, by separately considering of score changes in each of the two groups, internal changes pattern significantly differs between the two groups. Inter-group comparison showed significant progress or regress in total scores of two groups (F=55.089 and P=0.001).

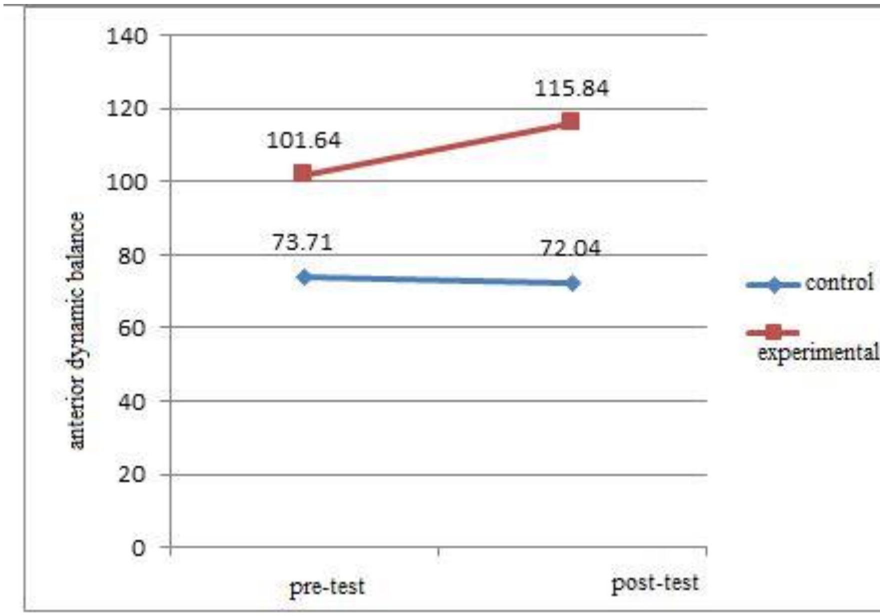

Figure 4- Linear diagram pf changes in dynamic balance test (anterior part)

The mean record of dynamic balance in internal part in pre-test in two experimental and control groups was respectively 123.82 and 94.51 steps, and it was 137.84 and 93.67 steps in post-test, respectively. The mean of these differences was statistically significant (F=32.788 and P=0.001). In other words, inter-group differences between different research groups during two stages of test taking were matched (P<5%). In Figure 5, we see that the slope of the line in the experimental group is more than that in the control group. This means that there is significant interaction between the two groups (F=54.670 and P=0.001). In other words, by separately considering of score changes in each of the two groups, internal changes pattern significantly differs between the two groups. Inter-group comparison showed significant progress or regress in total scores of two groups (F=43.005 and P=0.001).

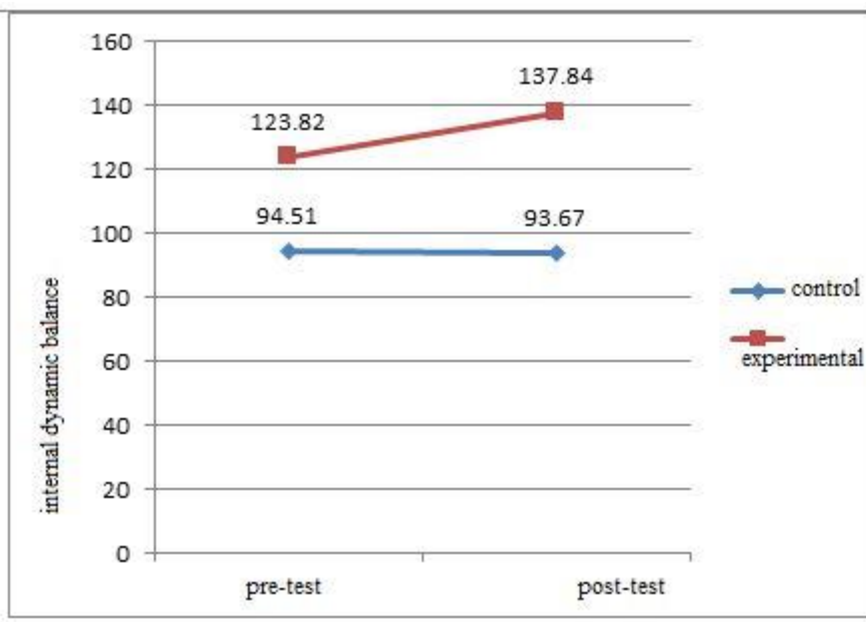

Figure 5- Linear diagram of changes in dynamic balance test (internal part)

The mean record of dynamic balance in external part in pre-test in two experimental and control groups was respectively 121.74 and 102.22 steps, and it was 134.71 and 100.80 steps in post-test, respectively. The mean of these differences was statistically significant (F=21.862 and P=0.001). In other words, inter-group differences between different research groups during two stages of test taking were matched (P<5%). In Figure 6, we see that the slope of the line in the experimental group is more than that in the control group. This means that there is significant interaction between the two groups (F=75.021 and P=0.001). In other words, by separately considering of score changes in each of the two groups, internal changes pattern significantly differs between the two groups. Inter-group comparison showed significant progress or regress in total scores of two groups (F=48.275 and P=0.001).

