Prevalence of "Reversal Nystagmus" in Benign Paroxysmal Positional Vertigo

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Abstract

Purpose To investigate the prevalence of reversal nystagmus in individuals with benign paroxysmal positional vertigo (BPPV).

Study Design Prevalence of reversal nystagmus was assessed in 28 subjects with unilateral posterior canal BPPV, canalithiasis type. Six trials of Dix-Hallpike testing were completed for each subject.

Results Reversal nystagmus was present in 129 out of 167 Dix-Hallpike maneuvers that were performed (77.2%). In 19 trials where nystagmus was absent with the dependent position of Dix-Hallpike testing, reversal nystagmus was nonetheless demonstrated in 11 trials (57.9%).

Conclusion Reversal nystagmus is commonly demonstrated in individuals with posterior canal BPPV, canalithiasis type. It is frequently evoked even when there is no nystagmus with the dependent position of Dix-Hallpike testing. Observation of reversal nystagmus may enhance the identification of BPPV during Dix-Hallpike testing.

Keywords
- benign paroxysmal positional vertigo
- vestibular
- nystagmus
- dix-hallpike

Benign paroxysmal positional vertigo (BPPV) is a common cause of peripheral vestibular dysfunction. Individuals with BPPV typically experience brief episodes of dizziness provoked by changes in head position. Episodes typically last seconds and tend to occur with mobility in bed and performance of overhead activities. In most instances, the suspected mechanism for BPPV is "canalithiasis," which involves a cluster of free-floating fragmented utricular membranes with attached and detached otoconia disturbing normal semicircular canal mechanics.[1,2] Position changes induce a migration of otoconia to the most dependent location within the endolymph-filled semicircular canal. This creates a pressure differential within the canal which displaces the cupula and its associated hair cells. This displacement results in the illusion of head movement. BPPV commonly involves the posterior semicircular canal accounting for 85 to 95% of BPPV cases.[3]

BPPV is commonly idiopathic but may also be secondary to genetic predisposition,[4,5] Meniere's disease,[6] vestibular neuritis,[7] recent ear surgery,[8] and head trauma or serum vitamin D level.[9] The incidence of BPPV increases with age with a cumulative incidence of nearly 10% at the age of 80 years.[10] The condition is more common in females than in males at a ratio of approximately 2:1.[11]

BPPV can have a significant impact on productivity and quality of life; therefore, an accurate and timely diagnosis is critical. One study[10] reported that 86% of subjects with BPPV required a medical consultation, experienced an interruption in daily activities, or required time off from work. Additionally, treatment of BPPV may lessen the risk of falls.[12]

The gold standard for diagnosis of posterior canal BPPV is the Dix-Hallpike maneuver. A positive test induces an excitatory-driven upbeat torsional nystagmus toward the involved ear due to utriculofugal displacement of the cupula within the posterior canal. The Dix-Hallpike maneuver is reported to have a sensitivity of 79%.[13,14] Variables that may impact the sensitivity of the Dix-Hallpike maneuver include the particle–canal wall interactions and the degree of dispersal of the particulate matter within the canal.[15] The

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sensitivity of Dix-Hallpike testing improves with repeat testing.[14,16]

The presence of nystagmus with return to a seated position following the dependent position of Dix-Hallpike testing may also be a useful indication of posterior canal BPPV. With return to sitting, it can be postulated that migrating debris induces utriculopetal displacement of the posterior canal cupula. This results in an inhibitory-driven downbeating nystagmus with a torsional component away from the involved ear (►**Supplementary Video 1**, online only). Henceforth, the term "reversal nystagmus" will be utilized in this article to describe this type of nystagmus regardless of the presence or absence of nystagmus with the dependent position of Dix-Hallpike testing. Postural instability is commonly associated with reversal nystagmus (►**Supplementary Video 2**, online only). While reversal nystagmus has been previously reported as a feature of posterior canal BPPV,[3,17] its prevalence and relationship to the dependent position of the Dix-Hallpike have not been formally investigated to our knowledge.

Supplementary Video 1

Reversal nystagmus in subject with right posterior canal BPPV. Online content is viewable at: https://www.thieme-connect.com/products/ejournals/html/10.1055/s-0040-1718894.

