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Comparison of Vestibular Evoked Myogenic Potential and Dizziness Handicap Inventory in Patient with Peripheral Vestibular Lesions between Pre and Post Vestibular Rehabilitation

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ABSTRACT

Aim and objective: VEMP is brief latency electromyography and is elicited by a high-intensity auditory stimulus. The aim of the current study was to compare VEMP and DHI in patients with peripheral vestibular lesions between pre and post vestibular rehabilitation.

Method: A total of 30 participants with peripheral vestibular lesions were considered, among which 15 were given vestibular rehabilitation, and 15 were not given vestibular rehabilitation. The participants were subjected for cVEMP, oVEMP, and DHI testing before and after vestibular rehabilitation.

Result: The latency and peak to peak amplitude measures showed no major difference among the training phase and between training and group for both cVEMP and oVEMP responses. However, the DHI scores were found to be significantly improved after vestibular training in the participants with dizzness. The above findings explain that even in the presence of peripheral vestibular lesion, symptomatic relief from vertiginous symptoms is possible.

Conclusion: These were inculcated by vestibular rehabilitation prompted vestibular compensation. Vestibular rehabilitation should be practiced among individuals with peripheral vestibular lesions, irrespective of age.

Keywords: VEMP; vestibular rehabilitation; peripheral vestibular lesion.

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INTRODUCTION

The vestibular system, an inevitable part of the inner ear which plays an essential role in maintaining bodily equilibrium[1]. Vestibular dysfunction is one of the major problems affecting the individuals, which impedes the functioning level and impairs the quality of life to a great extent[2]. The individual with vestibular dysfunction exhibits postural unsteadiness, blurring of vision with the movement of the head, and independent complaints of imbalance. Vestibular lesions are classified into, peripheral vestibular lesions and central vestibular lesions. The lesions within the end organs of the inner ear or the eighth nerve result in peripheral vestibular pathologies. The interruption in the pathways connecting and coordinating CNS and vestibular system causes central vestibular pathologies[3]. VEMP testing is a non-invasive method to access the vestibular system using higher level acoustic stimuli. Accordingly, one of the reliable procedure for clinical investigation of myogenic potential is to evaluate click-evoked vestibule-collic reflex[4]. The VEMP responses can be acquired from sternocleidomastoid muscle (SCM) are known as cervical (cVEMP)[5]. The cVEMP pathway includes saccule, inferior vestibular nerve, vestibular nucleus, medial and lateral vestibulospinal tract to the ipsilateral SCM muscle[6]. The VEMP responses acquired from extra-ocular muscles known as ocular (oVEMP)[7]. The oVEMP signifies arousal of the extra-ocular muscles through stimulation of vestibulo-ocular pathways. The oVEMP response follows a crossed pathway where stimulating specific ear activates contralateral extra ocular muscles[8]. Dizziness Handicap Inventory (DHI) is one of the reliable and valid measures of self- perceived postural instability or balance issues[9]. There are mainly 25 items with three subscales physical, emotional and functional. In each subscale there are certain statements. These subscale scores can be used to track the progress of dizziness as well[10]. Vestibular Rehabilitation (VR) is an effective treatment in reducing vertigo. The primary goals of VR are to promote visual stabilization, refine static and dynamic balance, reduce the sensitivity during head movement, and overall function of the patient via proprioceptive as well as vestibular visual stimulation maneuvers[11]. Vestibular rehabilitation is one of the powerful methods which enable to regain balance in a patient with vestibular dysfunction especially pertaining to peripheral vestibular dysfunction[12]. Randomized control study results came out with the evidence suggesting that VR exercises are effective in improving postural control, in individuals reported of dizziness symptoms, and emotional status with nonspecific causes[13]. VR is considered one of the safe and effective management for peripheral vestibular lesion[14]. There are literatures which reports VEMP findings in patients with otolith dysfunction in pre and post vestibular rehabilitation. The result revealed that the VEMP findings worsened after vestibular rehabilitation especially whose DHI score was more than forty[15]. Literature had reported that no significant influence on otolith dysfunction after vestibular rehabilitation, and patients with only otolith dysfunction did not show any improvement with respect to symptoms severity, self-perceived handicapped and balance performance after vestibular rehabilitation[16]. There are evidences which explain an improvement in DHI after vestibular rehabilitation in peripheral vestibular disorder[11,17-19]. Hence this study was taken to see that in case of peripheral vestibular lesion is there any change after vestibular rehabilitation using the outcome measures such as VEMPs and DHI. The aim of the current study was to compare VEMP and DHI in patients with peripheral vestibular lesions between pre and post vestibular rehabilitation.

