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v-HIT in peripheral and central pathologies

PRODUCT INSIGHTS

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This document provides a comprehensive overview of how to perform the video Head Impulse Test, starting from the physiological bases up to daily diagnostics. SYNAPSYS VHIT is a unique system that represents a fundamental step forward in the evaluation of the vestibular system. It does not require the patient to wear any goggles; all results are obtained from the analysis of the patient's head and eye movements, recorded by a remote camera.

The vHIT: clinical value and benefits

- For the first time all three semicircular canals in each ear can be evaluated independently;
- abnormal findings are highly specific and denote a lesion involving the corresponding semicircular canal or its afferent neural pathway;
- can be used to track changes to the VOR function over time;
- can be used for testing children without any problem;
- the entire test can be performed in less than 10 minutes;
- the equipment is portable.

The v-HIT should not be considered a replacement or alternative to the caloric test as they are two different tests, which complement one another in that they provide information on different frequential vestibular ranges.

The vHIT: clinical applications

- As a first test in evaluation of dizziness and vertigo.
    - In emergency room, can help differentiate between vestibular lesions and stroke.
    - In outpatient settings, it can reduce the time and cost for determing diagnosis.
- In conjunction with VEMP, can provide information about different vestibular structures that are not available from other tests.
- Can be used for serial testing to assess vestibular function over time.
    - Monitoring vestibulotoxicity (e.g., chemotherapy, gentamicin for Ménière).

    - Monitoring recovery after a vestibular lesion (e.g., vestibular neuritis).
- Can be used to assess bilateral vestibular function.
- Can be used before and after planned ablative, procedures (e.g., surgery for vestibular schwannoma, cochlear implantation).

The vHIT in acute vertigo

The v-HIT is necessary to exclude a normal impulsive test being linked to covert corrective saccades.

Labyrinthine lesions involving the horizontal canal (labyrinthitis, labyrinthine infarction, chemical or surgical labyrinthectomy or selective obstruction of the canal), and lesions in the vestibular nerve affecting the horizontal canal afferents (total vestibular or upper branch neuritis, surgical vestibular neurectomy) will produce a pathological HIT.

In addition, brain stem lesions perfused by the anterior-inferior cerebellar artery (AICA), affecting the entrance area of the eighth cranial nerve root or the vestibular nucleus, will produce a clinically pathological HIT, mimicking a peripheral lesion.

On the contrary, diseases affecting the region of the posteroinferior cerebellar artery (PICA), i.e. the lateral medulla and/or the cerebellum, in general are anatomically below the VOR pathway and do not produce clinically evident defects on the HIT, which will consequently be negative.

Cases of inferior vestibular neuritis will have a negative vHIT (mimicking stroke from HI.N.TS.), since these lesions spare the afferents of the horizontal canal.

It will be possible to montior the vestibular compensation and the degree of return of the canal function over time.

In addition to this, by combining the outcome of the v-HIT results of cVEMPs and oVEMPS, a precise topo-diagnosis of the vestibular nerve lesion may be implemented.

The vHIT in Vestibular Neuritis

Since the v-HIT allows the six semicircular canals to be assessed independently, in the case of vestibular neuritis it will be possible to determine whether the lesion involved the branches of the upper or lower vestibular nerve (in which case the caloric tests will be normal!) or both.

The vHIT in post Gentamicin IT monitoring in Ménière's disease

In the case of patients with Ménière's disease for whom the intratympanic injection of gentamicin has been scheduled, the v-HIT will allow the vestibulo-toxic effect to be evaluated, also during chemotherapy or after schwannoma surgery.
The v-HIT will allow the stability of the ablative result (it is known that in some cases there may be a recovery of the vestibular function after many months) to be monitored.

The vHIT in Cochlear Implants

The v-HIT, in determining the state of vestibular function, can be helpful in choosing the ear to be operated on and in estimating the probability of post-surgical symptoms in a person in whom a cochlear implant has been planned, considering that this examination is well tolerated in children and provides an assessment of the function of all semicircular canals.

The vHIT in bilateral caloric deficit

Because caloric testing provides only a relative measure of right *vs* left responses, it is not suitable for bilateral assessment of vestibular function. Bilateral caloric weakness does not necessarily represent a pathology unless confirmed by another test (kinetic test or v-HIT).

In the past, rotatory chair testing was the gold standard to determine if the caloric finding represented true bilateral vestibular loss, or an artifact resulting from heat transfer problems. In case of true bilateral vestibular loss, rotary chair can help in differentiating between partial and complete loss of function.

vHIT can provide similar information (presence of lesion and whether it is complete) in patients with bilateral caloric weakness at a substantially reduced cost and space requirement compared to rotatory chair testing.

The vHIT in Ménière's disease

The literature summarizes the relationship between v-HIT and caloric test in daily activity, indicating the two conditions in which patients will have to undergo the caloric test: if the v-HIT is normal in a patient with suspected vestibulopathy and in cases of Ménière's disease.

