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COMPARISON OF cVEMP IN PRACTITIONERS AND NON PRACTITIONERS OF KALARIPAYATTU

Medical Science

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ABSTRACT

BACKGROUND: Hearing and balance are vital functions that are mediated by our auditory system. Our balance system helps us to walk, run and move without falling and the system is known as vestibular system. If balance problem develops it can cause profound disruptions in our daily life. So it is very important to assess and manage various balance disorders. It is also important to know how traditional practices all over the world our balancing system at different ages.

Aim of the present study was to get an insight into kalaripayattu.

OBJECTIVES OF THE STUDY: 1) To investigate the effects of practicing kalaripayattu on the cVEMP amplitude and 2) to compare the cVEMP amplitude in kalaripayattu practitioners and non practitioners.

METHOD: the study consisted of two groups of 18 participants in each group. cVEMP was obtained from each individual for different types of stimuli and at different intensities to obtain the P1 – N1 amplitude for right and left ear separately. The mean amplitude of the P1-N1 between the groups was calculated.

RESULTS: The responses were recorded at 95dBnHL and 75dBnHL for click stimuli and 500Hz tone burst stimuli for right and left ear separately. The data was subjected to Mann Whitney U test to obtain mean differences at 95% confidence interval. The results indicated higher mean amplitude for both the intensity levels for the group with practitioners of kalaripayattu.

CONCLUSIONS: The study concludes that these practitioners have a well defined and more robust sacculocollic pathway compare to control group.

KEYWORDS

Kalaripayattu, VEMP, Tone burst, Click, Amplitude

INTRODUCTION:

Balance is controlled through signals to the brain from our eyes, the inner ear, and the sensory systems of the body (such as the skin, muscles, and joints). This balance system is known as the vestibular system which is housed in the inner ear. The balance system is controlled by the integration of various senses and also mainly by the peripheral and central vestibular system. The peripheral vestibular system includes the paired vestibular sensory end-organs of the semicircular canals (SCCs) and the otolithic organs. In Central Vestibular System, the Primary vestibular afferents enter the brainstem dividing into ascending and descending branches. Within the brainstem there appears to exist a nuclear region with four distinct anatomic types of second-order neurons called vestibular nuclei namely superior (Bechterew's nucleus), lateral (Deiters'nucleus), medial (Schwalbe's nucleus), and descending (spinal vestibular nucleus).

Our ability to maintain balance is a complex process that depends on three major components:(1) Our sensory systems for accurate information about our body's position relative to our environment.(2) Our brain's ability to process this information and (3) Our muscles and joints for coordinating the movements required to maintain balance. Individuals may feel giddiness or vertigo when the Semicircular Canal or otoliths gets disrupted. Hence it is important to do vestibular assessment to identify the peripheral vestibular problems.

Vestibular Evoked Myogenic Potential (VEMP) is one such test that is obtained from muscles of the neck (or eyes), in response to high level acoustic stimulation. Based on various lines of evidence, it is believed that the VEMP is primarily, if not solely, the result of vestibular end-organ stimulation (likely the saccule and/or utricle). The purpose of the VEMP test is to determine if the saccule, one portion of the otoliths, as well the inferior vestibular nerve and central connections, are intact and working normally.

The *cervical VEMP* (cVEMP) measures a relaxation response in the SCM coincident with presentation of sound or vibration whereas the ocular *VEMP* (oVEMP) measures an activation response from muscles under the eyes and on the forehead. For both types of VEMP testing, clicks and/or tone bursts are introduced via earphones or a bone conduction oscillator. Results of VEMP testing may provide insight into pathologies that affect balance and/or cause dizziness, such as superior semicircular canal dehiscence, vestibular neuritis and Meniere's disease.

