VEMP Findings in Individuals with Otitis Media

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Abstract

The study aimed to assess reliability of bone conducted VEMP and also to determine relationship between duration of Otitis media and VEMP results. Two groups of subjects were taken for the study, control group (30 adults) having normal hearing and clinical group (30 adults) having otitis media. Air conducted and bone conducted VEMP were recorded for all the subjects in both control and clinical group after establishing the pure tone thresholds and assessing middle ear status through pure tone audiometry and immittance audiometry respectively. The results showed that the mean p13 and n23 latencies were prolonged and peak to peak amplitude reduced for bone conducted VEMP in clinical group than the control group & there was a positive correlation between the mean latency of p13 and duration of otitis media. The results of the present study suggest that bone conducted VEMP may be used as a clinical tool to evaluate the functioning of vestibular system (saccule/ inferior vestibular nerve) in individuals with otitis media, and the degree of hearing loss and duration of otitis media may be factors affecting the VEMP findings.

Keywords: *VEMP, otitis media, vestibular system.*

Otitis media is one of the major diseases that cause conductive hearing loss with a high prevalence. Adverse effects of otitis media include sensori neural hearing loss, tinnitus, dizziness and disequilibrium with hearing loss being the major focus and vestibular function being overlooked in research (Paparella, Brady & Hoel, 1970). Takahashi , Nakamura , Yui and Mori (1985) reported 50 cases of facial palsy due to otitis media. In humans, chronic otitis media seems to lead inner ear involvement in addition to the sequels caused in the middle ear (Paparella, Oda, Hiraide & Brady, 1972). The mechanism is believed to be that the middle ear inflammatory mediators damage the inner ear through the round window and the oval window (Paparella, Oda, Hiraide & Brady, 1972). The saccule is anatomically nearer to the oval window than the cochlea and semicircular canals due to which saccule is influenced to a greater extent in individuals with chronic otitis media (Seo, Miyamoto, Saka, Shimano, Nishida & Hashimoto, 2008).

Cody, Jacobson, Wailker and Bickford (1964) first described the use of vestibular evoked myogenic potentials (VEMPs) to assess saccular and inferior vestibular nerve function. VEMP is a myogenic potential of neck muscles elicited by stimulating the vestibular system with click or tone burst sound stimuli. The reflex is believed to be sacculocolic conducted through the inferior vestibular nerve (Wu, Young & Murofushi, 1999). VEMPs have been applied as a clinical test to explore the integrity of the sacculo-collic reflexes (Colebatch, Halmagyi & Skuse, 1994). VEMP is a short latency evoked potential. It is recorded from the contracted sternocleido mastoid muscle. Recording of VEMP require high intensity acoustic stimulation, usually 95 dBnHL for air conduction and 60 – 70 dBnHL for bone conduction stimulus (Miyamoto, Seo, Node, Hashimoto & Sakagami, 2006; Yang & Young, 2003). The responses consist of positive and negative successive waves (p13-n23), with latency values in adults about 13 and 23 ms respectively (Wu et al., 1999).

Hart, Nichols, Butler and Barin (1998) showed that otitis media with effusion significantly affected balance and motor skills in children. The earliest publication related to this belongs to Merica (1942) who found that Eustachian tube obstruction caused dizziness in children. Golz, Westerman, Gilbert, Joachims and Netzer (1991) found abnormal Elecronystagmography in 71% of the children with otitis media with effusion compared to 4% in children without otitis media. Casselbrant, Furman, Rubenstein and Mandel (1995) evaluated vestibular functions in children with otitis media using moving posture platform test with velocity as the measurement parameter and their results suggested that middle ear effusion affects vestibular system in children.

Sheykholeslami, Murofushi, Kermany, Kaga, (2000) reported that bone conducted VEMP (B-VEMP) may be used in patients with bilateral external auditory canal atresia, with or without the middle ear anomalies. Seo et al, (2008) reported that B-VEMPs have high specificity to detect the presence of vertigo in patients with unilateral chronic otitis media (COM).

