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Original Article

Clinical Characteristics of Patients with Dizziness after Motor Vehicle Accident

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OBJECTIVE: The purpose of this study was to identify the clinical characteristics of dizziness occurring after a motor vehicle accident.

MATERIALS and METHODS: We retrospectively analyzed 217 patients who had visited a tertiary medical center complaining of dizziness after a motor vehicle accident between January 2009 and December 2014. Of the 217 patients, we enrolled 54 patients who had undergone a vestibular function test and had no definite evidence of fracture of the temporal bone or intracranial lesions. Patients were divided into two groups: the dizziness group (group A, 29 patients) and the dizziness with audiological symptoms (hearing disturbance, tinnitus, ear fullness) group (group B, 25 patients).

RESULTS: The prevalence of benign paroxysmal positional vertigo was higher in group A. Apart from this finding, the clinical features did not differ significantly between the two groups. Group B had a higher number of patients who exhibited asymmetric hearing on pure tone audiometry, but the difference was not statistically significant.

CONCLUSION: There were no notable characteristics in patients with dizziness after motor vehicle accidents, although patients without hearing symptoms tended to have benign paroxysmal positional vertigo, whereas other patients tended to have hearing disturbance. This information may be helpful for clinicians in counseling and managing patients with dizziness and audiological symptoms after motor vehicle accidents.

KEYWORDS: Dizziness, trauma, motor vehicle accident, hearing disturbance

INTRODUCTION

Due to the use of seat belts and air bag protection, mortality rate following traffic accident (TA) has decreased [1]. In contrast, injuries associated with TAs, such as whiplash injury and traumatic brain injury (TBI) still represent a significant social and medical problem [1, 2]. Whiplash injury is the most common injury associated with TAs in many countries [3]. It is reported that dizziness is one of the most frequent complaints following whiplash trauma with up to 50% of patients complaining of dizziness following whiplash trauma induced by TAs [1, 4]. The TBI associated with TAs can cause dizziness via a number of different mechanisms, including labyrinthine concussion, benign paroxysmal positional vertigo (BPPV), and perilymphatic fistula [5].

Despite this high prevalence, the dizziness reported after TAs has not been thoroughly researched. Patients may use the word "dizziness" to describe sensations of disequilibrium, instability, vertigo, light-headedness, and chronic nausea. It is difficult to diagnose, treat, and predict the prognosis because the characteristics of the symptom are variable [6]. Dizziness is not the only symptom experienced following TAs; other symptoms, including headache, psychological symptoms, and audiological symptoms (such as hearing disturbance, tinnitus, and ear fullness) are reported by many patients [7].

In this study, we aimed to investigate the clinical characteristics of dizziness occurring after TAs with or without audiological symptoms.

MATERIALS and METHODS

Subjects

Between January 2009 and December 2014, we retrospectively reviewed the medical records of 217 patients who had visited a tertiary medical center for dizziness (disequilibrium, instability, vertigo, light-headedness, and chronic nausea) following TAs. Of these

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217 patients, we enrolled 54 patients who had had a vestibular function test performed. Twenty-five out of these 54 patients presented with a whiplash injury resulting from TAs, and all were car passengers. Patients showing a definite fracture of the temporal bone or the presence of an intracranial lesion were excluded. Patients were divided into two groups: a dizziness without audiological symptoms (hearing disturbance, tinnitus, and ear fullness) group (group A, 29 patients) and a dizziness with audiological symptoms group (group B, 25 patients). Among the patients in group B, 19 had tinnitus, 8 had ear fullness, and 6 had hearing disturbance.

Classification and Parameters

We analyzed the demographic information and classified patients by the grade of brain injury. We defined "severe" grade as Glasgow Coma Scale (GCS) score ranging from 3 to 8, "moderate" grade as GCS score ranging from 9 to 12, and "mild" grade as GCS score over 13. In addition, the patients in each group were further classified as either "car passengers," "motorcycle passengers," or "pedestrians."

To evaluate structural injuries such as temporal bone fracture, brain hemorrhage, or perilymph fistula, all patients underwent computed tomography (CT) scanning.