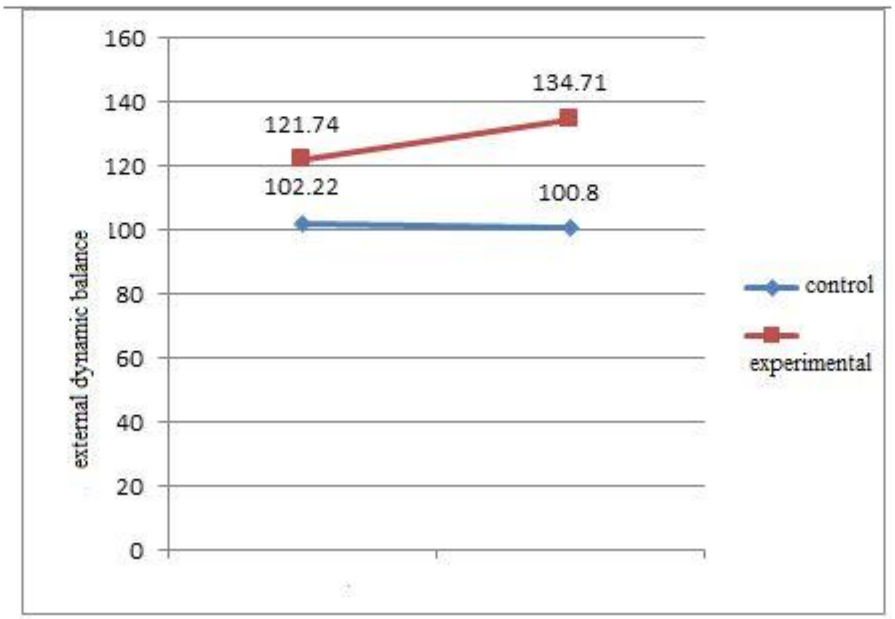

Figure 5- Linear diagram of changes in dynamic balance test (external part)

By determining the difference between two groups and finding that performance of two groups in rebound therapy exercises was different, determining the better performance value of the subjects in dynamic and static balance is reported in Tbale 3.

Table 3. Information related to variables in the pre-test, post-test, and results of analysis of variance for duplicate data

Factor	Group	Pre-test Mean ± SD	Post-test Mean ± SD	Inter-group	Group interaction	Intra-group
Static balance	Rebound	7/43 ± 5/01	32/43 ± 13/75	F= 16/030 * P=0/000	F= 53/643 * P=0/000	F= 7/622 * P=0/010
	Control	14/81 ± 14/52	3/5 ± 1/86			
Anterior balance Y	Rebound	101/64 ±19/05	115/84 ±18/00	F= 26/532 * P=0/000	F= 88/367 * P=0/000	F= 55/089 * P=0/000
	Control	73.71 ± 20/72	72/04 ±21/37			
Internal balance Y	Rebound	123/82 ±11/97	137/84 ± 11/39	F= 32/788 * P=0/431	F=54/670 * P=0/000	F=43/005 * P=0/000
	Control	94/51 ± 23/06	93/67± 23/34			
External balance Y	Rebound	121/74 ±11/69	134/71 ±11/12	F=21/862 * P=0/431	F=75/021 * P=0/000	F=48/275 * P=0/000
	Control	102/22 ±20/35	100/80 ±19/79			

