Aud Vest Res (2018);27(1):12-18.

RESEARCH ARTICLE

Modified clinical test of sensory interaction on balance test use for assessing effectiveness of Epley maneuver in benign paroxysmal positional vertigo patients rehabilitation

Yones Lotfi[1], Mohanna Javanbakht[1], Maryam Sayaf[1*], Enayatollah Bakhshi[2]

[1]- Department of Audiology, University of Social Welfare and Rehabilitation Sciences, Tehran, Iran

[2]- Department of Biostatistics, University of Social Welfare and Rehabilitation Sciences, Tehran, Iran

Received: 4 Sep 2017, Revised: 23 Sep 2017, Accepted: 2 Oct 2017, Published: 15 Jan 2018

Abstract

Background and Aim: Benign paroxysmal positional vertigo (BPPV) is most common type of vertigo in general population. Epley maneuver is the most effective treatment technique. However, there is no clinically valid test to verify effectiveness of maneuver quickly after treatment in the same session. Modified clinical test of sensory interaction on balance (mCTSIB) is considered as a quick and simple test. This study aimed to use mCTSIB for assessing effectiveness of Epley maneuver in BPPV patients.

Methods: The study was carried out on 44 patients (36 female and 8 male, mean age of 53.11 (SD=7.09) diagnosed with posterior semicircular canals BPPV in Dix-Hallpike test and no other vestibular disorders. mCTSIB in four conditions was assessed, before and after Epley maneuver. Balance time, lateral and anterior-posterior sway were recorded. mCTSIB repeated after three weeks to assess reliability.

Results: The time for balance control in mCTSIB after maneuver did not change significantly relative to before maneuver (p>0.05). Lateral sway changes in conditions 2, 3 and 4 in mCTSIB significantly reduced after maneuver (p=0.04). Anterior-posterior sway changes in conditions 1 and 2 showed no significant difference after maneuver, however, differences in conditions 3 and 4 were statistically significant (p<0.05). Test-retest showed reliable results.

Conclusion: mCTSIB is seems be a valid test with simple and quick apply for verifying the effectiveness of Epley maneuver in BPPV patients.

Keywords: Benign paroxysmal positional vertigo; Epley; postural control

Citation: Lotfi Y, Javanbakht M, Sayaf M, Bakhshi E. Modified clinical test of sensory interaction on balance test use for assess effectiveness of Epley maneuver in benign paroxysmal positional vertigo patients' rehabilitation. Aud Vest Res. 2018;27(1):12-8.

Introduction

Benign paroxysmal positional vertigo (BPPV) is the most common type of vertigo in dizzy patients, and is generally due to posterior semicircular canal involvement [1-3]. The overall prevalence of BPPV is estimated at 2.4% [4]. The most commonly accepted pathophysiologic causes for BPPV are cupulolithiasis (separation of statoconia from the macula, and possibly their adhesion to the copula) and canalithiasis (separation of statoconia from the macula, and free rotation in the endolymph of the semicircular canals). BPPV occurs as a subjective objective

[*] **Corresponding author:** Department of Audiology, University of Social Welfare and Rehabilitation Sciences, Daneshjoo Blvd., Evin, Tehran, 1985713834, Iran. Tel: 009821-22180100, E-mail: maryam70_dr@yahoo.com

rotating dizziness that usually takes a few seconds. This dizziness occurs alternately following head movements, especially when changing the body position in bed [5].