VEMP recordings in adults with a normal functioning vestibular system will yield a two component biphasic potential with a peak and a trough. The waveform consists first of a positive peak, relative to the baseline, labeled p13, which has a latency of approximately 13ms. The second component, a negative trough relative to the baseline, labeled n23 has a latency of approximately 23ms. The peak-to-peak amplitude value, which is measured from the positive peak of p13 to the negative peak of n23 varies widely amongst healthy subjects. Research shows a range of 16 to 179microvolts (μV) using a 100 dBnHL click stimuli and a range of 15-337μV when recording VEMPs to a 500 Hz tone burst stimulus presented at an intensity of 90 dBnHL (Akin & Murnane, 2003)[3] and 18.3-137.1 μV at 95 dBnHL (Colebatch et al, 1994)[5].

Balance training is important because proprioception is the body's ability to interpret and use information about our position in space. By training to develop greater balance, we will recognize improvements in coordination, athletic skill, and posture. This in turn will result in fewer injuries and greater stability as we age, which can help prevent falls and keep us both strong and independent longer. Martial arts are one of the main physical exercises that involve fine coordinated and sophisticated activity of the vestibular system which are hypothesized to improve balance system function. Existence of Martial arts in India for over 3000 years can be proved by the mention of martial arts in the Vedas.

Kalaripayattu, which is the most popular amongst many martial arts practiced in India, is believed to have been founded by Parasurama. Kalaripayattu is probably the oldest form of martial arts in India. The word Kalaripayattu is a combination of two words, namely, 'kalari' and 'Payattu' which mean training ground and fight. Kalari requires speed, agility and coordination of body parts. Kalaripayattu, originally developed from Kerala is now practiced widely across its homeland along with fringes of Karnataka and Tamil Nadu and also in Sri Lanka. Kalaripayattu includes strikes, kicks, grappling, preset forms, weaponry and healing methods. It is characterized by high jumping and kicking techniques, low stances, blows and blocks delivered by arms and leg that are almost fully extended and a high level of energetic and acrobatic movement.

Scientific interest in Kalaripayattu practitioners has led researchers to focus its effect on some body functions. Chandran, Harikumaran and

Shashidhar (2004)[2] studied the Respiratory Functions in Kalaripayattu Practitioners, whereas Shankar and Sivaji (2013)[9] reported the effect of selected Kalaripayattu Skills Training Programme on Selected Psychomotor Variables of High School Boys. Only few studies have looked into balance functioning with the use of VEMP. Keerthiraj (2011)[1] did a comparison of Click Evoked Vestibular Evoked Myogenic Potentials in Bharatanatyam Dancers and untrained population and found that the ear effects were significant in the experimental group (dancers) and there existed no significant difference in mean latencies of P1 and N1 between the intermediate and expert dancers. Sinha, Bohra, Sanju (2013)[8] assessed the sacculocollic and otolith ocular pathway function using cervical vestibular evoked myogenic potentials (cVEMP) and ocular vestibular myogenic potentials (oVEMP) in dancers and non-dancers. Their findings concluded that not all forms of dance training bring about a change in the plasticity of the sacculocollic and otolith ocular pathways. Swathi and Sathish (2013)[11] investigated the influence of dance training on sacculocollic pathway using VEMP test and reported that there was statistically significant increase in amplitude of P13-N23 as well as early latency of P13and N23 in professional dancers compared to the control group.

NEED FOR THE STUDY:

With the premise that the intensive training in Kalaripayattu would enhance the functioning of the vestibular system, specifically the sacculocollic pathway, the present study was taken up to describe compare VEMP responses in practitioners and non-practitioners of Kalaripayattu. However the role of Kalaripayattu on the balancing system has not been reported so far. Hence we attempt to describe the same as it will be the first study ever to report in the world on vestibular response and balance function in these highly skilled population. This information will give us the needed evidence to suggest practice of martial arts such as Kalaripayattu to improve one's balance and motor co-ordination.

OBJECTIVES OF THE STUDY:

1. To describe VEMP p1 - n1 amplitude responses in practitioners and non practitioners of Kalaripayattu using different stimulus and intensity for right ear and left ear at 95 dB and 75 dB tone bursts and click.
2) To compare amplitudes of VEMP responses between kalaripayattu practitioners and non practitioners for right ear and left ear using two different stimulus and two differently intensities.

METHOD

The design of the study was a case study with two groups of populations.

