A Practical Comparison of Caloric Irrigation Measures, Rotary Chair and Video Head Impulse Testing (vHIT)

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It is common knowledge in the field of vestibular disorders that the “dizzy” patient is one of the most complex and time-consuming patients to diagnose. In the past, vestibular clinicians have had to rely on bulky, expensive equipment that took upwards of 20-30 minutes to assess the patient. Recently, technology has been introduced that is promising toward giving the vestibular clinician information about the status of the semi-circular canals in a more cost-efficient and time-efficient manner – the Video Head Impulse Test (vHIT). Because this technology is fairly new, there is question about how the vHIT relates to the VNG caloric testing and rotational chair testing. This article will compare and contrast these three methods of assessing vestibular function.

Caloric Testing

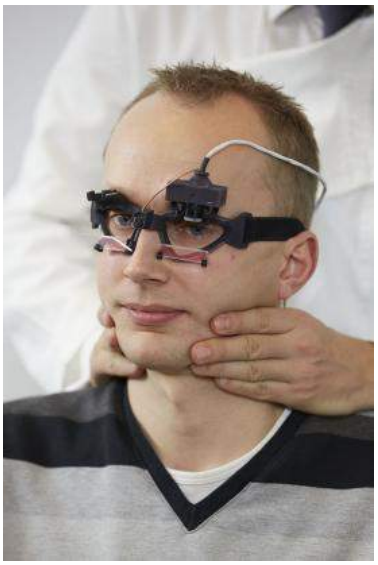
For more than 50 years, the caloric irrigation has been the gold standard for assessing the function of the entire vestibular system. Caloric irrigations involve introducing warm air and cool air/water into the outer ear, creating a convection current which results in a change in the internal temperature of the temporal bony labyrinth which results in motion of the fluid within the semicircular canals. The motion of this fluid causes a stimulation of the nerve fibers within the vestibular end-organs, essentially “tricking” the brain into the perception of motion. The brain, in response, sends signals to the eyes to produce eye movement to compensate for the perceived motion (nystagmus). Using videonystagmography (VNG) or electronystagmography (ENG), this eye movement is recorded and measured in an effort to determine whether the two vestibular end-organs (specifically, the lateral semicircular canals) are functioning symmetrically. Because the brain relies on equal-but-opposite input from the vestibular end organs, an asymmetry in function of the vestibular end organs is known to result in disequilibrium – often called “vertigo”, “dizziness” or “imbalance”. This test is usually performed in the dark using an irrigator. It has the advantage of being able to test the labyrinths independently. It simulates a very slow movement of 0.002-0.004 Hz.

Rotational Chair Testing
Rotational chair testing is another means of assessing the horizontal/lateral canals. The primary purpose of rotational chair testing is to assess the integrity of the vestibulo-occular reflex (VOR). There are multiple tests that can be performed using the rotational chair, each of which is designed to analyze vestibular responses by observation of eye movements at different frequencies and directions of motion. Rotational chair testing can often be performed on more difficult-to-test populations than caloric stimulation.

To perform rotational chair testing, the patient is seated in a motor driven rotary chair with the head bent slightly forward. This will bring the horizontal semicircular canals into the plane of rotation. The patient is tested with eyes open in total darkness while performing mental alerting tasks. Specialized infrared goggles are used to allow for monitoring and video-recording eye movements during the test. In each of the rotational chair subtests, the physiologic nystagmus that results from the motion of the chair is recorded and monitored by the infrared cameras within the goggles. It simulates a rotational movement within the range of 0.02 – 0.64 Hz.

vHIT Testing

vHIT is based on a premise that was introduced by Halmagyi et al more than two decades ago. Halmagyi's Head Impulse Test assesses the vestibulo-ocular reflex (VOR). The VOR requires equal-but-opposite input from each of the peripheral vestibular organs in order to keep the eyes fixed on a stationary object while the head is in motion. Without a means to capture and record eye movement in response to head movement (VOR), the Head Impulse Test is limited in clinical usefulness. The test requires a highly trained eye to look for small saccades within the patient's VOR. Often the corrective saccades that might indicate the head impulse test is "normal" or "abnormal" are too small or too fast to be detected by the human eye and are frequently missed. Therefore, the test might be interpreted as "normal" when there was actually an underlying vestibular deficit. The Video Head Impulse Test (vHIT) utilizes infrared cameras to quickly and precisely record and measure the VOR and thereby provides a reliable, repeatable measure of the VOR that can be documented and used for future comparisons of vestibular function.



An important point to mention when comparing the vHIT to caloric and rotational chair testing is that each of these tests is measuring a different frequency of the vestibular end-organs. The VNG caloric measures nystagmus in response to what is perceived by the brain as a very low frequency (0.002-0.004Hz). The rotational chair uses an average stimulus of about 0.02 Hz – 0.64 Hz. These low frequencies are not "physiological". The vHIT, however, can cover a wider range of frequencies (1-10Hz) and is much more representative of "normal" head movement. Therefore, these tests may actually be complementary to one another and give the clinician information about what is happening at different frequencies of head movement – and in doing so, possibly evoking a vestibular deficit that otherwise might not present itself until the system is confronted by a higher frequency of head movement.

Below is a table that provides a side-by-side comparison of the benefits and limitations of the different tests.

vHIT	Calorics	Rotary Chair
Objective measure of vestibular function	***Objective*** measure of vestibular function	***Objective*** measure of vestibular function
Low variability in test findings	***High variability*** in test findings	***High variability*** in test findings
Assesses each peripheral vestibular system ***independently of the other***	Assesses each peripheral vestibular system ***independently of the other***	***Cannot assess*** peripheral end organs ***independently.***
Can assess ***horizontal/lateral*** canals and ***vertical*** canals	Can assess ***only horizontal/lateral*** canals	Can assess ***only horizontal/lateral*** canals
Tests the vestibular system at ***higher frequencies***	Tests the vestibular at very ***low frequencies***	Tests the vestibular at very ***low- mid frequencies***
Assess the canals using natural stimulus for ***better estimate of function***	Assess the canal using "low freq" stimulus giving ***less realistic findings***	Assess the canals using natural stimulus for ***better estimate of function***
No need for alerting ***tasking*** and less affected by medicines	Dependent on ***alerting tasks and medications***	Dependent on ***alerting tasks and medications***
Can be used on a ***broad patient population***	***Limited to populations*** that can (and are willing to) tolerate the test	Can be used on a ***broad patient population***
Can test acute patient ***at bedside***	Usually tested in clinic ***days after*** acute onset	Usually tested in clinic ***days after*** acute onset
Less time consuming	***More time*** consuming	***More time*** consuming
Generally ***well tolerated*** by people	Generally ***less well tolerated*** by people	Generally ***well tolerated*** by people
Equipment is ***smaller*** and more ***portable***	Equipment is ***bulky*** and ***less portable***	Equipment is ***bulky*** and ***less portable***
Usually the test ***does not have to be repeated***	Often one or more caloric's ***need to be repeated***	Usually the test ***does not have to be repeated***

After reviewing each of the protocols, it may *seem* that the vHIT has many more benefits over the VNG caloric method or rotational chair method of measuring peripheral vestibular function. However, the one benefit that vHIT does *not* have is longevity and the opportunity for extensive research on its efficacy at detecting peripheral vestibular function. Until this method of testing has undergone extensive research, many, many trials and years of peer review, it is in the patient's (and the clinician's) best interest to view the vHIT as one of many tools used to do a thorough assessment of the peripheral vestibular system.