Epley maneuver is the most effective maneuver in treating BPPV caused by posterior semicircular canal, with a reported efficacy of 70 to 100% [5]. Despite the overall effectiveness of Epley maneuver in the improvement of patients with BPPV [5], there is currently no clinical evaluation method to confirm the definitive effectiveness of the maneuver after its implementation. Therefore, in some patients, the continuation of symptoms associated with BPPV is observed after performing the maneuver, referral and re-performing the maneuver for the patients is required. It is also recommended that the Dix-Hallpike test not be used immediately after maneuvering to ensure its effectiveness. Because the lack of observation of nystagmus after the implementation of the Epley maneuver can be due to nystagmus fatigue, and it does not mean the definitive confirmation of the effectiveness of the Epley maneuver [6-8], and also because of changing head and neck position during Dix-Halpike test, it is recommended that this test be performed at least 24 to 48 hours after the Epley maneuver [9-11]. One of the tests that seems to provide a clinical evaluation by spending a little time and use of simple and inexpensive device is the modified clinical test of sensory interaction on balance (mCTSIB) [12]. The initial test, clinical test of sensory interaction in balance (CTSIB), was first developed by Shumway-Cook and Horak as the sensory interaction effect on balance. The purpose of this test was to evaluate the effect of sensory interaction on postural stability in standing position in patients with neurological problems, stroke, peripheral neuropathy and lower limb amputation, and included 6 conditions: 1) standing on a firm surface with open eyes 2) standing on a firm surface with closed eyes 3) standing on a firm surface while the error input was given to the visual system of the individual 4) standing on a foam with open eyes 5) standing on a foam with eyes closed 6) standing on a foam while an error input was given to the individual's visual system [13]. As previous studies have shown that there is no significant difference in the degree of balance between patients with closed eyes and the condition of visual challenge on the foam and the firm surface, steps 3 and 6 were eliminated and the name of the test was changed to the modified clinical test of sensory interaction for balance (mCTSIB) to provide an estimate of the individual balance in the least possible time [14,15]. The scoring of the test is based on the amount of body sway in lateral and anterior-posterior directions and the duration of maintaining balance [13]. Because of the simple and inexpensive tools used, you can perform the test by spending a small amount in any vestibular assessment and rehabilitation clinic.

Mulavara et al. found that for screening, mCTSIB test shows balance problems more than the sensory organization test (SOT) and is faster, more challenging, and more affordable [16].

In a study, Zhou et al. evaluated the balance performance using static balance (mCTSIB) and dynamic (SOT) tests, and it was determined that both static and dynamic posturography could detect postural disorders due to dysfunction in the posterior semicircular canal [17].

Vaz et al. used mCTSIB, timed up and go (TUG), and lower limb test before and after therapeutic maneuver in the elderly, and it was found that the clinical and functional aspects of the static and dynamic balance of the body in the elderly with BPPV have improved after the maneuvering [5]. Considering the high prevalence of BPPV, the balance disorders that resulted from BPPV, and the advantages mentioned for the mCTSIB test, this study aimed to quickly assess the effectiveness of Epley maneuver in rehabilitation of patients with BPPV using mCTSIB test.

Methods

This interventional study was performed on 44 subjects with mean age of 53.11 (±7.09) years old (36 female (81.8%) and 8 male (18.2%)). The criteria for entering the study included age range of 40 to 60 years, and confirmation of posterior canal BPPV using the Dix-Hallpike test, the lack of disorder in other videonystagmography (VNG) tests, individual consent to participate in the study, no history of neurological disorders, ability to collaborate and execute the commands during the test. Exclusion criteria included the unwillingness of the individual to continue participation in the study or the loss of any entry criteria during the research. Participants were selected from among patients referring to hearing and balance clinics of Amir Alam and Rofaydeh Hospitals, Tehran, Iran.

The equipment used included the history of the patient, a checkered sheet with centimeter precision, a timer, a 6-volt laser with a special design, a foam with a size of 8 * 50 * 50 cm [13].

After completing an informed consent by patients, a complete history from them was recorded and using a questionnaire, the criteria of inclusion and exclusion from the study were examined. Otoscopic examination, audiometry, tympanometry, and then VNG and Dix-Hallpike tests were performed to confirm the diagnosis of posterior canal BPPV and rejection of other vestibular disorders, and after that, mCTSIB test was performed in all 4 positions.