Participants:

The study consisted of a control group and an experimental group. The control group consisted of 30 ears of 15 males within the age range of 20 – 30 years with a mean age of 25 years. Individuals with prior practice in any kind of martial arts were excluded. The experimental group consisted of 30 ears of 15 males within an age range of 20-30 years with a mean age of 25years who practiced Kalaripayattu on a daily basis for not less than 6 months.

The inclusion criteria common to both groups included, no history of any kind of head trauma within last 5years, no history of metabolic disorders, Normal otoscopic findings, hearing threshold of less than 20 dB HL in all frequencies from 250 Hz to 4 KHz (ANSI 1996) and Speech Recognition Score of greater than 90% in each ear, 'A' type of tympanogram and presence of reflexes at BBN, 500Hz, 1 KHz, 2 KHz and 4 KHz below 100 dB HL, presence of DPOAE's, and normal gait test result.

Procedure:

Otoscopic examination was carried out to rule out any external ear abnormalities or presence of any foreign bodies in the external auditory canal. Hearing thresholds for both air and bone conduction were estimated using GSI 61 dual channel audiometer. The tympanograms and reflexes were checked for each ear to BBN, 500Hz, 1 KHz, 2 KHz and 4 KHz tones to check the integrity of the auditory system using GSI Tympstar middle ear analyzer version 2.0.VEMP responses were recorded for right and left ear at the presentation levels of 95dBnHL and 75dBnHL using 500 Hz tone burst with 2-0-2cycle and clicks with100 microsecond duration using Neuro-Audio digital ABR system software Version 1.0.97.0. The non-inverting electrode (+ve) was placed on the belly of the sternocleido mastoid muscle (SCM). The inverting electrode (-ve) was placed on the sterno-clavicular junction and Ground was placed on the high forehead. Individuals were asked to keep the head down completely such that chin touches the chest and then turn towards the opposite side of the test ear and then slightly up, to get the maximum contraction of the SCM muscle. Also, the individuals were asked not to move until the recordings were completed. Between each recording the individuals were asked to take a break or relax for 15-20 secs by releasing the tension of the SCM muscle. The replicability of the waveforms were assessed at both intensities for both the stimuli.

Stimulation rate	**- 5.1/sec**
Analysis time window	**- 80 millisecond**
Filter setting	**- 10Hz - 1500Hz**
Sampling rate	**- 5000Hz**
Polarity	**- rarefaction**
Stimulus waveform	**- tone burst 500Hz of 2-0-2 cycle and clicks of 100 microsec**

The Recordings were carried out at 2 different intensity level (95dBnHL and 75dBnHL) and for 2 different stimuli (500Hz Tone Burst and click). A total of 16 recordings were done to obtain the amplitudes in both the group. Recordings were completed in a single sitting and it required approx. 20-30 minutes for each individual.

RESULTS AND DISCUSSION

The amplitude differences for VEMP p1 and n1 peaks were measured at 95 dBnHL and 75 dBnHL for 500 Hz tone burst and click stimuli in control and experimental group for right and left ear separately. Non-parametric Mann Whitney U test was carried out to find the mean differences between the two groups, with the p value of less than 0.05 considered as statistically significant at 95% confidence interval. Independent sample t-test was used to estimate statistical significance of mean p1-n1 amplitude at both intensities for click and tone burst for each ear separately.

The results of the participants were described using the following subheadings:

(a) Comparison of amplitude for right ear at 95 dBnHL tone burst in experimental vs control group

The amplitude of p1-n1 was found to be 90.25µV with a SD of 31.02µV in the experimental group in comparison to 81.87µV with a SD of 35.05µV in the control group (Fig. No:1). However, the statistical analysis did not reveal a significant difference between the groups as the p value was found to be 0.293. The high mean amplitude in experimental group could be supported by the study done by Sinha et al (2013)[8]. They reported that the mean amplitude of dancers was 47.76µV in comparison to 43.26µV in non- dancers. Dancers and Kalaripayattu practitioners can be considered to use extreme physical movements of body, the latter carrying out jumping, low stances, blows and blocks delivered by arms and leg that are almost fully extended and a high level of energy and acrobatic movement.

