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Comparision Of Clinical Vestibular Evaluation And Video Head Impulse Test In Detection Of Semicircular Canal Dysfunction

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Abstract
Introduction: *Bedside Head Impulse Test (HIT) is a very useful test in detecting nystagmus in semicircular canal dysfunction. The direction of nystagmus will lead to the identification of the affected semicircular canal. However, this clinical test has limitations as some saccadic eye movements can be missed clinically. Video Head Impulse Test (VHIT) provides objective, quantitative data and it helps to assess vestibular function with speed and accuracy.*
Methodology: *Clinical history , otoscopic examination and vestibular evaluation were performed for 61 patients in a tertiary care hospital, and the results were recorded. VHIT was conducted and the results were recorded ;comparison was done between bedside HIT and VHIT results.*
Results: *The mean Vestibulo-Ocular Reflex (VOR) gain was 0.67. The sensitivity of VHIT was 91.3% and accuracy was 81.97% with positive predictive value and negative predictive value 85.7% and 66.6% ,respectively.*
Conclusion:
vHIT detects dysfunction of individual semicircular canals and also in patients with clinically normal vestibular evaluation. It is also non-invasive, easy to use and practice in clinics.
Keywords: *Video Head Impulse Test, vertigo, BPPV, VOR, vestibular evaluation.*

INTRODUCTION

The VHIT (Video Head Impulse Test), introduced by Halmagyi and Curthoys in 2009, evaluates the Vestibulo-Ocular Reflex (VOR), which stabilizes gaze during head movement. A normal VOR ensures eye speed matches head or target speed, maintaining image focus on the retina[1]. If eye speed is reduced, VOR gain drops below 100%, indicating vestibular dysfunction. Compensatory eye movements called saccades then occur[2]. While bedside tests which was discovered by the former in 1988 detect large saccades, smaller ones may be missed. VHIT addresses this by recording subtle saccades with video, offering a more accurate, comfortable, and examiner-independent evaluation using two-dimensional pupil tracking[3].

. MATERIALS AND METHODS

After obtaining institutional ethics clearance (SRMIEC-ST0325-2488).

SAMPLE SIZE CALCULATION

$$n = \frac{Z^2_{1-\alpha/2} * P * (1-P)}{d^2} = \frac{(1.96 \times 1.96) * 0.802 * (1-0.802)}{0.10 \times 0.10}$$

$$n = \frac{3.8416 \times 0.802 \times 0.198}{0.01}$$

= 0.61/0.01= 61

Sample size is 61

Inclusion criteria:

All patients who reported to our Outpatient Department in our tertiary care hospital with complaints of vertigo, in the age group of 18-70 and patients who are willing to participate in our study were included.

Exclusion criteria:

We excluded patients with active giddiness who had taken anti labyrinthine drugs within one week. Patient who had Cervical Spondylosis, Cerebrovascular Accident, Meniere's Disease, Transient Ischemic

Attack, Road Traffic Accidents, Diabetic Ketoacidosis, Anaemia, Seizures, Perilymph fistula, Chronic Otitis Media and eye motility disorders like nystagmus and squint were excluded.

Subjects:

61 patients ranging from age 18 to 70 were evaluated and the otoscopic findings were recorded after which bedside head impulse test was done. Subsequently video head impulse test was done, and the findings were compared.

Hypothesis

Our hypothesis was that Video head impulse test is more sensitive in identifying semicircular canal dysfunction than vestibular evaluation.

METHODOLOGY:

Bedside head impulse test:

After getting informed consent from the patient, a detailed history and examination of the ear was done. Vestibular evaluation was done after which patient was asked to focus on the examiners nose or ear. For testing the lateral canals, the patient head tilted 30^0 forward and left and right head movements were given and head was returned to the midline[4].

For testing the left anterior and right posterior canal, patient head was rotated 45^0 to the left and for right anterior and left posterior the head was rotated 45^0 to the right. The examiner held the patients head and gave rapid and unexpected up and down movements[4]. The presence or absence of corrective saccades and their direction should be note

Video head impulse test:

Patients were asked to fix their eyes on a laser dot about 1m distance in a dimly lit room. In our department we use the neuro-equibrium software for neuro-otology. A special video goggles with an in-built camera, which has a high frame rate of 250 frames per second is placed on the patient's head. For testing the left anterior and right posterior canal, patient head was rotated 45^0 to the left and for right anterior and left posterior the head was rotated 45^0 to the right. The examiner held the patients head and gave atleast 10 up and down movements and the findings were recorded. For testing the lateral canals, the patient head tilted 30^0 forward and atleast 10 left and right head movements for the left and right lateral semicircular canal respectively were given and head was returned to the midline[5]. The VOR gain for each impulse was calculated and the average was obtained, and findings were recorded.

Figure 1 shows a) bedside head impulse test, b) video head impulse test and c) video head impulse test goggles.

RESULTS

Data were presented as mean, standard deviation, frequency and percentage. Sensitivity, specificity, positive predictive value, negative predictive value and accuracy were calculated using standard formulas. Significance was defined by P values less than 0.05 using a two-tailed test. Data analysis was performed using IBM-SPSS version 21.0 (IBM-SPSS Science Inc., Chicago, IL).

