Comparison between cervical vestibular evoked myogenic potential response in normal children and adults

Original Article

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ABSTRACT

Objective: Vestibular-Evoked Myogenic potential (VEMP) is a non invasive test for vestibular function. It is a series of electrical waves that are generated by vestibular pathway in response to loud acoustic stimulation. It can be recorded from surface electrodes placed over muscles and according to the site of recording there are two types cervical VEMP and ocular VEMP. The primary goal of the present study is to compare cervical evoked myogenic potential (cVEMP) findings in normal hearing children and adults.

Materials and Methods: This study included 60 subjects of normal hearing. They were selected from relatives; friends and relatives of patients attending Audiology Unit of Alzahraa University Hospital. 30 were children in the age range of 5-15 years and 30 were adults in the age range of 20-40 years. All subjects were submitted to cVEMP (air-conducted sound). Amplitude, latencies, asymmetry amplitude ratio and threshold were measured.

Results: There was statistically significant difference in latencies and amplitudes and no statistically significant difference in asymmetry ratio of cVEMP responses between children and adults. There was no statistically significant difference in threshold between right and left ears in adult and children but there was statistically significant difference between the two groups as regard cVEMP threshold.

Conclusion: cVEMPs responses in children have shorter latencies and lower thershold than adult responses, which should be considered in interpretation of cVEMP responses in children. Normative data for different age groups should be collected as cVEMPs responses, as age has a significant effect on them.

Key Words: Adults, children, cVEMPs

Received: 14th April 2019**, Accepted:** 07th September 2019

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ISSN: 2090-0740, November 2019 Vol.20, No.3

INTRODUCTION

VEMP response is an evoked potential which consist of an initial positive wave (P1) followed by negative wave (N1). Although P1 is positive, it is shown negative on many VEMPs. The purpose of the VEMP test is to determine if the saccule, one portion of the otoliths, as well the inferior vestibular nerve, vestibular nuclei, lateral and medial vestibulospinal tracts and central connections are intact and working normally[1].

The saccule, which is the lower of the two otolithic organs, has a slight sound sensitivity and this can be measured. This sensitivity is thought to be a remnant from the saccule's use as an organ of hearing in lower animals[2, 3].

VEMP is a series of electrical waves that evaluate vestibule-collic reflex including the vestibulo-spinal tract in response to loud acoustic and vibration stimulation. It is evoked by air, bone or galvanic stimulation[4].

Sternocleidomastoid (SCM) contraction is necessary during testing as the response is sought to be a brief inhibition or relaxation of this contraction in response to the high intensity acoustic stimulus. The higher the level of muscle contraction, the larger the response[5].

Studied VEMP in children 3 to 11 years old with clicks at 90 dB by[7] and reported that P1 peak was at a mean 11.3 msec with N1 peak at 17.6 msec. While in the study by[4], they described P1 peak at 13 msec and N1 peak at 23 msec.

cVEMP has been extensively studied in adults with significant benefit in characterizing superior canal dehiscence syndrome, vestibular neuritis, Meniere's disease and failed vestibular nerve section. In contrast, VEMP testing in children has been limited and controversial. Obtaining VEMP parameters in children provides further information for pediatric normative VEMP data. So this study is conducted to compare children to adults regarding cVEMP parameters.

 DOI: 10.21608/ejentas.2019.11952.1100

MATERIALS AND METHODS

This study was performed in the Audiology Unite of Alzahraa University Hospital in the period from September 2016 to December 2017 with 60 subjects. They were divided into two groups; the children group consisted of 30 children in the age range of 5-15 years (not below 5 years because of poor reliability of children below this age to maintain neck muscle contraction in used technique) and young adults group consisted of 30 young adults in the age range of 20-40 years (over 40 years old will be another age group). Both groups were selected from relatives; friends and relatives of patients attending Audiology Unit of Alzahraa University Hospital.

Both groups had bilateral normal peripheral hearing threshold, (did not exceed 25 dB in adults and did not exceed 15 dB in children at the frequency range of 250-8000 Hz), normal middle ear function as evidenced by tympanometry and acoustic reflex threshold. Subjects with very low thresholds of Bone conducted thresholds, history of ear disease, noise exposure , ototoxic drugs intake, complaing of dizziness or history of vestibular disorders and complaing of any neurological such as Migraine or muscular disease were excluded.

All subjects were submitted to Full history taking, Otologic examination, Basic audio logical evaluation in the form of Pure tone audiometry and speech audiometry using Two channel audiometer (Interacoustics, model AC 40), Immitancemetery using MAICO model MI44and Vestibular evoked myogenic potentials (VEMPs) using Evoked potential measuring system (Interacoustics Eclips model EP 25).

