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# Analysis of Vestibular Evoked Myogenic potentials in Migraines individuals attending a Tertiary Care Hospital

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**Abstract:**

**Introduction:**Migraine is a neurologic disease, often associated with a unilateral throbbing pain, which is categorized under primary headache disorder according to the International headache society (ICHS-3) beta edition. Migraine is the 3rd most prevalent illness and also the 6th most disabling illness in the world. Female: Male ratio: (3:1). Vestibular dysfunctions are frequently associated with migraine including the common type.

**Material and method**:

The cross observational study was done among the patients who had migraine in Chettinad super speciality hospital, kelambakkam over my study period. Participants who fulfill the international classification of Headache Disorders criteria were recruited from the Neurology OPD. Subjects are enquired about their history of diagnosis, Family history, Investigations and diagnostic tests such as cVEMP

**Results:**Prolonged latencies are likely due to the degradation of central vestibular processing of otolith signals rather than a decline in peripheral vestibular function . VEMP amplitudes can be used as independent quantitative measures of otolith function. Several studies have reported that Abnormal VEMP potentials and Amplitude asymmetry are seen in Migranious individuals. Even though migraine is not an inner ear disorder, but of the brain, generally lower threshold is noted in migraine individuals. **Conclusion:**Migraine have very few available diagnostic tests with less statistical significance, VEMP studies on migraine patients may shed new light on its pathophysiology as well as only p13 and amplitude were considered .N23 0r N1 potential was used for only identifying p13.

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**Introduction:**

Migraine is a neurological condition, characterized by episodic varying intensity (Mild Moderate - severe) headaches, which usually lasts for hours to days, begins unilaterally, but may spread bilaterally. Migraine may be accompanied by any combination of symptoms such as visual disturbances, hypersensitivity to light, sound and smell, inclination to vomit, vomiting and vestibular manifestations [1]. These manifestations will differ from individual to individual and persons may have different symptoms during different episodes. Each episode may vary in duration and occurrence.The ICHD – 3 (International classification of Headache disorders) classify several types of headaches that includes different manifestations [2]. Migraine is categorized under primary headache disorder according to ICHD -3 with many subdivisions depending upon specific features, but commonly migraine descends under two major groups : Migraine with Aura, Migraine without Aura [14].The aura indicates "Warning sign", is the multiplex of neurological symptoms such as sensory, Speech, visual, Motor and other central nervous symptoms, which can exist for minutes in length and is reversible [3]. The aura's can be unilateral, that usually happens before the headache, but it may also happens after or persists with the phase of headache has commenced. The term called "Silent migraine" defines aura which may experienced by individuals without headache episodes.

The episodes of migraine attacks without warning signs, which generally lasts for 4 – 72 hours when it's treated or unsuccessfully treated. Manifestations include unilateral throbbing or pulsating pain accompanied with Vomiting or inclination to vomit, hypersensitivity to smells, Sounds and light, mood changes, fatigue, confusion and visual disturbances [4]. Migraine headache may be exacerbated by performing physical tasks (Walking or climbing stairs) and during menstrual cycles. Moreover, the migraine without aura is more vulnerable to worsen with recurrent use of symptomatic medications [5].The symptoms of migraine may differ according to many phases, depending on what the individual was in. A migraine may happen in 4 stages, but it's not mandatory that all migraine individuals should experience all the stages [6]. (1)The Prodromal Stage, (2) The Aura stage, (3) The Attack stage, (4) The Postdromal Stage.The prodromal stage also known as prodrome or preheadache stage / phase. It may happen hours or even days before the migraine episode. The prodromal stage can be viewed as warning sign migraineur's "Yellow light" which alerts individuals as well as doctors of an forthcoming migraine [7]. The manifestations of this stage are often attributed to medications taken to recover from migraine [13].

In this study to analyse the vestibular evoked myogenic potentials in migraine individuals attending a tertiary care hospital and to identify the potential changes and abnormalities if any which could be specific to migraine [16]. The cross observational study was done among the patients who had migraine Participants who fulfil the international classification of Headache Disorders criteria were recruited from the Neurology OPD. Subjects are enquired about their history of diagnosis, Family history, Investigations and diagnostic tests such as cVEMP.[15] VEMP study of 58 Migrainous individuals' shows abnormal findings in 65% of patients and normal findings in 34% of patients. Though, 65% of patients had abnormal VEMP findings, there is no statistically significant correlation with location of headache or pain intensity [17]. Further studies with larger sample sizes, preferably with case and controls are required to corroborate the findings of this study.

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**Materials and method:**

Observational cross sectional study. 58 patients presenting with complaints of migraine in attending chettinad hospital and research institute during this study period to analyse the vestibular evoked myogenic potential changes in migraine individuals attending a tertiary care hospital. Minimal sample size requirement for the study is calculated using the formula (p =0.04); (q=1-p); (d=0.05); n=p*q (1.96/d)2 and the minimum sample size requirement was 58. Inclusion Criteria**:** (a) Age > 18 years, (b) Patients who fulfil ICHD-3β edition (1.1 and 1.2) diagnostic criteria for migraine according to International Headache Society. Exclusion Criteria:(a) Technical difficulty: Patients with pericranial, neck and shoulder muscle tenderness and/or associated myofascial pain syndrome. Because these conditions can affect muscle tension or posture during method leads to the degree of muscle contraction affects the cVEMP result and its interpretation,(b)Patient having a chronic neurological, systemic or inner ear / auditory condition indicating an otological disorder that would affect the results of VEMP analysis or a past cervical trauma.