At follow-up, we repeatedly checked the vertigo symptoms of patients, and classified them into three categories: complete remission (CR), partial remission (PR), and continuing symptoms (CS). The CR was defined as the total disappearance of the symptoms during follow-up, the PR was defined as a decrease but not complete disappearance of the symptoms, and the CS was defined as either no improvement or an aggravation of the symptoms.

Vestibular dysfunction of patients was evaluated by the binaural bithermal caloric test. We used 50°C air as the warm stimuli and 24°C air as the cold stimuli. Vestibular function was determined based on the absolute value of canal paresis (CP). In this study, we defined the diagnostic criteria for unilateral vestibular dysfunction as a CP value of 25% or greater.

The average value of pure tone audiometry (PTA) thresholds was calculated according to the widely used system of the American National Standards Institute (ANSI) (1969), that is, the three-frequency average (3FA) method (0.5, 1, and 2 kHz) and the American Academy of Otolaryngology-Head and Neck Surgery (AAO-HNS) standards for reporting hearing loss including PTA at 0.5, 1, 2, and 3 kHz (4FA) [8]. Hearing loss was defined as a PTA threshold of more than 25 dB HL, as suggested by the International Organization for Standardization (1964). Patients who had hearing loss in one ear and normal hearing in the other were diagnosed with unilateral hearing loss.

Statistical Analysis

Comparison between the groups was carried out using the Mann-Whitney test and Fisher's exact test (PASW statistics 18, SPSS Inc.; Chicago, IL, USA). A p-value less than 0.05 was considered to be statistically significant.

Ethics Committee Approval and Informed Consent

This retrospective study was conducted under the review and approval of the Institutional Review Board of a tertiary medical center, and the informed consent from each patient was waived.

Table 1. Average age and sex ratio of both groups

	Group A	Group B	p
Age (years)	49.0±17.6	45.4±19.7	0.482
Female	75.90%	64.00%	0.341

Table 2. Pure tone audiometry threshold average of both groups

	Group A	Group B	p
Rt 3FA	24.64±17.96	28.12±28.58	0.686
Rt 4FA	26.79±18.06	29.78±28.51	0.727
Lt 3FA	21.67±16.11	16.52±12.72	0.288
Lt 4FA	23.93±17.22	17.61±13.50	0.222

Rt right; Lt left

Table 3. Caloric test results of patients with unilateral hearing loss

Patient Number	Group	Laterality	Canal Paresis Weakness
1	A	Rt	Lt 14.99%
2	A	Lt	Rt 18.07%
3	A	Rt	Rt 16.09%
4	A	Rt	Rt 18.41%
5	B	Rt	Rt 81.48%
6	B	Rt	Rt 30.84%
8	B	Rt	Rt 50.88%
9	B	Rt	Rt 64.97%

Canal paresis value of 25% or more was defined as diagnostic criteria for unilateral vestibular dysfunction. All patients with unilateral hearing loss in group B were accompanied with ipsilateral vestibular dysfunction, but patients with same condition in group A had no unilateral vestibular dysfunction. Patient number 7 who belongs to group B did not undergo caloric test.

Rt right; Lt left

RESULTS

Demographic Information

The average age of group A was 49.0±17.6 years and of group B 45.4±19.7 years. Of the 54 patients, 38 were female (70.4%). In group A, 75.9% (22/29) of the patients were female, and 64.0% (16/25) were female in group B. No statistical difference in age or sex was observed between the two groups (Table 1).

The patient follow-up period averaged 8.58 months: 7.0±11.51 months in group A and 10.16±18.28 months in group B. There was no statistically significant difference between the groups.

Grade of Brain Injury and Type of Patients

For all patients, more than half (59.6%) showed mild brain injury, and severe brain injuries were rare. In group A, 67.9% of patients were found to have mild-, 25% moderate-, and 7.1% severe-grade brain injury. In group B, mild brain injuries were seen in 50% of patients, moderate-grade in 45.8%, and severe-grade brain injury was reported in only one case (Figure 1). Loss of consciousness (LOC) at the moment of accident was reported in 28.6% of patients in group A and 54.2% of patients in group B (Figure 2). Although this finding was more common in patients with audiological symptoms, there was no significant difference found for the brain injury grade or presence of LOC.

