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Vestibular Vibrator

PRODUCT INSIGHTS

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This document provides a comprehensive overview of how to perform tests using SYNAPSYS Vestibular Vibrator, a device which can be used in order to complete exams available with the NYSTALYZE system in conjunction with the SYNAPSYS VideoScope and VNG software. Unique for its adaptability, NYSTALYZE offers both a wireless mask and a wired version, catering to the diverse needs and preferences of users.

INTRODUCTION

Clinicians managing patients with dizziness should complement their clinical examination with first-line tests to refine the neurotological diagnosis towards a central or peripheral lesion, identify the affected side, and guide subsequent vestibular explorations or imaging.

Von-Bekesy in 1935 reported that vibration applied to the skull induced reflexes and motion illusions which he attributed to stimulation of vestibular receptors. The skull vibration-induced nystagmus test (SVINT), described incidentally and anecdotally by Lücke in 1973, has been used in clinical practice since 1999 by Hamann and Schuster and Dumas et al.

It has been described as a “vestibular Weber test” and is also known as the “Dumas test”. This author published the largest series of patients explored (18.500 patients) in his PhD Thesis at University of Lorraine and has worked on the validation of the test and location/frequency optimization of the stimulus. Georges Dumas can be considered one of the greatest experts on SVINT.

We can consider SVINT as a robust, rapid, and non-invasive test, which can be performed during the bedside examination. This test explores the vestibuloocular reflex (VOR) at high frequencies (100 Hz) not studied by usual vestibular tests. Vibration-induced nystagmus (VIN) is not altered due to vestibular compensation at these high frequencies. The physiological basis of this test has been clarified by the work of Curthoys et al. in a healthy animal model without labyrinthine bone lesions, demonstrating that 100 Hz stimulation of otoliths and semicircular canals (SCC) was effective, whereas only otoliths were stimulated at 500 Hz.

TECHNIQUE

The SVINT is performed on a sitting patient and the induced nystagmus is observed using NYSTALYZE system with VideoScope and VNG software. The subject

must keep a midline gaze, looking straight ahead, with the eyes wide open and blinking as little as possible. Any visual fixation must be suppressed to avoid inhibition of the VOR. This test is well tolerated in both adults and children.

The examiner performs the test standing in front or behind the patient, holding the vibrator firmly, preferably with the dominant hand to ensure greater reproducibility.

The vibrator must be applied perpendicular to the mastoid process or at the vertex. The examination requires a total of 3 stimulation sequences, each lasting 5 to 10 seconds: the two mastoid processes and the vertex are stimulated successively. At the mastoid process, the vibrator is applied behind the auricle, at the level of the external auditory canal. The examiner must refrain from stimulating the tip of the mastoid process, which can trigger proprioceptive stimulation of the trapezius and sternocleidomastoid muscles. A force of about 10 N or 1 kg is exerted. The examiner uses his free hand to keep the patient's head in the correct position.

POSITIVITY CRITERIA

Three strict criteria are required:

- VIN begins and stops with stimulation (no after-nystagmus), does not have any secondary reversal, is constant on both mastoid processes, and beats in the same direction. VIN beating towards the right on the right mastoid process and towards the left on the left mastoid process is not significant: The test is considered negative.
- The slow-phase velocity (SPV) of the VIN must be > 2.5°/s.
- It is reproducible and must be identical or similar on two consecutive tests.