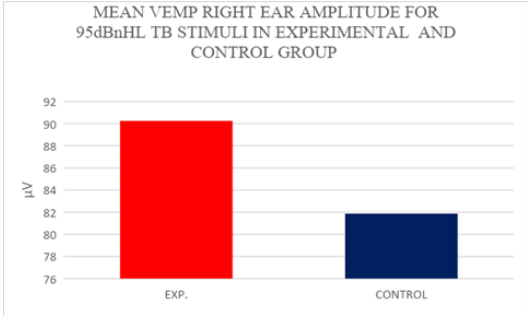

Fig.1 Amplitude for right ear at 95dBnHL tone burst in experimental and control group.

(b) Comparison of amplitude for right ear at 95 dBnHL click in experimental vs control group.

The amplitude of p1-n1 was found to be 60.71µV with a SD of 20.80µV in experimental group in comparison to 47.06µV with a SD of 17.03µV in control group (Fig. No:2). Besides, the statistical analysis revealed a significant difference between groups as the p value

was found to be 0.040. Similar results were reported by Philips and Korsack (2013)[10] who found mean amplitudes in the range of 11.34µV to 146.1µV in normals to click-evoked VEMP at various intensities. As intensity decreased, amplitude also decreased with right ear showing better amplitudes than left.

The high amplitude in experimental group in comparison to control group could be observed in the findings of Keerthiraj (2011)[1]. He found earlier latencies in Bharatanatyam Dancers when compared to non-dancers which was statistically significant. Kalaripayattu practitioners similar to dancers also showed higher amplitude in our study.

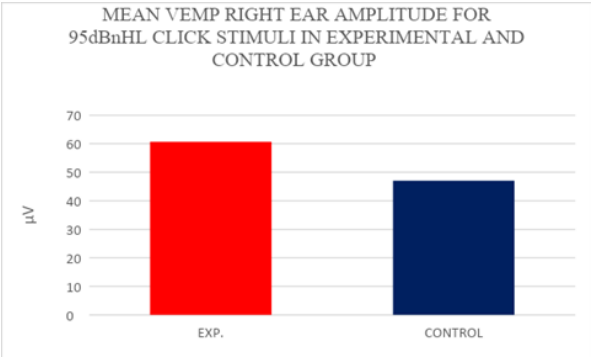

Fig.2 Amplitude for right ear at 95dBnHL click in experimental and control group.

(C) Comparison of amplitude for right tear at 75 dBnHLone burst in experimental vs control group

The amplitude of p1-n1 was found to be 36.05µV with a SD of 12.87µV in experimental group in comparison to 24.20µV with a SD of 15.80µV in control group (Fig No:3). Besides, the statistical analysis revealed a significant difference between groups as the p value was found to be 0.037.

We could not trace any supporting studies to justify our findings at this intensity. All available data on c-VEMP in normals using Toneburst stimuli were restricted to 90dBnHL starting from 120dBnHL. The fact that experimental group recorded c-VEMP even at 75dBnHL supports the premise that physical activities involved in Kalaripayattu improve vestibular and balancing systems, which in turn show VEMP responses at lower intensities.

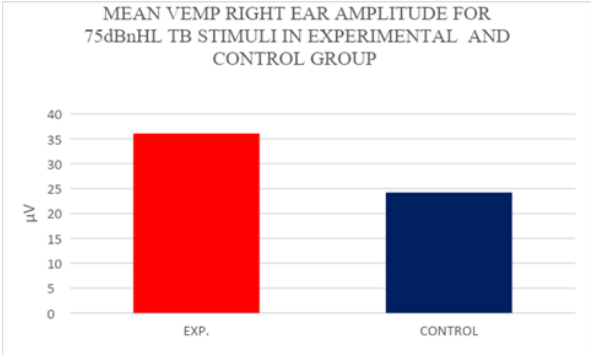

Fig.3 Amplitude for right ear at 75dBnHL Tone burst in experimental and control group.

