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RESEARCH ARTICLE

CERVICAL VESTIBULAR EVOKED MYOGENIC POTENTIALS IN PATIENTS WITHTYPE IIDIABETES MELLITUS

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Abstract

Introduction: Vestibular impairment has been demonstrated in patients with diabetes mellitus. Vestibular evoked myogenic potential (VEMP) is a short latency electromyographic response to sound or vibration stimuli that may reflect otolith organ or related reflex functions. cVEMPs are summation responses recorded from the contracted sternocleidomastoid inresponse to synchronized acoustic stimulation of the ipsilateral ear/saccule.In diabetic patients.
Objective: Here, we asses prevalence of vestibular dysfunction by measuring cVEMP findings in patients with diabetes mellitus typeII.
Methods: This study was carried out on two groups of subjects including 20 adult subjects with diabetes mellitustypeIIand 20 adult subjects'non-diabetics, both group their aged ranged from 20-60 years.
Results:showed statistically significant difference in cVEMP between diabetes mellitus type 2 control group with increase in latencies of P1 and N1 and decrease in amplitude.
Conclusion: In diabetic individuals who are asymptomatic and never complained of vestibular dysfunction, cVEMPsis able to identify these patients.

Introduction:-

Diabetes mellitus (DM) is a chronic metabolic disease characterizedby deficiency of insulin causing chronic degenerativecomplications affecting almost every organ of the human body [(1)].

Patients with DM mostly suffering from peripheral neuropathy and retinopathy that consecutively affect balance leading to balance impairment [(2,3).]

Although the exact mechanism has not yet been fully clarified,studies by Agrawal et al. [(4&5)],Ward et al. [(6)]. recorded vestibular dysfunction in diabetic patients, with ratio of 70%higher in diabetic patients than non-diabetic healthy persons.

One of the objective test batteries used for assessment of the peripheral vestibular dysfunction is cervical vestibule-evoked myogenic potentials (cVEMP)

Vestibular-evoked myogenic potentials (VEMP) are short latency electromyographic responses to high-intensity soundstimuli that may reflect saccule and inferior vestibular nervefunctions, called cervical VEMP (cVEMP) [(7)]

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VEMP findings in DM show conflictingresults in the literature that could be attributed to several factors first, the number of studies evaluating vestibular endorgan pathologies with objective vestibular testing tools in diabeticpatients is still insufficient in the literature. Secondly, heterogeneouspatient groups, particularly in terms of disease duration andHbA1c levels, may affect the VEMP responses. DM has thecapabilityof generating multi-organ disease, including the central andperipheral vestibular system. Therefore, results obtained fromobjective vestibular diagnostic tools can be affected by the degreeand localization of DM-induced pathology involving vestibularstructures.

Objective:-

Studies of vestibular function in non-symptomatic diabetic patients with type II showed conflicting results. Thus, our aim was to assess the saccular functions using cVEMP testing, and also to study the correlation of duration of DM with the vestibular function specifically the saccular function.

Methodology:-

The present study was conducted in the Department of the audio-vestibular medicine at Hearing and Speech Institute, Egypt.

Written informed consent was obtained fromthe participants and the study. The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Institutional Review Board of General organization of teaching hospitals and institutes (GOTHI)

We recruited 40 participantsdivided into 2 groups: The study group consisted of 20adult subjects withdiabetes mellitus type 2(group 1), and the control group (group 2) consisted of 20healthy adults subjects (non diabitics). All cases were subjected to carful history taking including onset and duration of DM, medications, andhistory of complication of DM, basic audiological evaluation including pure tone audiometry for both air conduction (for the frequency range 250 - 8000Hz) and bone conduction (for the frequency range 500 - 4000Hz), speech audiometryusingTwo Channel Audiometer (Interacoustics, model AC40) Denmark,and Acoustic Immittancemetry using Middle ear analyzer (Interacoustics model Az26) Denmark. The diagnosis of DM was made according to the American Diabetes Association criteria [(1)]. Patients with fasting plasma glucose (PG) $\geq$ 126, second hour PG $\geq$ 200 during the 75-g oral glucose tolerance test or spot PG $\geq$ 200 with Symptoms related to diabetes were diagnosed as DM.

