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Original Article

Video Head Impulse Test Findings in Benign Paroxysmal Positional Vertigo Patients before and after Epley's Maneuver

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Abstract

Background: In the field of otolaryngology, dizziness is a common presenting symptom. Benign paroxysmal positional vertigo (BPPV) is the most common cause for dizziness. It is caused by otoconial debris that travels from the utricularmacula to one or more SCCs and the ampullary crest is stimulated accidently. The posterior canal BPPV vertigo (p-BPPV) is the most common form.

Methods: Two groups were included in this study. Control group: 17 healthy subjects with normal peripheral hearing sensitivity and study group: 17 patients diagnosed with BPPV. Basic audiological evaluation and vHIT tests were conducted on all the subjects in this study**.**

Results: As regard pure tone audiogram thresholds across all frequencies, there was no statistically significant difference between the study and control groups. Furthermore, there was no significant difference between the two groups in terms of vHIT gain. Moreover, there was no difference in vHIT gain among the study group before and after the Epley maneuver.

Conclusion: vHIT is an objective quantitative test of VOR function through measuring the gain of the semicircular canals individually but it has on significant role in diagnosis or assessment of BBPV treatment.

Keywords: vHIT, Benign Paroxysmal Positional Vertigo, Epley's maneuver, vestibular.

Introduction

In the field of otolaryngology, dizziness is a common presenting symptom. Benign Paroxysmal Positional Vertigo (BPPV) is diagnosed in about 17 % to 24 % of cases, with a reported prevalence of 10.7 to 64.0 cases per 100,000 people and a lifetime prevalence of 2.4 % [1]. This illness is referred to as "benign" because there is usually minimal involvement of the central nervous system and the prognosis is generally favorable [2].

BPPV is distinguished by transient spinning sensations that last less than one minute and are caused by a change in head position in relation to gravity. When a patient gets in or out of bed, rolls over in bed, tilts the head back, or bends forward, vertigo usually develops. BPPV attacks are usually without a known cause, though they may be linked to head trauma, a prolonged recumbent position, or other inner ear problems [3].

The most frequent type of BPPV is posterior canal benign paroxysmal positional vertigo (p-BPPV), which affects 85–95 % of cases [4]. The Dix-Hallpike maneuver is considered the gold standard test for the diagnosis of p-BPPV [5]. BPPV in the lateral (horizontal) canal occurs for 5% to 15% of all BPPV cases. There are also a few additional uncommon forms, such as anterior canal BPPV, multicanal BPPV, and bilateral multicanal BPPV [6].

The repositioning approach was reported by Epley as a treatment for BPPV that included transferring particles from the posterior semicircular canal (SCC) into the vestibule by a series of head position changes [7]. Patients treated with Epley's maneuver had a better likelihood of recovery in terms of clinical symptoms and diagnostic positional tests of 6.5 times and 5.19 times, respectively, according to a meta-analysis conducted in 2010[8].The absence of nystagmus during positional tests was linked to treatment efficacy in another meta-analysis [9].

BPPV is characterized by spontaneous remission and recurrence, the annual recurrence rate is estimated to be around 15% [10]. Patients with BPPV are more likely to fall and have difficulty performing daily tasks [11]. As a result, the importance of early BPPV diagnosis and treatment can significantly enhance the quality of life of patients suffering from this disease.

Recently, some tests were added to the assessment battery to increase the sensitivity and specificity in the differentiation of vestibular pathologies. One of these tests the video head impulse test (vHIT) [12]. The vHIT is characterized by that it is easily applicable, fast, practical, and it can individually evaluate all SCCs [13].

METHODS

Study design and subjects: This case-control observational study was carried out in the audio-vestibular unit, ENT department, Faculty of Medicine, Zagazig University Hospitals. The sample size was calculated to be 34 subjects classified into two groups:

Study group: involved 17 BPPV patients diagnosed by Dix-hallpike test and supine roll test. They ranged in age from (20-60) years of both genders (male and female)

Exclusion criteria: a history of other systemic disorders, cervical lesion with limited neck range of motion, patients who had received vestibular suppressant medication, a history suggesting vestibular neuritis, labyrinthitis, migraine, Meniere’s disease or any central nervous system disease.

