

# Risk factor of benign paroxysmal positional vertigo in trauma patients

## A retrospective analysis using Korean trauma database

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### Abstract

Benign paroxysmal positional vertigo (BPPV) is a comorbid condition prevalent in patients recovering from trauma. Due to the paucity of studies investigating the etiology of this condition, the present study sought to analyze the high-risk group of BPPV patients following trauma.

Trauma patients visiting the emergency department from January to December 2016 were enrolled. The study excluded patients with minor superficial injuries, those who were dead, and those discharged within 2 days after their visit. The medical records were reviewed, and every abbreviated injury score, injury severity score, and other clinical characteristics, such as age and sex, were gathered. A diagnosis of BPPV was reached only after a provocation test was administered by an otolaryngologist. The correlation was statistically analyzed.

A total of 2219 trauma patients were analyzed. The mean age of the patients was 52.6 years, and the mean injury severity score (ISS) was 7.9. About 70% of the patients were men. Additional BPPV patients were identified among patients with injuries to head and neck, chest, and abdomen, and those with external injuries. However, patients with head and neck (odds ratio [OR] [95% confidence interval [CI] = 10.556 (1.029–108.262), and abdominal injury (OR [95% CI] = 78.576 [1.263–4888.523]) showed statistically significant correlation with BPPV in the logistic regression analysis. Patients—not only those with head and neck injuries but those with abdominal injuries—who complain of dizziness need to be evaluated for BPPV using provocation tests. Further studies investigating traumatic BPPV are needed.

**Abbreviations:** AIS = abbreviated injury score, BPPV = benign paroxysmal positional vertigo, CI = confidence interval, ISS = injury severity score, KTDB = Korean trauma database, OR = odds ratio, SCC = semicircular canal.

**Keywords:** abdominal injury, benign paroxysmal positional vertigo, risk, trauma

### 1. Introduction

Trauma is still a major health concern. Worldwide, it is the leading cause of death and disability in people younger than 45.<sup>[1,2]</sup> Trauma care systems show significant improvement in trauma-related outcomes, including mortality.<sup>[3]</sup> Improved trauma-related outcomes have been reported in several studies.<sup>[4–6]</sup> However, few studies reported minor injuries combined with a major injury. As major trauma patients often sustain multiple injuries,<sup>[7]</sup> management of these combined injuries is needed.

Benign paroxysmal positional vertigo (BPPV) is a frequent complication associated with trauma.<sup>[8]</sup> It is defined as an abnormal sensation of motion or vertigo lasting 10 to 30 seconds, triggered by changes in the head position with specific nystagmus.<sup>[9]</sup> The nature of nystagmus is decided by 1 of the 3 semicircular canals (SCC) in the inner ear. Vertigo can be caused by dislodged canaliths migrating from the utricle to the SCC, and the posterior canal is the most common site of lesion.<sup>[10,11]</sup> Therefore, it is diagnosed with a set of provocation tests called the Dix-Hallpike maneuver and the supine roll test. The Dix-Hallpike test is used to diagnose posterior or anterior SCC BPPV, and the supine roll test is used to diagnose horizontal SCC BPPV.<sup>[12]</sup> Further, once the SCC involved has been determined, the BPPV is treated via canalith repositioning in the appropriate canal.

Several studies have investigated post-traumatic BPPV compared with non-traumatic BPPV diagnosed by an otolaryngologist. The studies focused on the differences in post-traumatic BPPV epidemiology or prognosis. Patients with post-traumatic BPPV were younger and more intense,<sup>[9,12]</sup> and their condition frequently had involvement of horizontal and anterior SCC, as well as multiple and bilateral involvements. Furthermore, in these patients the symptom resolution rate after repositioning was worse than in patients with non-traumatic BPPV.<sup>[9]</sup> For a trauma surgeon or emergency physician, distinguishing high-risk cases of BPPV among general trauma patients is important; however, information about risk factors for BPPV in trauma patients is lacking. Therefore, we analyzed the characteristics of BPPV compared with those of general trauma.