Researches and observations in recent years suggest that otitis media with effusion causes dizziness in children (Golz et al., 1991; Casselbrant et al., 1995). There is dearth of information on otitis

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media and VEMP. Also, it has not been correlated with the duration of otitis media and VEMP findings. Thus, it is necessary to carry studies in this area. It is difficult to record VEMP using air conducted acoustic stimulus because a typical sound-evoked VEMP response is dependent upon a good energy transfer of sound from middle ear to inner ear. The air conducted VEMP responses are typically absent in the existence of conductive hearing loss (CHL) in which the air- bone gap (ABG) is >20dB. So it is essential to use Bone conduction as an alternate mode of stimulation to record VEMP. It is also essential to have some norms for bone conducted VEMP in order to use it as a clinical tool. A comparison of air conducted and bone conducted VEMP recorded from normal hearing individuals would provide information regarding the efficacy of using bone conduction as stimulation mode.

The study aimed to develop database for B-VEMP and assess reliability of B-VEMP results by comparing with air conducted VEMP findings. The study also aimed to determine occurrence of B-VEMP in individuals with normal hearing and to determine relationship between duration of otitis media and VEMP results.

Method

Subjects: To accomplish the aim, two groups of subjects were taken for the study. They were, control group having normal hearing individuals and clinical group having individuals with otitis media. Control group consisted of 30 normal hearing adults (15 males and 15 females) with an age range of 18 to 55 years having mean age of 23 years. Clinical group also consisted of 30 individuals having otitis media with an age range of 15 to 55 years having a mean age of 30.5 years.

Subject selection criteria for control group: All the subjects had air conduction hearing sensitivity within 15 dB HL at octave frequencies from 250 to 8000 Hz and 'A' type tympanogram with presence of acoustic reflexes. They did not have any history or presence of any otological problem (like ear discharge, ear ache) or any neurological symptoms. All of them had 100% speech identification score (SIS) at 40 dB SL (ref: SRT) and uncomfortable levels (UCL) for speech of greater than 105 dB HL.

Subject selection criteria for clinical group: All of them had presence of bilateral otitis media with duration of more than five years. Duration of five years was taken because, prevalence of inner ear damage due to otitis media is more if the duration is more than 3 years. Presence of otits media was diagnosed by an experienced Otologist. The severity of hearing loss ranged up to moderately severe degree. Thresholds for bone conduction were within normal limits (15 dB HL). They did not have any history or presence of any neurological symptoms. All of them had SIS of 100% at 40 dB SL and UCL of greater than 105 dB HL.

All the tests were carried out in a sound treated room. The ambient noise level was as per the recommendation of ANSI (S.3.1, 1991.).

Procedure

Prior to the audiological evaluation, a detailed case history was taken from the clinical group in order to gather information regarding the age of onset of otitis media, thus estimating the duration of the same. Information regarding age of onset of the problem, ear pain, ear discharge, itching and blocking sensation gave primary data regarding the presence of otitis media which was later confirmed by an experienced Otologist.

A calibrated diagnostic audiometer (GSI-61) was used to estimate the pure-tone threshold for air conduction threshold, bone conduction threshold, and UCL for speech for all the subjects. Pure-tone threshold was obtained using modified version of Hughson and Westlake procedure (Carhart & Jerger, 1959). Thresholds across octave frequencies from 250 to 8000Hz for air conduction and from 250 to 4000Hz for bone conduction were obtained. Speech was presented through the headphone (TDH-39) at different intensities using ascending method to determine the uncomfortable loudness level (UCL) of the subjects.

A Calibrated immittance meter (GSI Tympstar) was used for tympanometry and reflexometry using 226Hz probe tone to analyze the middle ear status of all the subjects. Acoustic reflexes were measured at 500Hz, 1 KHz, 2 kHz and 4 kHz. Control group showed 'A' type tympanogram with acoustic reflexes at normal levels whereas it was 'B' type with absent acoustic reflexes for clinical group.