MATERIALS AND METHODS

The research was oriented towards exploring the prognostic importance of Vestibular Evoked Myogenic Potential and Dizziness Handicap Inventory by comparing the responses as well as scores obtained during pre and post vestibular rehabilitation. The study began after the reception of approval notification from the Institutional Human Research Ethical Committee and all participants were enrolled with informed consent. A total of 30 participants with peripheral vestibular lesions (Meniere's disease/Vestibular neuritis/ labyrinthitis) were taken for this study. All the participants were diagnosed by the otolaryngologist. The study comprised of two groups, a control experimental. The individuals with peripheral vestibular dysfunction who took an active part in VR and were added to the experimental group. Among the disordered population who has taken passive VR were considered under control group. In each group, 15 participants were taken with both males and females, within an age range of 18 to 60 years. Individuals with orthopedic disorders with restricted movements of limbs, central vestibular lesion, and middle ear pathology were excluded from the study. A calibrated GSI 61 clinical audiometer was used to evaluate hearing assessment. To see the status of middle ear calibrated GSI tympstar immittance was used. Intelligent Heraing system with electrically shielded Ear-tone ER- 3A insert earphones were cast to record and analyze cVEMP and oVEMP. DHI was administered in all the participants.

cVEMP Testing: The participants were seated in an erect relaxed position with non-inverting electrode placed on the mid-portion of sternocleidomastoid muscle bulk adjacent to the test ear, inverting electrode over the sternoclavicular junction and ground electrode was over the forehead. 500Hz tone burst with 8ms duration was presented monaurally at a stimulus intensity level of 105dBnHL with ER-3A Insert earphones. A total of 200 sweeps of rarefaction stimuli were presented at a repetition rate of 5.1/sec. The electromyographic signals were amplified 5,000 times and band pass filtered between 30 and 1500Hz. The time window for the recording was 60ms post-stimulus and -10ms pre-stimulus. The tonic muscle contraction was monitored from 50 to 150μV throughout

the recording using integrated visual feedback software. By providing visual feedback to the participant, the software ensured that sufficient muscle contraction was achieved throughout the testing. The biphasic wave with a Positive (P1) and a subsequent Negative (N1) peaks were recorded to determine the latency and peak to peak amplitude for bilateral responses.

oVEMP testing: Participants were seated in an upright relaxed position. The non-inverting electrode placed beneath the eye and the inverting electrode is placed 1-2cm below the non-inverting electrode over the cheek, contralateral to the ear being tested along with forehead on ground electrode. oVEMP was documented from the contraction of the contralateral extra-ocular muscle. A tone burst of 500Hz (8ms duration) at a loud stimulus level of 105dBnHL was presented monaurally to each ear with ER-3A insert earphone. Responses from 200 stimulus sweeps were averaged. A time window of 70ms (pre-stimulus -10ms & post-stimulus 60 msec) and the repetition rate of 5.1/sec was incorporated. The amplification provided for the EMG signals were about 50,000 times, band pass filtered between 1-1000Hz. Approximately >2m distance from the eyes, participant was requested to fix a target of 30-35 degree above the horizontal. The recording was initiated and the initial biphasic wave with a negative (n1) peak followed by a positive peak (p1) was used to determine the latency and peak to peak amplitude for bilateral responses.

Dizziness Handicap Inventory: An internationally validated tool, invented by Jacobson and Newman in 1990, which was administered on participants who were, satisfied the inclusion criteria offered in this study. DHI is a subjective measure of the patient's perception of handicap due to dizziness. This questionnaire checks the three aspects physical, emotional and functional. The patient was prompted to give responses such as "Yes" if the symptom present always, "sometimes" if the symptom present occasionally, and if it was absent the patient was obliged to give "No" as a response. The "Yes" responses were rewarded with 4 points, "sometimes" responses were rewarded with 2 points and "No" were rewarded with zero points. The top score is 100 suggestive of maximum perceived disability, the bottom score is 0 suggestive of no perceived disability. A score of 16-24 suggest mild handicap, 36-52 suggest moderate handicap, and 54 above suggest severe handicap[20].

