Original Research Article

Study of brainstem auditory evoked response in type 2 diabetes mellitus

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ABSTRACT

Background: *Diabetes is a major cause of morbidity and among its complications neuropathies are the most common. Diabetes may alter both the central and peripheral nerve functions but the peripheral manifestations of diabetic neuropathy are more frequently discussed in the literature than the impairment of central nervous system.*

Objective: *To study the Brainstem Auditory Evoked Response (BAER) in 30 type 2 diabetes mellitus patients and compared to age and sex matched 30 non diabetic group.*

Methods: *30 Type 2 diabetics and 30 age and sex matched control group were selected and subjected to BAER. Duration of latencies, interpeak latencies and amplitudes were recorded.*

Results: *According to BAER report, Left side latencies III , both left and right IPL III – V , right side ampliude V decreased with p > 0.05 in type 2 DM compared to control group .*

Conclusion: *The study showed bilateral changes in BAER report in type 2 DM. This indicates use of evoked potentials like BAER helps in evaluating central neuropathy in patients with type2 DM. Earlier diagnosis of central neuropathy is recommended for proper management.*

Key words: *Brainstem Auditory Evoked Response, latencies, interpeak latencies, amplitude, neuropathy*

Introduction

The constellation of abnormalities caused by insulin deficiency is called diabetes mellitus. [1] Lack of control of diabetes may be due to absence of insulin production by the pancreas (Type 1 diabetes) or inability to produce enough insulin (Type 2 diabetes). Type 2 is often accompanied by insulin resistance (i.e., the body does not respond to its presence effectively), further exacerbating the problem. According to the American Diabetes Association more than 90% of patients with diabetes belong to type 2. [2]

According to the International Diabetes Federation (IDF), in 1985, 30 million people had diabetes worldwide. The number rose to 150 million in 2000,285 million in 2010 and it is estimated to be 435 million by 2030 (7.8% of the adult world population). India has the highest number of diabetics, in the world. By next year, the country will be home to 50.8 million diabetics, making it the worlds unchallenged diabetes capital. The number is expected to go up to 87 million (8.4 % of the country's adult population by 2030). [3] DM is a non communicable chronic disease with numerous cardiovascular, neurological and other complications. [4] A study funded by the National Institutes of Health (NIH) hearing loss is about twice as common in adults with diabetes mellitus compared to those who do not have the disease. [5]

The term auditory neuropathy was first coined in late 1970's. It was also referred to as central auditory dysfunction and auditory neural synchrony disorder.

However the term auditory neuropathy has found more favor. It is an overlap syndrome between otology and neurology. [6] Earlier studies conducted showed weak correlation or no correlation between diabetes mellitus and hearing loss. But some studies have shown positive correlation between hearing loss and DM. Diabetes mellitus can lead to Sensory Neural Hearing Loss mainly by causing damage to the auditory portion of eighth cranial nerve, which is located between cochlea and the brainstem. This condition is also called as auditory neuropathy due to diabetes mellitus. [6]

Brainstem Auditory Evoked Response (BAER) is an objective way of eliciting brain stem potentials in response to audiological click stimuli. These waves are recorded by electrodes placed over the scalp. This investigation was first described by Jewett and Williston in 1971. Even though BAER provides information regarding auditory function and sensitivity, it is not a substitute for other methods of audiological evaluation. It should be always viewed in conjunction with other audiological investigations. In auditory brain stem evoked response audiometry, the impulses are generated in the brain stem. These impulses when recorded contain a series of peaks and troughs. The positive peaks are referred by the Roman numerals I-V. These peaks occur in response to click stimuli over a period of 1-10 milliseconds after the stimulus is given. [7] The ABR (Auditory Brainstem Response) test measure the neural synchrony of the auditory nerve through the auditory brainstem structures. Evoked potentials are electric signals from the central nervous system triggered in response to the stimulation of a receptor. These tests are characterized by very high sensitivity, although not specificity, they are non- invasive and have no side effects. A nerve tract damage increases the latency and reduces the amplitude of the response. Five waves are distinguished in the auditory brainstem response. Waves are corresponded to the conduction of potential in the particular structure in the central nervous system. [8] This study was carried out to study the Brainstem Auditory Evoked Response in type 2 diabetes mellitus patients and compared to age and sex matched control group.