p= significance level *significance at the level of 0.05

Discussion and conclusion

The objective of this study was to examine the impact of rebound therapy exercises on postural control (static and dynamic balance) in hearing-impaired people. The results showed significant differences between dynamic balance in all three directions of anterior, posterior internal, posterior-external, and static balance (postural control) in subjects of experimental and control group after participating in rebound therapy exercises. The results of this study are in line with the results of Anderson et al., Graham (2006) and Reese (2005) who reported rebound therapy exercises as factor improving balance status. During the access action, contraction of hamstring and quadriceps muscles occurs in all directions (30). Quadriceps in the anterior direction has the highest activity since to perform this test in the anterior part, subject should lean backward and trunk should be in the extension status so that the person can maintain his balance (30). In this situation, the gravity force acting on the upper part of body causes high torque of knee flexion and it should be controlled by extension torque (eccentric contractions) generated by the quadriceps muscle (30). Broad external muscle activity in internal and posterior-internal directions is higher. This probably due to muscular consolidation occurs against muscular forces that are active in these directions to do access action. According to these findings, it can be concluded that an increase in the power and eccentric control of quadriceps, balance control can be improved in these directions. Therefore, probably the effect of the rebound therapy exercises on strength of muscles controlling torque produced in these directions, the sensitivity of somatosensory receptors and contractile receptors of active muscles was in three directions led to improved access performance (30). While performing the access action, of the femoral biceps muscle is active and it has the maximum activity in the posterior –external direction. This can be explained according to the effect of gravity force acting on trunk that causes hip flexion torque (31). To act in posterior-external direction, the person should have flexion in trunk so that he can open the leg backwards and in this situation, hamstring muscles should be contracted eccentrically to resist against hip flexion torque. In addition, at act in external direction requires external rotation of thigh. Therefore, it leads to activity above the femoral biceps muscle. As a result, the power of muscles surrounding and acting on muscle and their contraction to stabilize the joints of lower extremity, the activity of depth receptors and neuromuscular control in order to maintain the balance during action and obtaining the maximum distance from the access action in the dynamic test have special importance. According to the results of the research, it can be said that the rebound therapy exercises will lead to improving the dynamic balance (31). It is perceived that the main cause of the increased strength in the first few weeks of exercises compliance in nervous system. The strength of muscles surrounding acting on joint to stabilize the joints of the lower extremities, deep receptors activity and neuromuscular control in order to maintain balance when performing the action and obtaining the maximum distance have special importance. In addition, it has been stated that one of the prerequisite of trampoline exercises is dynamic balance. In the trampoline exercises, the individual should maintain his balance when landing, and this need increases as the intensity of the exercises increases. Therefore, in successful implementation of trampoline exercises, neuromuscular system is forced to maintain balance and this can be a factor in enhancing the dynamic balance (31). Balance of people is obtained by the interaction of sensory components such as vestibular, visual, and sensory-deep system, which coordinate the contractions that stabilize the leg muscles. As a result, it is obviously seen that balance process is based on two factors of good sense and the performance of the muscles. The performance of muscles is improved by strengthening them (32). However, it seems only balance exercises can enhance sensory –deep system (33). Enoka believes that increased muscle strength due to related exercises might be due to changes in neural mechanisms such as increased output of spinal nerve, the neural pathway change, increased activity of common muscles or effective communication among neuron pathways (34). Therefore, in explaining the results of the study, we can say that improving static balance according to the lack of manipulation of visibility has been due to strengthening of muscles .Therefore, results of this study indicate that rebound therapy exercise can have a positive and significant impact on static balance. Rebound therapy exercise can affect the motor part of balance control and thereby improve the static balance. However, to manipulate the sensory-control part of balance, that is, system of sensory-depth, other exercises such as balance exercises are required (33). According to the results of the research, it can be said that as long as the effect of different protocols rebound therapy exercises and the effect of various types of exercise variables as well as its bio-chemical effects have not been identified, we should reflect on its prescription as completely safe exercise method for hearing-impaired people. However, these exercises can be recommended as exercise method to achieve balance quickly that is a factor in improving the sport performances, due to effects of these exercises in a short time.

Recommendations

Considering the results of this study and the importance of balance for hearing-impaired people, it is suggested that coaches, parents, and officials of exceptional schools and centres to use regular rebound exercises in their rehabilitation program for hearing-impaired children.

Acknowledgement

This article is taken from a master's thesis Islamic Azad University of Khorasghan. Thereby, we appreciate deputy of Islamic Azad University of Khorasghan, Exceptional Education Ministry of Isfahan, Isfahan Mir Exceptional Deaf School Officials and all the students of this school who cooperated with us sincerely in this study.

References

1. Myklebust, HR. (1953). Towards a new understanding of the deaf child. Am Ann deaf; 98, pp: 345- 357
2. Myklebust, HR. (1953). The psychology of deafness. 2nd ed. New York . NY: Grune and Stratton Inc.
3. Morsh, JE. (1936). Motor performance of the deaf. Comparative psychological monograph; 13, PP:1-51.
4. Punakallio, A. (2005). Balance abilities of workers in physically demanding jobs: With special reference to firefighters of different ages. J Sports Sci & Med.6.PP:146-152.
5. Shumway-Cook A, Woollacott MH. Motor control: Theory and practical applications. USA: Lippincott Williams & Wilkins pub; 2001.
6. Frändin K, Sonn U, Svantesson U, Grimby G. Functional balance tests in 76-year-olds in relation to performance, activities of daily living and platform tests. Scand J Rehabil Med 1995;27(4):231-41.
7. Riemann BL, Myers JB, Lephart SM. Sensorimotor system measurement echniques. J Athl Train 2002;37(1):85-98.
8. Cote KP, Brunet ME, Gansneder BG, Shultz SJ. Effects of pronated and supinated foot postures on static and dynamic postural stability. J Athl Train 2005;40(1):41-6.
9. Winter, D., Patla, A., Frank, J. (1990).Assessment of balance control in umans. Med Prog Technol. 16, 31-51.
10. Tavalaee, Sh. (2008). Familiarity with audio-verbal method. Journal of Special Education, 83, 87-85.