Vestibular Rehabilitation Therapy (VRT): VRT administered after the first VEMP (pre-VEMP) recording. VRT consist of exercises augmenting gaze stability such as head turns, head-trunk turns, head turns while walking, exercises for augmenting eye movements such as saccade, imagery pursuit, exercises for augmenting postural stability such as stand with one leg, sway back and forth, stand with one leg crossed, march in place, ankle strategy. Exercises were not given together, starting from gaze stabilization and ending up with postural stability which followed a systematic order. The exercises administered during the first stage were slow in manner. The frequency and the rapidness of the exercises increased as the therapy progressed. The participants were requested to practice VR at home, 3 times per day (morning, afternoon, evening), with a frequency of 10 for each of the exercises, without fail. Gradually the speed of the exercise increased based on the symptomatic relief after one week. Within five follow up most of the exercises were encountered. After 8 weeks of intensive vestibular rehabilitation post-VRT cVEMP, post-VRT oVEMP and post-VRT DHI were recorded.

Statistical Analysis: These obtained data were then tabulated using software SPSS version 16.0. To document any significant differences among the group as well as training phases repeated measures of ANOVA was carried out. In order to verify any substantial differences separately for each group before and after VR, the paired t-test was done.

RESULTS

The pre cVEMP responses were obtained with an average P1 latency of 17.51 ± 1.99ms and post average P1 latency of 17.01 ± 1.68ms for the experimental group. The average N1 latency of 23.36 ± 1.86ms pre and post responses were obtained with an average of 23.63 ± 1.57ms. In the control group, the mean P1 latency for pre cVEMP is 17.17 ± 2.68ms and post responses were 16.87 ± 1.60ms. The average N1 latency of 24.11 ± 2.06ms pre and post response were 23.40 ± 1.83ms. To understand the significant effect on the training phase and also the interaction between training and groups repeated measures of ANOVA was done. The result showed no significant difference obtained for P1 latency measures between the training phase ($F(1,28)=1.127$, $P=0.29$). Neither significant interaction ($F(1,28)=.140$, $P=0.79$) between training and group for P1 latency measures nor significance difference obtained for N1 latency measures between the training phase ($F(1,28)=0.326$, $P=0.57$). And also no major interaction ($F(1,28)=1.57$, $P=22$) between training and groups observed. The average P1-N1 amplitude of pre cVEMP for the experimental group was 25.59 ± 9.97 μV and post mean latency was 29.25 ± 9.73 μV. Average P1-N1 amplitude of pre cVEMP for the control group was 19.41 ± 10.30 μV. The mean P1-N1 amplitude of post cVEMP for the control group was 21.51 ± 5.81 μV. No significant differences obtained between the training phase ($F(1,28)=2.00$, $P=0.16$) as well as no major difference in interaction ($F(1,28)=0.14$, $P=0.70$) for peak to peak amplitude between training and groups in repeated measures of ANOVA. The mean n1 latency for pre oVEMP responses and post oVEMP responses was found to be 12.27 ± 1.13 msec and 11.65 ± 1.19 respectively for the experimental group. The average p1 latency was 16.72 ± 1.03 msec for pre oVEMP responses and 16.98 ± 1.15 msec for post oVEMP responses. In the control group, the mean n1 latency for pre oVEMP

responses was found to be 11.65 ± 1.65 msec and 11.27 ± 1.01 msec for post oVEMP responses. The average p1 latency was 17.12 ± 1.35 msec for pre oVEMP responses and 16.78 ± 0.79 msec for post oVEMP responses. No substantial differences were obtained for n1 latency measures between the training phase ($F(1,28)=3.9$, $P=0.50$) and also there was no significant interaction $F(1,28)=.22$ $P=0.64$) between training and group while comparing pre and post n1 latency using repeated measures of ANOVA. No significant difference obtained for p1 latency measures between the training phase ($F(1.28)=0.01$, $P=0.89$) and also no significant interaction $F(1,28)=1.18$, $P=.28$) between training and groups. In the experimental group, the mean n1-p1 amplitude for pre oVEMP responses was 3.22 ± 2.45 μV and post oVEMP responses were 4.04 ± 1.52 μV. In the control group, the mean n1-p1 amplitude for pre oVEMP responses was 2.98 ± 1.86 μV and post oVEMP responses were 3.18 ± 1.45 μV. On comparing pre and post n1-p1 amplitude using repeated measures of ANOVA, there was no significant difference obtained within the training phase($F(1,28)=1.87$, $P=0.18$). No interaction was evident ($F(1,28)=0.67$, $P=0.42$) between training and groups. In the experimental group the average score for pre and post-DHI total scores were found to be 45.20 ± 25.98 and 17.60 ± 15.36. In the control group the average score for pre and post-DHI total scores were found to be 36.40 ± 19.06 and 33.20 ± 20.23. Repeated Measures of ANOVA showed significant difference obtained for total scores between the training phase ($F(1,28)=26.86$, $P=.00$). A significant difference in total score obtained due to interaction ($F(1,28)=16.85$, $P=00$) between training and group. Paired t-test analysis was done to determine the significant difference in total scores obtained for the control and experimental group. There was a significant difference ($t=5.64$, $P=0.000$) in overall DHI scores between pre and post rehabilitation in the experimental group. There was no significant difference ($t=0.98$, $P=0.359$) in overall DHI scores between pre and post rehabilitation in the control group.