Since the test is highly dependent on the individual's understanding of the purpose of the test and his/her learning, before the mCTSIB test was started, once training of the patients was done for all stages by the examiner. In all stages, the person was told to stand quietly, his hands on his chest and legs together with the person standing in each position for 30 seconds without moving. The test was carried out for all subjects in a quiet environment with sufficient light. According to the previous studies, the test was performed with feet together [15] and without shoes. Within a maximum of 30 seconds, the amount of the body sway in lateral and anterior-posterior directions in a standing position and the time he/she is able to maintain his/her balance is observed and recorded in each of the conditions. To prevent fatigue, each condition was tested at intervals of 60-90 seconds from the previous stage. After each step to prevent changing the foam state, it was rotated 90 degrees [12]. Then, Epley maneuver and mCTSIB re-test were performed.

The implementation of the Epley maneuver is such that the patient first sits on the bed with a 45 degree head rotation to the involved ear, then, keeping the head position, he/she is placed in the supine position with the help of the examiner, so that the head hangs at a 20 degree angle from the bed. Then, the head is rotated 90 degrees towards the healthy ear. Again the patient's head is rotated 90 degrees, and the patient's body moves from the supine position to the lying position on the side of the healthy ear, while the head is toward the ground, and the examiner, if necessary, in some cases, uses a vibrator to beat the mastoid of the affected ear and the patient sits keeping the head position. At the last stage, the patient's chin is placed on the chest. The duration of each stage is twice as long as the initial nystagmus or until the nystagmus of the patient is resolved [18,19]. According to the results of previous studies on the adequacy of performing Epley maneuver just once in 80.2% of cases, and in order to unify interventions, only one maneuver was used in the first session [20-22].

The mCTSIB test repeat and the re-evaluation of the balance status was performed for 15 participants, after about 3 weeks after the initial maneuvering session (according to the time of patients' referral from 18 to 24 days) to confirm the reliability of the results.

The scoring of the test was based on the amount of lateral and anterior-posterior sway displacement and the duration of balance [12]. Time and sway variables were separately studied in each test condition at different times (before maneuvering, after maneuver and at the retest). In subjects who, due to imbalance during the test, it was not possible to record their amount of sway for statistical calculations [as in study 23], the anterior-posterior sway that its highest amount was 10 cm, was considered 12.5 cm, and the lateral sway with the highest amount of 17.5 cm for other patients, was considered to be 20 cm in order to avoid computational errors in statistical analysis.

Data were analyzed using SPSS 22. Descriptive

Table 1. Mean (standard deviation) of the duration of maintaining balance (time) and sway in two direction, before and after maneuver in different modified clinical test of sensory interaction on balance conditions (n=44)

	Mean (SD) time(s)			Mean (SD) lateral sway (cm)			Mean (SD) anterior-posterior sway (cm)		
Conditions	**Before**	**After**	**p**	**Before**	**After**	**p**	**Before**	**After**	**p**
1	30.00 (0.00)	30.00 (0.00)	1.00	3.31 (1.61)	3.05 (2.35)	0.47	1.62 (1.18)	1.48 (1.52)	0.50
2	28.93 (5.00)	28.97 (4.97)	0.95	5.25 (3.94)	4.28 (2.92)	0.04	1.81 (2.16)	2.28 (3.13)	0.21
3	29.50 (3.02)	29.50 (3.31)	1.00	5.62 (3.90)	4.86 (2.53)	0.04	2.64 (2.60)	1.60 (2.18)	<0.05
4	28.27 (5.66)	29.02 (4.53)	0.17	8.89 (5.52)	7.39 (3.59)	0.04	3.84 (3.59)	2.94 (2.89)	0.03

statistics, mean and standard deviation were used to describe the data. The Kolmogorov-Smirnov test was used to assess the normality of the data and to test the homogeneity of variances, the Levene's test was used. To determine the effectiveness of the maneuver, comparison of the results before and after the maneuvering and the re-test, paired t-test was used. A repeated measurement test was also used to evaluate the stability of the test results.