Procedure to record VEMP: Subjects were seated upright on a reclining chair. They were instructed to turn their head to opposite side of the test ear to activate the sternocleidomastoid muscle (SCM) unilaterally. Subjects were instructed not to move their head and neck while VEMP recording and also to fix their gaze in front to control eye movement. Intelligent hearing systems (HIS) Smart EP version: 3140 was used to record and analyze VEMP. Eartone 3- A insert earphone was used to deliver the air conducted stimulus. Radio ear B-71 was used to deliver stimulus through bone conduction.

Non-inverting electrode (+) was placed at midpoint of the sternocleidomastoid muscle of the side being stimulated. Sternoclavicular junction was the location for placement of inverting electrode (-)

and forehead for ground electrode. Before placing the electrodes, the sites were cleaned using skin preparation paste and silver chloride electrodes were placed with the ten-20 conduction paste to increase the conductivity. The electrode impedance was checked and it was ensured that the absolute impedance at each electrode site was within 5 kOhms and inter electrode impedance was within 3 kOhms. The parameters used to record VEMP are given in Table 1.

Table1. Parameters used to record VEMP

Stimulus parameters		Acquisition parameters	
Type of stimulus	500Hz tone burst	Analysis time	70 ms
Duration	5000 µs	Amplification	50000
Stimulus intensity for : air conduction	105 dBnHL	Filter settings	High pass: 30Hz
Stimulus intensity for : bone conduction	66 dBnHL		Low pass: 1500Hz
Rate	5.1/sec	Notch filter	Off
Polarity	Rarefaction	Electrode	Disc type
Total no of stimulus	200		

While recording VEMP, the tonic EMG level was monitored and maintained for each of the subjects between 50-150 microVolts. A visual feedback available in the instrument was provided to each of the subjects to monitor the tonic EMG level of sternocleidomastoid muscle activation. p13 and n23 latency and p13 – n23 peak to peak amplitude was noted for the comparison.

Results

Air conduction VEMP (A-VEMP) response obtained in control group: A-VEMP was recorded from 70 ears and all of them (100%) had VEMP responses. Out of 70 ears, 8 ears had poor wave morphology. A-VEMP response obtained from an individual with normal auditory and vestibular function is shown in Figure1.

Bone conduction VEMP response obtained in control group: Out of 70 ears, 61 ears (87.14%) had bone conduction VEMP. Out of 61 ears, 29 ears had poor waveform morphology. B-VEMP response obtained from an individual with normal auditory and vestibular function is shown in Figure 2.

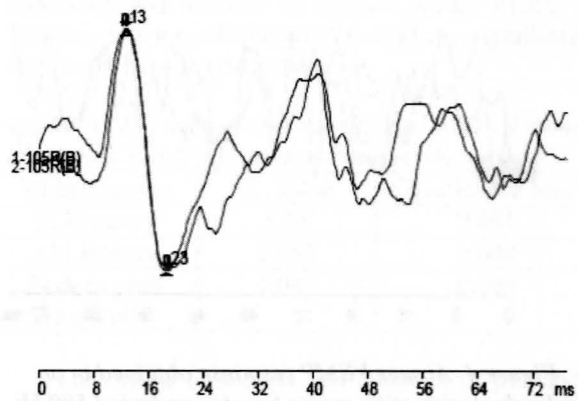

Figure 1. VEMP response obtained for 500 Hz air conducted tone burst presented at 105 dBnHL in an individual with normal hearing.

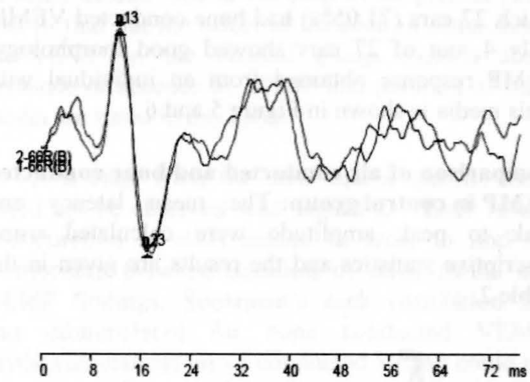

Figure 2. VEMP response obtained for bone conducted 500 Hz tone burst presented at 66 dBnHL in an individual with normal hearing.