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**2. Methods**

The Ministry of Health and Welfare requires hospitals to submit basic information of every trauma patient visiting their emergency departments to a Korean trauma database (KTDB). The information of every trauma patient has been saved in the database, except for those involving superficial injuries, first-degree burns, frostbite, foreign bodies, and poisoning. The information in the database includes sex, age, hospital stay, self-harm, abbreviated injury score (AIS), injury severity score (ISS), and mortality. Therefore, the authors planned to use data from the KTDB to investigate the characteristics of BPPV among general trauma patients.

Consecutively, every trauma patient who registered with the KTDB from January to December 2016 was included in the analysis. The patients' age, sex, hospital stay, AIS, and ISS were reviewed. Patients with an ISS >15 were judged to have had major trauma. Their medical records were reviewed, and BPPV patients were selected. BPPV diagnosis was performed as follows. Patients with dizziness were referred to an otolaryngologist. They underwent physical examination including history and provocation tests comprising Dix-Hallpike and supine roll tests. The tests were not conducted on patients with pain associated with cervical spine or torso, including pelvis and chest wall. Patients with abnormal test results were diagnosed with BPPV. Patients who were not evaluated with the tests or showed normal results were not regarded as BPPV patients, although they complained of dizziness. Patients with unconsciousness, mortality, those 17 years old or younger, and those discharged within 48 hours of arrival in the emergency department were excluded because their complaints of dizziness were regarded as unreliable for evaluation.

Enrolled trauma patients were divided into BPPV and non-BPPV groups. The patients' trauma-related information, gathered from KTDB, was analyzed. An independent *t* test was used for quantitative analysis, and Chi-squared and Fisher exact tests were used for qualitative analysis. Additionally, binary logistic regression analysis with enter method was performed to calculate the odds ratios (OR) and 95% confidence intervals (CI) for every parameter. *P*-values (*P*) <.05 were regarded as statistically significant. All statistical analyses were performed using IBM SPSS Statistics for Windows, V 25.0 (IBM Corp., Armonk, NY). The institutional review board of Uijeongbu St. Mary's hospital approved this retrospective study, and informed consent was waived.

**3. Results**

A total of 2219 trauma patients were registered with KTDB during the period of the study. The average age of the patients was 52.6±18.4 years, and the sex ratio (male:female) was 69.5:30.5. Patients who intended self-harm constituted 1.4% (n=30). The mean length of the hospital stay was 14.8 days. Each and every BPPV were diagnosed within the hospital stay. Almost all the mechanisms of trauma were blunt injuries (93.8%) and every BPPV patient was injured via blunt injury. The characteristics of the patients are summarized in Table 1. The prevalence rate of BPPV was 1.0% (23/2219). The mean ISS was 7.93, and the number of patients with major trauma reporting ISS >15 was 340. The AIS of a total of 6 parts is summarized.

Patients in the BPPV groups were compared with those in the non-BPPV group (Table 2). Additional BPPV patients were identified with head and neck injuries (21.1% vs 60.9%, *P*<.001), chest injuries (21.6% vs 47.8%, *P*=.002), abdominal

Mean age	52.6±18.4
Sex	
Male	1543 (69.5)
Female	676 (30.5)
Self-harm	
No	2189 (98.6)
Yes	30 (1.4)
Benign paroxysmal positional vertigo	
No	2196 (99.0)
Yes	23 (1.0)
Length of hospital stay	14.8±15.6
Mechanism of injury	
Blunt	2081 (93.8)
Penetration	89 (4.0)
Mixed	49 (2.2)
Injury severity score	
Mean	7.93±7.87
≤15	1879 (84.7)
>15	340 (15.3)
Abbreviated injury score	
Head and neck	
Mean	0.63±1.331
0	1742 (78.5)
1	45 (2.0)
2	180 (8.1)
3	100 (4.5)
4	74 (3.3)
5	78 (3.5)
Face	
Mean	0.28±0.66
0	1859 (83.8)
1	109 (4.9)
2	247 (11.1)
3	4 (0.2)
Chest	
Mean	0.57±1.13
0	1734 (78.1)
1	45 (2.5)
2	113 (5.1)
3	295 (13.3)
4	15 (0.7)
5	6 (0.3)
Abdomen	
Mean	0.30±0.84
0	1952 (88.0)
1	12 (0.5)
2	150 (6.8)
3	80 (3.6)
4	22 (1.0)
5	3 (0.1)
Extremity	
Mean	1.10±1.17
0	1030 (46.4)
1	267 (12.0)
2	625 (28.2)
3	263 (11.9)
4	31 (1.4)
5	3 (0.1)
External	
Mean	0.34±0.58
0	1549 (69.8)
1	607 (27.4)
2	56 (2.5)
3	4 (0.2)
4	0 (0.0)
5	3 (0.1)