Results

The subjects were 47 patients with BPPV of the posterior semicircular canal, of which 3 were excluded from the study because of severe or unilateral hearing impairment. 44 of the subjects left aged in the range of 40 to 60 years and 36 female and 8 male participated in the study. The higher number of women among those referred to these centers was probably due to their hormonal disorders and higher BPPV incidence [5].

The duration of maintaining balance after the maneuver was not significantly different from that of before maneuvering ($p<0.05$). The lateral sway in position 1 after the maneuver was lower compared to before the maneuver, but this difference was not statistically significant ($p<0.05$). This variable was significantly decreased in conditions 2, 3 and 4 ($p=0.04$). The amount of change in anterior-posterior sway was not significant in the conditions 1 and 2 ($p<0.05$), but it was significant in the 3rd and 4th conditions ($p=0.00$ and 0.03, respectively). The corresponding values can be observed in Table 1.

In the retest, a slight decrease in the mean of lateral sway changes was observed compared to the after maneuvering, which was not statistically significant ($p<0.05$). In the retest, subjects were able to fully maintain their balance for 30 seconds in all conditions (Table 2).

Discussion

The average time of maintaining balance did not significantly change in any of the conditions, because the duration the mCTSIB test was performed in each condition was 30 sec to determine the normality of the results. It seems that in the static position, patients with BPPV have less balance problems than patients with other balance disorders, there is no significant change in the time criterion. The average time of maintaining balance in four conditions has been close to the normal value (30 sec. balance maintenance time [13]) before the maneuver, and it showed no significant change after maneuver.

In Cohen et al., subjects in the conditions 1 and 2 were able to fully maintain their balance for 30 seconds, but in the current study, only in condition 1, patients were able to fully stand for 30 seconds and keep their balance. In conditions 3 and 4 of the test, of course consistent with the findings of Cohen et al., the duration of maintaining balance significantly decreased. This also applies to the tests before

Table 2. Mean (standard deviation) of the duration of maintaining balance (time) and sway in two direction, after maneuver (n=44) and re-test (n=15) in different modified clinical test of sensory interaction on balance conditions

	Mean (SD) time(s)			Mean (SD) lateral sway (cm)			Mean (SD) anterior-posterior sway (cm)		
Conditions	**After**	**Re-test**	**p**	**After**	**Re-test**	**p**	**After**	**Re-test**	**p**
1	30.00)0.00)	30.00)0.00)	<0.05	3.05 (2.35)	2.83 (0.85)	0.42	1.48 (1.52)	0.76 (0.41)	0.11
2	28.97 (4.97)	30.00)0.00)	0.33	4.28 (2.92)	3.43 (1.30)	0.29	2.28 (3.13)	1.50 (1.18)	0.46
3	29.50 (3.31)	30.00)0.00)	<0.05	4.86 (2.53)	3.40 (1.33)	0.19	1.60 (2.18)	0.83 (0.69)	0.83
4	29.02 (4.53)	30.00)0.00)	<0.05	7.39 (3.59)	5.93 (2.52)	0.11	2.94 (2.89)	1.76 (0.56)	0.13

and after the maneuver [12]. In Vaz et al., using the CTSIB test, the elderly patients with BPPV had no problem in maintaining balance in condition 1 before the treatment, but in other conditions, they could maintain their balance less than 30 seconds. After treatment with Epley maneuver, subjects were significantly improved and were able to maintain balance for 30 seconds in conditions 1 to 4 and for more than 29 seconds in coditions 5 and 6. The results of this research were in line with that study [5]. In Macedo et al., using the full version of the CTSIB test, in patients with vestibular disorders, the lowest balance maintenance time was in condition, and except in condition 6, a decrease in the time of maintaining balance from conditions 1 to 6 was observed. The present study also had similar results to this study [24]. In Amor-Dorado et al., CTSIB test and the probability of BPPV in patients with systemic sclerosis were investigated, and the time criterion was calculated so that if, in each condition, the individual fails to maintain its balance for more than 50% of the test time, it is considered to be abnormal and the test time was considered 30 seconds [25]. In our study, if a patient could not fully maintain his/her balance for 30 seconds balance, it was considered abnormal that was different from their study.