(d) Comparison of amplitude for right ear at 75 dBnHL click in experimental vs control group

The amplitude of p1-n1 was found to be 38.95µV with a SD of 10.57µV in experimental group in comparison to 17.30µV with a SD of 12.50µV in control group (Fig No:4). The statistical analysis further revealed a significant difference between groups as the p value was found to be 0.002.

However, there are no studies available to support findings in control group as the minimum intensity at which click evoked c-VEMP recorded previously was at 80 dBnHL (Janky and Sheperd, 2009)[6].

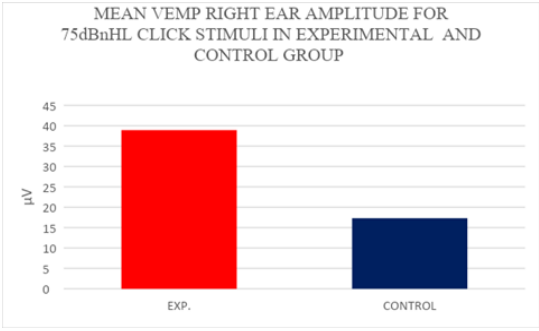

Fig.4 Amplitude for right ear at 75dBnHL click in experimental and control group.

e) Comparison of amplitude for left ear at 95 dBnHL tone burst in experimental vs control group

The amplitude of p1-n1 was found to be 94.66µV with a SD of 36.83µV in experimental group in comparison to 75.43µV with a SD of 24.43µV in control group (Fig No:5). However, the statistical analysis did not reveal a significant difference between groups as the p value was found to be 0.111. The findings in control group were supported by the study done by Maes, Vinck, and De Vel in 2009[7] who found mean amplitude of p1 – n1 to be 147.34µV with a SD of 68.66µV. No previous studies ear specific VEMP findings for 95dBnHL tone burst stimuli in any population. The mean p1-n1 amplitude of the experimental group was better compared to the control group, although a significant difference was not observed between the two groups.

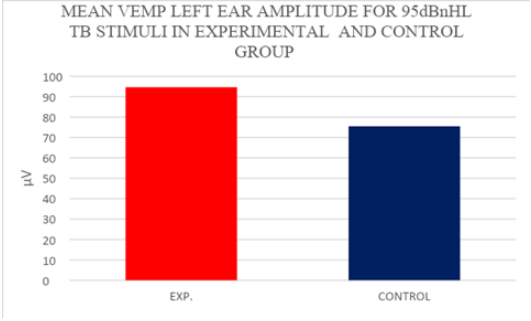

Fig.5 Amplitude for left ear at 95dBnHL Tone burst in experimental and control group

(f) Comparison of amplitude for left ear at 95 dBnHL click in experimental vs control group.

The amplitude of p1-n1 was found to be 58.65µV with a SD of 20.06µV in experimental group in comparison to 55.10µV with a SD of 25.31µV in control group (Fig No:6). However, the statistical analysis did not reveal a significant difference as the p value was found to be 0.389. There were no studies to validate our findings in experimental group as it's the first study to report these measures in Kalaripayattu practitioners. However similar findings were reported in control group by Wu, Shiao, Yang, and Lee (2007)[4] who studied cVEMP amplitude in 22 normal individuals in the age range of 17 to 30 years using rarefaction click stimulus at 95dbnHL. They found that the mean amplitude were 81.23µV with a SD 32.56µV. Also, there is a lack of data on ear specific responses for p1-n1 amplitude of VEMP at this stimulus conditions which could have supported our findings.

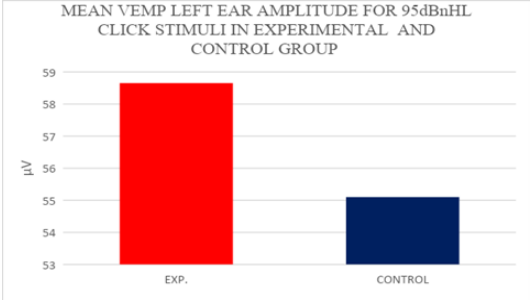

Fig.6 Amplitude for left ear at 95dBnHL click in experimental and control group

g) Comparison of amplitude for left ear at 75 dBnHL tone burst in an experimental vs control group

