

Comparative evaluation of the diagnostic value of the VHIT and Dix-Hallpike test in patients with balance system disorders in out-patient healthcare practice and expertise preparation

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ABSTRACT:

Introduction: This study aimed to perform comparative analysis of the diagnostic value of the Video Head Impulse Testing (VHIT) Ulmer I and Dix-Hallpike Test in patients with balance system disorders in outpatient healthcare practice and medical jurisdiction.

Material and methods: The study included 63 patients, aged 20–79, 28 women (20–72 years) and 35 men (23–79 years), divided into two groups: group I (study group) – 33 patients with vertigo of mixed origin (on the basis of the Fitzgerald-Hallpike caloric test during the VNG), and group II (reference group) – 30 healthy subjects. After the ENT interview and physical examination, exclusion of pathological lesions in the external acoustic meatus and middle ear, each patient underwent the Fitzgerald-Hallpike caloric test in VNG as well as the VHIT and Dix-Hallpike test, with the evaluation of eyeball reaction during head rotation.

Results: In the group of patients with mixed origin vertigo (group I), the Fitzgerald-Hallpike caloric test showed unilateral labyrinth disturbances in 90.9% of the patients (mean 41.8%) and relative directional preponderance of the mean value of 19.0%, whereas in 9.1% of the patients, the detected values of labyrinth excitability were normal. Benign paroxysmal positional vertigo was diagnosed in 9.1% of all the examined vertigo cases. This diagnosis was based on the positive response to the Dix-Hallpike maneuver and indicative of damage to the posterior semicircular canal in VHIT (without signs of deficiency in VNG).

Conclusion: VHIT and the Dix-Hallpike test enable quick and precise detection of benign paroxysmal positional vertigo in outpatient healthcare practice and medical jurisdiction.

KEYWORDS:

VHIT Ulmer I, Dix-Hallpike test, vertigo

INTRODUCTION

Benign paroxysmal positional vertigo (BPPV) is one of the most common vertigo of peripheral origin. On average, it occurs in the fourth and fifth decade of life and more often in women.

The risk of developing disorders increases with age and the in-

cidence rate is 10.7-64/100,000 population per year. It is caused by the release and free floating of otoconias (otoliths) within the semicircular canals of the inner ear [1–3].

Benign paroxysmal positional vertigo may be caused by disorders in all of the three semicircular canals of the vestibular organ. And thus, respectively, in the semicircular posterior canal

they occur in 60–90% of cases, in the lateral canal in 5–30% of cases and in the anterior canal only in 2% of cases [4].

In most cases, BPPV is idiopathic (primary), whereas in 30% of cases, a specific cause can be identified, hence it is determined as secondary (symptomatic) benign paroxysmal positional vertigo.

The causes of secondary BPPV are: trauma (head trauma, whiplash), Meniere's disease, vestibular neuritis, sudden hearing loss, migraine headaches (basal and vestibular), ear surgery (stapedectomy, cochlear implantation), paranasal sinuses and dental surgeries and long-term immobilization. Head injuries have been estimated to be the most frequent cause of secondary BPPV and they account for 8.5–20% of all BPPV cases [5–8].

Typical symptoms include sometimes very severe, short vertigo (sense of spinning) following head repositioning, e.g., when turning from side to side, bending forward when twisting the head, when changing body position from horizontal to vertical and vice versa. Often vertigo is accompanied by vegetative symptoms such as nausea, vomiting, pallor and excessive sweating. Earlier works [9, 10] assessed the diagnostic value of the Videonystagmography Head Impulse Test (VHIT) in semicircular canal injuries in patients with vertigo.

This study aimed to perform comparative evaluation of the diagnostic value of the VHIT Ulmer I test and the Dix-Hallpike test in patients with balance disorders in the outpatient healthcare practice and medical jurisdiction.

MATERIAL AND METHODS

A total of 63 patients, 28 women aged 20–72 years (mean 50.25 years) and 35 men, aged 23–79 years (mean 47.65 years) were examined and divided in two groups:

- I (study group) – 33 patients with vertigo of mixed origin (on the basis of Fitzgerald-Hallpike caloric test in VNG).
- II (reference) – 30 healthy subjects.

After taking otorhinolaryngological medical history, physical examination, exclusion of pathological lesions of the external acoustic meatus and the middle ear, each patient underwent a Fitzgerald-Hallpike caloric test in the VNG using a water calorimeter. The caloric test assessed excitability of labyrinths, absolute and relative directional preponderance and unilateral deficit. Water at a temperature of 30°C and 44°C was administered bilaterally to the external auditory canal each time for 45s. This was followed by performance of the Dix-Hallpike

maneuver in each patient with the assessment of eyeball reactions during head rotation (Fig. 1).