Material and methods

This was a case control study carried out at Narayana Medical Collage and hospital, Nellore for duration of 12 months from August 2010 to 2011. Test group includes type 2 DM patients attending outpatient department. 30 diabetic individuals between 40- 60 yrs of age, including both sex with no past history of consumption of ototoxic drugs, ear surgeries**,** infections of ear, nose and throat were included. Occupational history (where noise pollution is more) such as factory workers, traffic police were excluded. The control group was 30 teaching & non teaching healthy staff individuals of the college aged between 40 - 60 yrs, including both sex with no history of DM. Informed consent was taken from both the groups. All the subjects underwent a detailed clinical examination before being included in the study as per the study protocol and study was approved by institutional ethical committee. Both case and control group were subjected to Brainstem Auditory Evoked Response (BAER). A brief auditory stimulation generates action potentials in the auditory pathway and these potentials were recorded from the ear and vertex as BAER. Absolute latency, inter peak latency and waves were

recorded. Absolute latency measured in msec from peak of the respective waves and Absolute amplitude measured in microvolts (uV) from the peak of the wave to the bottom of the wave. Commonly used Interpeak latency (IPL) in clinical practice are I-V, I-III and III-V. I-V IPL means latency difference between wave I and V, I-III IPL means latency difference between wave I and III and III -V IPL means latency difference between wave III and V. [9] Wave I was generated from distal part of auditory nerve, Wave II from proximal part of auditory nerve, III mainly from the cochlear nucleus, IV mainly from superior olivary complex & also from lateral leminiscus and Wave V was generated mainly by lateral leminiscus (positive component) & inferior colliculus (negative components). [10] Analysis was done by SPSS package, the data was subjected to Student t - test to know the p values significance.

Results

Left side BAER report, among Latencies I, III & V, latency III is decreased with p value 0.012 in diabetic when compared to non diabetic group. (Fig. 1) Among Interpeak letencies I-III, I-V & III-V , IPL III -V is decreased with significant p value of 0.012 in diabetic when compared to non diabetic group. (Fig. 2) Left side amplitude I and V were not significant in diabetic when compared to non diabetic group. (Table:1) Right side interpeak letencies, among Interpeak letencies I – III , I – V & III – V, IPL III – V is decreased with significant p value of 0.010 in diabetic compared to non diabetic group. (Fig. 3) Right side ampliude, among ampliude I & V, amplitude V is decresed with significant p value of 0.024 in diabetic compared to non diabetic group. Right side latencies were not significant in diabetic when compared to non diabetic group. (Fig. 4, Table:2) Decrease in the latencies, interpeak latencies & amplitude indicates that there is a delay in transmission of auditory impulse as well as neuropathy at brainstem level in the auditory pathway.

