Continue

Caloric reflex test

The caloric test evaluates lateral vestibular canal function by assessing the body's reaction to temperature changes in the ear. When the brainstem vestibulo-ocular reflex is stimulated, it causes the eyes to move towards the head turn, maintaining fixation on an object. However, with movement, the frontal eye field initiates a fast corrective saccade in the opposite direction, resulting in horizontal nystagmus. The caloric test involves irrigating the ear with warm or cold water (7 degrees above or below body temperature) for 30-40 seconds, causing convection currents and thermal stimulation of the vestibular apparatus. This stimulates the hair cells, leading to a fast component of horizontal nystagmus beating towards or away from the stimulating ear. The test measures the reduced vestibular response and directional preponderance using the Jongkee formula. An interaural variability in caloric paresis exceeding 22-25% and a directional preponderance greater than 26-30% indicate an asymmetric response. Abnormal patterns may result from incorrect lead placement, air caloric testing in an ear with a perforated tympanic membrane, or lesions within the floor of the fourth ventricle. These include caloric inversion, perversion, dysrhythmia, and arreflexia. The caloric reflex test evaluates tonic vestibular stimulation with its slow eye movement and fast corrective saccade, which may be impaired in comatose patients. Caloric reflex testing plays a crucial role in assessing brainstem function, particularly in comatose patients. An intact caloric reflex can indicate the integrity of brainstem pathways. The test involves irrigating warm or cold water into the ear and observing eye movements. In patients with suspected peripheral vestibular problems, bithermal caloric testing coupled with electronystagmography (ENG) can identify the affected side. Caloric areflexia may suggest bilateral vestibulopathy caused by toxins like aminoglycosides or cisplatinum. In comatose patients, bedside vestibulo-ocular (VOR) testing is usually the first step. If VOR testing is negative, a monothermic cold caloric test can provide further insights. An absence of tonic deviation during cold water irrigation indicates brainstem involvement. During monothermic cold caloric testing, loss of abduction or adduction of eyes to the affected side may indicate specific brainstem problems. Caloric reflex testing has limitations, including time-consuming procedures, high interrater bias, and poor patient compliance due to discomfort. The test's results can be influenced by factors such as ear canal size and convection current generation. However, it remains a valuable tool in intensive care settings, particularly when patients are comatose. The caloric reflex test is most commonly used in intensive care units (ICUs) where the patient is being closely monitored by nursing staff and intensivists who assess the etiology of coma and determine the prognosis. The pharmacist plays a crucial role in advising on medication use and side effects, while consultation with neurology teams may be necessary for interprofessional management. any generalized or localized brainstem disorder help in assessing the prognosis. The monothermic ice water cold caloric test is essential for brainstem reflex assessment to determine if a patient has brain death. This evaluation is an integral part of the interprofessional organ transplant team activities. Tumors of the sinonasal tract are a type of cancer that affects the nasal cavity and sinuses, as described in Cummings Otolaryngology: Head and Neck Surgery. Audiometry is the process of testing hearing, which is discussed in Pfenninger and Fowler's Procedures for Primary Care. Diagnostic audiology and electrophysiologic assessment of hearing are also important tools for diagnosing hearing problems, as outlined in Cummings Otolaryngology: Head and Neck Surgery. Additionally, auditory, vestibular, and visual impairments can occur due to various factors, including sensorineural hearing loss, which is discussed in Braddom's Physical Medicine & Rehabilitation. Sensorineural hearing loss in adults is a common condition that affects the inner ear, as described in Cummings Otolaryngology: Head and Neck Surgery. There are different types of hearing loss, including noise-induced hearing loss, which is caused by exposure to loud sounds, as discussed in Hearing Loss. Genetic sensorineural hearing loss is another type of hearing loss that can be inherited, as outlined in Cummings Otolaryngology: Head and Neck Surgery. The treatment for tinnitus, or ringing in the ears, may involve fixing any underlying problems, such as removing ear