Subjects with symptoms of balance impairment, conductive hearing loss, ototoxic drug use, blindness or poor neck range of motion were excluded from the study.

Cervical vestibular evoked myogenic potentials (cVEMP):

All participants of the study subjected to cVEMPs using Evoked potential system GSI Eclipse.each percipient was asked to lie down on a couch and to contract the ipsilateral sternocleidomastoid muscleby doing flexion of the head to 20°–30° opposite to gravity so. Electrodes were placed such that the positive electrode was placed onsternocleidomastoid, negative on the sternum, and the ground electrode was placed on the forehead. Tone purst (95 dB nHL stimulus intensity) at a frequency of 500 Hz were presented through a headphone on the ear being tested, and the EMG activity was recorded. The latencies of P1 and N1 were measured, the inter amplitude of the waveform obtained was also calculated by difference betweenthe P1and N_1(P1−N1).

Data Analysis

The data were analyzed using SPSS software(Version 23). The quantitative results were presented withthe mean and standard deviation. Data between groups were analyzed by one-way ANOVA, and multiplecomparisons were performed by LSD method. The elicited rates of c -VEMP testing werecompared in two groups by chi-square test. The Pearson's correlation coefficient was used to evaluate thepossible relationships between quantitative data. A p-value less than 0.05 or 0.01 (P□0.05, P□0.01) wasconsidered statistically significant.

Results:-

The present study comprised 40 adult subjects divided into 2 groupsthe study group include 20 adult patients with type 2 DM(13 males and 7 females)The mean age for diabetic patients 50 years ± 1.57 years with an age range of 40 - 60years with their mean,and 20 adult healthy participants (11 males and 9 females) without DM and within normal

peripheral hearing threshold in both ears. the mean age was 36 years ± 9.73 years with an age range of 20- 54 years. The meanduration of diabetes disorder was 11.55±3.72 years.

As regards to hearing threshold's findings in both groups we found that the mean of PTA threshold in controlgroup was withinnormal range in both ears, and, on the other hand the mean of PTA threshold in diabetic patients showed mild to moderate sensorineural hearing loss (SNHL)bilaterallyat high frequencies (at 2-8KHz)in 15 cases and 2 cases had unilateral mild(SNHL) at high frequencies (at 2-8KHz) and 3 cases had bilateral normal peripheral hearing threshold(Table 1,2) analysis of data was performed in cases who had mild to moderate sensorineural hearing loss (SNHL)bilaterally at high frequencies (at 2-8KHz)(15) cases.

Regarding to cVEMP test waves of cVEMP recorded in 18 cases only in both ears, and absent in 2 cases, analysis of results only performed in cases with cVEMP response. By comparing the latency of P1and N1, and amplitude of c VEMP inboth right and left ears between the 2 tested group (Table 3) there was statistically significant difference between control group and study group in latencies of P1and N1 and amplitude. And also,there was statistically significant correlation between the duration of the DM and latencies of cVEMP(Table4).

Table (1):- Mean and Standard deviation (SD)of Pure tone threshold at tested frequenciesfor both ears for controlgroups.

frequency	Right(20 ears)			Left(20 ears		
	Mean	SD.	Range	Mean	SD.	Range
250 Hz	19.5	2.2	10	18	2.99	10
500 Hz	19.5	2.2	10	18	2.99	10
1000 Hz	19.5	2.2	10	19.75	1.9	10
2000 Hz	26.2	4.8	20	19.5	2.2	10
4000 Hz	19.5	2.2	10	19..5	2.2	10
8000 Hz	19.5	2.2	10	19..5	2.2	10

Table (2):- Mean and Standard deviation (SD)ofpure tone thresholdat tested frequenciesfor both ears for study groups.

