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Effect of Reference Electrode Placement on Measuring CVEMP – Preliminary Study

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Abstract- This study compared two electrode placements (Sternum versus Mastoid) for measuring cVEMP elicited by air conducted 500 Hz tone bursts in normal hearing individuals. Fifty normal hearing individual with the age range of (18 to 25 years) participated in the study of cVEMP.The Results showed thatthere is no significant difference for both Latency and amplitude were found for both the sternum and mastoid reference electrode placement. This study demonstrated that mastoid reference electrode resulted in large amplitude and slightly late latencies when compared to the sternum electrode placement. Our data substantiate the possible clinical benefits of this position, but further systematic patient verification is required.

Index Terms- c VEMP, Mastoid placement, Reference placements, Sternum Placement.

I. Introduction

Vestibular evoked myogenic potentials abbreviated as (VEMP) were initially described by (Colebatch, Halmagyi, 1992).VEMPcan be recorded in two ways: tonically contracted cervical muscletermed as colli (or) cervical VEMPs (cVEMPs) and from extra ocular muscles termed as ocular VEMPs (oVEMPs). Both are the shorter latency responses and they can be elicited using air conduction, bone conduction and also galvanic stimuli.The cervical VEMPwith air conduction is a manifestation of the vestibulo colli reflex, initiated by excitation of the saccule and inferior branch of vestibular nerve(Rosengren, Welgampoloa &Colebatch, 2010).Vestibular-dependent myogenic responses to intense sound were first described by (Bickford, Jacobson& Cody, 1964).

VEMP assesses vestibular function through the vestibulocollic reflex (VCR). The VCR arc includes the receptor (the saccule), the afferent pathway (the inferior vestibular nerve), and the efferent pathway (the lateral vestibulospinal tract, the medial vestibulospinal tract, and the end muscle).cVEMP testing is most successful when the patient lies supine with head elevated and turned away from the stimulated ear (Isaacson, Murphy & Cohen, 2006).

The myogenic potential may be recorded from various locations. The primary recording site that is used clinically is the sternocleidomastoid (SCM) along the cervical spine. In spite of its benefits, the procedure still has limitations in regards to eliciting a VEMP response from the SCM of patients with poor muscle tone, poor range of motion in the neck and the pediatric and geriatric populations.

The reliable procedure to record myogenic potentials from the SCM evoked by the tone burst stimulus and the biphasic positive and negative (P1-N1) occurs in the normal subjects were observed.The cVEMP tracing consists of a positive peak at approximately 13 ms and a negative peak at approximately 23 ms and represents the saccule’s response to sound when using an air-conducted stimulus (Colebatch et al., 1994; Murofushi & Curthoys, 1995; Todd, Cody, & Banks, 2000; Welgampola & Colebatch, 2001).

This study aimed on investigating effect of differentreference electrode placement and their variation in latency and amplitude using Cervical VEMP

II. METHOD

Subjects

Cervical VEMPs were performed on normal hearing individuals from the Madras ENT Research Foundation Institute of Speech and Hearing (MERF-ISH). Fifty participants, whose age ranged from 18 to 25 years with no history of hearing loss, vestibular or neurological disorders were recruited. All the participants had a normal otoscopic examination and a normal pure tone audiometric threshold.

Preparation

The electrode sites were prepped using a gauze cloth with NuPrep to obtain acceptable electrode impedances. Impedances were maintained below 5 kΩ. After skin preparation, the active surface electrode was placed over the middle of the SCM, and the reference electrode was placed over the sternum/Mastoid and the ground electrode was placedatthe forehead.

Positioning

The testing was done using The Intelligent Hearing System (IHS) Testing position to activate the SCM muscle included sitting with head turned, Target EMG level to maintain tonicity of the muscle throughout the test with minimum patient discomfort is variable and depends on the test position.

Table .1Stimulus and Recording Parameters

Parameters	**Selection**
Transducer	Insert ear phones
Type	Tone burst 500 Hz
Duration	2-0-2 cycle tone burst
Intensity	100 dB nHL
Polarity	Rarefaction
Rate	4.1/sec
ACQUISITION	
Analysis time	

Pre stimulus	10 to 20 ms
Post stimulus	50 to 100 ms
Electrode type	Disc Electrode
ELECTRODE LOCATION	
Noninverting	Midpoint of sternocleido mastoid muscle
Inverting	Sternum/ mastoid
Ground	Forehead
Filter settings	
High pass	10to 30 Hz
Low pass	250 to 1500 Hz
Notch	None
Amplification	5,000
Sweeps	200

Air-conductedalternating500Hztone bursts(duration5msec)werepresentedunilaterally via an ER3A-inserted earphone although the participants was sitting and turning his head to the contralateral side. A constant tonic activation of the SCM muscle was maintained at 30– 75μV with visual feedback. The EMG signals were amplified (5000X), filtered (bandpass 10–1500Hz with a Blackman gating function), and recorded. The stimulus intensity was started at 100dBnHL).A minimumoftwoVEMPrecordingfrom200stimuliwereaveraged and calculated within -10 to 50sec time window at 100dBnHL.

