Diagnosis of Meniere’s disease by investigating the Non-linear characteristics of Electrovestibulography signals

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Meniere’s disease is an inner ear disorder that can cause episodes of vertigo, ringing in the ears (tinnitus), a feeling of fullness or pressure in the ear, and fluctuating hearing loss [Balo01]. It affects 0.2% of the population of the United States. The area affected by Meniere’s disease is the entire labyrinth, which includes the semicircular canals, otolith organ, and the cochlea. The main problem in Meniere’s disease is an increase of the volume and pressure of endolymph, which can cause a dilation of the endolymph system [Balo01]. In fact, the underlying cause of Meniere's disease is unknown [Beas96]. Some theories suggest that Meniere’s disease is most often attributed to viral infections of the inner ear, head injury, a hereditary predisposition, and allergy; also migraine may cause symptoms that overlap with Meniere's disease [Selm05]. Diagnosis of Meniere’s syndrome is difficult especially when the patient is not experiencing severe symptoms; misdiagnosis has remained a problem [Mosi85].

Electrovestibulography (EVestG) is a technique similar to Electrocochleography (ECOG) wherein the acoustic stimulus is replaced by a passive whole body tilt [Lith06]. EVestG is a non-invasive technique to record neural activity from the vestibular apparatus and vestibular nuclei; it measures a vestibular driven response stimulated by passively whole body tilting the subject, who is seated in a special hydraulic chair located in an electrically and acoustically shielded chamber. The EVestG signal is recorded during dynamic and static phases via an electrode resting proximal to the tympanic membrane [Lith08, Lith09].

In this study, we used EVestG signals for diagnosis of Meniere’s Disease. EVestG data of 14 individuals with Meniere’s disease and 16 age-matched healthy controls were used. The field potentials and their firing pattern in response to whole body tilt stimuli from both left and right ears’ EVestG signals were extracted. We investigated several features of the field potentials in contralateral (CT) and ipsilateral (IT) side and back tilts. One-way analysis of variance (ANOVA) [Hogg87] was used to select the features showing the most significant differences between individuals with Meniere’s and the age-matched controls. Linear Discriminant analysis classification [Duda01] was applied to every selected feature using a leave-one-out routine. The result of each feature’s classifier related to every tilt was used in a heuristic average voting system. The results show more than 93% accuracy for Meniere’s diagnosis. The results are encouraging for use of vestibular response as a non-invasive screening tool for Meniere’s diagnosis.
REFERENCES