wax or treating teeth clenching and grinding. Medications may also be used to relieve symptoms of tinnitus, but no medication works for everyone. Other treatments include using a tinnitus masker, hearing aid, or counseling to help manage stress and learn to live with tinnitus. been proven to be effective, so it's essential to consult your provider before trying them. Tinnitus can be managed with the right plan, and talking to your provider is a great place to start. Additionally, the American Tinnitus Association offers valuable resources and support groups for those affected by tinnitus. References: Chole RA, Sharon JD. Chronic otitis media, mastoiditis, and petrositis. In: Flint PW, Francis HW, Haughey BH, et al, eds. Cummings Otolaryngology: Head and Neck Surgery. 7th ed. Philadelphia, PA: Elsevier; 2021:chap 140. Matlock AG, Pfaff JA. Otolaryngology. In: Walls RM, ed. Rosen's Emergency Medicine: Concepts and Clinical Practice. 10th ed. Philadelphia, PA: Elsevier; 2023:chap 58. Pelton SI. Otitis externa, otitis media, and mastoiditis. In: Bennett JE, Dolin R, Blaser MJ, eds. Mandell, Douglas, and Bennett's Principles and Practice of Infectious Diseases. 9th ed. Philadelphia, PA: Elsevier; 2020:chap 61. This guide provides a comprehensive introduction to performing and interpreting the caloric test, including its history, physiology, and clinical applications. Table of Contents: What is the Caloric Test? The Bi-Thermal Caloric Test Physiology of the Caloric Test Standard Caloric Position (Figure 1) Irrigation Techniques: A Review The instrumentation used for caloric irrigations involves two main types: open-loop water irrigators and air irrigators. The Aqua Stim, an open-loop water irrigator, uses a temperature range of 30 to 44 degrees Celsius, while the Air Fx, an air irrigator, has a temperature range of 20 to 50 degrees Celsius. The open-loop water irrigator is easy for examiners to perform but can be uncomfortable for patients due to the strong stimulation it causes. On the other hand, air irrigations are more comfortable for patients as they do not generate a strong response. However, air irrigators require more technical skill to administer and may affect the temperature in the ear canal depending on the design of the irrigator tip. When choosing between an open-loop water irrigator or an air irrigator, it's essential to select the one that is comfortable for you. If performed correctly, both methods can generate acceptable results with good test-retest reliability. Once a patient agrees to undergo a VNG test, it's crucial to record any nystagmus that occurs during the caloric test position. This is important because it can affect the interpretation of the results. 4. Irrigation The first irrigation begins with the VNG goggle on the patient without vision (cover on). The irrigator delivers a stimulus into the ear, and the software starts recording the eyes. The type of irrigation determines its duration: 30 seconds for water and one minute for air. After irrigation ends, engage the patient in alerting tasks to keep them awake throughout the rest of the test. After 15-30 seconds, nystagmus starts generating and grows in size before reaching a peak and then subsiding, usually within 40-45 seconds after caloric irrigation. Once it begins to subside, ask the patient to fixate on the built-in light in the VNG goggle and observe their pupil. When it shrinks, you know they're actually focusing. Record for about 10-15 seconds before switching off the fixation light. Wait a few seconds before recording again. The test is complete when each ear has received both warm and cool irrigations – so four irrigations in total. Caloric Test Technique Let's dive into the techniques behind warm and cool irrigations. Warm Irrigations When you start irrigating the external auditory canal with a warm medium, the area of the semicircular canal closest to the external auditory canal heats up. This causes the endolymph in the semicircular canal to become lighter and rise, putting pressure on the cupula and bending it towards the utricular sac. This cupular deflection in the lateral canal would cause excitation of the semicircular canal, resulting in a higher neural firing rate in the irrigated ear compared to the non-irrigated ear. The patient will experience rotation towards the irrigated ear and their VOR will move their eyes away slowly from the irrigated ear. Fast phases of nystagmus will then bring the eyes back towards the irrigated ear, resulting in left-beating nystagmus if this is the left lateral semicircular canal. Cool Irrigations When you irrigate the ear with a cool temperature, the endolymph becomes heavier and sinks. This type of