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Comparative study of Cervical Vestibular Evoked Myogenic Potentials (cVEMP) in both ears among males and females

Deepak Raj P V, Dr. Ravanan M P, Prasanth N P

Abstract

Gender does not influence the behavior of muscles in humans, but various studies have concluded a very large difference in total muscle volume between males and females (1). It is a known fact that cVEMP thresholds can be recorded only when there is sufficient contraction of sternocleidomastoid muscle (2). So, we study whether there is a difference in cVEMP parameters in males and females due to the difference in muscle volume. This study aims to compare Cervical Vestibular Evoked Myogenic Potential (cVEMP) parameters in both ears and among males and females. Statistical analysis of the findings reveals no significant difference in latency and amplitude of Cervical Vestibular Evoked Myogenic Potentials (cVEMP) in both ears among males and females.

Key words

Cervical Vestibular Evoked Myogenic Potentials.

P13 – A positive peak around 13milliseconds in the response window

N23 – A negative peak around 23milliseconds in the response window

Abbreviations

cVEMP – Cervical Vestibular Evoked Myogenic Potentials

VEMP – Vestibular Evoked Myogenic Potentials.

SCM – sternocleidomastoid

IHS – Intelligent Hearing System

Introduction

Vestibular system is the organ of balance and equilibrium in humans and other vertebrates. It is a sensory system that sense motion, head position and spatial orientation. It gives input to the motor system that helps to keep our balance, to maintain poster and also helps to stabilize our head and body during movement. A proper sensory processing and coordination of head motion, visual and postural movements maintain equilibrium for everyday function. The vestibular system helps us to achieve this goal by its complex and multiple levels of sensory processing. The five major structures located in the vestibular system are the utricle, the saccule, and the lateral, superior and posterior semicircular canals. In order to have a finer understanding of the human vestibular system, it is necessary to conduct a thorough examination of the semicircular canals and the otolith structures (utricle & saccule). Caloric testing and electronystagmography can be used to determine the integrity and function of the semicircular canals, but otolith organ functions cannot be evaluated using the same. So Vestibular Evoked Myogenic Potential (VEMP) is developed as a method to test the function of otolith organs (3).

In (cVEMP) Acoustic stimuli at high levels of intensity produce myogenic reactions in the brain when the sternocleidomastoid (SCM) muscle is tonically tensed. Electrodes are put on the ipsilateral side of the muscle to record its electrical activity. The SCM muscle synapses with a reflex channel that originates in the vestibular saccule and is conveyed by the inferior vestibular nerve. A positive peak (p13) appears early in the response waveform, followed by a negative peak (n23) ranging from 20 to 150 microvolt. Rise in the strength of the SCM muscle contraction caused a corresponding rise in cVEMP amplitude, which in turn correlated with both sound intensity and strength of SCM muscle contraction. As a result, a consistent muscular control must be accomplished in order to acquire an accurate status of the reflex route. By giving the client with feedback on the amount of SCM muscular contraction, it is possible to monitor this continual tonicity of the muscle (4).

Colebatch et al (1994) (2) were among the first to systematically document the clinical feasibility of VEMP measurement and to advocate clinical applications of the new technique. Parameters of the VEMP (latency and amplitude) are highly dependent on stimulus parameters, and also activity of the SCM muscle. Tone bursts are found to be more effective than clicks for elicitation of VEMP and, among the tone burst stimuli; low frequency is more effective than high frequency. Within published papers, the most common used stimulus for clinical measurement of VEMP is tone burst stimuli of 500 Hz. For successful measurement of the VEMP, the sternocleidomastoid muscle (SCM) must be maintained in tonic contraction (Bickford et al 1964, Colebath et al 1994)(5,2). (Welgampola and Colebath 2005) (6) described that VEMP is not produced by the contraction of the SCM muscle, but arises from modulation of background EMG activity. It differs from other neural potentials because it requires tonic contraction of the muscle. There are only few studies about the effect of gender on amplitude and latency of cVEMP. Thus this study aims to compare Cervical Vestibular Evoked Myogenic Potential (cVEMP) parameters among males and females.

Methodology

This experimental and prospective study was conducted among 100 participants with normal hearing sensitivity within age group (20-40) years. Among the 100 participants, there were 50 males and 50 females. Consent was obtained in writing from all the participants in this study. A detailed case history was taken for all participants. Investigations such as otoscopic examination, immittance audiometry and pure tone audiometry and were performed in all the subjects. All the participants in this study were having normal hearing sensitivity. Subjects having cervical spondylosis, neurogenic disorders, tinnitus, vertigo, diabetes, hypertension, altered hormone levels and use of ototoxic drugs were excluded from this study.

cVEMP thresholds were measured using Intelligent Hearing System (IHS Duet) and the transducer used was insert earphones (TDH 39). Specific efforts are made in VEMP measurement to increase muscle activity and to produce contraction of the muscles of interest, usually the sternocleidomastoid (SCM) muscle. Activation of the SCM muscles for VEMP measurement in adult patients is produced by manipulations of the head and neck. Contraction of the SCM muscle on one side of the neck can be obtained by rotating the head to the opposite side while sitting upright or lying in supine position (e.g. Murofushi et al 1999) (7). The VEMP can be recorded only from the SCM muscle that is activated and not from the relaxed SCM muscle on the opposite site. One electrode should be placed on the skin over the SCM muscle. There is no apparent consensus or convention for electrode placement in VEMP measurement. A monopolar recording method is most often used, with a recording electrode located on the surface of the SCM muscle, and the other recording electrode located at sites such as the nape of the neck or sternum(8).