Sitting with neck rotation is the used technique for recording cVEMP. The subjects were instructed before cVEMP recording to rotate their heads to the opposite side of the stimulated ear as much as possible such that the lateral part of the chin was in line with the acromioclavicular joint to activate ipsilateral SCM. SCM muscle contraction monitored by Patient EMG Monitor. Skin was cleaned with an alcohol soaked cotton pad, afterwards electrodes must be fixed with adhesive tape. Reference electrodes were placed on midpoints of each sternomastoid muscle (negative or inverting electrode) with positive or non inverting electrode on sternum, ground electrode was placed on the forehead. The electrode impedance was kept under 5 KΩ. cVEMP was recorded first from Rt ear using 500 Hz tone burst at 95 dB nHL intensity delivered by an insert receiver with rise/fall time 2 msec and plateau 1msecm,repetition rate was 5/sec. 200 stimuli were presented for each recording with a window of 80 msec and band pass filter 10 Hz and 1000 Hz (Manufacture manual of Interacoustic Eclips model EP 25).

Statistical analysis

Data were analyzed using Statistical Program for Social Science (SPSS) version 20.0. Quantitative data were expressed as mean ± standard deviation (SD). Qualitative data were expressed as frequency and percentage. Student T Test was used to assess the statistical significance difference between two study group means. Chi-Square test was used to test categorical variables. Probability (*P*-value) *P*-value <0.05 was considered significant. *P*-value < 0.001 was considered as highly significant.

RESULTS

Age and gender distribution in both adults and children groups (Table 1). VEMP recorded from all tested ears in children and adults (Figure 1 and 2). Mean and standard deviation for cVEMP results in adults group (Table 2). Mean and standard deviation for cVEMP results in children group (Table 3). There was statistically significant difference in latencies and amplitudes and no statistically significant difference in asymmetry ratio of cVEMP responses between children and adults (Table 4). There was no statistically significant difference in threshold between right and left ears in adult and children but there was statistically significant difference between the two groups as regard cVEMP threshold in both ears (Table 5).

Table 1: Age and gender distribution in both adults and children groups

Demographic Data	Group (I): Adults (No: 30)	Group (II): Children (No: 30)
Age (years)		
Mean±SD	29.95 ± 5.63	9.60 ± 3.12
Range	20-40	5-15
Gender		
Male	17 (56.6 %)	15 (50 %)
Female	13 (43.4 %)	15 (50 %)

Table 2: Mean and standard deviation for cVEMP results in adults group

Group (I): Adults	Mean	±SD
Latency P1	15.93	2.56
Latency N1	24.98	2.34
P1- N1amplitude	74.68	19.61
Asymmetry ratio	2.823	8.89

Table 3: Mean and standard deviation for cVEMP results in children group

Group (II): Children	Mean	±SD
Latency P1	13.51	2.21
Latency N1	21.14	2.54
P1-N1 amplitude	63.03	11.34
Asymmetry ratio	7.10	11.93

Table 4: Comparison between adults and children according to cVEMP latency and amplitude

	Adults Group (I):	Children Group (II):	t-test	*P*-value
P1 Latency (ms)	15.93 ± 2.56	13.51 ± 2.21	4.528	< 0.001
N1 Latency (ms)	24.98 ± 2.34	21.14 ± 2.54	7.032	<0.001
P1-N1amplitude (µv)	74.68 ± 19.61	63.03 ± 11.34	3.532	<0.001
Asymmetry ratio	2.823±8.89	7.10±11.93	1.746	0.085

Table 5: Mean and standard deviation for cVEMP results in children group

Threshold	Group (I): Adults	Group (II): Children	t-test	p-value
Right	75.00 ± 5.13	72.11 ± 1.83	3.356	0.002
Left	76.00 ± 5.13	71.75 ± 1.83	4.935	<0.001
t-test	0.445	0.851		
***p*-value**	0.532	0.403		