**Table 2**  
Comparison of BPPV and non-BPPV patients.

	Non-BPPV	BPPV	P
Age	52.60 ± 18.43	54.09 ± 1.913	.700
Sex			
Male	1530 (69.7)	13 (56.5)	.173
Female	666 (30.3)	10 (43.5)	
Hospital stay	14.71 ± 15.61	19.01 ± 10.78	.180
Head and neck injury			
No	1733 (78.9)	9 (39.1)	<.001
Yes	463 (21.1)	14 (60.9)	
AIS	0.62 ± 1.324	1.65 ± 1.56	.483
Face injury			
No	1841 (83.8)	18 (78.3)	.471
Yes	355 (16.2)	5 (21.7)	
AIS	0.28 ± 0.66	0.39 ± 0.78	.884
Chest injury			
No	1722 (78.4)	12 (52.2)	.002
Yes	474 (21.6)	11 (47.8)	
AIS	0.56 ± 1.12	1.26 ± 1.45	.979
Abdominal injury			
No	1936 (88.2)	16 (69.6)	.006
Yes	260 (11.8)	7 (30.4)	
AIS	0.29 ± 0.84	0.65 ± 1.03	.685
Extremity injury			
No	1018 (46.4)	12 (52.2)	.578
Yes	1178 (53.6)	11 (47.8)	
AIS	1.10 ± 1.16	1.13 ± 1.36	.906
External injury			
No	1538 (70.0)	11 (47.8)	.021
Yes	658 (30.0)	12 (52.2)	
AIS	0.33 ± 0.56	0.52 ± 0.551	.985
ISS	7.86 ± 7.84	13.83 ± 8.37	<.001
ISS ≥ 4			
No	552 (25.1)	0 (0.0)	.002
Yes	1644 (74.9)	23 (100.0)	
ISS ≥ 9			
No	1332 (60.7)	6 (26.1)	.001
Yes	864 (39.3)	17 (73.9)	
ISS ≥ 16			
No	1865 (84.9)	14 (60.9)	.001
Yes	331 (15.1)	9 (39.1)	

Data are presented as number (weighted BPPV, benign paroxysmal positional vertigo %) or mean ± standard deviation.

AIS=abbreviated injury score; BPPV=benign paroxysmal positional vertigo; ISS=injury severity score.

injuries (11.8% vs 30.4%,  $P=.006$ ), and external injuries (30.0% vs 52.2%,  $P=0.021$ ). Further, BPPV was associated with higher mean ISS ( $7.86 \pm 7.84$  vs  $13.83 \pm 8.37$ ,  $P<.001$ ) and additional major trauma (15.1% vs 39.1%,  $P=.001$ ). No statistical difference was identified in age or sex of the patients, or in the length of their hospital stay. A total of 3 BPPV patients had both abdominal injuries and head and neck injuries, and 5 BPPV patients had neither abdominal nor head and neck injuries.

Results of binary logistic regression analysis are shown in Table 3. Patients with head and neck (OR [95% CI]=10.556 [1.029–108.262]), and abdominal injury (OR [95% CI]=78.576 [1.263–4888.523]) showed significant results. Female patients (OR [95% CI]=2.350 [0.938–5.884]) and patients with other injuries showed no significant OR.