In most studies which CTSIB was used, the evaluation criterion was only time [5,12,24]. However, in the present study, in addition to the time, lateral and anterior-posterior sway were also examined, which according to the results reported in our study, after the maneuver the amount of time to maintain balance increased, and the overall amount of lateral and anterior-posterior sways decreased. In Chang et al., the sway velocity was investigated [23] and it was found that patients with BPPV had a higher sway velocity than normal subjects in standing position on a foam with closed eyes (condition 4). On the contrary, these patients due to their high reliance on the inputs of deep sense and vision to maintain balance, in contrast to normal subjects, had a lower sway velocity in standing position on the firm surface with both closed and open eyes (conditions 1 and 2). In general, patients with BPPV in our study, in line with the study by Chang et al., had higher sway in standing position on the foam than standing on the floor with both open and closed eyes [23]. Also, in Park et al. study on patients with uncompensated unilateral vestibulopathy, sway rate was evaluated using a posturography device and based on the device instruction from a zero score (inability to maintain balance) to 100 (maintaining balance without any sway for 30 seconds) and it was found that the mCTSIB test could replace the SOT test in assessing patients with uncompensated unilateral vestibulopathy [14].

On the effectiveness mCTSIB test and its suiability, we can also refer to the study of El-Kashlan et al., which was conducted on two normal groups and patients with various types of vestibular dysfunction, and it was found that the results of the CTSIB test are well correlated with the dynamic status assessment test, and this finding shows that the CTSIB test is useful in diagnosing patients with abnormal status control, which is also evident in the results of this study [26]. Lotfi et al., using the pediatric clinical test of sensory interaction for balance (P-CTSIB) test on 121 children, also showed that the test can be performed with high validity in children aged 4 to 6 years with legs together [27].

On the effectiveness of Epley maneuver in patients with BPPV, Zhang et al. performed static and dynamic postural control before and after the maneuver on 48 patients with BPPV of posterior semicircular canal, and it was found that after the maneuver, the disorder level in the dynamic postural control test has been decreased from 70.8% to 16.7%, which, similar to the results obtained before and after maneuvering in the present study, confirmed the effectiveness of the maneuver [28]. Okhovat et al. and Rabiee compared the two Epley and Semont maneuvers in terms of acceptability, effectiveness, and ease of implementation in 2003 and 2005, respectively and according to the results, Epley maneuver was more effective in treating patients with BPPV [29,30]. The results of our study in confirming the effectiveness of Epley maneuver in treating patients with BPPV are consistent with the results of these studies.

The overall reduction in lateral sway in all positions in post-Epley maneuvering can be one of the indicators of the effectiveness of the maneuver and the clinical improvement and statistical stability obtained in the retest also indicate the reliability of the results and possibly a gradual improvement in the balance of the individuals. It should be mentioned that cases with recurrent BPPV during the retest period of the study group were not observed in this study). It seems that further studies are needed to determine a precise criterion for the amount of sway that indicates the impact of Epley maneuver.

Conclusion

According to the results of this study, mCTSIB test can be used as a simple and fast criterion, without the need to place the patient in forbidden positions after preforming the maneuver, in order to investigate the effectiveness of Epley maneuver in rehabilitation of patients with BPPV in vestibular assessment and rehabilitation clinics, to prevent unnecessary referral of patients or to determine and confirm the need to repeat the maneuver in the same session. Meanwhile, it seems that in addition to considering the time criterion of maintaining the balance in the mCTSIB test, the use of the amount of sway, especially in patients with BPPV, also provides more complete information for the specialists in the field of balance in order to estimate the individual balance problems and the effectiveness of therapeutic maneuvering.

The results of this study can be generalized within the scope of the study and the application and results of mCTSIB test in other balance disorders or different test groups requires the design of future studies in these areas.

