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What is the potential clinical utility of vHIT when assessing adult patients with dizziness?

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Background

Head thrust tests were initially performed bedside to assess dizziness by clinically identifying eye movements associated with high impulse passive head rotation. The Video Head Impulse Test (vHIT) measures the vestibulo-ocular reflex (VOR), and is anatomically correlated to semicircular canal function in the peripheral vestibular system, motor nuclei in the brainstem, and extra-ocular muscles.[1] vHIT reveals vestibular hypofunction via measured gain reduction and the presence of covert or overt saccades. vHIT yields quick, objective results and has increased sensitivity compared to the clinical head impulse test (cHIT); measured covert saccades can be present even with central compensation and are often not detectable using cHIT. Debate exists regarding the utility of vHIT in the context of existing objective tests; in some cases, vHIT provides seemingly redundant diagnostic information. Of note, not all clinics may have access to equipment or adequately trained staff necessary to perform vHIT. Caloric irrigation and rotary chair similarly utilize the VOR to identify lesions in the peripheral vestibular system. However, results from these tests have also been shown to dissociate, perhaps because vHIT and calorics evaluate the vestibular system in different frequency ranges. Dissociation in test findings may be related to changes in measurable vHIT results as compensation progresses, whereas the caloric asymmetry remains more stable.[2] The goal of this paper is to review recent literature to determine the clinical utility of vHIT in assessing a dizzy adult patient.

Literature Review

A recent retrospective study evaluated 92 patients who presented with dizziness and underwent both bithermal caloric and vHIT testing.[3] Reported VOR gain of the affected ear measured by vHIT was positively correlated with corresponding unilateral weakness (UW) measured by caloric testing. With a UW cut-off of >25%, the corresponding vHIT gain cut-off was 0.875 (GN-Otometrics system). The authors found that vHIT and caloric results diverged in 18% of patients (primarily those with Meniere's Disease (MD) or recurrent vestibulopathy), in which caloric testing was abnormal but vHIT was normal. For chronic

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disease, vHIT may not substitute for bithermal caloric testing, but rather provides different information. The gain asymmetry measured by vHIT has lateralization value for determining unilateral vs. bilateral vestibular pathology, a key advantage for assessing vestibular loss using vHIT, as rotational chair measurements do not lateralize.

The potential limitations of vHIT in diagnosing MD or vestibular migraine (VM) are highlighted in a prospective study of patients evaluated with calorics and vHIT.[4] Caloric testing was abnormal in 67% of MD patients and 22% of VM patients, while vHIT had abnormal gain in 37% of MD and 9% of VM patients. No statistically significant difference between caloric ($p>0.44$) or vHIT ($p>0.13$) results was found whether measuring early or late-stage disease. Of the 25 patients with abnormal caloric tests, 10 had an abnormal vHIT (40%) and 15 had a normal vHIT (60%). This disassociation is critical, as it indicates that with respect to these two specific diseases, which often have fluctuating and variable presentations, a normal vHIT could be a false negative, and may not pick up the existing underlying pathology. This can be extrapolated to include other vestibulopathies with a chronic, but stable, time course, requiring follow-up caloric testing if vHIT is normal.

Another prospective study attempted to elucidate vHIT's role in diagnosing suspected vestibular neuritis.[5] Twenty-nine adult patients referred to a tertiary care center for vestibular neuritis underwent vHIT, caloric, and rotary chair testing, both at initial presentation and one month after treatment. vHIT identified vestibular neuritis accurately for all 29 adults in the acute setting. However, vHIT and calorics diverged upon follow up testing; 15 of 29 patients had normal vHIT at follow-up but 9 of 29 patients had normal calorics. Abnormal post-rotatory nystagmus measured via rotational chair was observed in only 23 patients at initial presentation, and no significant nystagmus was observed at follow-up. This highlights the increased accuracy of vHIT for identifying vestibular neuritis when compared to rotary chair. The authors conclude that for vestibular neuritis, an abnormal vHIT test in congruence with history and physical exam findings deems additional caloric testing unnecessary.

A recent systematic review included 37 articles describing five different vHIT systems.[1] The authors conclude that for patients with peripheral vestibular symptoms, vHIT can be performed first in the diagnostic work-up for two peripheral pathologies: vestibular neuritis and gentamicin-induced vestibulopathy. Patients with suspected MD should preferentially undergo caloric testing as part of their work-up, as should patients with central lesions such as vestibular schwannoma. The authors emphasized that for the dizzy patient, even if vHIT is normal, caloric testing must be performed to rule out peripheral vestibular disease. Notably, BPPV was not found to affect vHIT gain; patients with BPPV included in this review had normal results.

The utility of vHIT for follow-up continues to be explored; gain asymmetry is not always consistent with the symptomologic time course of the disease. This is possibly because nerves encoding high frequency vestibular sensations recover at different rates than the lower frequency responses measured by calorics. While central compensation can occur for some patients, covert saccades are expected to persist as part of dynamic compensation and can be captured by vHIT measurements.[1] Nevertheless, for chronic vestibular symptoms, vHIT may not capture ongoing disease as effectively as during an acute event.

For acute vestibular deficits, vHIT has a reported sensitivity of 68.84%, specificity of 100%, positive predictive value of 100% and negative predictive value of 62.5%.[5] Other specificity and sensitivity reported in the literature is 92% and 36% when assessing an acute vertiginous event (with caloric testing as the gold standard)[2].

Finally, time and cost are important considerations when determining the optimal algorithm for diagnosing clinical pathology. vHIT can be calibrated and measured substantially faster than calorics: 6 ± 1 minute vs. 21 ± 2 minutes (mean ± standard deviation).[2] Rambold (2015) argues that for all patients, regardless of suspected diagnosis, any vestibular testing should start with vHIT. Performing vHIT first, and only following with caloric testing if vHIT is normal, saved 64 hours for every 1000 patients. This approach saves the most time for suspected vestibular neuritis, followed by suspected central vestibular lesions and BPPV. For both vestibular migraine and Meniere's disease, testing calorics first saved a small amount of time.

Best Practice

vHIT provides information complementary to other available vestibular tests and may be a key part of evaluating suspected peripheral vestibular deficits. It is quick, objective, and able to measure covert saccades and all six semicircular canals. If after initial history and physical exam acute vestibular neuritis is in the differential, but is not certain, vHIT should be considered as part of the diagnostic work-up. If vHIT proves to be abnormal in the acute setting, further vestibular testing is not necessary. For chronic patients, vHIT is still an appropriate first test. However, if after the acute phase the vHIT results normalize, caloric testing should be performed to rule out ongoing peripheral disease. Given the dissociation between vHIT and calorics for fluctuating vestibulopathies (such as VM or MD), the literature suggests preferentially doing caloric testing. For pathologies such as BPPV, vHIT adds minimal diagnostic value. More research is needed to further characterize vHIT results when following the progression of vestibular disease, as well as enhancing training and access to vHIT.

Level of Evidence

Blodow and Bartolomeo level 1b, prospective cohort study. Alhabib level 2a, systematic review. Rambold and Park level 2b, individual restrospective cohort study

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