DOUBTFUL CASES

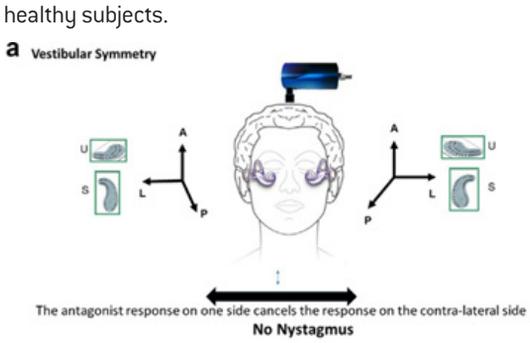
When only 2 of the 3 criteria are met, the test is doubtful:

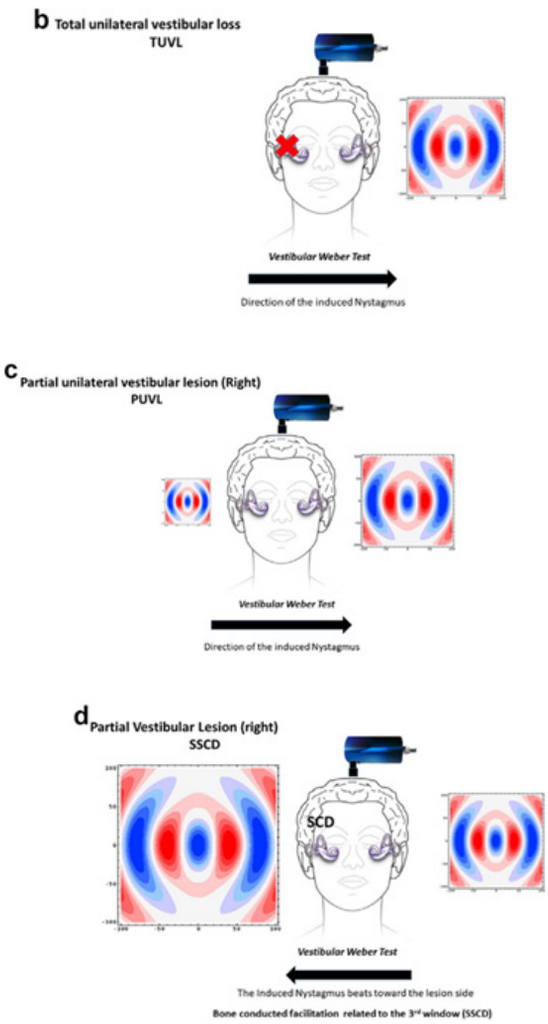
- Criterion 1 is not met: For example, VIN is obtained on only one mastoid process or only at the vertex, while criteria 2 and 3 are positive.
- Criterion 2 is not met: Slow-phase velocity (SPV) ≤ 2.5°/s, while criteria 2 and 3 are positive.
- Criterion 3 is not met: This situation is highly unlikely when criteria 1 and 2 are met and tends to suggest that the test was not performed correctly.

INTERPRETATION OF RESULTS

The SVINT is a robust, simple and non-invasive, screening test used in routine clinical practice that acts as a vestibular Weber test. It means that, in most cases, nystagmus is directed towards the healthy or more functioning vestibule. This rapid, non-invasive, first-line examination performed with SYNAPSYS Vestibular Vibrator instantly reveals any vestibular asymmetry, even in patients with very longstanding and compensated unilateral vestibular loss. It is not altered by vestibular compensation, which makes it a useful test in occupational and forensic medicine.

In patients with unilateral vestibular weakness, eye movement recordings revealed SVIN with a rapid phase usually beating away from the affected side. In total unilateral vestibular lesions (TUVL), it is the intact side that is stimulated. A SVIN occurs when there is an asymmetry between peripheral vestibular receptors and the nystagmus is beating toward the side of higher excitability in partial unilateral vestibular loss (PUVL). The usefulness of the test has been confirmed by many authors for Vestibular neuritis (VN), Menière's disease (MD), Labyrinthine commotion, and follow-up after intratympanic gentamicin or vestibular neurectomy or in superior semicircular canal dehiscence (SSCD) and rare central neurological diseases. In patients with central lesions, a VIN is usually not observed, except in the case of a unilateral lesion in the brainstem located on the VOR pathway. No significant nystagmus is observed in healthy subjects.