Frequency						
	Right(15 ears)			Left(15 ears)		
	Mean	SD.	Range	Mean	SD.	Range
250 Hz	23	8.013	30	21.25	7.232	25
500 Hz	23	8.013	30	22..25	10.062	35
1000 Hz	24	8.675	30	26.5	13.188	45
2000 Hz	3125	11.341	45	31.2	13.917	50
4000 Hz	34.25	12.594	40	38.25	15.498	50
8000 Hz	33	17.851	55	41.45	16.996	60

Table (3):- Mean and SD of cVEMP "s parameters for control and study groups in both ears using t- test.

cVEMP	control group (n=20)		cases group (n= 18)		t-test	p-value
	Mean	SD.	Mean	SD.		
P1- Rt	14.07	1.132	18.98	2.214	-4.74	.000***
N1-Rt	23.54	0.723	27.52	6.311	-5.42	.000***
AMP-Rt	117.94	58.972	125.21	37.031	-4.88	.000***
P1-Lt	14.10	1.157	19.45	1.862	5.42	.000***
N1-Lt	23.58	0.765	28.28	6.520	-4.88	.000***
AMP-Lt	148.37	60.036	127.31	38.158	-1.86	.000***

*** Highly statistically significant difference (p value < 0.01)

Table (4):- Correlation between cVEMP and duration of s diabetes mellitus.

Duration	cVEMP					
	P1- Rt	N1-Rt	AMP-Rt	P1-Lt	N1-Lt	AMP-Lt
R	.739**	.305	.087	.828**	-.361*	-.154

p-value	.000	.055	.593	.000	.022	.343

Correlation is significant at the 0.05 level (2-tailed)

Discussion:-

In ourcurrent case- control study, we compared the peripheral auditory threshold and saccular function of the peripheral vestibular systembetween diabetic adults with type 2 DM (cases) and, healthy participantsnon-diabeticwith normal peripheralhearing thresholds controls.

As regards to the auditoryevaluation in both groups diabetic patients showed statistically significant difference in hearingthreshold ofhigh frequency which affects mainly high frequencies from 2 through 8KHz, with mild to moderate degree of sensorineural type.This agreedwith Nourizadeh etal. [8] who also performed case control study between diabetics and non-diabetics and found that The PTA showed a significant difference between the two groups. The differences were minimal at lower frequencies and increased towards higher frequencies, also Konrad-Martin D et al. [9] reported that diabetes mellitus is a progressive bilateral sensorineural hearing loss, which mainly affect higher frequencies, similar to presbycusis their explanation of this results is attributed to the vascular insufficiency to the cochlea. But these findingsdisagreed withShargorodskyetal. [10] who performed prospective cohort study and they foundthat history of hypertension, diabetes mellitus, or obesity is not associated with increased risk of hearing lossThis differencebetween the studies may be explained by various reasons.one of these reasons is relationship between the duration of diabetes and the degree of hearing loss [11]. Moreover, the severity of diabetes and the ways to control it could affect this relationship. The quality of diabetes control was also unknown in different studies and could affect the study results.

The pathogenesis of hearing loss in DM explained by variousMechanisms which includes: atrophy or thickening of the stria vascularis[12], oxidative stress[11], microvascular abnormalities [11] sclerosis of the internal auditory artery and thickening of the basilar membrane and stria vascularis[12],auditory neuropathy [11],hearing cell dysfunctions due to electrolyte homeostasis change in endolymph[13].Results were also indicative of the relationship between diabetes and vestibular dysfunction. It has been reported that diabetes could increase the risk of vestibular dysfunction [14&15]. Even patients with bilateral vestibular hypofunction have a higher chance to develop diabetes.

In our study,parameters ofcVEMPswere statistically significant different between both studied groupswith an increasein latency of P1and N1and decrease in amplitude in patients with diabetes mellitus type 2 compared with controlgroup (Table 3).

Konukseven et al. [16],also found prolonged cVEMP latencies in patients with diabetes (n = 30) compared to prediabetes (n = 30) and healthy controls (n = 31).