DISCUSSION

The results revealed that no significant difference observed among experimental as well as a control group in terms of cVEMP and oVEMP findings with respect to latencies and amplitude. Similar to the present findings, literature had reported no significant influence on otolith dysfunction after eight weeks of the customized vestibular rehabilitation training program[16]. An improvement in DHI score was observed after rehabilitation in patient with dizziness[15]. An absent cVEMP response was associated with higher post rehabilitation DHI scores. Controversially, no changes in cVEMP and oVEMP after vestibular rehabilitation had been noticed even though the patients were free of symptoms[21]. There was a spontaneous recovery from postural inconstancy in individuals with abnormal VEMPs findings. This indicates that even though an otolith deficit demarcated through an objective test for otolith function, postural stability will be achieved by means of vestibular compensation mediated at the central level. Present work shows improvement in DHI score after 8 weeks vestibular rehabilitation in peripheral vestibular disorder. However, no significant differences in both VEMP tests, which indicate vestibular rehabilitation induces a symptomatic relief from vertiginous symptoms in the presence of constant peripheral vestibular pathology. Incomparable with the present study, an improvement had been reported in self-perceived handicap, symptoms severity and balance functions in individuals with otolith dysfunction[16]. There is a literature report of a significant reduction in DHI scores after vestibular rehabilitation in individuals with vestibular neuritis also[17]. Another study delineated that DHI scores of all domain improved after vestibular rehabilitation in individuals with vestibular paroxysmia[18]. The significant reduction in DHI scores after vestibular rehabilitation was demarcated in individuals with SCDS[22]. There are statements on significant improvement in DHI scores after vestibular rehabilitation in chronic vestibular dysfunction[19]. DHI scores and composite scores of posturography remained poorer with absent cVEMP in moderate to severe group of dizziness[15]. However, improved DHI scores have been reported in normal to mild subjective dizziness patients. Vestibular rehabilitation is considered as one of the safe and effective management for peripheral vestibular lesion[14]. Improvement in DHI scores delineates neurophysiological correlates for compensation achieved through vestibular rehabilitation. The intrinsic pliability of vestibular pathways mediates compensation, which triggers symptomatic relief from vestibular symptoms. Based on changing the environmental input through vision and other senses, the brain (vestibular nuclear complex and cerebellum) recalibrates the stored information regarding body balance, hence achieves vestibular compensation[3]. By determining posturography results, the effect of VRT is scored on different domains to check the recovery from imbalance symptoms in patient with bilateral vestibular dysfunction. Customized VRT programs are more effective than the generic exercises for retaining and stimulating the vestibular system, which is being assessed and stated that scoring before and after the VRT may aid in evaluating the progress in clinical practice[23]. The present study showed no changes in cVEMP and oVEMP response after rehabilitation in both groups, which suggest that the vestibular rehabilitation may be compensated by the central vestibular pathway. However, the peripheral pathway does not change the constituents of the vestibular system. There was an improvement on DHI scores for pre and post-rehabilitation, which indicates vestibular rehabilitation, reduces the dizziness and improve the quality of life in day to day.

CONCLUSION

The DHI scores were found to be significantly improved after vestibular training in the experimental group. The

above findings explain that even in the presence of peripheral vestibular lesion, symptomatic relief from vertiginous symptoms is possible. These were inculcated by vestibular rehabilitation prompted vestibular compensation. Vestibular rehabilitation should be practiced among individuals with peripheral vestibular lesions, irrespective of age.

CONFLICT OF INTEREST

The author declares no potential conflict of interest on publishing this paper.

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