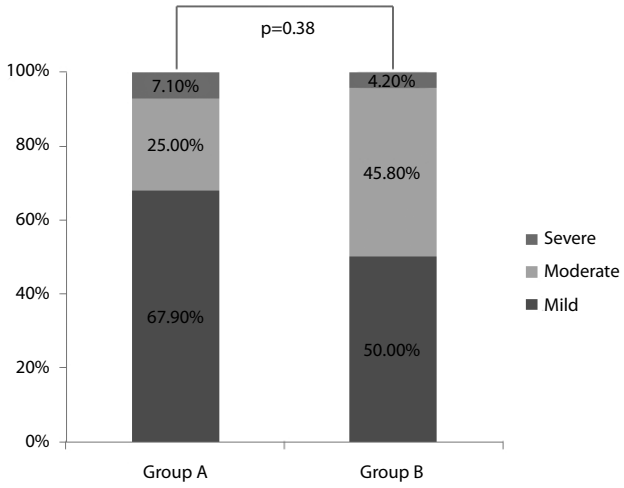

Figure 1. Distribution of the severity grade of head trauma. There were no differences between the groups. All groups showed a high prevalence of mild head injury.

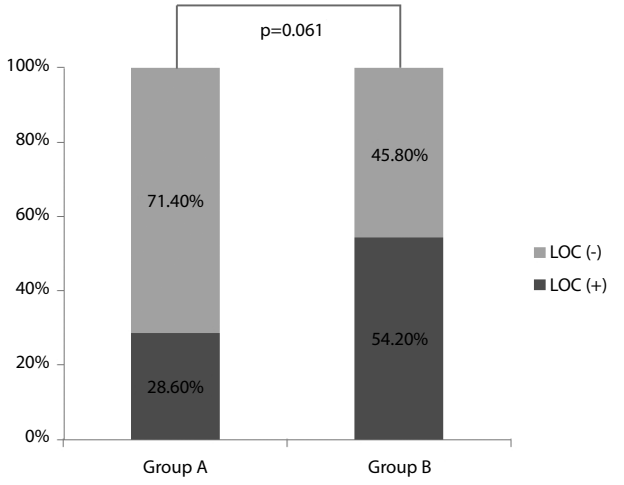

Figure 2. Proportion of patients with loss of consciousness (LOC). Group B showed a higher prevalence of LOC, but the difference was not statistically significant.

LOC loss of consciousness

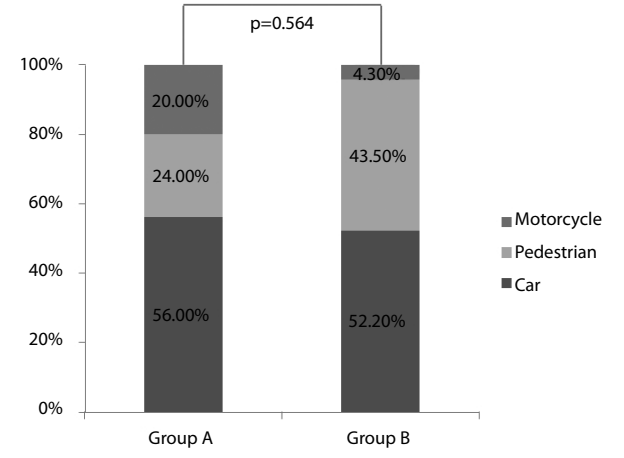

Figure 3. Distributions of motor vehicle accident type. There were no differences between the groups. *Motorcycle* motorcycle passenger, *Car* car passenger.

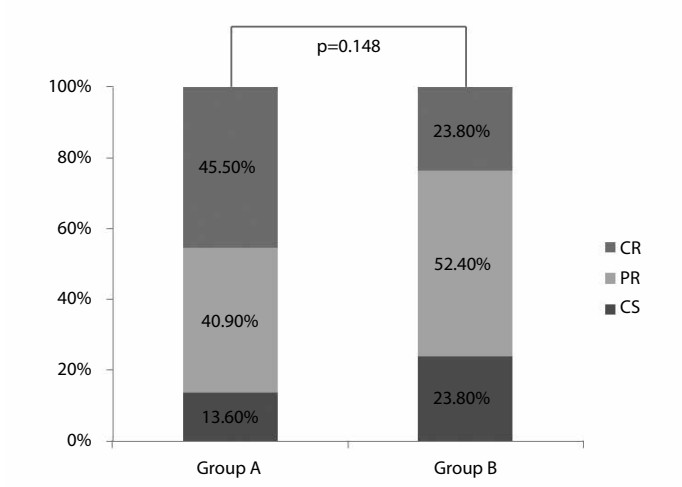

Figure 4. Dizziness remission rates. Group A seemed to have a more positive prognosis, but the difference showed no significance. *CR* complete remission, *PR* partial remission, *CS* continuing symptoms.