III. RESULTS& DISCUSSION

The collected data were subjected to statistical analysis using Statistical Package for Social Science (SPSS) version 16.0 software.Descriptive statistics includes Mean, Standard Deviation and Range for sternum and mastoid placement of cVEMP parameters and inferential statistics includes paired sample ‘t’ test were done to extract significant difference between two placement. The cVEMP response was present in all fifty participants (100 ears) on both right and left side, resulting in a response of 100%. Descriptive mean showed P1andN1peak latencies were slight longer for mastoid placement compare to the sternum placement and also P1 and N1 amplitude were higher amplitude for mastoid reference position. Table 4 shows significant difference(p >0.05) were obtained for latencies and amplitude of sternum and mastoid as reference position for cVEMP.

Table 2 MeanValues, Range and Standard Deviation of cVEMP Curve Parameters for Sternum Placement (100 ears)

VEMP Parameters	Mean	Range	SD
P1 Latency (msec)	16.74	13.10 -21.90	1.96
N1 Latency (msec)	23.81	17.40 -28.70	2.46
P1 Amplitude(μV)	80.50	24.97-166.09	34.13
N1 Amplitude(μV)	73.88	20.51 -167.11	36.07

Table 3 Mean Values,Range and Standard Deviation of cVEMP Parameters for mastoid Placement (100 ears)

VEMP Parameters	Mean	Range	SD
P1 Latency (msec)	17.30	13.40-24.50	2.34
N1 Latency (msec)	24.68	18.80 – 30.20	2.35
P1 Amplitude(μV)	91.09	20.20-196.60	35.73
N1 Amplitude(μV)	81.57	18.42-175.19	34.75

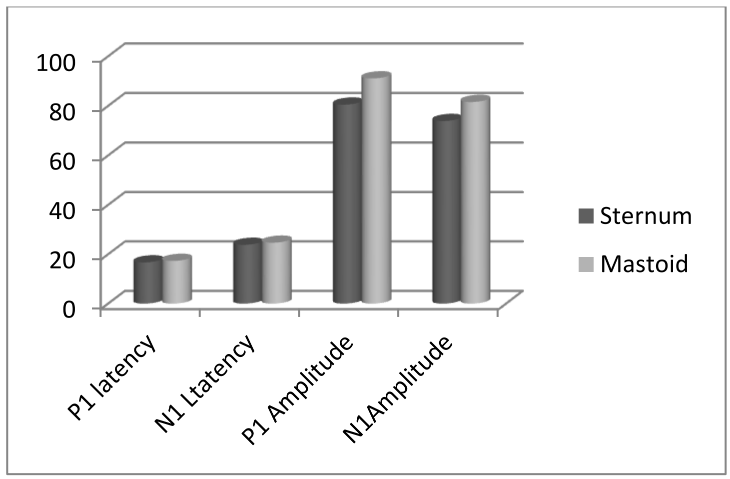

Figure 1 Mean of Latency and Amplitude in Sternum and Mastoid Placement

To infer from the present study findings of the data that the mean difference is presence could be due to the individual variability hence, the conventional electrode placement is mid point of the SCM muscle for recording Cvemp. In this present study the reference electrode was interchanged hence it is exhibited in the mean difference however the responses were elicited from the same muscle tendon. As it is depicted in the table 2 and 3 as well in the figure 1.