cupular deflection away from the utricular sac causes inhibition of the semicircular canal and decreases neural firing rates. The neural activity in the opposite ear is higher when patients experience a particular sensation. This can cause their eyes to move towards or away from the non-irrigated ear. The vestibular-ocular reflex (VOR) moves the eyes towards the irrigated ear with fast phases directed away from it. Irrigations at different temperatures generate nystagmus in opposite directions. Cool irrigations produce nystagmus beating away from the irrigated ear, while warm irrigations cause nystagmus to beat towards the irrigated ear. There are three important caloric test parameters: unilateral weakness, directional preponderance, and fixation index. Unilateral weakness refers to the relative difference in responses between the right and left ears. It is calculated by subtracting the total response from the left ear from that of the right ear, then normalizing it based on the total response from both ears. Directional preponderance is another important parameter that measures the difference in nystagmus between right-beating and left-beating directions. This can be caused by spontaneous nystagmus or an extremely rare type of directional preponderance where irrigation results are higher for one direction without substantial nystagmus. The fixation index is a measure of nystagmus intensity during fixation compared to before fixation. It is calculated by dividing the slow phase velocity right after fixation by that right before fixation. This index helps analyze and interpret the caloric test results. Normal caloric response assessment reveals characteristic patterns and abnormalities in nystagmus velocity profile, SPV plots against time. In normal conditions, the response exhibits a specific pattern: initial increase in amplitude after 20 seconds, peak at around 60-90 seconds, followed by decline. The literature emphasizes the use of peak nystagmus velocity as a quantifiable measure. Caloric response analysis can provide insights into peripheral vestibular system status, lateral semicircular canal function, and central connections. Unilateral weakness is the most common abnormality, where responses from one ear are lower than the other. This indicates a unilateral caloric weakness, likely due to a chronic or statically-compensated lesion. Possible causes of unilateral weakness include peripheral vestibular lesions affecting the lateral semicircular canal or its efferent pathways. This may be caused by diseases such as viral or bacterial labyrinthitis, initial episodes of Meniere's disease, or vestibular neuritis. Concussions or infarctions may be compensated or chronic, leading to conditions like Vestibular neuritis, viral or bacterial labyrinthitis, late stages of Meniere's disease, or vestibular schwannoma. Central lesions affecting the root entry zone of the vestibular nerve can cause unilateral weakness accompanied by other central nervous system signs. The directional preponderance threshold is typically set at 30%, with no value for localization. Spontaneous nystagmus may be a better indicator than directional preponderance, especially when measured in the caloric position. Abnormal amounts of spontaneous nystagmus can be corrected by considering the velocity and direction to verify unilateral weakness. Bilateral vestibular weakness, or hypofunction/hyporesponsiveness, is characterized by a total response in each ear of less than 12 degrees per second. A secondary test, such as rotational chair testing or video head impulse testing (vHIT), is necessary to confirm bilateral vestibular loss. This can be cross-checked with otolith function assessments using vestibular evoked myogenic potentials (VEMP). Given article text here The vestibular system's gravity-sensing organs can provide insight into its function, helping identify reduced or absent peripheral vestibular system activity. Bilateral weakness often results from a bilateral loss of peripheral function in both ears or central abnormalities that impede neural firing to the central nervous system. For instance, a tumor at the cerebellum can block neural signals, leading to bilateral vestibular loss. The most common cause is unknown, but known causes include idiopathic ototoxicity, bilateral Meniere's disease, and congenital malformations such as Chiari malformation. Hyperresponsiveness, characterized by excessive caloric test responses, is a rare finding. Criteria for hyperactivity include total cool peak response exceeding 99 degrees per second or total warm peak response exceeding 146 degrees per second. Elevated total peak responses (total cool plus total warm) also indicate