The age of the patients ranged from 18 to 70 years old with average age group being 40- 49 years with a mean age of 44.9 years and standard deviation of 15.13. Approximately 54% were male and 46% were female (figure 4).

Most of the patients had torsional nystagmus (58%) which is related to lateral semicircular canal (figure 2) followed by horizontal (29%) which is related to anterior semicircular canal.

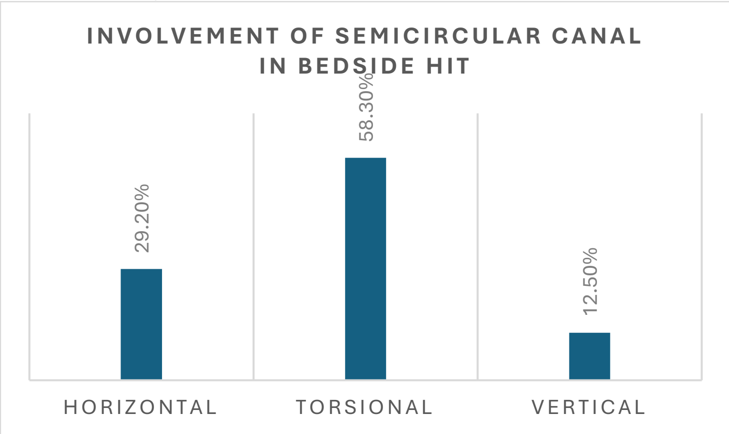

Figure 2: Distribution of bedside impulse test

Out of the 61 patients included in this study (table 1), 75 % had a positive vestibular evaluation with nystagmus, and 25% did not have any significant finding.

		Number of Patients	Percentage
VESTIBULAR EVALUATION	No nystagmus or subjective giddiness	15	24.6%
	Nystagmus positive with giddiness	46	75%

Table 1: shows the findings of vestibular evaluation in the study group

The most common side of abnormality in our study was the right semicircular canals which was 47% followed by left side which was 27%. (table 2)

Table 2 :the side of involved canals in vestibular evaluation.

	SIDE	NUMBER OF PATIENTS	PERCENTAGE
VESTIBULAR EVALUATION	RIGHT	29	47%
	LEFT	17	27%
	NO NYSTAGMUS	15	24%

In Video Head Impulse Test, the most commonly affected semicircular canal was posterior semicircular canal (27.9%) followed by lateral semicircular canal (18%) and the most affected side was right (46.9%). (Table 3)

		Number of Patients	Percentage
VIDEO HEAD IMPULSE TEST	Left	16	32.7%
	Right	23	46.9%
	Right and Left	10	20.4%
VIDEO HEAD IMPULSE TEST	No abnormality noted	12	19%
	Anterior abnormal VOR gain	10	16.4%
	Anterior and Posterior abnormal VOR gain	7	11.5%
	Lateral abnormal VOR gain	11	18.0%
	Lateral and Posterior abnormal VOR gain	1	1.6%
	Lateral, Anterior and Posterior abnormal VOR gain	3	4.9%
	no abnormality noted	12	19.7%
	Posterior abnormal VOR gain	17	27.9%

Table 3: shows the most commonly affected side and semicircular canal in VHIT.

The results of both vestibular evaluation and VHIT were compared. In 85% of patients that had abnormal vestibular evaluation, (i.e. nystagmus and giddiness) a positive Video Head Impulse Test was observed. In 33% of patients, abnormal vestibular evaluation findings were present but VHIT findings were negative. In 66.6% of patients, negative findings on vestibular evaluation correlated with VHIT results, while 14% had no significant vestibular evaluation findings but had positive VHIT findings. (Table 4)

		VESTIBULAR EVALUATION			
		Abnormal		Normal	
		Count	Row N %	Count	Row N %
VIDEO HEAD IMPULSE TEST	Abnormal	42	85.7%	7	14.3%
	Normal	4	33.3%	8	66.7%

Table 4: shows the most commonly affected side and semicircular canal in VHIT.

The sensitivity of VHIT was found to be 91% indicating it is a reliable tool for detecting semicircular canal dysfunction with an accuracy of 81.9%. The positive predictive value representing the presence of semicircular dysfunction in diseased patients, was 85% while the negative predictive values representing the absence of disease in a healthy patient is 66%.

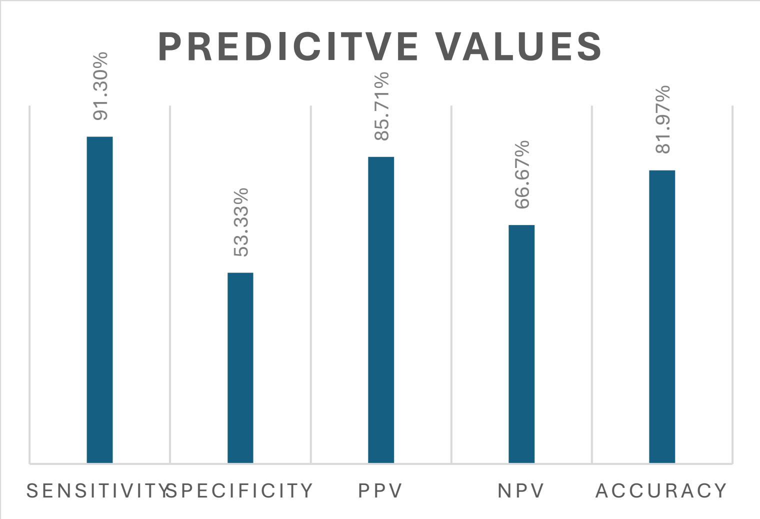

Figure 3 shows the predictive values of VHIT
The confidence intervals were calculated which falls with 95% confidence