**Statistical Methods:**

The statistical analysis was performed using the SPSS software package (version 21.0, SPSS, Chicago, IL, U.S.A.). Descriptive statistics will be applied to calculate demographic variables like Mean, Median, Standard, Deviation, Confidence interval P values are calculate. Pie chart /Bar graph will be used to explain the cVEMP changes in migrainous individual. The student t-test was executed to determine the significant change in mild (right) between moderate (left) and severe (bilateral) latencies were compared. Further, the Pearson's correlation analysis was carried to determine the interdependency between the pain severities. The statistical significant was considered, if p-value < 0.05.

**RESULTS**

**BASED ON AGE:**

| AGE (IN GROUPS) | MIGRAINE WITH AURA | PERCENTAGE | MIGRAINE WITHOUT AURA | PERCENTAGE |
|---|---|---|---|---|
| 20 years or less | 1 | 3 | 2 | 8 |
| 21-30 years | 15 | 48 | 12 | 45 |
| 31-40 years | 7 | 23 | 6 | 22 |
| 41-50 years | 1 | 3 | 3 | 11 |
| 51-60 years | 4 | 13 | 2 | 7 |
| 61-70 years | 2 | 7 | 2 | 7 |
| > 70 years | 1 | 3 | 0 | 0 |

**TABLE: 1.0**

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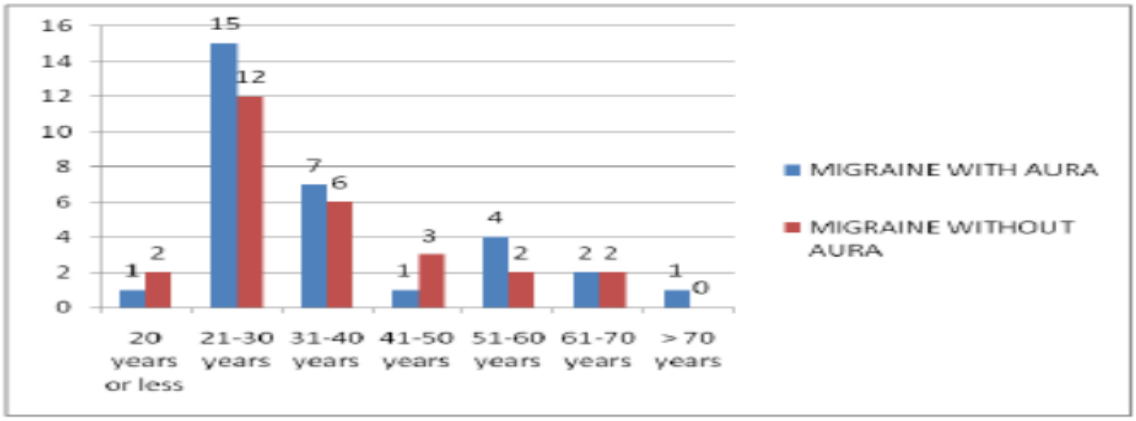


Figure 1

The above table 1.0 shows number of patients in the study who had migraine with aura or without aura and their age wise distribution. The chart 1 shows graphical representation of age wise distribution. Among 58 patients, incidence of migraine is maximum in age group of 21 - 30 years MWA 48 %, MWOA 45 %.

**BASED ON GENDER:**

| **GENDER** | **NUMBER** | **PERCENTAGE** |
|---|---|---|
| **MALE** | 14 | 25 |
| **FEMALE** | 44 | 75 |

**TABLE: 1.1**

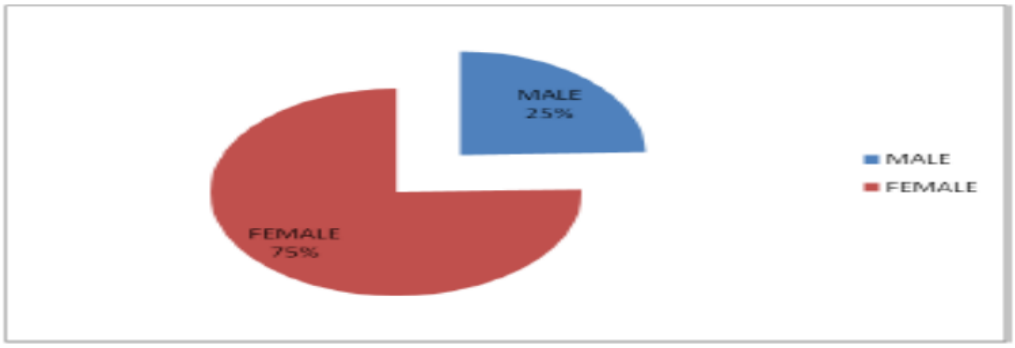


Figure 1.1

**MWA** **MWOA** **VEMP FINDING**

| GENDER | NUMBER | % | NUMBER | % | NORMAL | ABNORMAL | % | % |
|---|---|---|---|---|---|---|---|---|
| Male | 7 | 50 | 7 | 50 | 3 | 11 | 21 | 78 |
| Female | 23 | 48 | 21 | 48 | 17 | 27 | 38 | 61 |