hyperactive characteristics. Further analysis reveals that the patient's caloric response exhibited hyperactive traits, suggesting a central lesion. This is often due to loss of inhibitory responses at the vestibular nuclei and can be seen in patients with cerebral atrophy, cerebellar degeneration, or diseases affecting the cerebellum. The failure of fixation suppression, where the fixation index exceeds 50% or 60%, indicates an abnormality. This patient's case showed abnormal fixation suppression during right irrigations. Caloric Testing: Advantages and Limitations Abnormality of fixation suppression has significant implications in the central nervous system, including the pons, cerebellum, and parietal-occipital cortex. It often manifests as midline cerebellar abnormalities, which can have far-reaching consequences. Calibration and Irrigation Techniques in Bilateral Vestibular Hypofunction Testing: Practical Considerations Calibrating between irrigations is crucial for ENG systems but not necessary for VNG, as it may introduce variability. For VNG, a good initial calibration can suffice unless camera or goggle positions are changed. Order of Irrigations: Start with warm temperature, which is more effective and excitatory. A study showed that starting with warm irrigations tends to produce stronger responses than cool ones. However, if you plan to do all four irrigations, starting with cool might be better. Wait Period between Irrigations: The ANSI recommends a fixed interval of around 5 minutes, while the British Society of Audiology suggests a minimum interval of 7 minutes. A practical approach is to wait for residual nystagmus to subside before starting the next irrigation. Air Irrigators: In the USA, ANSI disapproves air irrigators, recommending open-loop or closed-loop water systems instead. However, clinicians have not followed this recommendation, with a ratio of air to water irrigator sales at around 4:1. It’s likely you’re getting this result because of the good things we’ve discussed earlier. How many tests for fixation suppression should you do? At least two, one for each direction of nystagmus but it’s best to do them for all four irrigations. By doing so, you can pick the two where the nystagmus intensity is similar before irrigation which makes a fair comparison and how you should compare fixation suppression for right and left. Are monothermal irrigations enough? Probably not because your false positive rate will be very high and you’ll miss some artifacts. But if you use monothermal warm calorics as a screening test, that’s primarily to find normal calorics. A 2009 study by Murnane et al showed what parameters must be met for this type of test: No oculomotor abnormalities No gaze-evoked or spontaneous nystagmus The difference between peak responses should be less than 10%. If these conditions are met, it’s likely your calorics are normal and you can stop after two irrigations. Caloric testing, a method used to assess vestibular function, is not recommended for older patients due to issues with heat transfer. In children under five years of age, especially those with developmental delays, caloric testing may also be inadvisable. While some patients under these age limits may show normal responses when tested using alternative methods like rotation or vHIT, it's essential to recognize the potential for artifacts and take steps to minimize their impact. One common artifact is nystagmus beats, which can be missed or falsely verified during computer analysis. It's crucial to ensure that only clean and consecutive nystagmus beats are considered when determining slow phase velocities. Additionally, one irrigation result should not be significantly different from the others; if it does, it may be an outlier that needs to be repeated. By being aware of these potential pitfalls and taking steps to eliminate them, caloric testing can provide accurate results for most patients. However, certain age limits must be respected to ensure patient safety and effectiveness. The caloric test is a useful diagnostic tool for detecting unilateral vestibular lesions, although it may not identify the specific cause of the issue. With the introduction of the vHIT (video head impulse testing), some cases can now be diagnosed using alternative methods. However, in certain situations, such as peripheral pathologies like endolymphatic hydrops, the caloric test remains a valuable tool for assessing the sensitivity of the peripheral vestibular system. Recent research suggests that even in early stages, changes in caloric test results may indicate peripheral vestibular system dysfunction, making it an essential component of vestibular diagnostics.