Air conduction VEMP response obtained in clinical group: Air conducted VEMP was recorded from 38 ears having otitis media, out of which only 4 ears (10.52%) had air conducted VEMP response. Out of 4 subjects in whom air conducted VEMP could be recorded, 3 of them had poor wave morphology. VEMP response obtained from an individual with otitis media is shown in Figure 3 and 4.

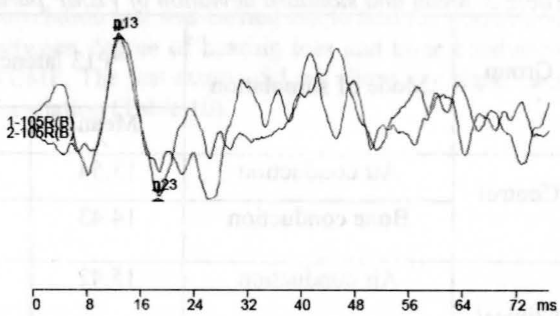

Figure 3. A-VEMP response obtained for 500 Hz air conducted tone burst presented at 105 dBnHL in an individual with otitis media.

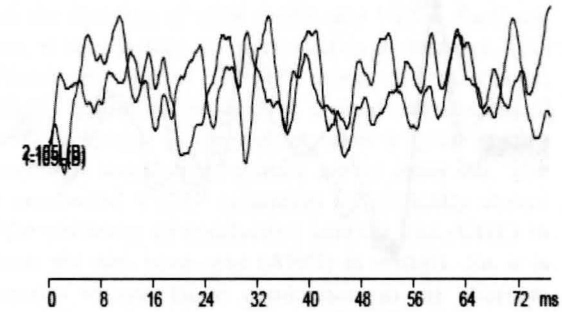

Figure 4. Absent VEMP response obtained in an individual with otitis media for air conducted 500 Hz tone burst presented at 105dBnHL.

Bone conducted VEMP response obtained in the clinical group: Bone conduction VEMP was recorded from 38 ears having otitis media, out of which 27 ears (71.05%) had bone conducted VEMP. Only 4, out of 27 ears showed good morphology. VEMP response obtained from an individual with otitis media is shown in Figure 5 and 6.

Comparison of air conducted and bone conducted VEMP in control group: The mean latency and peak to peak amplitude were calculated using descriptive statistics and the results are given in the Table 2.

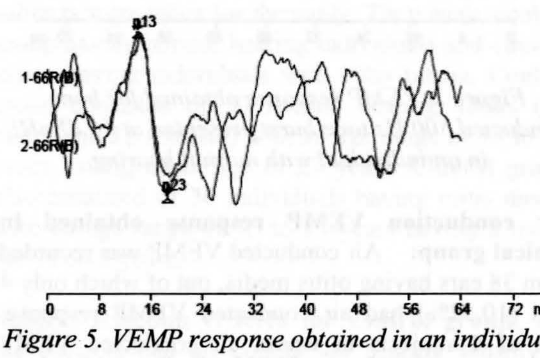

Figure 5. VEMP response obtained in an individual with otitis media for 500 Hz tone burst presented at 66 dBnHL through bone conduction.

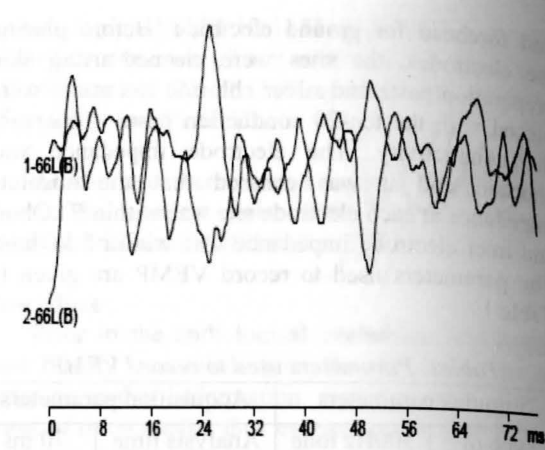

Figure 6. Absent VEMP response obtained in an individual with otitis media for 500 Hz tone burst presented at 66 dBnHL through bone conduction.