A so-called dissociation between v-HIT and caloric test has been repeatedly highlighted in a cohort of patients with "clinically defined" Ménière's disease, if they have pathological caloric tests and normal v-HIT.

Similarly, it has been shown that high-frequency VOR remains unaffected in Ménière's disease even in advanced stages if the patient has been treated conservatively. The dissociation between the results of the caloric test and the v-HIT can therefore be considered an instrumental characteristic of Ménière's disease.

Fluctuations in the VOR gain values, measured by means of v-HIT, were evaluated during an acute Ménière's episode. The beginning of the attack was associated with a rapid change in the VOR gain on the side of the affected ear. A progressive reduction in the VOR was evident in the phase of paralytic nystagmus, while during the phase of the VOR gain recovery it returned to normal, and the direction of the previous nystagmus was reversed. Fluctuations in the VOR gain values, calculated using v-HIT, were examined not only during an acute episode, but also during inter-critical periods.

The vHIT in posterior canalithiasis with persistent positional down-beating Ny

In peripheral genesis persistent Positional Down-beating Ny, the presence of otolithic material within a canal can potentially alter the dynamics of endolymphatic fluids or cupular response mechanisms, causing a decrease in the VOR gain values of the affected canal measured by v-HIT.

This physio-pathogenetic hypothesis would be able to realistically justify the signs found and the restoration of the VOR gain values for the canals affected by lithiasis after treatment. v-HIT is useful in distinguish posterior apogeotropic canalithiasis form anterior one by detecting the reduction of gain.

The vHIT: new frontiers

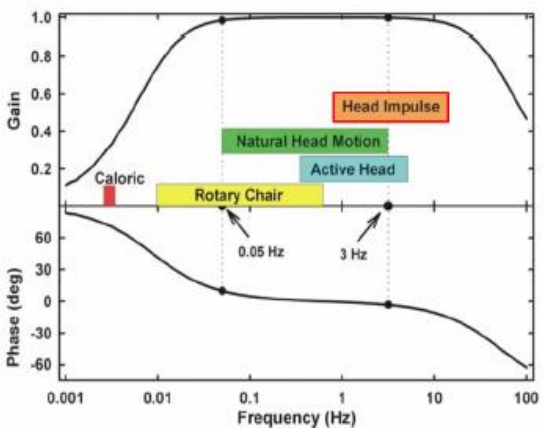
Using the v-HIT has allowed innovative results to be obtained in relation to the study of central vestibular pathologies; in recent years many papers have enriched knowledge in this area.

The analysis of gain and corrective saccadic movements in patients affected by pontine stroke and vestibular neuritis constitutes the backbone of this new field of investigatation as it has been demonstrated how, through the analysis of gains and compensatory saccades, the v-HIT enables differentiation between pontine stroke and vestibular neuritits.

Many papers were published in a short period that focused on topographic differential diagnosis regarding acute mono-symptomatic central-type non-positional vertigo.

An additional contribution provided by v-HIT concerns internuclear ophthalmoplegia (INO) whose pattern demonstrates non-conjugate eye movements in horizontal plane and contralesional posterior canal deficit.

Finally, Wernicke encephalopathy demonstrates a particular trait on v-HIT. Some papers have shown that a bilateral reduction in gain in the horizontal semicircular canals bilaterally is detectable due to a selective lesion of the medial vestibular nuclei.



CALORIC TEST	VHIT
Tests the lateral canals only	Can test all six canals independently
Very low-frequency stimuli	High frequency stimuli
Stimuli are unpleasant, highly-variable, and time-consuming to administer	Stimuli can be precise, well-tolerated, and the entire test can be performed in minutes
Not suitable for serial testing	Can be used to monitor changes in VOR gain
Irrigators can be bulky	Equipment is portable and small
Has a long history of clinical usefulness	Is beginning to gain widespread clinical use

ROTATORY CHAIR TESTING	VHIT
Tests the lateral canals only	Can test all six canals independently
Stimuli are very precise, repeatable, and cover low to mid frequencies	Stimuli are adequately precise, repeatable, and cover high frequencies
Requires a large space and is expensive	Portable and relatively inexpensive
Gold standard for determining presence and extent of bilateral vestibular dysfunction	Can determine presence of bilateral vestibular dysfunction and whether it is a complete or partial loss
Not effective in providing side of lesion information because velocities are usually not adequate to create VOR asymmetries	Can provide side of lesion information

VORTEQ	VHIT
Can test both lateral and vertical canals but does not provide side of lesion information	Can test all six canals independently and can provide side of lesion information
Can provide information about bilateral vestibular dysfunction but the results may be contaminated by activation of neck receptors	Can provide information about bilateral vestibular dysfunction and the results are not contaminated by neck receptors because of passive stimulation

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