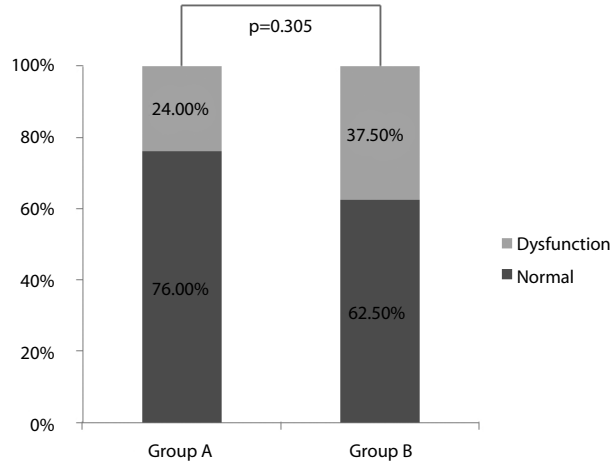

Figure 5. Proportion of patients with unilateral vestibular dysfunction diagnosed by the caloric test. There were no significant differences between the groups.

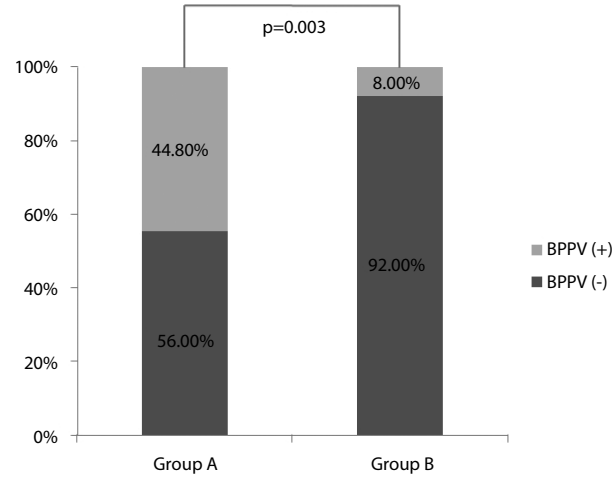

Figure 6. Proportion of patients with benign paroxysmal positional vertigo (BPPV). Group A showed a higher prevalence of BPPV. *BPPV* benign paroxysmal positional vertigo.

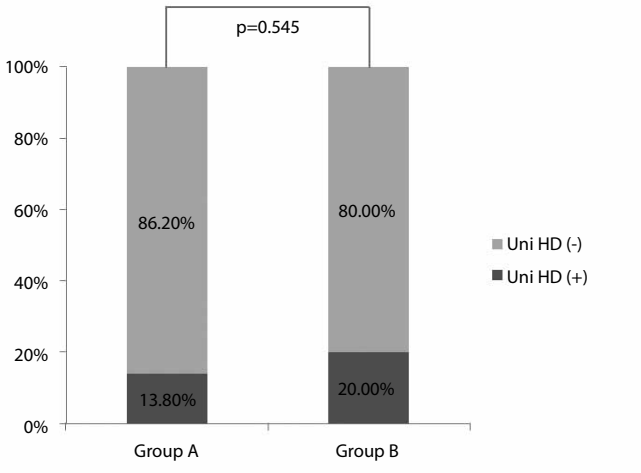

Figure 7. Proportion of patients with unilateral hearing disturbance. There were no differences between the two groups. *Uni HD* unilateral hearing disturbance.

Car passengers were the most common type among the TAs (54.2%), followed by pedestrians (33.3%) and motorcycle passengers (12.5%). Among patients in group A, 56% were car passengers, 24% were pedestrians, and 20% were motorcycle passengers. In contrast, pedestrians were more common (43.5%), and motorcycle passengers were less common (4.3%) in group B (Figure 3). However, these differences were not statistically significant.