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X2 tests**TABLE: 1.3**

| | Value | Df | P |
|---|---|---|---|
| X2 | 1.39 | 1 | 0.238 |
| N | 58 | | |

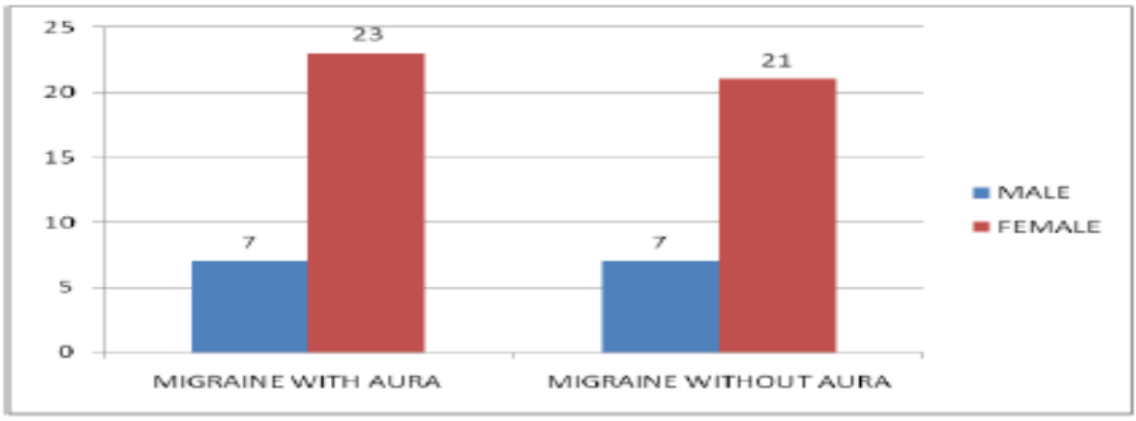


Figure 1.2

The above table 1.3 and chart 1.2 shows gender distribution of patients in this study. The table 5.3 shows Out of 58 participants, 50 % of male and 48 % of female had migraine with aura and 50% male and 48 % of female had migraine without aura. Normal male 21%, Female 38%, Abnormal male 78%, Female (61%).Based on gender, p value 0.238, is not statistically significant. The above chart 3 shows graphical representation of migraine patients with aura and without aura based on gender. On based on gender analysis, the increased incidence of migraine is noted in female population.

**BASED ON PAIN SEVERITY:**

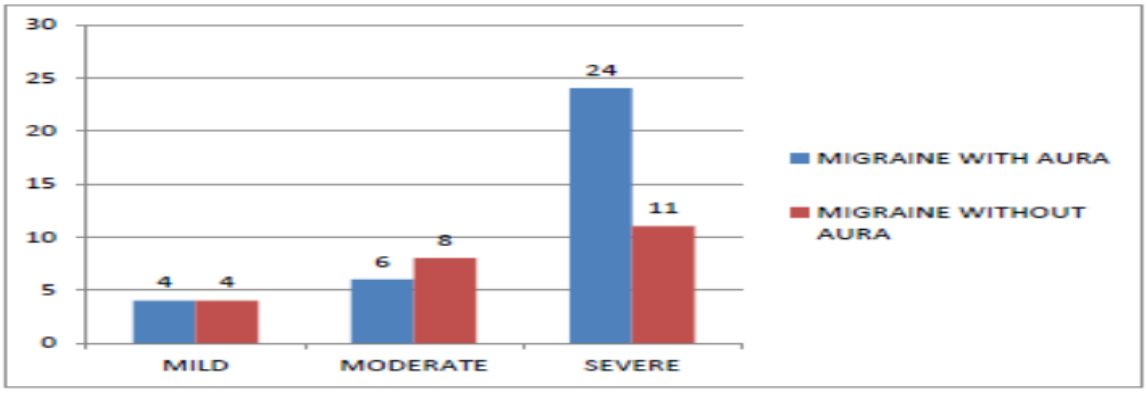


Figure 1.3

**CHART: 4**

**TABLE: 1.3**

| **PAIN INTENSITY** | **%** | **PERECENTAGE** | **MIGRAINE WITHOUT** | **%** |
|---|---|---|---|---|

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| | | | AURA | |
|---|---|---|---|---|
| **MILD** | 4 | 12 | 4 | 17 |
| **MODERATE** | 6 | 18 | 8 | 35 |
| **SEVERE** | 24 | 70 | 11 | 48 |

The above table 1.3 shows incidence of migraine with aura and without aura based on pain severity. The above chart 4 shows graphical representation of migraine with aura and without aura based on pain severity. Based on pain severity, increased incidence of severe pain intensity 70 % in migraine with aura and 48 % in migraine without aura is noted. The above table 5.4 shows incidence of migraine with aura and without aura based on pain severity. The above chart shows graphical representation of migraine with aura and without aura based on pain severity Based on pain severity, increased incidence of severe pain intensity 70 % in migraine with aura and 48 % in migraine without aura is noted.