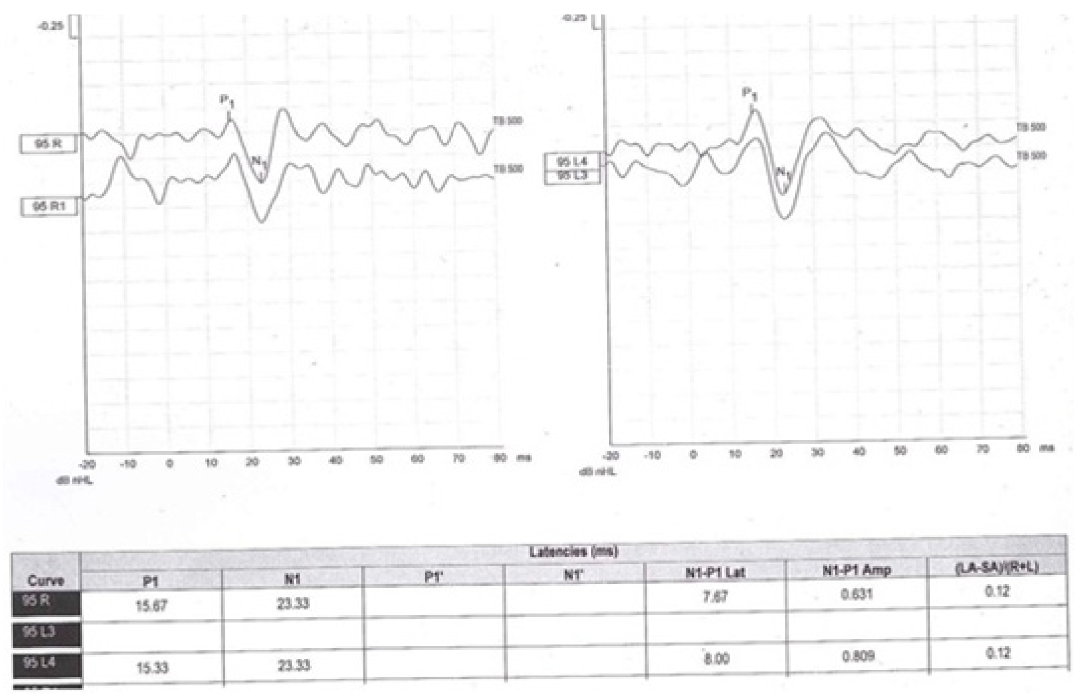
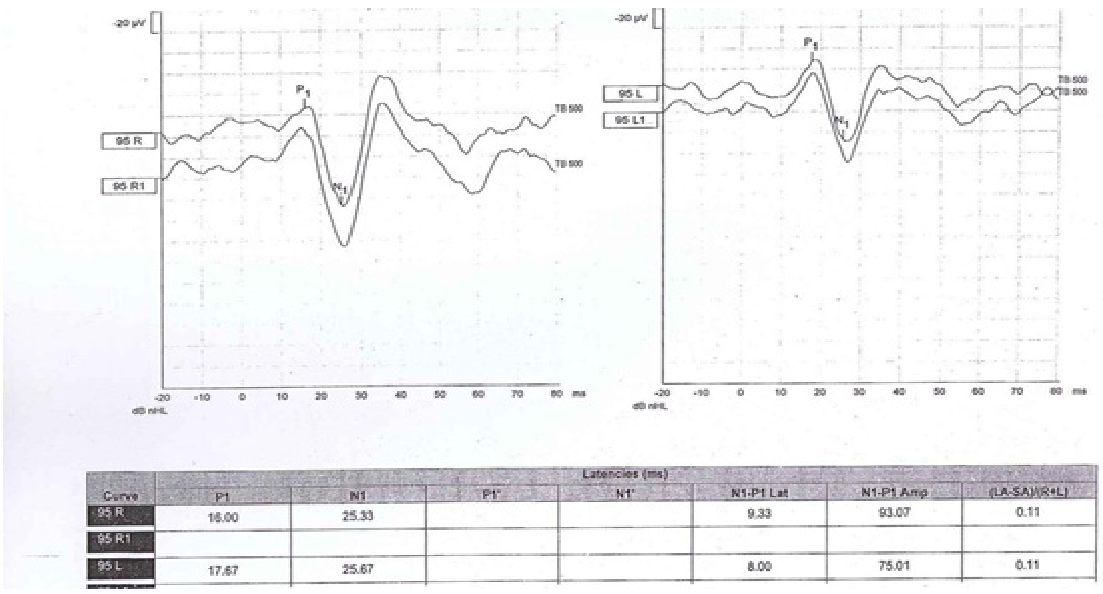


Fig. 1: Example of normal VEMP response in 12 years old child.



Curve	P1	N1	P1'	N1'	N1-P1 Lat	N1-P1 Amp	(LA-SA)/(R+L)
95 R	16.00	25.33			9.33	93.07	0.11
95 R1							
95 L	17.67	25.67			8.00	75.01	0.11

Fig. 2: Example of normal VEMP response in 25 years old adult.

DISCUSSION

In the current study, reproducible VEMP traces were successfully recorded with 500 Hz tone burst at 90 dBnHL in all subjects when either the right or the left ears was stimulated. In the current study, the mean value of wave P1 and N1 latencies (Table 2) were 15.93 ± 2.56 and 24.98 ± 2.34 respectively These values agreed with[6,19,5,16,26] who reported similar mean value of wave P1 and N1 latencies recorded by 500 Hz tone burst stimuli presented at 95 dBnHL to the ears of adults with normal vestibular function.