It can be observed that p13 latency was significantly shorter for air conduction mode compared to bone conduction. The mean peak to peak amplitude was significantly higher for air conduction mode. However, latency of n23 did not differ significantly between air conduction and bone conduction.

Paired t – test was carried out later, to find the significant difference between air conducted and bone conducted VEMP in control group. The details of the t- test results are shown in the Table 3.

Comparison of air conducted and bone conducted VEMP in clinical group: It is observed from the table 2 that the mean latencies of p13 and n23 peaks were delayed for bone conducted VEMP. The mean peak to peak amplitude was reduced for bone conducted VEMP. Wilcoxon signed rank test was administered to find out the significant difference between air conducted and bone conducted VEMP in clinical group.

Table 2. Mean and standard deviation of VEMP parameters for both control and clinical groups

Group	Mode of stimulation	P13 latency		N23 latency		Peak to peak amplitude	
		Mean	SD	Mean	SD	Mean	SD
Control	Air conduction	13.54	1.21	20.06	1.62	90.5	37.2
	Bone conduction	14.43	2.61	20.45	2.52	34.13	18.25
Clinical	Air conduction	15.42	5.06	21.17	6.30	42.75	38.50
	Bone conduction	16.03	2.61	22.44	2.91	19.08	9.70

Table 3. t- values, significant level and degrees of freedom between VEMP parameters obtained through air and bone conduction mode

VEMP results	t- value	df	p
p13 latency	4.11	60	0.000
n23 latency	1.331	60	0.188
Peak to peak amplitude	12.24	60	0.000

The results revealed no significant difference between air conducted and bone conducted VEMP for latencies and peak to peak amplitude (Table 4).

Table 4. z - values and significant level obtained between air conducted and bone conducted VEMP in clinical group

VEMP	Z - value	p
p13 latency	0.365	0.715
n23 latency	0.365	0.715
Peak to peak amplitude	1.461	0.144

Comparison across groups for air conducted VEMP: It is evident from the table 2 that the mean latencies of p13 and n23 were prolonged in clinical group compared to control group. The mean peak to peak amplitude was reduced for clinical group compared to that of control group. In order to statistically verify these findings, Mann – Whitney test was administered.

Table 5. showing/ z/ values and significance level

VEMP	Z - values	p
P13 latency	0.036	0.971
N23 latency	1.125	0.261
Peak to peak amplitude	1.912	0.056

It can be observed that there is no statistically significant difference between mean latencies of p13, n13 and peak to peak amplitude elicited through air conduction mode between control and clinical groups (Table 5).

Comparison across groups for bone conduction VEMP: The mean latencies of p13 and n23 are prolonged in the clinical group compared to that of control group (Table 2). The mean peak to peak amplitude was reduced in clinical group. Mann – Whitney test was administered to find any significant difference between the groups.

Table 6. z- values and significant level of bone conducted VEMP parameters between the groups

VEMP results	Z - value	Significance level
p13 latency	3.25	0.001
n23 latency	2.897	0.004
Peak to peak amplitude	4.044	0.000

The results of suggest that latencies of p13 and n23 are significantly prolonged. Peak to peak amplitude obtained in clinical group was significantly reduced (Table 6).

Relationship between VEMP results and duration of otitis media: One of the aims of the present study was to find out the effect of duration of otitis media on VEMP in the clinical group. Details about presence or absence of VEMP and duration of otitis media are listed in the Table 7.