Dizziness Remission Rate

For all patients, 11 visited our clinic only once, so we were unable to assess whether their symptoms improved or not. Among the other 43 patients, 15 were free from dizziness at follow-up, 20 showed partial improvement, and 8 had CS. Patients in group B tended to have CS (13.6% vs. 23.8%), and those in group A showed higher CR rate (45.5% vs. 23.8%, Figure 4). However, there was no difference in the CR, PR, or CS between the two groups.

Vestibular Function Test and Pure Tone Audiometry

There were 15 patients (30.6%) with vestibular dysfunction in the present study. The incidence of vestibular dysfunction was 24.0% in group A and 37.5% in group B (Figure 5). The difference in the prevalence of vestibular dysfunction was not statistically significant. However, group A showed a significantly higher prevalence of BPPV than group B (44.8% vs. 8.0%, p=0.003, Figure 6).

We also compared PTA results with the 3FA and 4FA values for each ear. No difference in the PTA threshold averages was found for either group (Table 2). A total of 13.8% of patients in group A and 20.0% in group B were diagnosed with unilateral hearing loss (Figure 7).

DISCUSSION

Dizziness can be caused by a number of different mechanisms following TAs, including BPPV, labyrinthine concussion, whiplash injury, perilymphatic fistula, traumatic endolymphatic hydrops, and central lesions such as brain concussion, hemorrhage, and diffuse axonal injury [1,5].

Benign paroxysmal positional vertigo (BPPV) is the leading cause of post traumatic dizziness [5]. Liu [9] reported that traumatic BPPV more commonly shows bilateral involvement than idiopathic condition and tends to be hard to treat with the canalith repositioning maneuver. However, according to Lee et al. [10] patients with traumatic BPPV had a tendency to involve posterior semicircular canal more frequently, but the difficulty in treatment was similar to the idiopathic disorder. In our study group, of the 15 patients with BPPV, there was only one with bilateral BPPV, and the posterior canal was most commonly involved.

Labyrinthine concussion is also a common cause of post traumatic dizziness [5, 11]. This disorder is thought to be caused by non-specific injury to the labyrinth. Labyrinthine concussion usually causes hearing disturbance and tinnitus in addition to dizziness. Patients with this disorder may have vestibular dysfunction due to damage to the vestibule unlike patients with BPPV. When patients are diagnosed with labyrinthine concussion, perilymphatic fistula should be considered in the differential diagnosis because this can have a significant effect on the treatment plan [2]. In this study, 1 patient was suspected to have perilymphatic fistula based on history and CT finding, but the fistula test was negative.

In addition to dizziness, other otologic symptoms can also occur following TAs. In our study, we divided patients who complained of dizziness after TAs into two groups. Group B consisted of patients with audiological symptoms, including hearing disturbance, tinnitus, and ear fullness. The patients in group A did not show any of these symptoms. Among patients in group B, 19 complained of tinnitus, 8 of ear fullness, and 6 of hearing disturbance. Singh et al. [12] reported hearing disturbance in 21 out of 50 patients, with head injury and tinnitus in 12 patients. The prevalence of hearing disturbance in our study group was lower, presumably because we excluded patients with temporal bone fracture or intracranial lesions, who might have been more likely to have had severe head trauma.

The grade of TBI, the presence of LOC, and the type of patient did not affect whether audiological symptoms were present or not after TAs. This suggests that audiological symptoms concomitant with dizziness after TAs are not always associated with severity of accident or trauma.

It is known that dizziness after trauma is one of the risk factors for prolonged treatment [3]. Concomitant audiological symptoms appeared to be associated with a poorer prognosis in our patients although the difference was not significant. A study has reported that hearing disturbance after head trauma improved less when dizziness was present [11]. This may be because the damage to the labyrinthine or inner ear is greater in patients with dizziness and concomitant hearing symptoms.

We performed the binaural bithermal caloric test for vestibular dysfunction, positional tests including the Dix-Hallpike test for posterior and superior canal BPPV, and the supine head roll test for lateral canal BPPV. Patients with vestibular dysfunction tended to be more common in group B, although this finding was not statistically significant. In contrast, 15 patients were diagnosed with BPPV, and the prevalence of BPPV was significantly higher in group A than in group B (44% vs. 8%). In previous studies, 16%-28% of patients with head trauma had dizziness due to BPPV similar to the findings of our study

[10]. Patients in group A tended to have BPPV that seldom caused audiological symptoms. This finding is in agreement with a previous study [6].