**BASED ON LOCATION**:

| **LOCATION OF HEADACHE** | **MIGRAINE WITH AURA** | **%** | **MIGRAINE WITHOUT AURA** | **%** |
|---|---|---|---|---|
| **RIGHT** | 8 | 29 | 14 | 46 |
| **LEFT** | 7 | 25 | 5 | 17 |
| **BILATERAL** | 13 | 46 | 11 | 37 |

**TABLE: 1.4**

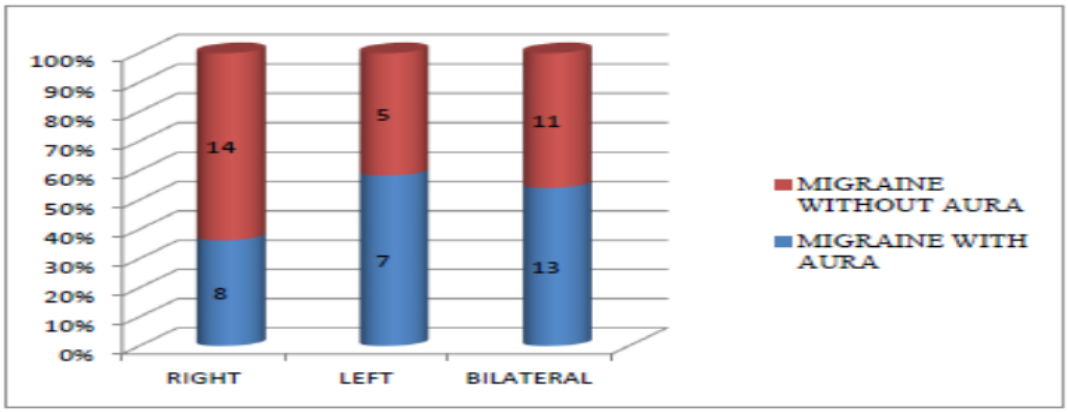


**Figure 1.4**

The Above table 1.4 shows incidence of migraine with aura and without aura based on location of headache. The Above chart 5 shows graphical representation of migraine with aura and without aura based on location of headache. Based on location of headache, the increased incidence of bilateral headache 46 % in migraine with aura and increased incidence of right sided headache 46 % in migraine without aura.

**VEMP LATENCIES CORRELATION: (p13 latency) BASED ON LOCATION:**

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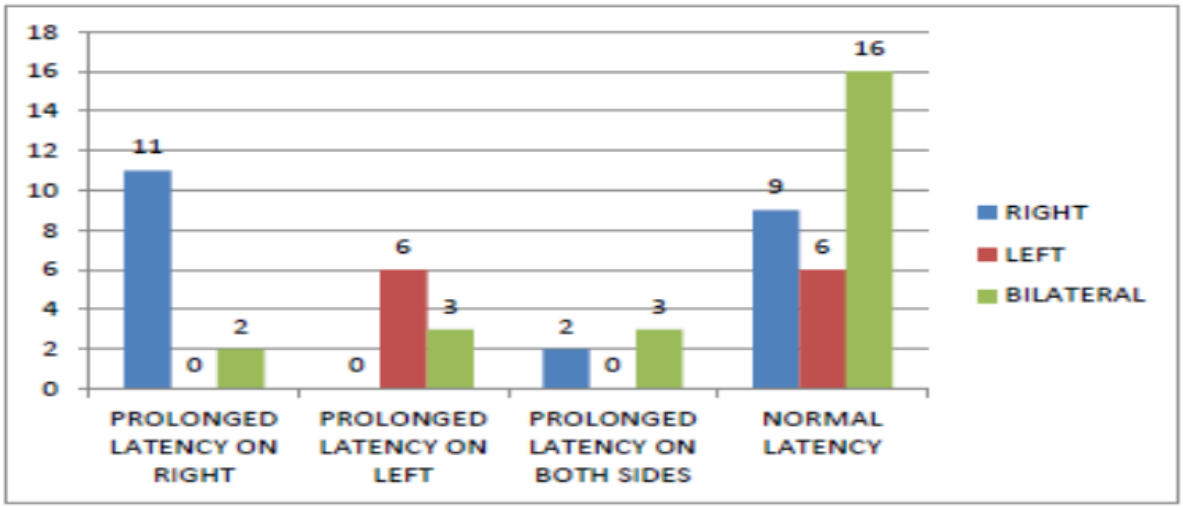


**Figure 1.5**

| LOCATION OF HEADACHE | PROLONGED LATENCY ON RIGHT | % | PROLONGED LATENCY ON LEFT | % | PRONLONGED LATENCY ON BOTH SIDES | % | NORMAL LATENCY | % |
|---|---|---|---|---|---|---|---|---|
| **RIGHT** | 11 | 50 | 0 | 0 | 2 | 9 | 9 | 41 |
| **LEFT** | 0 | 0 | 6 | 50 | 0 | 0 | 6 | 50 |
| **BILATERAL** | 2 | 8 | 3 | 12 | 3 | 13 | 16 | 67 |

**TABLE: 1.5**

The above table 1.5 shows correlation of VEMP latencies based on location of location of headache. The above chart 7 shows Right - 50 % of unilaterally prolonged latencies, nil % of latency prolongation on contralateral side, 9% of bilaterally prolonged latencies and 41 % of normal latencies. Left - 50 % of unilaterally prolonged latencies, nil % of latency prolongation on contralateral side, Nil % of bilaterally prolonged latencies and 50 % of normal latencies. Bilatera l – 8 % of latencies prolonged on right side, 12 % of latencies prolonged on left side, (13 %) of latency prolonged on both sides and 67 % of normal latencies. On whole, Out of 58 participants, In unilateral headache, maximum number of VEMP latency prolongation is noted on same side, Right sided headache 50 %, left sided headache 50 %, In patients with bilateral sided showed normal latency.