Control group: included 17 healthy volunteers with normal peripheral hearing sensitivity in the frequency range of 250-8000Hz (hearing threshold level $\leq$ 25 dB HL) and bilateral normal middle ear function. These subjects were confirmed to be of both genders, with age range (20-60) years old, with no history of noise exposure or any systemic diseases that affect balance {e.g. neurological diseases, hypertension, diabetes mellitus, ototoxic drug intake…etc.}. They matched the study group in age and gender.

Written informed consent was obtained from all participants, the study was approved by the research ethical committee of Faculty of Medicine, Zagazig University. The study was done according to The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Basic audiological evaluation:

All participants were subjected to otoscopic examination, pure tone audiometry, speech audiometry and immittancemetry.

Positioning test:

It included the following:

-Dix-hallpike maneuver: While the subject was seated on the table, the subject's head was turned 45 degrees to the right (or left) and the subject was taken to the supine position. The patient is kept in this position for 30 seconds, if there was no nystagmus the subject was returned to the sitting position. If nystagmus occurred, it was noted, and the individual was restored to a sitting position once the nystagmus had faded away.

- Supine roll test: The patient's head is elevated about 30 degrees in the supine position, and then quickly turned to either side.

Video head impulse test*:*

The vHIT was carried out with the help of an EYE SEECAM vHIT from Interacoustics. Recordings were obtained for each of the six SCCs in all patients (horizontal, LARP, RALP).The patient’s head was turned abruptly and unpredictably in the plane of a SCC pair and the instantaneous compensatory eye movement response was observed.

The head was rotated at a small angle (10–20) within the horizontal plane to left and right to assess the horizontal SCCs while it was rotated downward or upward to stimulate the LARP and RALP SCCs while positioned 40 degrees relative to the trunk. The head impulse has been conducted at least five times in each plane and direction.

Measured parameters of vHIT:

*Gain: is the usual measure of the adequacy of the VOR, reflects the ratio between the velocity of the eye and the velocity of the head. Gain >0.80 for horizontal SCCs and >0.75 for posterior and anterior SCCs without saccades are thought normal results. vHIT was considered abnormal if reduced VOR gain was present in at least one canal [13].

*Catch-Up Saccade: During each head impulse, the eye movement response of a healthy subject will compensate for head turn and the gaze will stay on a fixed target. However, the eyes of a patient with vestibular dysfunction will move with the head, so that the patient has to make a corrective (catch-up) saccade at the end of each head impulse in order to return his gaze to the target, which are called "overt saccades." Whereas saccades that may occur during head impulses are called "covert saccades". These corrective saccades observed by the clinician are the clinical sign of canal paresis [14].

Statistical analysis:

Microsoft Excel software was used to code, enter, and analyze data obtained during the history, basic clinical examination, laboratory investigations, and outcome measures. Data were then entered into Statistical Package for the Social Sciences (SPSS version 20.0) **(Statistical Package for the Social Sciences)** software for analysis. **The following tests were used**:

- Chi square test (X2): to test differences for significance, difference and association of qualitative variable
- *t* test: to test differences between quantitative independent groups .
- Paired *t* test: is used to compare the means between two related groups.

Threshold for significance: P-value <0.05 denotes a statistically significant difference, p≤0.01 denotes a highly statistically significant difference, and p≤0.001 denotes a very highly statistically significant difference. A non-statistically significant difference is indicated by a p≥0.05.