11. Wu, C. J., D., Brown, M. (2002). Parents and teachers expectation of auditory-verbal theraby. The volta.. review, 104(1), 5-20.
12. Harr, J. J. (2000). Relationships between parents of hearing-impaired children and teachers of the deaf. Deafness and Education International, 2(1), 12-25.
13. Hull RH. (1997). What Is Aural Rehabilitation? Aural Rehabilitiation. 3rd ed. San Diego, London; Singular Publishing Group. PP:1-18.
14. Jordan, S., Gruber, J.D., M.A. (2004). On the rebound: A fun easy way to vibrant Health & well- Being.
15. Rinne, M.B., Pasanen, M.E., Miilunpalo, S.I., Oja, P. (2001). Test-retest reproducibility and inter-rater reliability of a motor skill test battery for adults. International J Sports Med.22,192-200.
16. Smith, S. Cook, D. A., (1990). Study In the of Rebound Therapy for Adults with Special Needs. Physiother. 76(22) p.p. 734-735.
17. Chartered society of physiotherapy. (2007).safe practice in Rebound therapy. Chartered society of physiotherapy, London.
18. Powers, M.E., (1996). Vertical gump training for volleyball. Strength & Conditioning, 18(1), 18-23.
19. Hudson, A.L., Ross and Jackiel. Efficacy of a mini- trampoline program for improving the vertical jump . 63- 69.
20. Graham, E. (2006). The effect of rebound therapy on muscle tone. Unpublished Masterthesis Leeds Metropolitan University. 1-57.
21. Smith, S. Cook, D., (2007). Rebound therapy. In: Rennie, J., ed. Learning disability- ghysical therapy treatment and management- A collaborative Approach. 2nd Edition John Wiley and Sons. 249-62.
22. Vuillerm, N., Danion, F., Lamarin, G. (2001). The effect expertise in gymnastics on posturalControl. Neuroscience Letters. 303:83-6.
23. Samson, K.M. (2005). The effect of a five–week core stabilization–training Program or dynamic balance in tennis athletes. Master's Thesis, University of Virginia.
24. Gribble, P., Hertel, J. (2003). Considerations for the normalizing measures of the star excursion balance test. Measur Phys Educ Exer Sci. 7, 100-89.
25. Kinzey, S., Armstrong, C. (1998). The reliability of the star-excursion test in assessing dynamic balance. J Orthop Sports Phys The. 7(5), 356-60.
26. Gribble, P. (2003). The star excursion balance test as a measurement tool. Athl Ther Today. 8(2), 46-7.
27. Gribble,P., Hertel, J., Denegar, C., Buckley, W. (2004). The effects of fatigue and chronic ankle instability on dynamic postural control. J Ath Train. 39(4),321-29.
28. Tahmasby Boroujeni, Sh. Begum Ghods Mir Haydari, S. (2012). "The effect of different models of illustrating on balance of female students of Tehran University". Journal of Motor Learning and Movement - Sports, No. 9.
29. Asgari, T. Hadyan, MR. Ansari, N. Abd al-Wahhab, M. Jalili, M. Faghihzadeh, S. (2007). "The reliability of the Inter Ritter and intra Ritter of Berg Balance Scale of in evaluating the balance in children with hemiplegic cerebral palsy spastic". Faculty of Rehabilitation, Tehran University of Medical Sciences, Tehran, period 1. Number 1 and 2.
30. Earl, J.E., Hertel, J. (2001). Lower-extremity muscle activation during the star excursion balance tests. J Sport Rehabil. 10:93-104.
31. Hamdollah. H, Farhadi, H, Bashiri, M, 2011. Investigating the effect of six weeks of strength and plyometric training on dynamic balance of male college athletes. Research in Rehabilitation Sciences, 2: 215-224.
32. Anni A, Buttler AA, Lord SR, Rogers M, Fitzpatric R. (2008). "Muscle weakness impairs the proprioceptive control of human standing". Brain Res, 1242. pp: 244- 51.
33. Bellew JW, Click Fenter P, Chelette B, Moore R, Loreno D. (2002). "Effects of a short – term dynamic balance training program in healthy older women". J of eriatric Physical Ther, 28. pp: 01-05.
34. Enoka RM. (1997). "Neural strategies in the control of muscle force". Muscle Nerve, 5: pp:66-69.