**VEMP LATENCY CORRELATION BASED ON PAIN SEVERITY: ( p 13 latency) BASED ON PAIN SEVERITY:**

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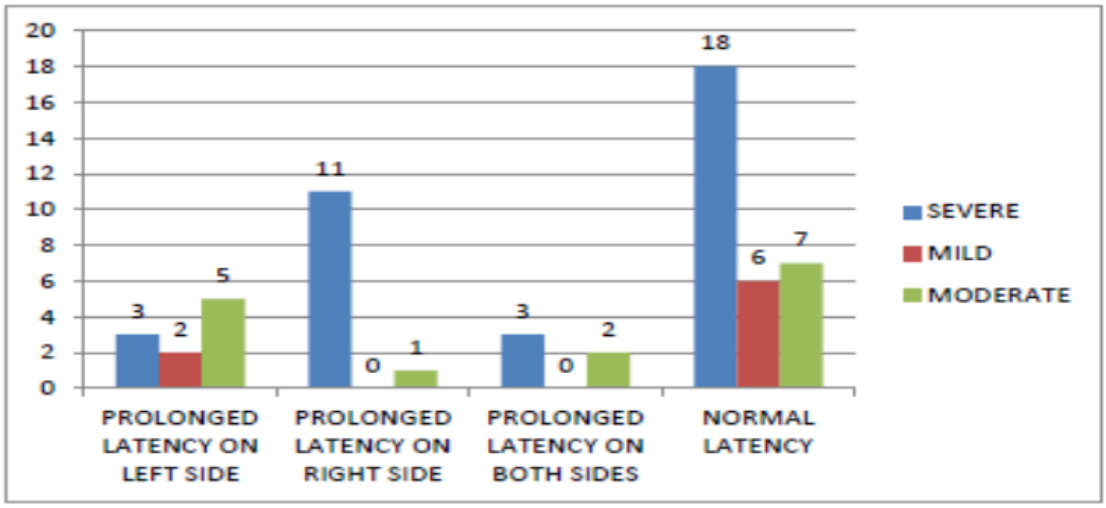


**Figure 1.6**

| PAIN SEVERITY | PROLONGED LATENCY ON LEFT SIDE | % | PROLONGED LATENCY ON RIGHTSIDE | % | PRONLONGED LATENCY ON BOTH SIDES | % | NORMAL LATENCY | % |
|---|---|---|---|---|---|---|---|---|
| MILD | 2 | 25 | 0 | 0 | 0 | 0 | 6 | 75 |
| MODERATE | 5 | 33 | 1 | 7 | 2 | 13 | 7 | 47 |
| SEVERE | 3 | 9 | 11 | 31 | 3 | 9 | 18 | 51 |

**TABLE: 1.6**

The Above table 1.6 shows prolonged latencies based on pain severity: The above chart 8 shows Mild - 25 % of prolonged latencies on left side, 75 % of Normal latencies is noted, hence in mild pain intensity – no significant latency prolongation, Moderate – 33 % of prolonged latencies on left side, 7 % of prolonged latencies on right side, 13 % of prolonged latencies on bilateral side and 47 % of normal latencies is noted, hence in moderate pain intensity – no significant latency prolongation. Severe – 9 % of prolonged latencies on left side, 31 % of prolonged latencies on right side, 9% of prolonged latencies on bilateral side and 51 % of normal latencies is noted, hence in severe pain intensity – no significant latency prolongation. On whole, Out of 58 participants, no significant latency prolongation based on pain severity.

**Independent Samples T-Test TABLE: 1.7**

**Independent Samples T-Test**

| LATENCIES | T-TEST | STATISTICS | df | p |
|---|---|---|---|---|
| RIGHT P13 | Student's t | -2.463 [a] | 56.0 | 0.17 |
| LEFT P13(ms) | Student's t | -2.500 [a] | 56.0 | 0.015 |
| LEFT N23 (ms) | Student's t | 1.099 [a] | 56.0 | 0.277 |
| RIGHT N23 (ms) | Student's t | -0.355 | 56.0 | 0.724 |

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Levene's test is significantly ($p<.05$), suggesting a violation of the assumption of equal variances. In this table 1.7 p13 latency shows statistical significance. N23 has no statistical significance

**VEMP AMPLITUDES CORRELATION: BASED ON LOCATION OF HEADACHE:**

| LOCATION OF HEADACHE | AMPLITUDE ASYMMETRY ON UNILATERAL SIDE | % | AMPLITUDE ASYMMETRY ON CONTRALATERAL SIDE | % | AMPLITUDE ASYMMETRY ON BOTH SIDES | % | NORMAL AMPLITUDE | % |
|---|---|---|---|---|---|---|---|---|
| **RIGHT** | 11 | 50 | 0 | 0 | 3 | 14 | 8 | 36 |
| **LEFT** | 9 | 75 | 0 | 0 | 0 | 0 | 3 | 25 |
| **BILATERAL** | 2 | 8 | 0 | 0 | 4 | 17 | 18 | 75 |