It is clear from the table that a specific trend could not be observed with regard to VEMP results and duration of otitis media. In order to find the relationship between duration of otitis media and VEMP findings, Spearman's rank correlation test was administered for bone conducted VEMP. Statistical analysis on air conducted VEMP could not be done as the number of subjects who had air conducted VEMP was less. The results indicated no significant correlation between the VEMP findings and duration of otitis media.

Relationship between degree of hearing loss and VEMP results: Another aim of the present study was to find out the correlation between VEMP findings and degree of hearing loss. Details regarding the presence or absence of VEMP and degree of hearing loss are given in the Table 9.

It is evident from the table that air conducted and bone conducted VEMP were present only when degree of hearing loss was less. Spearman's rank correlation test was carried out to find the correlation between degree of hearing loss and bone conducted VEMP. The test results did not show any significant correlation (Table 10).

Table 7. Presence or absence of VEMP and duration of otitis media

No of subjects	AC		BC		Duration
	Right	Left	Right	Left	
1	A	A	P	P	6.00
2	A	A	P	P	5.00
3	A	A	P	P	9.00
4	A	A	P	P	6.00
5	A	A	A	A	12.00
6	A	A	A	P	5.00
7	P	A	P	P	10.00
8	A	A	A	A	15.00
9	A	A	P	P	10.00
10	A	P	P	P	5.00
11	A	A	P	P	10.00
12	P	A	A	P	13.00
13	A	A	A	A	7.00
14	P	A	P	P	10.00
15	A	A	A	A	8.00
16	A	A	P	P	6.00
17	A	A	P	P	5.00
18	A	A	P	P	16.00
19	A	A	A	P	15.00

Table 8. r – values and significant level between bone conducted VEMP parameters and duration of otitis media

Parameters	r - value	p
p13 latency	0.15	0.959
n23 latency	-0.314	0.270
Peak to peak amplitude	-0.413	0.127

Table 9. Presence or absence of VEMP and degree of hearing loss

No of Subjects	AC		BC		Pure tone average in	
	Right	Left	Right	Left	Right	Left
1	A	A	P	P	40.00	41.66
2	A	A	P	P	38.33	41.66
3	A	A	P	P	45.00	31.66
4	A	A	P	P	40.00	51.66
5	A	A	A	A	48.33	36.66
6	A	A	A	P	55.00	35.00
7	P	A	P	P	33.30	50.00
8	A	A	A	A	58.30	45.00
9	A	A	P	P	36.60	30.00
10	A	P	P	P	48.33	38.33
11	A	A	P	P	31.60	28.33
12	P	A	P	A	25.00	56.66
13	A	A	A	A	46.66	45.00
14	P	A	P	P	38.33	45.00
15	A	A	A	A	51.66	55.00
16	A	A	P	P	41.66	28.33
17	A	A	P	P	35.00	38.33
18	A	A	P	P	41.66	31.66
19	A	A	A	P	36.66	33.30

Table 10. r- values and significant level between VEMP results and degree of hearing loss

Parameters	r- value	p
p13 latency	0.345	0.205
n23 latency	0.310	0.261
Peak to peak latency	-0.03	0.914

Discussion

Air conduction: The result obtained from the present study reveal that the percentage of occurrence of air conducted VEMP in control group was 100% which is in par with the literature. Sheykholeslami et al. (2000) also studied air conduction VEMP in normal individuals and reported 100% occurrence of VEMP in normal individuals.

The occurrence of air conduction VEMP in clinical group was 10.52%. The relatively less percentage of occurrences of air conducted VEMP in clinical group could be attributed to the degree of conductive hearing loss. As the degree of conductive hearing loss increased, the attenuation to acoustic signal also increased hence limited amount of sound reached the inner ear which might not be sufficient to evoke a VEMP in the stimulated ear. A study conducted by Wang, Liu, Yu, Wu and Lee (2009) on VEMP in individuals with chronic otitis media revealed that as the air bone gap decreased the percentage of occurrence of air conducted VEMP also increased from 41.7% to 66.7%.

So it can be concluded that the middle ear pathology due to chronic otitis media could delay and reduce the energy transfer of sound to the inner ear, resulting in absent or abnormal VEMP.

