Audio-Vestibular Pathways Dysfunction and Testing in Parkinson's Disease

Instability and falls and rapid eye movement (REM) sleep behavior disorder is commonly seen in parkinsonian disorders and suggests brainstem involvement. Parkinson's disease and atypical parkinsonian disorders affect various structures in the brainstem. Apart from checking eye movements (nystagmus, saccades, and pursuit movements), we can also study the involvement of central auditory and central vestibular pathways by testing brainstem auditory evoked responses (BAER) and vestibular evoked myogenic potential (VEMP).

The BAER is a relatively old test, and we know that prolongation of the I–III interpeak interval, in the presence of a prolonged I–V interpeak interval, reflects an abnormality within the neural auditory pathways between the distal eighth nerve on the stimulated side and the lower pons. The major generators of wave III are in the caudal pons while wave V is at the level of the mesencephalon.

VEMP is a relatively new vestibular function test performed by stimulating one ear with repetitive pulse or click sound stimulation and then measuring surface electromyographic (EMG) responses over selected muscles, averaging the reaction of the muscle electrical activity associated with each sound click or pulse. VEMPs are short-latency muscle reflexes recorded from the neck or eye muscles with surface electrodes. Assessment of VEMPs can be used to evaluate vestibular pathways in the lower brainstem (cVEMP) or upper brainstem (oVEMP). They assess the otoliths and vestibular system. The cVEMP represents a form of otolithic vestibulocollic reflex while the oVEMP represents an otolithic vestibuloocular reflex.

cVEMP assesses vestibular signals from the saccule carried via the vestibulospinal tract and the cervical vestibulocollic pathway to the ipsilateral sternocleidomastoid. It is performed by stimulation of one ear with clicking sounds while recording a surface EMG over the ipsilateral sternocleidomastoid muscle. There is momentary inhibition of muscle tone in the ipsilateral sternocleidomastoid muscle, and surface EMG responses are averaged to yield a biphasic waveform response, whose latency and amplitudes are measured.

oVEMP assesses the vestibular signals from the utricle via the superior vestibular nerve, which to the contralateral medial longitudinal fasciculus and the oculomotor nucleus. Averaged surface EMG responses are measured from the contralateral inferior oblique muscle to yield a biphasic waveform.

An isolated absent cVEMP would place the lesion at or below the vestibular nucleus, anabsent oVEMP would indicate a lesion at or above the vestibular nucleus, and a combined cVEMP/oVEMP abnormality would suggest a lesion in the vestibular nucleus or root entry zone.[1,2]

VEMPs have been studied in various disorders of the brainstem including strokes and demyelination, which showed abnormalities correlating with or even without imaging abnormalities.[1]

Several studies have looked at VEMPs in Parkinson's disease and other parkinsonian disorders. VEMP abnormalities have correlated with the severity of Parkinson's disease. They have been shown altered in PD, and the severity of the abnormalities correlated with the severity of the disease. The abnormalities were significantly correlated with postural instability and Rem behavior sleep disorder (RBD) also.[3,4]

VEMPS have been shown to be abnormal in idiopathic RBD also.[5]

Thus, possibly along with RBD, it may be worth looking at VEMPs as a biomarker to detect Parkinson's at an early stage for intervention.

Venhovens *et al*. also examined BERA and VEMP and demonstrated vestibular dysfunction to be highly prevalent in both PD and atypical Parkinsonism patients compared with healthy subjects and to be associated with an increased risk for falling.[6,7]

So BERA and VEMP may help in finding those cases of Parkinsonism who are at higher risk of falls and institute preventive interventions.

The present study studies a cohort of Indian patients with Parkinson's disease and has demonstrated abnormalities in the VEMP and BAER as well as correlation with RBD and postural instability. It would be worth looking at a long-term follow-up to see if the abnormalities could be used to predict and prevent falls and to diagnose PD at an earlier stage in cases of RBD.

To summarize, BERA and VEMP offer a way of looking for brainstem abnormalities in parkinsonian patients to detect those at risk of falls and along with RBD could be useful as a biomarker to detect PD in early stages.

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