**TABLE: 1.8**

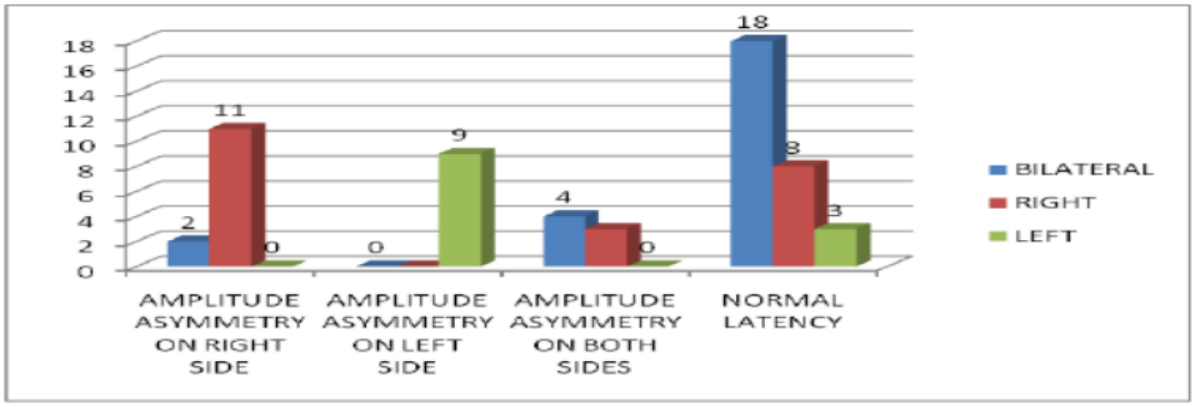


**Figure 1.7**

The above table 1.8 shows amplitude asymmetry based on location of headache. The above chart shows Right - 50 % of amplitude reduction in right, Nil % of amplitude reduction in left, 14 % of amplitude reduction in bilateral sides, 36 % of normal amplitudes is noted. Left – Nil % of amplitude reduction in right, 75 % of amplitude reduction in left, nil % of amplitude reduction in bilateral sides, 25 % of Normal amplitudes is noted. Bilateral – 8% of amplitude reduction in right, nil % of amplitude reduction in left, 17 % of amplitude reduction in bilateral sides, 75 % of normal amplitudes is noted. In unilateral headaches, right side shows 50 %of amplitude reduction and left side75 % reduction on same side. In bilateral headaches 75 % of normal amplitudes are noted.

**BASED ON VEMP FINDINGS:**

| VEMP FINDINGS | RIGHT | LEFT | BILATERAL | TOTAL |
|---|---|---|---|---|
| | | | | |

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| | | | | |
|---|---|---|---|---|
| **NORMAL** | 6 | 3 | 3 | 20 |
| **ABNORMAL** | 16 | 9 | 13 | 38 |
| **TOTAL** | 22 | 12 | 24 | 58 |

| X2 tests | Value | Df | p-value |
|---|---|---|---|
| X2 | 2.35 | 3 | 0.308 |
| N | 58 | | |

**TABLE: 1.9**

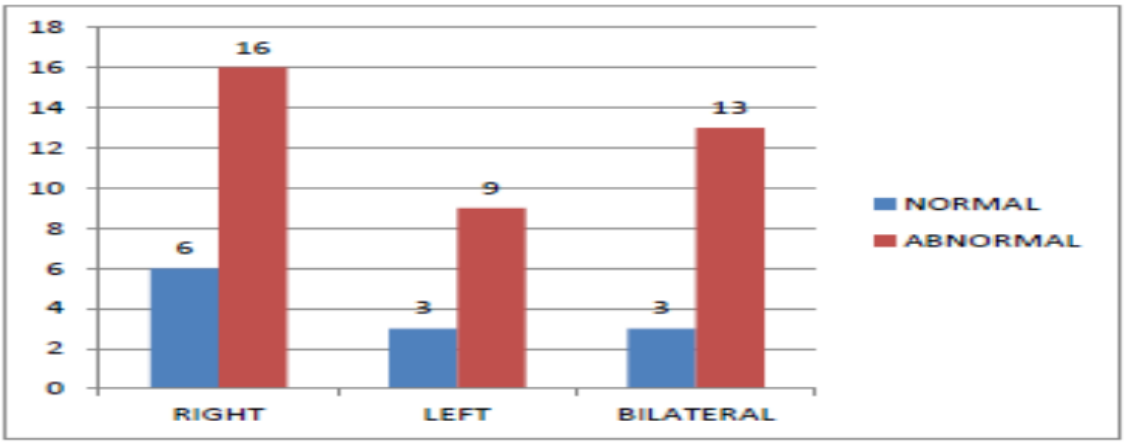


**Figure 1.8**

The VEMP findings showed right sided headache Normal VEMP in 30 %, Abnormal VEMP in 42 %, Left sided headache Normal VEMP in 15 %, Abnormal VEMP in 23 %, Bilateral headache Normal VEMP in 15 %, Abnormal VEMP in 34 %. P value 0.308 which shows less statistical significance. The above chart shows graphical representation of normal and abnormal VEMP findings on whole, the increased incidence of abnormality on right sided headache is noted.