In the control group, the mean latency of p13 and n13 were 13.54 ± 1.62 and 20.06 ± 1.21 respectively. The results of Sheykholeslami et al. (2000) also showed similar results. The mean latencies for p13 and n23 were 14.74 ± 2.6 and 23.41 ± 4.00 respectively.

The mean latency of p13 was 15.42 ms with a standard deviation of 6.30 and 21.17 ms with a standard deviation of 5.06 for n23 in the clinical group. The variations among individuals were very high as evident from the values of standard deviation. Wang and Lee (2007) studied air conducted VEMP in ears with middle ear effusion and found that the mean latency of p13 was 16.59 ms and the mean latency for n23 was 23.89 ms. Hence, it is clear that both the studies showed similar findings.

The mean peak to peak amplitude in the control group was 90.5μV. Welgampola, Rosengren, Halmagyi, and Colebatch (2003) also found similar results in normal individuals. The mean peak to peak amplitude was 72.5 ± 46.8μV with a range of 25 to 297 μV.

The mean peak to peak amplitude for air conducted VEMP in the clinical group was 42.75 μV with a standard deviation of 38.50μV which is similar to findings obtained by Wang and Lee (2007). The mean peak to peak amplitude obtained in their study was 65.39μV / with a standard deviation of 28.2μV in individuals with middle ear effusion. This increased up to 85.49μV with a standard deviation of/ 47.5μV after surgery for middle ear effusion. The relative reduction in peak to peak amplitude, compared to normal ears could be due to the attenuation and delay of sound energy caused by otitis media.

The clinical group had prolonged mean latencies and reduced peak to peak amplitude. This finding is similar to that obtained by Wang and Lee (2007). They compared normal ears and ears with middle ear effusion. Their results indicated that there exists a significant difference between the two groups. The mean latencies of p13 and n23 get prolonged and the mean peak to peak amplitude reduces in ears with middle ear effusion.

In the present study, statistical analysis could not find a significant difference between the groups and this may be attributed to the less number of ears that were considered for statistical analysis. Only four ears had air conducted VEMP responses, and this data was compared with 70 normal ears.

Bone conduction: The percentage of occurrence of bone conducted VEMP was 87.14% in the control group. The percentage of occurrence of bone conducted VEMP was less in the present study compared to a 100% occurrence obtained by Miyamoto, et al. (2006). The possible reason could be the difference in transducer used in both the studies. Radio ear B71 bone vibrator was used in the current study where as it was BR- 41; Rion, Japan used in study by Miyamoto, et al. (2006), which could be a better transducer to elicit bone conducted VEMP.

The percentage of occurrence of bone conducted VEMP in the clinical group was 71.05 %. This is similar to the findings of Seo et al. (2008). They had also reported that percentage of occurrence of bone conducted VEMP was less in ears with chronic otitis media which was 40 % compared to 100 % in normal ears. The reason for low percentage of occurrence of bone conducted VEMP in individuals with otitis media could be the saccular dysfunction due to chronic otitis media. The current study had higher percentage of occurrence than Seo et al. (2008). This could be due to a difference in subject selection criteria. All individuals in the present study had normal bone conduction thresholds where as in the study by Seo et al. (2008) involved individuals having abnormal bone conduction thresholds also. Sheykholeslami, Murofushi, Kermany and Kaga. (2000) reported in their study that bone conducted VEMP had poor wave morphology compared to air conducted VEMP which is observed even in the present study for both control and clinical group.

The mean latencies for p13 and n23 for bone conducted stimuli were 14.43ms and 20.45ms respectively for the control group. This is in consonance with the results obtained by Sheykholeslami, et al. (2000) for bone conducted VEMP in normal individuals. They observed 12.98 ms as the mean latency for p13 with a standard deviation of 1.34 ms and 20.00 ms mean latency with a standard deviation of 2.36 ms for n23.