Supplementary Video 2

Postural instability associated with reversal nystagmus in subject with left posterior canal BPPV. Online content is viewable at: https://www.thieme-connect.com/products/ejournals/html/10.1055/s-0040-1718894.

The aim of this study is to report the prevalence of reversal nystagmus and its relationship to the dependent position of Dix-Hallpike testing in subjects with known posterior canal BPPV. Information on this diagnostic finding with Dix-Hallpike testing may enhance recognition of posterior canal BPPV and expedite treatment.

Methods

The study protocol was approved by the Institutional Review Board Committee at Geisinger Medical Center. All individuals presenting to the Geisinger Otolaryngology Vestibular and Balance Center between March 2017 and August 2017 with symptoms consistent with BPPV were screened for inclusion. Informed consent was obtained from all participants. A total of 28 subjects met the inclusion criteria. A single clinician, J.W., interviewed and examined each subject. Exclusion criteria: the use of vestibular sedatives within 24 hours of the appointment, history of associated emesis, inability to tolerate or refusal to participate in the study protocol, limited spinal mobility, presence of spontaneous, gaze-evoked, or static positional nystagmus, individuals with variant forms of BPPV (multicanal BPPV, horizontal canal, bilateral BPPV, or cupulolithiasis), and failure to demonstrate nystagmus with the Dix-Hallpike testing protocol outlined in this study.

The study involved six testing trials per subject. Dix-Hallpike testing was considered negative if no nystagmus was evoked within 30 seconds. If nystagmus was evoked, the dependent position was maintained for an additional 30 seconds after the nystagmus abated. Subjects were transitioned from the dependent position of Dix-Hallpike testing to sitting within 2 seconds. Immediately in the upright position, the participants were observed for reversal nystagmus. Eye movements were video-recorded with the use of Micromedical monocular "Real Eyes" infrared goggles. To minimize saccadic eye movements, subjects were instructed to maintain primary gaze and fixation was consistently permitted. The examiner determined if reversal nystagmus was present, which included video review if needed. One minute of recovery time was provided between each of the six testing trials.

Results

The study population was made up of 28 subjects, which included 16 females and 12 males with a mean age of 59.6 years (standard deviation: 12.73). All study participants included in this report demonstrated nystagmus consistent with single-sided posterior canal BPPV, canalithiasis type with Dix-Hallpike testing.

There were a total of 167 Dix-Hallpike maneuvers performed (note: one participant could only tolerate five testing trials due to nausea and emesis); reversal nystagmus was observed with 134 trials (80.2%; ►**Table 1**). A total of 19 trials did not elicit any nystagmus with the dependent position of Dix-Hallpike testing; however, 13 (68.4%) of these trials demonstrated reversal nystagmus. Most study participants (27/28, 96.4%) exhibited reversal nystagmus on at least one of the six trials of Dix-Hallpike testing. With initial Dix-Hallpike testing, 21 of 28 subjects demonstrated reversal nystagmus (75%). With combining trial one and two, 25 of 28 subjects demonstrated reversal nystagmus with at least one of the trials (89.2%). The absence of reversal nystagmus was noted in 11 instances with trials one and two and 11 instances with trials five and six of Dix-Hallpike testing; therefore, the likelihood of evoking reversal nystagmus did not appear to change with repeated testing.

Discussion

Dix-Hallpike testing is well established for the diagnosis of BPPV. However, prior studies have not formally investigated the prevalence of reversal nystagmus. This study suggests that reversal nystagmus is quite common in individuals with posterior canal BPPV and can be present when no nystagmus is evoked with the head-dependent position of Dix-Hallpike testing.

