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# Peripheral Vestibular Evaluation - A New Horizon

Editorial

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Vertigo, imbalance, and dizziness are reported with a 1-year prevalence in the adult population of 48.3%, 39.1%, and 35.6% respectively [1]. Falls in the elderly represent 2.8 million emergency departments visits each year [2]. Reportedly, 5-8% of children will experience vertigo in the general population [3-5]. These statistics exemplify a significant public health issue with significant implications across populations. There is universal agreement that any investigation for reported vertigo, imbalance, and dizziness begins with a thorough medical evaluation. Regardless of the patient population or presenting symptoms it is imperative to first determine if any acute or chronic underlying medical conditions exist. This is, of course, not a simple task as the sheer number of possible pathologies resulting in vertigo, dizziness, and imbalance is daunting.

Often, quantitative evaluations can be quite valuable in guiding medical management decisions. Peripheral vestibular evaluation specifically can provide quantitative information as part of the overall medical evaluation for patients reporting vertigo, dizziness, and/or imbalance. Electronystagmography (ENG), videonystagmography (VNG) and rotary chair testing (RCT) comprise a typical peripheral vestibular evaluation. Electrophysiologic measures such as auditory brainstem response (ABR) and electrocochleography (ECOG) may also be useful in the evaluation of select peripheral vestibular disorders. These protocols, in the absence of additional techniques, provide information about peripheral vestibular function and in many cases, prove effective and efficient. Of course, these techniques also have inherent challenges that can limit their overall effectiveness across a wide range of populations in both the clinic and in the scientific community.

When assessing for peripheral vestibular hypofunction, either to confirm or rule out dysfunction, ENG/VNG and RCT only assess the horizontal semicircular canals (SCCs) and the superior division of vestibular nerve of the VIII cranial nerve. Additionally, caloric irrigation is an evaluation of non-physiologic low-frequency stimulation of the horizontal SCCs with RCT representing low- to mid-frequency stimulation. Neither caloric irrigation or RCT provide high-frequency stimulation. ABR evaluations can be quite valid for use in assessing patients for acoustic neuroma/vestibular schwannoma (AN/VS), however imaging studies can also confirm AN/VS and it is exceedingly rare, reported to occur with 19 tumors per million per annually [6]. ECOG testing, used specifically in cases of suspected Meniere's disease (MD), can be technically challenging and has been reported, when using extra tympanic measurement, to have poor sensitivity (71%), and especially in the early symptomatic period [7, 8]. When positive findings suggesting peripheral vestibular dysfunction are noted using these techniques they are quite valuable to proper diagnoses and management. However, due to the above noted factors these tests with negative findings for peripheral vestibular dysfunction can result in false negative findings and/or the inability to confidently rule-out dysfunction.

Peripheral vestibular evaluation technology has advanced, improving the ability to fully assess the peripheral vestibular system. Specifically, Video Head Impulse Testing (VHIT) and Vestibular Evoked Myogenic Potentials (VEMPs) have been added to the vestibular test battery. These tests have expanded the available information to include high-frequency stimulation, the function of the posterior SCCs, anterior SCCs, inferior division of the vestibular nerve of the VIII cranial nerve, the saccule, and the utricle. These tests combined with the traditional vestibular test battery allow for a more complete peripheral vestibular evaluation to either confirm peripheral dysfunction or rule-out vestibular involvement.

The VHIT utilizes video-oculography to allow for recording and detailed analysis of the vestibular-ocular reflex (VOR) for gain and catch-up saccades with high-frequency stimulation for all 6 semicircular canals independently [9-11]. VHIT provides the only clinically available method for assessing the posterior and anterior SCCs in a quantitative manner. VEMP evaluations (cervical and ocular) provide an evaluation of saccule and the inferior division of the vestibular nerve of the VIII cranial nerve and utricle and

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superior division of the vestibular nerve of the VIII cranial nerve function using the electrophysiologic evaluation of the vestibulo-spinal and vestibulo-ocular reflexes [12-15]. VEMP testing provides the only clinically available methods for assessing the otolithic organs in a quantitative manner. Additionally, VEMP testing has proved quite useful for the assessment of specific peripheral vestibular dysfunction and other dysfunction such as superior canal dehiscence, enlarged vestibular aqueduct, vestibular migraines, and MD [16-18].

It is important to note that both VHIT and VEMP, like traditional vestibular evaluation techniques, have their own limitations. VHIT testing has lower sensitivity than caloric testing, but higher specificity when assessing the horizontal SCCs [19, 20]. Both cVEMPs and oVEMPs have well-documented age-effects and can be difficult to obtain in older patients [21, 22]. VEMPs also have varied sensitivity and specificity to different peripheral vestibular pathologies [23]. It is the combination of VNG, RCT, ABR, ECOG, VHIT, cVEMP, and oVEMP results that can now provide information regarding each of the 10 sensory structures of the peripheral vestibular system as well as the inferior and superior divisions of the vestibular nerves at a wide spectrum of stimulation and disorders.

In addition, the ability to assess the vestibular structures through a wider variety of techniques now also allows for expanded clinical and research populations. RCT testing is not commonly available and caloric testing is often poorly tolerated leading to the common practice that children under the age of 6 were not testable. VHIT testing has been validated for use down to 3 years of age [24, 25]. cVEMPs and oVEMPs have been observed and measurable in neonates with modified techniques [26-28]. VEMPs specifically, have been integral in identifying an expanded population at elevated risk for vestibular dysfunction.

Several specific disorders such as CHARGE and Usher syndrome have been well-known to present with vestibular deficits; however, the occurrence of vestibular deficits with other types of hearing loss has not been extensively described. Recent research utilizing combination techniques to assess vestibular function in children with hearing loss have suggested 70-85% of children with hearing loss across etiologies demonstrate vestibular abnormalities on one or more of the currently available vestibular tests [29-32]. The new techniques combined with additional advances with traditional vestibular evaluation such handicap inventories and oculomotor testing have also helped to expand the diagnostic assessment and capabilities in the pediatric population [33-35].

Current peripheral vestibular techniques including ENG/VNG, RCT, ABR, ECOG, VHIT, cVEMPs, and oVEMPs allow for further investigation of vestibular function and improved ability to confirm or rule-out peripheral vestibular dysfunction in wider range of populations making for a new horizon in both the clinic and scientific communities. These techniques can help provide efficient and comprehensive management in patients with reported vertigo, imbalance, and/or dizziness with the goals of minimizing office visits, reducing the risk of falls, and providing proper identification and management of children with vestibular dysfunction as well as expanding the available scientific evidence across populations, disorders, and function.

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