Acknowledgment

This paper is emerged from M. Sayaf's M.Sc. dissertation submitted in University of Social Welfare and Rehabilitation Sciences and is confirmed by Ethic Code No. IR.USWR.REC.1395.299.

Conflict of interest

The authors declared no conflicts of interest.

REFERENCES

1. Gazzola JM, Ganança FF, Aratani MC, Perracini MR, Ganança MM. Circumstances and consequences of falls in elderly people with vestibular disorder. Braz J Otorhinolaryngol. 2006;72(3):388-92.
2. Norré ME. Sensory interaction posturography in patients with benign paroxysmal positional vertigo. Clin Otolaryngol Allied Sci. 1993;18(3):226-30.
3. Chang TP, Lin YW, Sung PY, Chuang HY, Chung HY, Liao WL. Benign paroxysmal positional vertigo after dental procedures: a population-based case control study. PLoS One. 2016;11(4):e0153092. doi: 10.1371/journal.pone.0153092
4. von Brevern M, Radtke A, Lezius F, Feldmann M, Ziese T, Lempert T, et al. Epidemiology of benign paroxysmal positional vertigo: a population based study. J Neurol Neurosurg Psychiatry. 2007;78(7):710-5. doi: 10.1136/jnnp.2006.100420

5. Vaz DP, Gazzola JM, Lança SM, Dorigueto RS, Kasse CA. Clinical and functional aspects of body balance in elderly subjects with benign paroxysmal positional vertigo. Braz J Otorhinolaryngol. 2013;79(2):150-7.
6. Richard W, Bruintjes TD, Oostenbrink P, van Leeuwen RB. Efficacy of the epley maneuver for posterior canal BPPV: a long-term, controlled study of 81 patients. Ear Nose Throat J. 2005;84(1):22-5.
7. Parnes LS, Agrawal SK, Atlas J. Diagnosis and management of benign paroxysmal positional vertigo (BPPV). CMAJ. 2003;169(7):681-93.
8. Atlas JT, Parnes LS. Benign paroxysmal positional vertigo: mechanism and management. Curr Opin Otolaryngol Head Neck Surg. 2001;9(5):284-9.
9. Wolf JS, Boyev KP, Manokey BJ, Mattox DE. Success of the modified Epley maneuver in treating benign paroxysmal positional vertigo. Laryngoscope. 1999;109(6):900-3.
10. Steenerson RL, Cronin GW, Marbach PM.. Effectiveness of treatment techniques in 923 cases of benign paroxysmal positional vertigo. Laryngoscope. 2005;115(2):226-31. doi: 10.1097/01.mlg.0000154723.55044.b5
11. Yimtae K, Srirompotong S, Srirompotong S, Sae-Seaw P. A randomized trial of the canalith repositioning procedure. Laryngoscope. 2003;113(5):828-32. doi: 10.1097/00005537-200305000-00011
12. Cohen H, Blatchly CA, Gombash LL. A study of the clinical test of sensory interaction and balance. Phys Ther. 1993;73(6):346-51; discussion 351-4.
13. Shumway-Cook A, Horak FB. Assessing the influence of sensory interaction of balance. Suggestion from the field. Phys Ther. 1986;66(10):1548-50.
14. Park MK, Kim KM, Jung J, Lee N, Hwang SJ, Chae SW. Evaluation of uncompensated unilateral vestibulopathy using the modified clinical test for sensory interaction and balance. Otol Neurotol. 2013;34(2):292-6. doi: 10.1097/MAO.0b013e31827c9dae
15. Wrisley DM, Whitney SL. The effect of foot position on the modified clinical test of sensory interaction and balance. Arch Phys Med Rehabil. 2004;85(2):335-8.