This agreed with Agrawal et al.[5] who reported a prevalence of vestibular dysfunction in 35.4% of patients diagnosed as diabetics .they assumed thatdelayed cVEMP latencies in diabetic patients may be indicative of a neuropathy of inferior vestibular nerve similar to the neurovascular damage seen in peripheral neuropathy in patients with diabetes mellitus, where prolonged latencies in nerve conduction studies are considered diagnostic[6]. These findings suggest increased vulnerability of vestibular hair cells to oxygen deprivation or metabolic disturbances.

Hamed et al[17] agreed with our results but their study was performed in children with type 1 DM and the found that Compared to healthy childrendiabetic patients had prolonged cVEMP P1 and N1 latencies and reduced P_{13}-N_{13} amplitude. Bilateral cVEMP abnormalities were found in 60% (vs 25% for unilateral abnormalities).

On the other hand , these finding disagreed with Ward et al.,[18] where in their study, 32% of patients with type II diabetes mellitus showed absent responses.

Also, Nourizadehetal foundthe results of the cVEMP test revealed that two cases had prolonged latencies in both ears and one case had amplitude asymmetry. The difference between the case and control groups was not significant (P□0.05).

Previous literatures explained cVEMP abnormal findings bythe localization of injury within the vestibular organs and their pathways. They suggested that reduced P1-N1amplitude is due to labyrinthine pathology, while prolonged

P1and N1 latencies are due to retrolabyrinthine pathology[19]Murofushietal.[19] observed prolonged P1of cVEMP (i.e. slow conduction) with multiple sclerosis and large acoustic neuroma, suggesting brainstem pathology secondary to demyelination in the vestibulo-spinal tract.
Significant positive correlation was found between the duration of DM and latencies of cVEMP in our study(Table 4)

Zhang etal [20]also found that cVEMP latency (P1,N1) were positively correlated with illness duration, regardingcVEMP, the bilateral $P1_1$ and N1 latencies were prolonged in the diabetic patients with peripheral neuropathy compared to the healthy control (all $P<0.01$),

Hamed et al. [18] also studied the correlation of duration of DM and cVEMP latencies in children with type 1 DM, their study included 40 patients with mean age of 13.63 ± 1.50 years, duration of diabetes of 5.62 ± 2.80 years and they found that differences in VEMP changes in relation to diabetes duration (i.e. > 5 years vs ≤ 5 years) Dysfunction or injury of the saccular macula and its pathways is prevalent in children with Type 1 DM.

Conclusion:-

The results of our study suggest that there is an association between diabetes mellitusand auditory and vestibular impairment. Also, there is a correlation between the duration of diabetes mellitus and vestibular dysfunction.