Results

Two groups of adults were included in this study. The study group involved 17 patients (7 male and 10 female). Their mean age was 51.41±8.29 years, the control group included 17 subjects (6 male and 11 female) and their mean age was 47.41±8.03 years. In terms of age and gender, there was no statistically significant difference between the two groups. Moreover, there was no difference between the control and study groups as regard pure tone thresholds at any frequency, SRT and WD% in the right and left ear.

The distribution of BPPV patients according to affected side in the study group was that 9 BPPV patients had right ear affection while 8 patients were left sided (Table 1). While, the distribution of the study group according to the affected semicircular canal (SCC) diagnosed by Dix-Hallpike maneuver was that the most affected canal in the study group was posterior canal (82.4%) (Table 2).

Regarding vHIT, among the study group, there was no statistically significant difference between affected and non-affected ears (Table 3). Also, there was no statistically significant difference between pre and post Epley results in affected ears (Table 6) as well as in non-affected ears (Table 7).

Furthermore, when comparing between the affected ears in study group and BPPV matched ears in control group regarding SCCs gain of VHIT, there was no statistically significant difference between them (Table 4). Same result was obtained when comparing between non-affected ears in study group and non BPPV matched ears in control group (Table 5).

Table (1): The distribution of BPPV patients according to affected side in the study group:

Affected side	No.	%
Right ear	**9**	**52.9**
Left ear	**8**	**47.1**
Total	**17**	**100**

Table (2): The distribution of the study group according to the affected semicircular canal (SCC) diagnosed by Dix-Hallpike maneuver**:**

Affected SCC	No.	%
Anterior	**3**	**17.6**
Posterior	**14**	**82.4**
Total	**17**	**100**

Table (3): Comparison between affected and non-affected ears as regard VHIT in the study group:

Gain (º/s)	Affected ear (n=17)	Non affected ear (n=17)	Paired t	P
Lateral canal	1.03±0.1	0.9±0.3	1.695	0.0998
Anterior canal	0.98±0.2	1.1±0.3	1.372	0.1795
Posterior canal	0.79±1	0.99±0.8	0.643	0.524

Table (4): Comparison between affected ears in study group and BPPV matched ears in control group regarding SCCs gain of VHIT:

Gain (º/s)	Affected ears in study group (n=17) *mean±SD*	BPPV matched ears in control group (n=17) *mean±SD*	t	p
Lateral canal	1.03±0.1	1.2±0.3	0.912	0.368
Anterior canal	0.98±0.2	1.01±0.09	0.564	0.576
Posterior canal	0.79±1	0.98±0.9	0.582	0.564

Table (5): Comparison between non-affected ears in study group and non BPPV matched ears in control group regarding SCCs gain of VHIT:

Gain (º/s)	Non affected ears in study group (n=17) *mean±SD*	Non BPPV matched ears in control group (n=17) *mean±SD*	t	P
Lateral canal	0.9±0.3	1.1±0.4	1.649	0.108
Anterior canal	1.1±0.3	0.98±0.1	1.564	0.127
Posterior canal	0.99±0.8	0.87±0.3	1.372	0.179

Table (6): Comparison between pre and post Epley results in affected ears as regard VHIT in the study group:

Affected ears (n=17)				
	Pre Epley *mean±SD*	**Post Epley** *mean±SD*	**Paired t**	**P**
Lateral canal	1.03±0.1	1.08±0.07	1.688	0.101
Anterior canal	0.98±0.2	1±0.3	0.228	0.820
Posterior canal	0.79±1	0.83±0.9	0.122	0.903

Table (7): Comparison between pre and post Epley results in non-affected ears as regard VHIT in the study group:

Non affected ears (n=17)				
	Pre Epley *mean±SD*	**Post Epley** *mean±SD*	**Paired t**	**P**
Lateral canal	0.9±0.3	1.02±0.1	1.56	0.127
Anterior canal	1.1±0.3	0.98±0.4	0.989	0.329
Posterior canal	0.99±0.8	1.06±0.6	0.288	0.774

Discussion

Benign paroxysmal positional vertigo (BPPV) is an inner ear condition that is characterized by brief episodes of positional vertigo induced by changes in head position in relation to gravity. The posterior SCC, which is the most gravity-dependent canal, is the most common form of BPPV.