The results of the hearing test using PTA indicated that unilateral hearing loss was more prominent in group B than in group A. All patients with unilateral hearing loss in group B, except for one patient who did not undergo the caloric test, had ipsilateral vestibular dysfunction associated with CP, but the patients with same condition in group A had no unilateral vestibular dysfunction (Table 3).

There have already been some studies that have examined dizziness occurring after TAs using patient grouping [6,13]. Unlike previous studies, we divided patients based on their symptoms rather than their test results or diagnosis. This is an easier and faster way for categorizing patients regardless of whether or not they have audiological symptoms.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Jeju National University Hospital, Jeju, Korea.

Informed Consent: Written informed consent from each patient was waived.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - M.B.K., C.I.S.; Design - M.B.K., C.I.S.; Supervision - G.C.L.; Resources - G.C.L., C.I.S.; Materials - M.B.K., C.I.S.; Data Collection and/or Processing - M.B.K., S.W.C.; Analysis and/or Interpretation - M.B.K., S.W.C.; Literature Search - M.B.K., S.W.C.; Writing Manuscript - M.B.K., C.I.S.; Critical Review - G.C.L.

Conflict of Interest: No conflict of interest was declared by the authors.

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REFERENCES

1. Endo K, Ichimaru K, Komagata M, Yamamoto K. Cervical vertigo and dizziness after whiplash injury. Eur Spine J 2006; 15: 886-90. [CrossRef]
2. Marzo SJ, Leonetti JP, Raffin MJ, Letarte P. Diagnosis and management of post-traumatic vertigo. Laryngoscope 2004; 114: 1720-3. [CrossRef]
3. Oka H, Matsudaira K, Fujii T, Okazaki H, Shinkai Y, Tsuji Y, et al. Risk factors for prolonged treatment of whiplash-associated disorders. PLoS One 2015; 10: e0132191. [CrossRef]
4. Treleaven J, Peterson G, Ludvigsson ML, Kammerlind AS, Peolsson A. Balance, dizziness and proprioception in patients with chronic whiplash associated disorders complaining of dizziness: A prospective randomized study comparing three exercise programs. Man Ther 2016; 22: 122-30. [CrossRef]
5. Fife TD, Giza C. Posttraumatic vertigo and dizziness. Semin Neurol 2013; 33: 238-43. [CrossRef]
6. Lee MY, Chung SW, Suh MW, Rhee CK, Jung JY. Clinical characteristics of dizziness after motor vehicle accident. Korean J Otorhinolaryngol-Head Neck Surg 2009; 52: 718-23. [CrossRef]
7. Chetana N, Claussen CF. Vertigo in whiplash injury: A presentation of prevalent butterfly patterns of caloric tests. Indian J Otolaryngol Head Neck Surg 2010; 62: 208-14. [CrossRef]
8. Gurgel RK, Jackler RK, Dobie RA, Popelka GR. A new TJS AOP 4-2017 format for reporting hearing outcome in clinical trials. Otolaryngol Head Neck Surg 2012; 147: 803-7. [CrossRef]
9. Liu H. Presentation and outcome of post-traumatic benign paroxysmal positional vertigo. Acta Otolaryngol 2012; 132: 803-6. [CrossRef]
10. Lee JH, Song MH, Park JW, Ko KM, Shim DB. Clinical manifestations of benign paroxysmal positional vertigo after head trauma. Korean J Otorhinolaryngol-Head Neck Surg 2015; 58: 836-40. [CrossRef]
11. Choi MS, Shin SO, Yeon JY, Choi YS, Kim J, Park SK. Clinical characteristics of labyrinthine concussion. Korean J Audiol 2013; 17: 13-7. [CrossRef]
12. Singh G, Singh B, Singh D. Prospective study of 'otological injury secondary to head trauma'. Indian J Otolaryngol Head Neck Surg 2013; 65: 498-504. [CrossRef]
13. Hoffer ME, Gottshall KR, Moore R, Balough BJ, Wester D. Characterizing and treating dizziness after mild head trauma. Otol Neurotol 2004; 25: 135-8.[CrossRef]