References:-

1- American Diabetes Association, 2012. Standards of medical care in diabetes. 2012.
Diabetes Care 35, 11e63.
2- Simoneau, G.G., Ulbrecht, J.S., Derr, J.A., Becker, M.B., Cavanagh, P.R., 1994. Postural instability in patients with diabetic sensory neuropathy. Diabetes Care 17, 1411e1421.
3- Schwartz, A.V., Vittinghoff, E., Sellmeyer, D.E., Feingold, K.R., de Rekeneire, N., Strotmeyer, E.S., Shorr, R.I., Vinik, A.I., Odden, M.C., Park, S.W., Faulkner, K.A.,
Harris, T.B., Health, Aging, and Body Composition Study, 2008. Diabetes-related
complications, glycemic control, and falls in older adults. Diabetes Care 31, 391-396.
4-Agrawal et al., 2009: Agrawal, Y., Carey, J.P., Della-Santina, C.C., Schubert, M.C., Minor, L.B., 2009. Disorders of balance and vestibular function in US adults: data from the national health and nutrition examination survey, 2001-2004. Arch. Intern. Med. 169, 938-944.
5-Agrawal et al., 2010: Agrawal, Y., Carey, J.P., Della-Santina, C.C., Schubert, M.C., Minor, L.B., 2010. Diabetes, vestibular dysfunction, and falls: analyses from the national health and nutrition
examination survey. Otol. Neurotol. 31, 1445e1450.
6-Ward et al., 2015: Ward, B.K.,Wenzel, A., Kalyani, R.R., Agrawal, Y., Feng, A.L., Polydefkis, M., Ying, H.S., Schubert, M.C., Zuniga, M.G., Della-Santina, C.C., Carey, J.P., 2015. Characterization of vestibulopathy in individuals with type 2 diabetes mellitus. Otolaryngol. Head Neck Surg. 153, 112e118.
7- Rosengren SM, Kingma H (2013) New perspectives on vestibular
evoked myogenic potentials. CurrOpin Neurol 26:74–80.
8- NavidNourizadeh , Mina Jahani, SadeghJafarzadeh,: Auditory and Vestibular Assessment of Patients with Type Two Diabetes Mellitus: A Case-Control Study.
Iranian Journal of Otorhinolaryngology, Vol.33(5), Serial No.118, Sep-2021
9-Konrad-Martin D, Austin DF, Griest S, McMillan GP, McDermott D, Fausti S. Diabetes-related changes in auditory brainstem responses. Laryngoscope 2010;120(1):150-158Mccrimmon RJ, Deary IJ, Frier BM. Auditory information processing during acute insulin-induced hypoglycaemiainnon-diabetic human subjects. Neuropsychologia. 1997; 35(12):1547-1553.
10- Shargorodsky J, Curhan SG, Eavey R, Curhan GC. A prospective study of cardiovascular risk factors and incident hearing loss in men. The Laryngoscope. 2010;120(9):1887-91.
11 Gupta S, Eavey RD, Wang M, Curhan SG, Curhan GC. Type 2 diabetes and the risk of incident hearing loss. Diabetologia. 2019;62(2):281-5.
12. Austin DF, Konrad-Martin D, Griest S, McMillan GP, McDermott D, Fausti S. Diabetes-related changes in hearing. The Laryngoscope. 2009;119(9):1788-96.
13. Frisina ST, Mapes F, Kim S, Frisina DR, Frisina RD. Characterization of hearing loss in aged type II diabetics. Hearing research. 2006;211(1-2):103-13.

14. Cohen Atsmoni S, Brener A, Roth Y. Diabetes in the practice of otolaryngology. Diabetes & metabolic syndrome. 2019;13(2):1141-50.
15. Albernaz PL. Hearing Loss, Dizziness, and Carbohydrate Metabolism. International archives of otorhinolaryngology. 2016;20(3):261-70.
16- Konukseven, O., Polat, S.B., Karahan, S., Konukseven, E., Ersoy, R., Cakir, B., Kutluhan, A., Aksoy, S., 2015. Electrophysiologic vestibular evaluation in type 2diabetic and prediabetic patients: air conduction ocular and cervical vestibular evoked myogenic potentials. Int. J. Audiol. 54, 536e543.
17- Sherifa Ahmed Hamed, Kotb Abbas Metwalley, Hekma Saad Farghaly, Amira Mohamed Oseily. Vestibular function for children with insulin dependent diabetes using cervical vestibular evoked myogenic potentials testing. World J Clin Pediatr 2022 January 9; 11(1): 61-70
18- Ward WK, LaCava EC, Paquette TL, Beard JC, Wallum BJ, Porte D Jr., et al. Disproportionate elevation of immunoreactiveproinsulin in type 2 (non-insulin-dependent) diabetes mellitus and in experimental insulin resistance. Diabetologia1987;30:698-702.
19-Murofushi T, Matsuzaki M, Wu CH. Short tone burst-evoked myogenic potentials on the sternocleidomastoid muscle: are these potentials also of vestibular origin? Arch Otolaryngol Head Neck Surg 1999; 125: 660-664 [PMID: 10367923 DOI: 10.1001/archotol.125.6.660] 1
20-Jinying Zhang, Jiayu Lin, Huapin Huang: Vestibular Nerve Function In Patients With Type 2 Diabetes Detected By Vestibular Evoked Myogenic
Potentials.Research square: DOI: https://doi.org/10.21203/rs.3.rs-1296202/v1.