The present study was designed to evaluate the function of VOR of the three SCCs in normal adults versus patients of BPPV using the vHIT and to study the role of this test in the evaluation of Epley's maneuver as a repositioning procedure in BPPV patients.

In our ongoing study no corrective saccades were seen in any of the patients. Absence of corrective saccade in BPPV patients was also reported by **Fallahnezhad et al.** [15] and **Cinar et al.** [16]. They explained the existence of corrective saccades could indicate other concomitant vestibular disorders.

In a literature review of vHIT, **Cinar et al.** [16] stated that no statistically significant difference was found when comparing VOR gain of each SCC between the affected and non-affected ears among BPPV patients. As shown in (Table 3), our data in the present study was in agreement with this study. It was obvious from (Table 4, 5) that the BPPV and control groups had no statistically significant differences in the values of vHIT parameters or the number of patients with VOR gains abnormalities. These results were consistent with **Alhabib and Saliba.** [17] and **Cinar et al.** [16].

Moreover, our work revealed that there was no differences between pre and post Epley's maneuver results either on the affected or on the non-affected ears as regards VOR gain in the BPPV patients (Table 6, 7). These results were also reported by **Cinar et al.** [16].

So we assumed that the BPPV is a mechanical ailment with vestibular dysfunction due to an overstimulation of SCCs rather than a vestibular reduction and that this pathological condition would have no effect on VOR gains. Accordingly, BPPV has no effect on the vHIT parameters in the present study.

Also, **Fallahnezhad et al.** [15] hypothesized that abnormal VOR gain in SSC might be noticed in BPPV patients as well as in healthy individuals. The method of eye movement recording usually results in questionable SSC gains. As a result, VOR gain in SCC should be interpreted cautiously.

Likewise, in many other researches, VOR gain exhibited some abnormalities in some cases, as was proven by **Halmagyi et al.** [14]. They reported that the eyelid may obscure part of the pupil when the head moves in the direction of the SCC (particularly the anterior SCC), which is considered a prominent artifact that disrupts SCC response. Besides that, **Alhabib and Saliba.** [17] stated that vHIT will be abnormal only if the vestibular function is reduced by more than 40%. Moreover, **Fallahnezhad et al**. [15] considered recurrent BPPV as an obvious cause for abnormal VOR gain.

On the other hand, **Fallahnezhad et al.** [15] who studied vHIT in 29 patients with unilateral posterior SCC-BPPV and demonstrated abnormal VOR gain in 55.17% of patients. They suggested that VOR gains in patients with PSCC-BPPV may be diminished because free floating particles in the posterior SCC disrupt endolymphatic flow, resulting in VOR and gaze stabilization deficits.

In other word, **Castellucci et al.** [18] hypothesized that otoconial debris alters endolymphatic dynamics and cupular response mechanisms, resulting in a high-frequency VOR deficit for the involved canal. This pathology is most likely to arise when an otoconial mass settles in the distal portion of the non-ampullary arm of posterior SCC, close to the common crus, where it may get partially entrapped because of the narrow lumen at this location.

Taken together, all of our previous results and findings may be contributed to the limitations of the vHIT technique, as well as the pathophysiology of BPPV disease. Furthermore, vHIT measurement necessitates an experienced examiner who can reliably perform a quick head movement.

Conclusion

For the diagnosis of BPPV, the history and physical examination (Dix–Hallpike and Supine Roll test) are considered the gold standard. BPPV is a treatable, otoconial, peripheral vestibular disorder which is corrected mechanically by canalith repositioning maneuvers.

The vHIT is a physiological, fast, and well-tolerated test for examining vestibular function, and it is the only feasible test for assessing all six SCCs independently, however it is not specific for BBPV diagnosis or treatment evaluation.

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