As with any evoked response test protocol, in VEMP measurement the skin should be prepared prior to electrode placement to produce inter electrode impedance of less than 5000 ohms (5 k ohms) for each electrode and balance impendence among electrodes (optimally within 2 k ohms) electrode site on the SCM muscle should be prepared on both sides (right and left) during preparation for VEMP measurement. The stimulus used was 500Hz tone burst with 10 -1000 Hz band pass filter and amplified 10 – 25 microvolt per division (9).

Statistical Analysis & Results

Codes given

MLRP13 ------ Males - Latency- Right ear - P13.
MLRN23 ------ Males -Latency - Right ear - N23
MLLP13 ------ Males - Latency - Left ear - P13
MLLN23 ------ Males - Latency - Left ear - N23
MARP13 ------ Males - Amplitude - Right ear - P13
MARN23 ------ Males - Amplitude - Right ear - N23
MALP13 ------ Males - Amplitude - Left ear - P13
MALN23 ------ Males - Amplitude- Left ear - N23
FLRP13 ------ Females - Latency- Right ear - P13.
FLRN23 ------ Females -Latency - Right ear - N23
FLLP13 ------- Females - Latency - Left ear - P13
FLLN23 ------- Females - Latency - Left ear - N23
FARP13 ------- Females - Amplitude - Right ear - P13
FARN23 ------- Females - Amplitude - Right ear - N23
FALP13 ------- Females - Amplitude - Left ear - P13
FALN23 ------ Females - Amplitude- Left ear - N23

Males

Descriptive Statistics	LRP13	LRN23	LLP13	LLN23	ARP13	ARN23	ALP13	ALN23
Mean	14.660	24.536	14.630	24.356	25.505	24.864	24.698	23.907
Standard deviation	1.531	1.798	1.628	1.860	5.244	5.675	6.070	7.033
Minimum	11.88	20.22	11.83	20.35	14.33	14.66	15.44	11.88
Maximum	17.44	27.13	17.01	27.35	34.14	36.44	36.44	35.44

Females

Descriptive Statistics	LRP13	LRN23	LLP13	LLN23	ARP13	ARN23	ALP13	ALN23
Mean	14.496	24.179	14.290	24.487	25.930	24.911	22.687	23.907
Standard deviation	1.653	1.692	1.551	1.678	5.332	6.452	6.905	5.980
Minimum	12.12	21.81	11.88	20.22	16.77	13.66	11.88	14.33
Maximum	17.01	26.54	17.00	27.13	34.14	34.66	33.22	33.22

Comparison of VEMP parameters among males and females

Independent sample t test was used for the comparison of VEMP parameters among males and females. It is found that there is no significant difference in VEMP parameters between males and females ($p>0.05$).

Variables	t value	p value
LRP13	0.364	0.718
LRN23	0.722	0.474
LLP13	0.756	0.453
LLN23	0.262	0.795
ARP13	0.284	0.778
ARN23	0.027	0.978
ALP13	1.093	0.280
ALN23	0.000	1

Right Ear

Descriptive Statistics	MLP13	MLN23	MAP13	MAN23	FLP13	FLN23	FAP13	FAN23
Mean	14.660	24.536	25.505	24.864	14.496	24.179	25.930	24.911
Standard deviation	1.531	1.798	5.244	5.675	1.653	1.692	5.332	6.452
Minimum	11.88	20.22	14.33	4.66	12.12	21.81	16.77	13.66
Maximum	17.44	27.13	34.14	36.44	17.01	26.54	34.14	34.66

Left Ear

Descriptive Statistics	MLP13	MLN23	MAP13	MAN23	FLP13	FLN23	FAP13	FAN23
Mean	14.630	24.356	24.698	23.907	14.290	24.487	22.687	23.907
Standard deviation	1.628	1.860	6.070	7.033	1.551	1.678	6.905	5.980
Minimum	11.83	20.35	15.44	11.88	11.88	20.22	11.88	14.33
Maximum	17.01	27.35	36.44	35.44	17.00	27.13	33.22	33.22

Comparison of VEMP parameters in right and left ear

Independent sample t test was used for the comparison of VEMP parameters among right and left ear. It is found that there is no significant difference in VEMP parameters between right and left ear (p>0.05).

Variables	t value	p value
MLP13	0.067	0.947
MLN23	0.349	0.729
MAP13	0.503	0.617
MAN23	0.529	0.599
FLP13	0.454	0.652
FLN23	0.645	0.522
FAP13	1.858	0.069
FAN23	0.571	0.571

Conclusion

The study revealed no significant change in amplitude and latency of cVEMP in both ears and among males and females. Thus it can be concluded that difference in muscle volume between males and females doesn't influence the amplitude and latency of cervical vestibular evoked myogenic potentials. cVEMP parameters does not show any significant difference across right and left ear. So a standard normative value can be established in VEMP parameters across gender and also in different ears. This normative data can be very useful while conducting study or evaluation in clinical population with balance and vestibular disorders.

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