16. Mulavara AP, Cohen HS, Peters BT, Sangi-Haghpeykar H, Bloomberg JJ. New analyses of the sensory organization test compared to the clinical test of sensory integration and balance in patients with benign paroxysmal positional vertigo. Laryngoscope. 2013;123(9):2276-80. doi: 10.1002/lary.24075
17. Zhou R, Liu B, Zhang S, Liu D, Liu J, Leng Y, et al. [The balance function of the patients with benign paroxysmal positional vertigo during standing]. Lin Chung Er Bi Yan Hou Tou Jing Wai Ke Za Zhi. 2015;29(22):1966-9. Chinese.
18. Herdman SJ, Hoder JM. Physical therapy management of benign paroxysmal positional vertigo. In: Herdman SJ, Clendaniel RA. Vestibular rehabilitation. 4th ed. Philadelphia: F. A. Davis Company; 2014. p. 324-58.
19. Bhattacharyya N, Gubbels SP, Schwartz SR, Edlow JA, El-Kashlan H, Fife T, et al. Clinical practice guideline: benign paroxysmal positional vertigo (update). Otolaryngol Head Neck Surg. 2017;156(3_suppl):S1-S47. doi: 10.1177/0194599816689667
20. Casqueiro JC, Ayala A, Monedero G. No more postural restrictions in posterior canal benign paroxysmal positional vertigo. Otol Neurotol. 2008;29(5):706-9. doi: 10.1097/MAO.0b013e31817d01e8
21. Cohen HS, Jerabek J. Efficacy of treatments for posterior canal benign paroxysmal positional vertigo. Laryngoscope. 1999;109(4):584-90. doi: 10.1097/00005537-199904000-00012
22. von Brevern M, Seelig T, Radtke A, Tiel-Wilck K, Neuhauser H, Lempert T. Short-term efficacy of Epley's maneuver: a double-blind randomized trial. J Neurol Neurosurg Psychiatry. 2006;77(8):980-2. doi: 10.1136/jnnp.2005.085894
23. Chang WC, Hsu LC, Yang YR, Wang RY. Balance ability in patients with benign paroxysmal positional vertigo. Otolaryngol Head Neck Surg. 2006;135(4):534-40. doi: 10.1016/j.otohns.2005.10.001
24. Macedo C, Gazzola JM, Ricci NA, Doná F, Ganança FF. Influence of sensory information on static balance in older patients with vestibular disorder. Braz J Otorhinolaryngol. 2015;81(1):50-7. doi: 10.1016/j.bjorl.2014.11.004
25. Amor-Dorado JC, Barreira-Fernandez MP, Arias-Nuñez MC, Gomez-Acebo I, Llorca J, Gonzalez-Gay MA. Benign paroxysmal positional vertigo and clinical test of sensory interaction and balance in systemic sclerosis. Otol Neurotol. 2008;29(8):1155-61. doi: 10.1097/MAO.0b013e31818a086e
26. El-Kashlan HK, Shepard NT, Asher AM, Smith-Wheelock M, Telian SA. Evaluation of clinical measures of equilibrium. Laryngoscope. 1998;108(3):311-9.
27. Lotfi Y, Kahlaee AH, Sayadi N, Jalilzadeh Afshari P, Bakhshi E. Test-retest reliability of the pediatric clinical test of sensory interaction for balance in 4-6 years old children. Aud Vest Res. 2017;26(4):202-8.
28. Zhang DG, Fan ZM, Han YC, Yu G, Wang HB. [Clinical value of dynamic posturography in the evaluation and rehabilitation of vestibular function of patients with benign paroxysmal positional vertigo]. Zhonghua Er Bi Yan Hou Tou Jing Wai Ke Za Zhi. 2010;45(9):732-6. Chinese.
29. Okhovat AR, Berjis NAD, Naghdi S. [Assessment and comparison of the effectiveness of epley and semont maneuvers in treatment of benign paroxysmal positional vertigo (BPPV)]. J Isfahan Med Sch. 2003;20:36-8. Persian.
30. Rabiei S. [Comparison of effectiveness of epley"s- and semont"s maneuver in the treatment of BPPV]. Iran J Otorhinolaryngol. 2005;17(1):40-5. Persian.