**Discussion:**

Among 58 patients, Based on age, incidence of migraine is maximum in age group of 21 - 30 Years MWA 48 %, MWOA 45 % [27]. Based on gender analysis, the increased incidence of migraine is noted in female population 50 % of male and 48 % of female had migraine with aura and 50% male and 48 % of female had migraine without aura, Normal male 21%, Female 38%, Abnormal male 78%, Female 61% based on gender and also shows p value 0.238, which is not statistically significant [26]. Based on pain severity, increased incidence of severe pain intensity 70 % in migraine with aura and 48 % in migraine without aura is noted. Based on location of headache, the increased incidence of bilateral headache 46 % in migraine with aura and increased incidence of right sided headache in migraine without aura. Based on associated symptoms, photophobia 24 % and vertigo / giddiness 18 % are the most common associated symptoms [25]. Based on VEMP latencies correlation headache location, in unilateral headache, maximum number of VEMP latency

prolongation is noted on same side, Right sided headache 50 %, left sided headache 50 %, in patients with bilateral sided showed normal latency. Based on VEMP latencies correlation with pain severity - No significant latency prolongation. Based on VEMP amplitude correlation with location of headache - On whole, In unilateral headaches, right side shows 50 %of amplitude reduction and left side75 % reduction on same side [22-24]. In bilateral headaches 75 % of normal amplitudes is noted. Based on VEMP findings, right sided headache Normal VEMP in 30 %, Abnormal VEMP in 42 %, Left sided headache Normal VEMP in 15 %, Abnormal VEMP in 23 %, Bilateral headache Normal VEMP in 15 %, Abnormal VEMP in 34 %. P value 0.308 which shows less statistical significance. On whole, the increased incidence of abnormality on right sided headache is noted [18-21]. In this table p13 latency shows statistical significance. N23 has no statistical significance. Several studied revealed that migraine patients with no or delayed VEMPs [39,38]. The findings of the present study tend to lean towards central vestibular disorders in this disease [35-37]. In my study, 22 migraine patients with Right side pain, 12 patients with left side pain and 24 patients with bilateral pain participated [40]. Based on VEMP latencies correlation headache location, right sided headache shows high significant percentage of latency prolongation on unilateral side compared to both left and bilateral. Based on VEMP latencies correlation with pain severity - No significant latency prolongation is noted. Based on VEMP amplitude correlation with location of headache [30-34]]. Unilateral headaches showed significant amplitude reduction on ipsilateral side compared to bilateral headaches may be due to lower threshold levels at the headache site. Based on VEMP Findings right sided headache showed more VEMP abnormality 42 %.

**CONCLUSION:**

VEMP study of 58 Migraine's individuals' shows abnormal findings in 65% of patients and normal findings in 34% of patients [28]. Though, 65% of patients had abnormal VEMP findings, there is no statistically significant correlation with location of headache or pain intensity [29]. Further studies with larger sample sizes, preferably with case and controls are required to corroborate the findings of this study.

**References:**

1. Olesen, Jes, et al. "The international classification of headache disorders, (beta version)." Cephalalgia 33.9 (2013): 629-808.
2. Zhang, Yixin, et al. "International Classification of Headache Disorders 3rd edition beta-based field testing of vestibular migraine in China: Demographic, clinical characteristics, audiometric findings and diagnosis statues." Cephalalgia 36.3 (2016): 240-248.
3. Curthoys, Ian S. "A critical review of the neurophysiological evidence underlying clinical vestibular testing using sound, vibration and galvanic stimuli." Clinical Neurophysiology 121.2 (2010): 132-144.
4. Burton, Wayne N., et al. "The impact of migraine and the effect of migraine treatment on workplace productivity in the United States and suggestions for future research." Mayo clinic proceedings. Vol. 84. No. 5. Elsevier, 2009.

5. Stewart, W. F., G. C. Wood, and H. Razzaghi. "Migraines Result in Lost Work Productivity and Reduced Effectiveness."
6. Clarke, C. E., et al. "Economic and social impact of migraine." QJM: monthly journal of the Association of Physicians 89.1 (1996): 77-84.
7. Bag, B., and N. Karabulut. "Pain-relieving factors in migraine and tension-type headache." International journal of clinical practice 59.7 (2005): 760-763.
8. Isaradisaikul, Suwicha, et al. "Cervical vestibular-evoked myogenic potentials: norms and protocols." International journal of otolaryngology 2012 (2012).
9. Dieterich, Marianne, Mark Obermann, and NeseCelebisoy. "Vestibular migraine: the most frequent entity of episodic vertigo." Journal of neurology 263.1 (2016): 82-89.
10. Allena, M., et al. "The vestibulo-collic reflex is abnormal in migraine." Cephalalgia 27.10 (2007): 1150-1155.
11. Vitkovic, Jessica, Mark Paine, and Gary Rance. "Neuro-otological findings in patients with migraine-and nonmigraine-related dizziness." Audiology and Neurotology 13.2 (2008): 113-122.
12. John, Mathew. Involvement of auditory pathway in migrainous vertigo among those visiting the audio-vestibular clinic in a tertiary care hospital. Diss. Christian Medical College, Vellore, 2013.
13. Zhou, Yujuan, Yongzhen Wu, and Jing Wang. "Otolithic organ function in patients with profound sensorineural hearing loss." Journal of otology 11.2 (2016): 73-77.
14. Power, L., et al. "Clinical characteristics and treatment choice in vestibular migraine." Journal of Clinical Neuroscience 52 (2018): 50-53.
15. Dieterich, Marianne, Mark Obermann, and NeseCelebisoy. "Vestibular migraine: the most frequent entity of episodic vertigo." Journal of neurology 263.1 (2016): 82-89.
16. Baier, Bernhard, N. Stieber, and M. Dieterich. "Vestibular-evoked myogenic potentials in vestibular migraine." Journal of neurology 256.9 (2009): 1447.
17. Zaleski, Ashley, et al. "Vestibular evoked myogenic potentials in patients with vestibular migraine." Otology &Neurotology 36.2 (2015): 295-302.
18. Papathanasiou, Eleftherios S., et al. "International guidelines for the clinical application of cervical vestibular evoked myogenic potentials: an expert consensus report." Clinical Neurophysiology 125.4 (2014): 658-666.
19. Venhovens, J., J. Meulstee, and W. I. M. Verhagen. "Vestibular evoked myogenic potentials (VEMPs) in central neurological disorders." *Clinical Neurophysiology* 127.1(2016):40-49.
20. Tihana, MaslovaraSinišaVešligaj. "Can a finding of cervical vestibular evoked myogenic potentials contribute to vestibular migraine diagnostics." MedicinskiglasnikLjekarskekomoreZeničko-dobojskogkantona 13.1 (2016): 36-43.