Demicircular canals, due to their specific orientation, cooperate in the following pairs: left and right lateral canal (horizontal), left anterior and right posterior (vertical) canal, right anterior and left posterior (vertical) canal.

Taking into account the above physiological assumptions, the function of semicircular canals was examined in this test in the following way: sitting position with the head tilted 30° forward with eyes looking at a fixed point followed by quick movements to the left or right (respectively to stimulate the left lateral (Fig. 2A) or the right lateral semicircular canal (Fig. 2B)), which was recorded by the camera. When the vertical semicircular canals were tested, the patients head was tilted laterally 45° to the left and quick movements were performed forwards or backwards (respectively to stimulate right anterior (Fig. 2C) or left posterior semicircular canal (Fig. 2D)). When the head was tilted 45° to the right and several quick movements were performed forward or backward, the respectively left anterior (Fig. 2E) or right posterior semicircular canal (Fig. 2F) was stimulated. The function of the canal was determined on the basis of the percentage (GAIN) expressed by the formula:

$$DG/RH \times 100\%,$$

where DG – deviation of gaze, RH – rotation of head. The normal value of GAIN ranges from 1–40%.

The obtained data were analyzed statistically calculating the following values: minimum, maximum, median, mean and standard deviation.

RESULTS

In patients with vertigo of mixed origin (Group I), the Fitzgerald-Hallpike caloric test showed unilateral deficit of the labyrinth in 30 patients (90.9%) of mean value 41.8% and a relative directional preponderance of mean value 19.0% (Tab. I), whereas in 3 patients (9.1%) the values of the excitability of labyrinths were normal. In group II, no labyrinth deficiency was found in VNG – values in normal ranges (Tab. I).

In group I, VHIT most frequently revealed injury in one canal (table II), respectively: anterior semicircular - in 12 cases (36.4%), posterior – in 7 cases (21.2%) and lateral – in 1 case (3.0%); within two canals respectively: anterior and lateral – in 4 cases (12.1%), lateral and posterior – in 3 cases (9.1%) and anterior and posterior – in 2 cases (6.1%) and within three canals respectively: an-



Fig. 1. Dix-Hallpike maneuver. Explanations: A—sitting position (head is turned 45°). B—supine position (head straight rotated to the right), C—return to sitting position (head is turned 45°), D—supine position (head straight rotated to the left).

Tab. I. Patients depending on the mean value of the Fitzgerald-Hallpike caloric test results.

MEAN VALUES	LEFT EAR COLD [R/S]	RIGHT EAR COLD [R/S]	RIGHT EAR WARM [R/S]	LEFT EAR WARM [R/S]	EXCITABILITY [R/S] [6 TO 80 R/S]	DIRECTIONAL PREPONDERANCE ABSOLUTE [R/S] [MAX.: 2 R/S]	DIRECTIONAL PREPONDERANCE RELATIVE [%] [MAX.: 11%]	UNILATERAL DEFICIT [%] [15%]
Group I	16.1	15.9	25.6	28.8	59.1	2.4	19.0	41.8
Group II	10.4	10.1	14.2	12.9	25.8	1.3	15.8	7.7

Tab. II. Patients depending on the occurrence of semicircular canal injuries in VHIT.

SEMICIRCULAR CANAL INJURY:	GROUP I [N]	GROUP I [%]	GROUP II [N]	GROUP II [%]
Anterior	12	36.4	0	0.0
Anterior and lateral	4	12.1	0	0.0
Anterior and posterior	2	6.1	0	0.0
Anterior, lateral and posterior	4	12.1	0	0.0
Lateral	1	3.0	0	0.0
Lateral and posterior	3	9.1	0	0.0
Posterior	7	21.2	0	0.0
Total	33	100	0	0

terior, lateral and posterior – in 4 cases (12.1%). In total, injuries in the semicircular canals were found in all group I patients.

Tables III, IV and V demonstrate respectively the minimum, maximum and mean values of GAIN for group I and II. In group II, all values were in normal range.

In group I, a positive response was obtained after the Dix-Hallpike maneuver only in 3 patients (9.1%), whereas VHIT showed injury of the posterior semicircular canal and on this basis benign paroxysmal positional vertigo was diagnosed. In healthy subjects (group II) VNG, VHIT and Dix-Hallpike test did not demonstrate deviation from normal values.

DISCUSSION

Dizziness, especially BPPV, is often misdiagnosed by inexperienced doctors, and as such, is diagnosed late. Abbott et al. [11] indicate that the average time between the onset of symptoms and the definitive diagnosis was 70 months and about eight hospitalizations of the patient. Vigilance and appropriate knowledge allow for the patient's early referral to a specialist, basic tests and implementation of appropriate treatment, which is important in outpatient practice and medical jurisdiction.