In the present study the mean of P1-N1 amplitude was 74.68 ± 19.61 µV (Table 2). These results agreed with[21,6] in a matched age group to the same frequency. They reported that P13N23 peak to trough amplitude to be 66.6 µV, 67.1 µV (± 40.2) respectively. There is wide variability in P13-N23 amplitude between subjects[22], so amplitude asymmetry ratio is used for clinical decision making, particularly when determining the site of lesion (right or left saccule). If the amplitude on one side is three times larger than the other side, it would be indicative of significant vestibular asymmetry[23].

In the current study asymmetry ratio was 2.823 ± 8.89 in adult group which is considered normal. According to[24], asymmetry ratio should exceed 34 % to be pathological. This agree with[25], who found that the mean asymmetry ratio for 95 dB as 12 ± 8.1 %.

In the current study, the mean value of wave P1 and N1 latencies in children group were 13.5±2.21 ms and 21.14 ± 2.54 ms respectively. P1-N1 peak to trough amplitude was 63.03±11.34 (Table 3).These values agreed with [7, 8, 9, 14 and 26]. In the present study asymmetry ratio was 7.10±11.93 in children group which is also considered normal.

Comparison of children data with adult norms as regard VEMP, revealed significantly shorter *P*1 and N1 latencies for children (Table 4). The earlier appearance of latency values in children populations agree with the data reported by[8, 7, 9].

[8]Reported that the mean value of wave P1 and N1 latencies in children were shorter than adults and[7] reported that the mean value of wave P1 and N1 latencies in young children aged from 3 to 11 years were 11.3 ms and 17.6 ms respectively. [9]Studied cervical vestibular myogenic in children, they reported that, P1 latency and N1 latency in fewer 10 years children were shorter than adults. The current study also agreed with findings of[24] related the effect of age on VEMP in 70 normal subjects' ages 25 to 85 years and found significant increase in the N1 peak latency with age.

This significant difference between adult and children as regard latencies and amplitude of VEMP could be explained by structural differences such as neck length and head size, by differences in conduction velocities or immature inhibition of the reflex pathways[8, 11, 12].

In the current study comparison of children data with adult norms as regard P1-N1 peak to trough amplitude, revealed also that P1-N1 peak to trough amplitude was smaller in children than adults (Table 4).

These results agree with[13]. They studied cervical vestibular myogenic in children aged 8-13 years without otoneurologic complaints, they found that increasing age was accompanied by a significant increase in peak P1 and N1 amplitudes. These results disagreed with[27], who compared pediatric data with adult norms; they found significantly larger interpeak amplitudes for children than adults. They explained larger amplitude measured in children on the base of the inverse relationship of subcutaneous muscle thickness to raw amplitude as described by[11]. Moreover[15], did not report any age differences for normalized amplitude values. This difference from the current study could be attributed to different testing protocols and equipment.

Comparison asymmetry ratio in children with adults group showed no statistical significant difference although it was noted to increase in children than adults (Table 4) this agreed with [25] who found no statistical significant difference in asymmetry ratio between different age groups.

In the current study, there was statistical significant difference between adult and children as regard VEMP thresholds (Table 5). VEMP threshold in adults was 75.00 dBnHL ±5.13. This agreed with[16]. They reported that VEMPs thresholds in adults ranged from 75 to 85 dBnHL for 500 Hz tone burst. Also[5] reported that VEMPs thresholds in adults were 78 (±7) dB.

In children VEMP threshold was 72.11±1.83 (*P*=0.002).This means cVEMP thresholds increases with an increase in the age (Table 5). This result agree with[17] who found children (4-9 years) had significantly lower thresholds compared with adults (age 20-29) for cVEMP (500 Hz: *P*=0.002. This result agreed also with[18] and[19] who found a significant correlation between age and the evoking threshold of the VEMP. They concluded that the correlation between age and the threshold of the VEMP is presumably secondary to age-related functional changes in the sensory and neural elements of the VEMP. It may be due to hair cell loss of the otolith organ. Also significant correlation between vestibular evoked myogenic potential (VEMP) threshold and age was reported by[20].

CONCLUSION AND RECOMMENDATION

cVEMPs responses in children have shorter latencies and lower threshold than adult responses, which should be considered in interpretation of cVEMP responses in children. Normative data for different age groups should be collected as cVEMPs responses, as age has a significant effect on them.

CONFLICT OF INTEREST

There are no conflict of interest

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