Dumas et al. How to do and why perform the skull vibration-induced nystagmus test. European Annals of Otorhinolaryngology, Head and Neck diseases 138 (2021) 287–290.

ADVANTAGES RESPECT TO OTHER VESTIBULAR TESTS

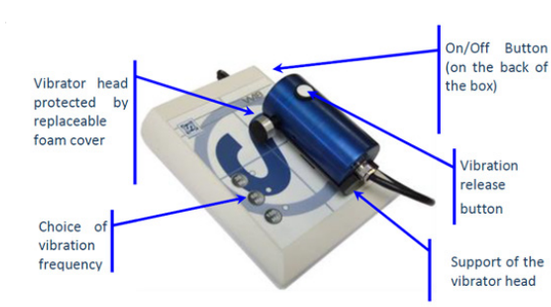
This test is particularly useful in the presence of a perforated eardrum, which contradicts the water caloric test or in the presence of external auditory canal agenesis or malformation. In older subjects with atherosclerosis or osteoarthritis of the neck, it is less invasive than the head shaking test (HST) or the video head impulse test (VHIT). The test is useful for monitoring the course of a disease, objectively and simply confirming the efficacy of treatment, for example: chemical labyrinthectomy by intratympanic gentamicin in debilitating Meniere's disease. It is a reliable marker of vestibular deafferentation, not modified by vestibular compensation. Recent extension of the applications of this test includes its use in the pre-cochlear implantation vestibular assessment. Tests performed with SYNAPSYS Vestibular Vibrator are also used to guide the choice of implantation side in the case of unilateral cochlear implantation, especially in children. In cases of conductive hearing loss with a normal eardrum, observation of torsional components of VIN beating towards the affected side is highly suggestive of superior semicircular canal dehiscence (SSCD).

TOLERANCE AND ADVERSE EFFECTS

Some patients with recent acute peripheral vestibular disorder described lateropulsion sensations (usually toward the intact side), while other subjects with SSCD may report nausea when the test is repeated. These mild manifestations usually do not prevent the conclusion of the examination.

It is recommended to perform this test cautiously in certain situations (recently operated otosclerosis, retinal detachment, history of recent cerebral hematoma, poorly controlled anticoagulant therapy).

DEVICE VVIB 3F



Before any examination with SYNAPSYS Vestibular Vibrator, check the condition of the vibrator head. The head must have a protective foam cover and be in good condition in order not to injure the patient. **It is recommended that the foam head be changed regularly.** Stiffening the rubber can make the test less comfortable for the patient and the response less reliable. The device can be repeatedly cleaned with an alcohol-soaked wipe or disinfectant wipe. Do not immerse it into water.

There are 3 stimulation frequencies available: 30-60-

100 Hz. The reference frequency is 100 Hz. The performer is free to use the available frequencies according to his clinical judgment because thanks to the three available vibration frequencies (30, 60 and 100 Hz), it can cover all patient conditions.

Furthermore high intensity raises the chances of inducing induced nystagmus.

As per the specifications highlighted in the Dumas' work (*G. Dumas et al. How to do and why perform the skull vibration-induced nystagmus test. European Annals of Otorhinolaryngology, Head and Neck diseases 138 (2021) 287–290.*), at 100 Hz the vibration amplitude must be 0.06 mm with an acceleration of 11.5 m/sec2 and the pressure exerted on the vibrator head must be approximately 10 N or 1 kg. Respecting these parameters allows you to obtain the best results which agree with international literature.

Before starting the test, it is useful to apply the vibrator in areas other than those being examined (mastoids and vertex) as shoulders or hips. This allows the patient to become familiar with the sensation produced by the device and reduce defensive reactions during the test.

Inhibition of fixation is necessary (VNG mask completely occluded) and VNG recording is highly recommended for measuring the SPV of induced nystagmus (remember the significance limit of 2.5°/sec).

The protocol involves the repetition of vibratory stimulation in each site, to confirm the oculomotor response.

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