Diagnosis of BPPV is based on characteristic symptoms and includes the performance of liberatory maneuvers, i.e., the



Fig. 2. The V HIT Ulmer I test. Explanations: A – head tilted 30° forward, rapid rotation of the head to the left – stimulation of the left lateral semicircular canal, B – head tilted 30° forward, rapid rotation of the head to the right – stimulation of the right lateral semicircular canal, C – head tilted 45° to the left, rapid tilting of the head forward – stimulation of the right anterior semicircular canal, D – head tilted 45° to the left, rapid movement of the head backward – stimulation of the left posterior semicircular canal, E – head tilted 45° to the right, rapid tilting of the head forward – stimulation of the left anterior semicircular canal, F – head tilted 45° to the right, rapid movement of the head backward – stimulation of the right posterior semicircular canal.

Dix-Hallpike test and the supine roll test, which result in the movement of otoconia (otoliths) within the semicircular canals of the labyrinth. During examination, the patient reports sudden dizziness and nystagmus. The triggered nystagmus must have specific characteristics to be considered a positive maneuver [12].

The positive Dix-Hallpike maneuver confirms injury within the posterior semicircular canal, whereas the positive supine roll test confirms injury in the lateral semicircular canal. In

patients with BPPV, no hearing impairment is observed and the results of videonystagmography are usually within normal range. It is also helpful to use VHIT, which allows to determine a specific site of canal injury within the organ [13–16], which was the case in our research study.

In group I, a positive Dix-Hallpike response was obtained only in 3 patients (9.1%), whereas VHIT revealed injury of the posterior semicircular canal (no deficit in VNG) and on this basis, benign paroxysmal positional vertigo was diagnosed.

Tab. III. Patients depending on minimal GAIN values.

VHIT [%]	RE-ANTERIOR CANAL [%]	RE-LATERAL CANAL [%]	RE-POSTERIOR CANAL [%]	LE-ANTERIOR CANAL [%]	LE-LATERAL CANAL [%]	LE-POSTERIOR CANAL [%]
Group I	0	3	0	0	0	0
Group II	0	0	1	0	0	0
Total	0	0	0	0	0	0

Tab. IV. Patients depending on maximal GAIN values.

VHIT [%]	RE-ANTERIOR CANAL [%]	RE-LATERAL CANAL [%]	RE-POSTERIOR CANAL [%]	LE-ANTERIOR CANAL [%]	LE-LATERAL CANAL [%]	LE-POSTERIOR CANAL [%]
Group I	110	97	71	110	110	110
Group II	35	39	39	37	38	39
Total	110	97	91	110	110	110

Tab. V. Patients depending on mean GAIN value.

VHIT [%]	RE-ANTERIOR CANAL [%]	RE-LATERAL CANAL [%]	RE-POSTERIOR CANAL [%]	LE-ANTERIOR CANAL [%]	LE-LATERAL CANAL [%]	LE-POSTERIOR CANAL [%]
Group I	40.0	23.5	26.6	35.3	29.5	35.0
Group II	17.9	16.0	21.4	17.7	14.6	19.7
Total	28.3	19.7	25.4	26.5	21.4	27.4

The criteria for diagnosis of BPPV include: a 2–3-second period of latency before the attack of vertigo and nystagmus, torsional or horizontal with torsional component nystagmus in supine position with the fast phase beating upward towards the affected ear, duration of nystagmus and vertigo less than 60 seconds, reversal of nystagmus direction after returning to a sitting position, habituation and fatigue of nystagmus with repeated maneuver.

The goal of the treatment and rehabilitation of BPPV is dislocation of pathological particles away from the cupula of the posterior semicircular canal to the end of the vestibule, where they no longer cause disease symptoms. These techniques are called repositioning techniques. Epley's repositioning and Semont's liberatory maneuvers are the most common treatment methods. The latter can be used in patients with severe changes in the cervical spine, which prevent a full range of movements, i.e., head tilting backwards, whereas at home, patients can be recommended to perform the Brandt-Daroff exercise [16, 17].

Movement rehabilitation is the only effective treatment for

BPPV. Pharmacological treatment for vertigo of this type is of supportive importance. Rehabilitation maneuvers in BPPV may be performed by a physician or physiotherapist dealing with otoneurology and appropriately qualified in this area. Therapeutic effects after application of rehabilitation maneuvers in BPPV often occur after just one exercise and in some patients, maneuvers often have to be repeated until regression of symptoms [10, 18, 19].

CONCLUSIONS

1. In the conducted study benign paroxysmal positional vertigo was diagnosed in 9.1% of all cases. It was diagnosed on the basis of a positive Dix-Hallpike test, whereas in VHIT, injury of the posterior semicircular canal (no deficit in the VNG) was observed.
2. VHIT and the Dix-Hallpike test allow for quick and precise diagnosis of benign paroxysmal positional vertigo in outpatient healthcare practice and medical jurisdiction.

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