The amplitude of p1-n1 was found to be 37.93µV in the experimental group in comparison to 22.27µV in the control group (Fig. No:7). Besides, the statistical analysis revealed a significant difference between the groups as the p value was found to be 0.003. However, none of the published literature could actually record VEMP in any experimental groups at lower intensities. It can be hypothesized that practice of Kalaripayattu improved vestibular functioning which could possibly explain why we were able to record cVEMP for TB at 75dBnHL. The general tendency of reduction in amplitude with reduced intensity levels for any Auditory Evoked Potentials and the presence of a statistically significant difference between control and experimental groups confirms that the responses were rightly elicited rather than just an artifact.

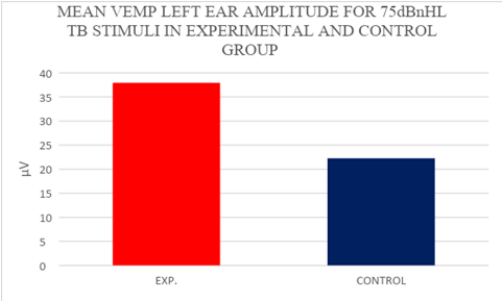

Fig.7 Amplitude for left ear at 75dBnHL Tone burst in experimental and control group.

(h) Comparison of amplitude for left ear at 75 dBnHL click in experimental vs control group

The amplitude of p1-n1 was found to be 32.16µV with a SD of 10.68µV in experimental group in comparison to 13.53µV with a SD of 11.99µV in control group (Fig. No:8). Besides, the statistical analysis revealed a significant difference between groups as the p value was found to be 0.002. The findings of the control group were similar to those previously established by Janky and Sheperd (2009)[6]. They reported mean amplitude of 27.88µV with a SD of 9.87µV at 80dBnHL to click stimuli in normal individuals in the age range of 20-29 years. However, there were no published studies in Kalaripayattu or any other martial art form practitioners using VEMP at 75dBnHL for click or Toneburst which could support our results. The fact that we were able to elicit responses for both Toneburst and clicks at lower intensity levels allows us to accept the hypothesis that practice of Kalaripayattu has a positive effect on functioning of peripheral vestibular system.

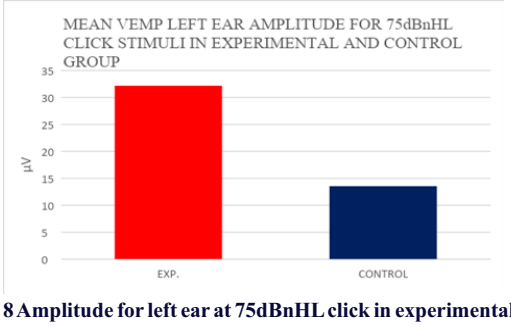

Fig. 8 Amplitude for left ear at 75dBnHL click in experimental and control group.

CONCLUSION

Studies have reported that martial arts such as Tai-Chi, Aikido etc. improve balancing and vestibular functioning in adults. However the role of Kalaripayattu (an art form that involves extreme co-ordination and balance) on improving balancing system has not been reported yet. This is the first ever study to be done in Kalaripayattu practitioners which used VEMP as an assessment tool to measure the functioning of vestibular system compared to other literature on dance forms and not necessarily martial arts. We recorded cVEMPs from 18 participants in control and experimental group for click and toneburst stimuli at two intensities to obtain the p1-n1 amplitude for right and left ear separately.

In general, we found that the mean amplitude of the experimental group was higher than the control group. In addition, the mean amplitude of right ear was better than left ear for tone burst stimuli at both intensities in control group and vice versa for experimental group. We were able to elicit responses as low at 75 dBnHL in experimental group which was not previously recorded or reported by any authors. In conclusion, the present study is first of its kind to be reported in the world, which clearly provides evidence to the hypothesis that practicing of Kalaripayattu and other martial arts improves the functioning of the peripheral vestibular system. However, future additional research involving more participants across gender inculcating latency parameters and assessing the effect of years of practice is warranted.

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