Table 1 Results of the six testing trials for the 28 study participants

Subject #	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6
1	+/+	−/+	−/+	−/−	+/+	+/+
2	+/−	+/−	+/+	+/−	+/−	+/−
3	+/+	+/+	+/+	+/+	+/+	+/[a]
4	−/−	+/+	+/+	+/−	+/+	+/+
5	+/+	+/+	+/+	−/−	+/+	+/+
6	+/+	+/+	+/+	+/+	+/+	+/+
7	+/+	+/+	+/+	+/+	+/+	+/+
8	+/−	+/+	+/+	+/−	+/−	+/+
9	−/−	+/+	+/+	+/+	+/+	+/+
10	+/+	+/+	+/+	+/+	+/+	+/+
11	+/+	+/+	+/−	+/+	+/+	+/+
12	−/+	+/+	+/+	−/−	+/−	+/−
13	+/+	+/+	−/+	+/+	+/+	+/+
14	+/−	+/−	+/+	−/+	+/−	−/−
15	+/+	+/+	+/+	+/+	+/+	+/+
16	+/+	+/−	+/+	+/+	+/+	+/+
17	+/+	+/+	+/+	+/+	+/+	+/+
18	+/+	+/+	+/+	−/+	−/+	−/+
19	+/+	+/+	+/+	+/+	+/+	+/+
20	+/+	+/+	+/+	−/+	+/+	−/+
21	+/+	+/+	+/−	+/+	+/−	+/−
22	+/+	+/+	+/+	+/+	+/+	+/+
23	+/−	+/+	+/−	+/−	+/+	+/+
24	+/+	+/+	+/+	+/+	+/+	+/+
25	+/+	+/+	+/+	+/+	+/+	+/+
26	+/+	+/+	+/+	+/+	+/+	+/+
27	+/−	+/−	+/−	+/−	+/−	+/−
28	+/+	+/+	+/+	−/+	−/+	−/+
Summary	25/21	27/24	26/24	21/20	26/22	24/23

Note. Result of each trial refers to the frequency that nystagmus was present with Dix-Hallpike testing/frequency of reversal nystagmus.
+/+ : Nystagmus was evoked with the dependent position of Dix-Hallpike testing and reversal nystagmus was present.
+/− : Nystagmus was evoked with the dependent position of Dix-Hallpike testing and reversal nystagmus was absent.
−/+ : Nystagmus was absent with the dependent position of Dix-Hallpike testing and reversal nystagmus was present.
−/− : Nystagmus was absent with the dependent position of Dix-Hallpike testing and reversal nystagmus was absent.
[a]Reversal nystagmus was not assessed in the sixth trial for subject 3 due to nausea/emesis.

Current BPPV clinical practice guidelines state that "clinicians should diagnose posterior semicircular canal BPPV when vertigo associated with torsional, up-beating nystagmus is provoked by the Dix-Hallpike maneuver."[17] According to research in the primary care setting by Hanley et al, a positive Dix-Hallpike test is associated with an 83% positive predictive value, and a negative test is associated with a 52% negative predictive value.[18] Thus, a negative Dix-Hallpike test does not exclude BPPV. Subjects with BPPV, but an absence of nystagmus with the dependent position of Dix-Hallpike testing, may still exhibit reversal nystagmus as demonstrated in this study. Observation of reversal nystagmus may improve the negative predictive value of Dix-Hallpike testing. In instances where repeated canalith repositioning maneuvers have failed, it may be helpful to confirm the presence of reversal nystagmus. This would further assure that the etiology is canalithiasis and not an alternative cause.

There are several limitations of this study. Subjects were closely observed by an experienced clinician with video infrared goggles. It is possible that an inexperienced clinician without goggles may have more difficulty identifying reversal nystagmus. Another limitation of our study is that some potential subjects refused participation in the study protocol due to anxiety or nausea. This may have biased our study population toward mild-to-moderate BPPV. Additionally, this study was not designed to formally investigate sensitivity or specificity. Further study would be needed to address these values. The findings from this study are likely not applicable to other less common variants of BPPV (cupulolithiasis, horizontal canal BPPV). Lastly, this study did not measure nystagmus velocity. Current videonystagmography technology measures horizontal and vertical eye movements only, not torsional nystagmus. Torsion is prominent with reversal nystagmus. Measurement of torsional nystagmus currently relies on the use of scleral coils which is not practical in a large-scale clinical study.

Conclusion

Reversal nystagmus is commonly demonstrated in individuals with posterior canal BPPV, canalithiasis type. It is frequently evoked even when there is no nystagmus with the dependent position of Dix-Hallpike testing. Observation of reversal nystagmus should be considered as an option with standard Dix-Hallpike testing especially in cases where no nystagmus is evoked with the dependent position of Dix-Hallpike testing.

Conflict of Interest
None declared.

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