Table 5: shows confidence intervals

Predictive values	**Value** (%)
Sensitivity	84.2%-98.4%
Specificity	40.8%-65.8%
Positive prediction	76.9%-94.5%
Negative prediction	54.8%-78.5%
Accuracy	72.3%-91.6%

Kappa coefficient was calculated as 0.479 which indicates moderate agreement between both tests.

DISCUSSION

The most common case of vertigo is Benign Paroxysmal Positional Vertigo (BPPV) with a prevalence of 2.4%. [6] The first clinical description was attributed to Barany in 1921 and in 1952, Dix and Hallpike described the provoking manoeuvres. In semicircular canals, there are calcium carbonate crystals also known as otoconia seen in the macula of utricle and saccule. These are very sensitive to changes in linear acceleration and gravity and are seen in the endolymph of macula. The semicircular canals are more sensitive to angular acceleration. In BPPV, otoconia collect in semicircular canal and makes them gravity sensitive.

It can be caused by two theories, Cupolithiasis and Canalolithiasis. Cupolithiasis occurs when otoconia stick to the cupula and makes it gravity sensitive. In Canalolithiasis debris from otoconial float freely and when exposed to gravity, falls to the lowest part of canal which causes a change in the endolymph pressure with displacement of cupula.[7]

These changes will give rise to giddiness which will present as nystagmus and saccades in the eyes. VHIT not only helps to quantify the defect in VOR gain, but also helps in identifying overt and covert saccades which can sometimes be missed by examiners. Nystagmus is a condition which is characterised by rapid involuntary and uncontrollable movements of one or both eyes and can be caused by various conditions like BPPV, stroke, multiple sclerosis and brain tumours. In BPPV, there are different directions of nystagmus for each semicircular canal, i.e. posterior semicircular canal has upbeat torsional nystagmus, horizontal canal has geotropic type and anterior canal has down beating nystagmus. Overt saccade is the catching motion in the eyes, which emerges after head rotation and the covert saccade is the catching motion that we cannot detect with our eyes at the time of head rotation. [8] In our study we found that the mean overall pathological VOR gain was 0.75 with lateral canal having the highest of 0.81 followed by anterior (0.71) and posterior canal (0.70) compared to a study done by Blodoew et al who had a VOR gain of 0.9 in the lateral canals and 0.8 in vertical canals. [9]

The VOR gains are affected according to the person who does the procedure and is affected by many factors such as hand position, speed of rotation, tightness of eye patch and distance from wall. So, it is important to focus on the saccade rather than the gain. We found that 46 patients had a positive VHIT with positive saccades found in 38 patients having positive saccades (62.2%) and 8 patients (13%) having negative saccades with a positive VHIT as compared to a previous study which showed a positive value of 62.5% where in 20 patients out of 32 had positive saccades.[9]. In the 15 patients that had negative VHIT, 9 (14%) had negative saccades with negative VHIT and 6 (9%) had positive vestibular evaluation with negative VHIT.

The sensitivity in our study was found to be 91.3% as compared to another study which had a sensitivity of 66%. The accuracy and specificity of our study was 81.9% and 53.5% respectively compared to another study done by Hamilton et al who demonstrated 100% specificity. Our positive predictive value and negative predictive value was 85.7% and 66.6% compared to another study who had a positive predictive value of 100% and a negative predictive value of 90.9%. [10]

The Video Head Impulse test was found to be more sensitive than the bedside impulse test and also helps in determining which semicircular canal has dysfunction. The video head impulse test (VHIT) also provides information about the pathology of the vestibular nerve or its branches. For instance, it can show superior vestibular nerve involvement in anterior and lateral canal damage due to vestibular neuritis, or indicate inferior vestibular nerve damage affecting the posterior canal. Additionally, VHIT is utilized to differentiate central vestibular diseases, investigate superior canal dehiscence, and monitor posterior canal occlusion in cases of treatment-resistant BPPV.[11]

CONCLUSION

For the diagnosis of BPPV, it is important to consider the provocation manoeuvres and bedside head impulse test. As it easy to miss saccades even by trained investigators, VHIT can be used as an adjunct for the diagnosis of BPPV. As it is easy, non-invasive and can be done as an outpatient procedure, it is a useful and sensitive tool for diagnosis and treatment of vertigo

COMPLIANCE WITH ETHICAL STANDARDS:

We have gotten clearance from our institutional ethical clearance(SRMIEC-ST0325-2488).
There are no conflict of interest and written consent was obtained from all our human participants.

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