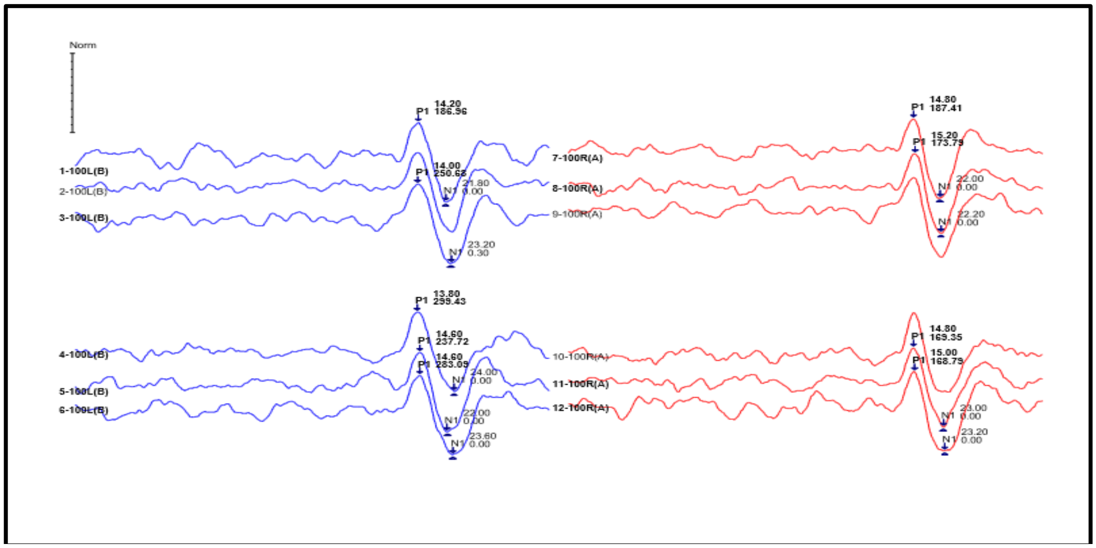

Figure 2a

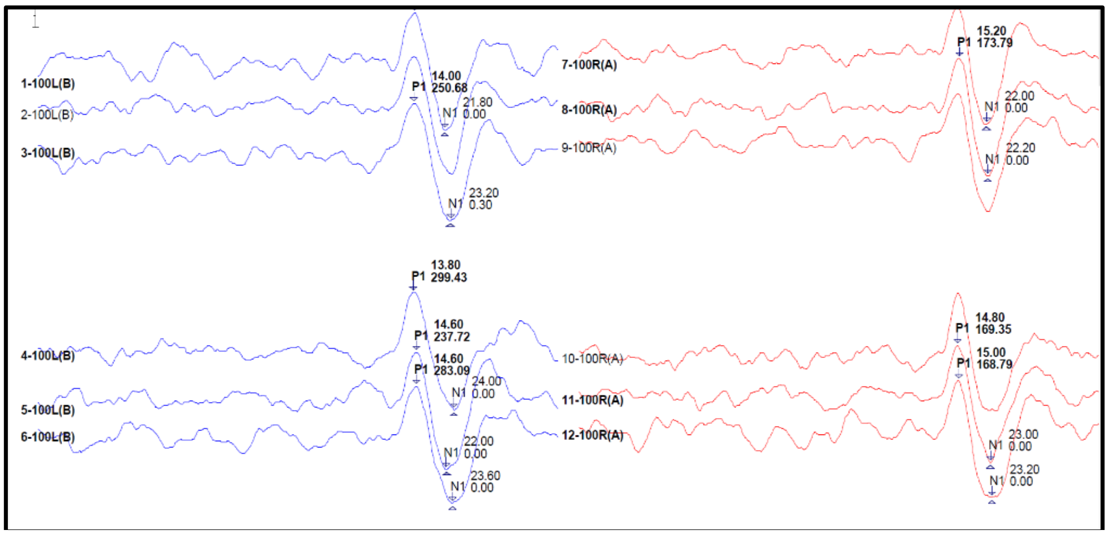

Figure 2b

FIGURE 2 a and 2 b: Normative CVEMP waveform for both the Mastoid and Sternum placement for the right and left ear.

The above figure 2 a and b are clearly depicting the latency and amplitude information of two different electrode placements i.e (Sternum and Mastoid) for both right and left ear.

Table 4 comparison Between Sternum and Mastoid Placement of cVEMP Parameters.

Comparison between electrode positions.	**Paired 't' test (p value)**
Sternum vs Mastoid P1 Latency	>0.05
Sternum vs Mastoid N1 Latency	>0.05
Sternum vs Mastoid P1 Amplitude	>0.05
Sternum vs Mastoid N1 Amplitude	>0.05

The table 4 is clearly depicting the results of paired t test were there is no significant difference could be noticed for both the latency and amplitude parameters. Hence the present findings are in disagreement with the literature support reported by 'Colebatch' that CVEMP was recorded with the reference electrode placed on the sternoclavicular joint and C7 reference position and there was a clear morphological changes with differing the recording sites for the two reference electrodes. However the early latency and larger amplitude were observed for sternum placement but increased latency and reduced amplitude were noticed when the reference electrodes were placed in sternoclavicular and C7 positions. This reference placement may be contaminated by other evoked myogenic activity. Hence in this present study, reveals there could have been lesser contamination of the myogenic activity as well as no significant post auricular muscle artifact were noticed. when the reference electrode were placed in mastoid.

IV. CONCLUSION

The findings in this study suggest that normal c VEMP can be recorded in either one of the reference placement, this study further directs to implement on a larger sample as Although the current study found only trends supporting testing may be warranted to determine the different reference electrode placement can be used for the recording, however By studying specific populations the future research may be able to better understand the c VEMP and Furthermore, future research should assess test-retest reliabilitySuch standardization of equipment parameters, testing protocols and clinical uses is crucial for cVEMP testing to be fully implemented into a clinical setting.

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