21. Makowiec, Kathryn F., et al. "Ocular and cervical vestibular evoked myogenic potentials in patients with vestibular migraine." *Otology &Neurotology* 39.7 (2018): e561-e567.
22. Gaurav, Ashish. To establish normative data in an Indian population for static and dynamic Subjective Visual Vertical and Horizontal (SVV & SVH) examination and to determine the role of SVV & SVH in evaluation of patients with migrainous vertigo. Diss. Christian Medical College, Vellore, 2015.
23. Chang, Tzu-Pu, and Michael C. Schubert. "Association of the video head impulse test with improvement of dynamic balance and fall risk in patients with dizziness." JAMA Otolaryngology–Head & Neck Surgery 144.8 (2018): 696-703.
24. Sandhu, J. S., et al. "Introduction of video head impulse testing to an ENT outpatient clinic: objective vestibular evaluation at first point of contact." Hearing, Balance and Communication 16.4 (2018): 227-231.
25. Fife, Terry D., et al. "Practice guideline: Cervical and ocular vestibular evoked myogenic potential testing: Report of the Guideline Development, Dissemination, and Implementation Subcommittee of the American Academy of Neurology." Neurology 89.22 (2017): 2288-2296.
26. Felipe, Lilian, et al. "Vestibular-evoked myogenic potential (VEMP) to evaluate cervical myelopathy in human T-cell lymphotropic virus type I infection." Spine 33.11 (2008): 1180-1184.
27. Zuniga, M. Geraldine, et al. "Can vestibular-evoked myogenic potentials help differentiate Ménière disease from vestibular migraine?." Otolaryngology--Head and Neck Surgery 146.5 (2012): 788-796.
28. Rosengren, Sally M., and Herman Kingma. "New perspectives on vestibular evoked myogenic potentials." Current opinion in neurology 26.1 (2013): 74-80.
29. Heide, Günther, et al. "Brainstem representation of vestibular evoked myogenic potentials." Clinical neurophysiology 121.7 (2010): 1102-1108.
30. Weber, Konrad P., and Sally M. Rosengren. "Clinical utility of ocular vestibular-evoked myogenic potentials (oVEMPs)." Current Neurology and Neuroscience Reports 15.5 (2015): 22.
31. Salviz, Mehti, et al. "Diagnostic value of frequency-associated vestibular-evoked myogenic potential responses in Ménière's disease." Audiology and Neurotology 20.4 (2015): 229-236.
32. Lee, Sun-Uk, et al. "abnormal cervical Vestibular-evoked Myogenic Potentials Predict evolution of isolated recurrent Vertigo into Meniere's Disease." Frontiers in neurology 8 (2017): 463.
33. Murofushi, Toshihisa. "Vestibular evoked myogenic potential." World J Otorhinolaryngol 4.2 (2014): 6-11.
34. Jung, Jae Hoon, et al. "Prognostic significance of vestibulospinal abnormalities in patients with vestibular migraine." Otology &Neurotology 36.2 (2015): 282-288.
35. Mojahed, Mohammad El-Sayed, et al. "Ocular vestibular evoked myogenic potential in patients with myasthenia gravis: A prospective clinical study." AurisNasus Larynx 45.3 (2018): 407-411.

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36. Rosengren, Sally M., and James G. Colebatch. "The contributions of vestibular evoked myogenic potentials and acoustic vestibular stimulation to our understanding of the vestibular system." Frontiers in neurology 9 (2018): 481.
37. Silva, Tatiana Rocha, et al. "Applications of vestibular-evoked myogenic potentials: a systematic literature review."
38. Utkur, BurcuÇatýker, et al. "Evaluation of VEMP Findings in Migrainous Vertigo, Migraine and Meniere's Disease." The Journal of International Advanced Otology 9.3 (2013): 359.
39. Uyarılmış, MigrenliHastalardaServikalVestibüler. "Evaluation of Cervical Vestibular Evoked Myogenic Potentials in Patients with Migraine."
40. Kılıç, S., et al. "Cervical vestibular evoked myogenic potentials to air-conducted sound in early amyotrophic lateral sclerosis." Neurophysiologie Clinique/Clinical Neurophysiology 42.3 (2012): 119-123.