#### 4. Discussion

Dizziness is one of the frequent symptoms following trauma. Possible reasons include traumatic brain injury (such as

**Table 3**  
Logistic regression analysis of risk factors for BPPV.

	Odds ratio (95% confidence interval)	P
Sex		
Male	Reference	
Female	2.350 (0.938–5.884)	.068
Head and neck injury		
No	Reference	
Yes	10.556 (1.029–108.262)	.047
Abdominal injury		
No	Reference	
Yes	78.576 (1.263–4888.523)	.038

BPPV=benign paroxysmal positional vertigo.

intracranial hemorrhage, cerebral concussion, diffuse axonal injury) and side effects of medication, including opioid analgesics. BPPV is another factor associated with dizziness. According to a report, 25% of patients with dizziness following head trauma showed diagnoses of BPPV confirmed by positional test.<sup>[13]</sup> Therefore, medical personnel attending to trauma patients with dizziness ought to consider the possibility of BPPV and use appropriate tests for confirmation.

The present study investigated the risk factors of BPPV and the statistically increased OR. Female patients did not show statistically high OR in the present study. However, according to a literature review, estradiol deficiency in perimenopausal period was reported as one of the risk factors for idiopathic BPPV.<sup>[14]</sup> Postmenopausal changes might influence microcirculation of SCC and influence the risk of BPPV.<sup>[15]</sup> However, these studies did not analyze trauma BPPV patients, but idiopathic BPPV patients. Therefore, there might be difference in pathophysiology of BPPV and it is hypothesized that further studies with a large number of patients might yield different results. Also, to increase our understanding of BPPV pathophysiology, further studies investigating BPPV and hormonal changes in trauma patients are needed. Additional the study including various baseline parameters, for example ASA classification, might be desirable.

Traumatic brain injury or whiplash injury is a well-known etiology of BPPV.<sup>[9,11,16]</sup> Similarly, in the present study, patients with head and neck injuries also showed statistically increased risk of BPPV, with the highest OR in logistic regression analysis.

Additionally, trauma patients with abdominal injury showed increased OR. To the best of the knowledge of the investigators, the present study is the first to report the statistical correlation between BPPV and abdominal injury. In Korea, most trauma involves blunt injuries and not penetrating injuries. Also in the present study, all the BPPV patients were injured via blunt injury. The mechanical or wave-to-torso impact at the time of accident may dislocate the otoconia from the utricle, leading to BPPVs such as cervical whiplash injuries. Although the precise mechanism requires confirmation, the correlation between BPPV and abdominal injury is the focus of medical attention, and it warrants further study.

The present study had several limitations, such as missed diagnoses of BPPV because provocation tests were not performed in patients sustaining trauma of the spine and pelvis, and rib fractures. Evidence supporting the safety of the provocation tests was inadequate for clinical application, although a few patients successfully underwent the testing. The clinical feasibility of provocation tests in patients with trauma of the spine or with pelvis or rib fractures needs to be determined.

Furthermore, due to the unreliability of their complaints of dizziness, several trauma patients were excluded from the analysis. Several patients were not analyzed, such as those who were discharged within 48 hours of entry into the emergency department, those who were young, and unconscious patients. Therefore, the possibility of additional BPPV patients existed. Nevertheless, the prevalence of BPPV in the present study was about 1.0% (24/2409), which was higher than in the general population. The overall prevalence of BPPV has been reported to range from 10.7 to 140 per 100,000 of population.<sup>[17]</sup> Further study analyzing more BPPV patients with other various parameters, and including subgroup-analysis, could yield more profound understanding.

In conclusion, the prevalence of traumatic BPPV was higher in female patients, patients with head and neck injury, and those with abdominal injuries. Therefore, patients sustaining head and neck or abdominal injuries complaining of dizziness need to be examined using the provocation tests. Additional studies investigating traumatic BPPV are required.

### Author contributions

**Conceptualization:** Maru Kim, Dae-Sang Lee, Tae Hwa Hong, Hang Joo Cho.

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