The mean latencies for bone conducted p13 and n23 in the clinical group were 16.03mses and 22.44 ms respectively in the present study. Seo et al (2008) also studied bone conducted VEMP in ears having chronic otitis media and the mean latencies obtained were 14.39 ms and 24.49 ms for p13 and n23 respectively.

The mean peak to peak amplitude obtained from control group was 34.13μV with a standard deviation of 18.25μV. The peak to peak amplitude obtained was relatively less in the current study compared to results obtained by Sheykholeslami, et al. (2000) which was 158.48μV. The variation in the results could be due to the higher intensity (77 dBnHL) used by Sheykholeslami, et al. (2000), compared to 66 dBnHL used in the current study. Another reason could be the difference in transducer used in both the studies.

The mean peak to peak amplitude for bone conducted VEMP in the clinical group was 19.08 μV with a standard deviation of 9.70 μV which is significantly less than that of control group. This finding is in support with the findings of Seo et al (2008). They found that the mean peak to peak amplitude in individuals with chronic otitis media was lower than that was obtained in normal ears. The possible reason for reduced peak to peak amplitude in ears with otitis media could be the damage that has taken place at the saccule due to chronic otitis media. Seo et al.(2008) also discussed the saccular dysfunction in ears with chronic otitis media which would result in reduced peak to peak amplitude in bone conducted VEMP.

Degree of conductive hearing loss and VEMP

Air conduction: A general trend which could be observed in the mean latencies and peak to peak amplitude was that occurrence of air conducted VEMP reduced as the degree of hearing loss increased. This finding is in agreement with that of Wang, Liu, Yu, Wu and Lee (2009). They also reported a similar trend, as the degree of conductive hearing loss increased occurrence of air conducted VEMP diminished. The possible reason could be attenuation and delay of the sound energy reaching to the inner ear due to the conductive hearing loss.

Bone conduction: The results of the present study reveal that there exists a correlation between them which are not significant statistically. The mean latencies of p13 and n23 was prolonged with increasing degree of hearing loss whereas the mean peak to peak amplitude decreased with increasing degree of hearing loss. Seo et al (2008) found that the occurrence of bone conducted VEMP was reduced in ears with otitis media. Occurrence of bone conducted VEMP was 40% in ears with otitis media compared to 100% in normal ears. Their study did not attempt to find a correlation between degree of hearing loss and bone conducted VEMP parameters.

Duration of otitis media and bone conducted VEMP

The results suggest that the peak to peak amplitude has a negative correlation with duration of otitis media. This indicates that the mean peak to peak amplitude reduced as the duration of otitis media increased. But this correlation is not statistically significant. These results are similar to that obtained by Seo et al (2008). Their findings indicated that complaints of disequilibrium were more in individuals who had chronic otitis media for a mean duration of 29.09 years with a standard deviation of 23.3 years. As the literature clearly shows that chronic otitis media can cause damage to otic capsule (Paperella et al, 1970), involvement of saccular dysfunction may be suspected in such cases (Seo et al, 2008). The results of the present study, in agreement with previous studies (Seo et al, 2008; Sheykholeslami, et al. (2000)) suggest that bone conducted VEMP may be used as a clinical tool to evaluate the functioning of vestibular system (saccule/ inferior vestibular nerve) in individuals with otitis media, and the degree of hearing loss and duration of otitis media may be factors affecting the VEMP findings.

Conclusions

This study helped to understand that (1) bone conduction mode can be used to record VEMP effectively, (2) The bone conduction VEMP is useful to assess the saccular function in subjects with conductive hearing loss, (3) Saccular function needs to be evaluated in individuals with chronic otitis media, (4) Provides information regarding the effect of duration of middle ear effusion and severity of hearing loss on vestibular system, (5) Adds information, to the literature related to effects of chronic otitis media.

Future studies could aim to involve more number of subjects and find, if there is any statistical significant relationship between duration of otitis media and VEMP findings. The present study involved subjects who had normal bone conduction thresholds in the clinical group. A future research could be aimed to record bone conducted VEMP in subjects with otitis media having poor bone conduction threshold in pure tone audiometry.

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