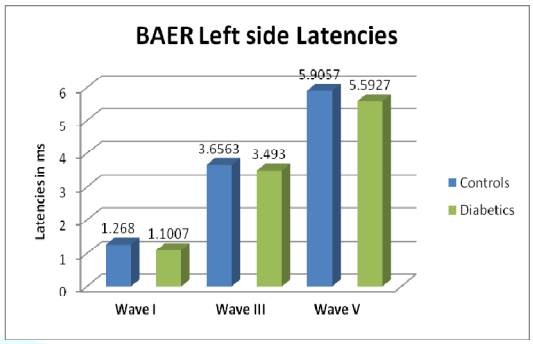

Fig. 1 Left side BAER

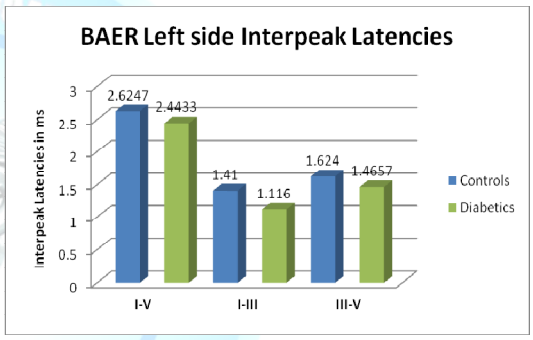

Fig. 2 BAER left side Interpeak latencies

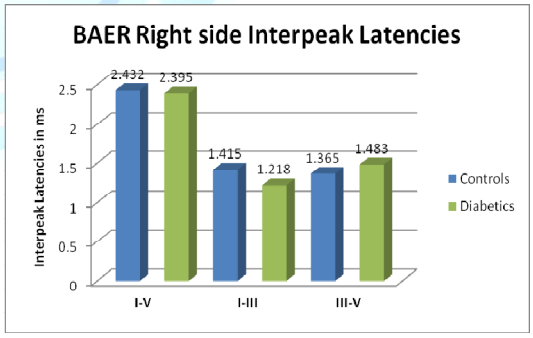

Fig. 3 BAER right side Interpeak latencies

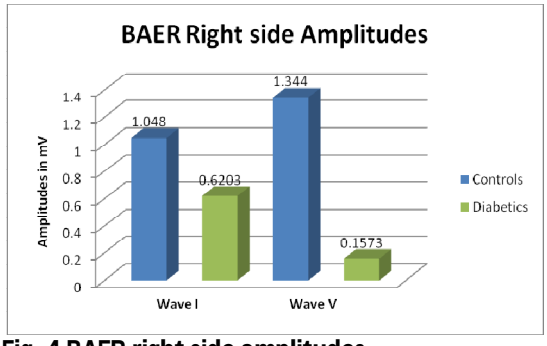

Fig. 4 BAER right side amplitudes

Table:1 Brain stem auditory evoked responses (Left)

		Latency (ms)			Interpeak latency (ms)			Amplitude (µv)	
		I	III	V	I-V	I-III	III-V	I	V
Non Diabetic	Mean±SD	1.1±1.0	3.2±1.8	5.9±0.3	2.4±2.0	1.4±1.2	1.4±0.8	0.1±0.1	1.3±4.4
Diabetic	Mean±SD	1.4±1.6	3.3±1.9	5.4±2.0	2.4±2.0	1.2±1.2	1.5±0.9	0.6±3.1	0.2±0.1

Table:2 Brain stem auditory evoked responses (Right)

		Latency (ms)			Interpeak latency (ms)			Amplitude (µv)	
		I	III	V	I-V	I-III	III-V	I	V
Non Diabetic	Mean ± SD	1.3 ±1.0	3.7±1.3	5.9±0.3	2.6±2.0	1.4±1.1	1.6±0.7	0.1±0.3	0.7±2.7
Diabetic	Mean ±SD	1.1 ±1.1	3.5±1.8	5.6±1.9	2.4±2.2	1.1±1.2	1.5±0.9	0.1±0.1	0.2±0.1

Discussion

The auditory system requires glucose and high-energy for its complex signaling. This suggests that the cochlea may also be a target organ for the ill effects of hyperglycemia. Increased glucose exposure, even for short periods, initiates a metabolic cascade that could disrupt the cochlea both anatomically and physiologically. Histopathalogical studies in patients with SNHL due to diabetes mellitus have shown damage to the nerves and blood vessels of inner ear.

In our study the mean of duration of DM was 9.333 & mean right IPL III-V is 1.4830 and mean left IPL III-V is 1.4657 with a significant p value < 0.05(Right IPLIII-V =0.010 & Left IPL III-V= 0.012). This study correlates with the study conducted by Chi-Ren Huang & Rahul Gupta in which IPL I – III, III – V & I-V was delayed in diabetic group, Suggesting delayed transmission of auditory stimulus in the auditory pathway of diabetics at the level of brainstem and midbrain. The delay in the latency of wave III&V in diabetics indicate neuropathy at brainstem and midbrain level in the auditory pathway. [11]

In our study the loss of hearing in diabetic males when compared to diabetic females showed no difference. The same is correlated with the study carried out by Dhanraj GA in 2006. However other studies have showed that male diabetics were having higher hearing loss when compared with female diabetics though, the difference was not statistically significant. [12] Atrophy of spiral ganglion in the cochlea, demyelination and beading of the myelin sheaths of the VIII cranial nerve & lack of degenerative change in central auditory pathways are the main pathological findings in patients with DM. [11]

The exact pathophysiology of SNHL in DM is not known. Various mechanisms have been put forward some of the more accepted ones are discussed below. Increased permeability of endothelium of the stria vascularis may lead to changes in auditory electrolyte homeostasis in the endolymph. This can interfere with hair cell signal transduction and transmission. Hemorrhage in the endolymph and perilymph, loss of hair cells and atrophy of spiral ganglion was also observed in many histopathalogical studies. Similar changes may occur in the diabetic cochlea, where tight junctions act as anatomical barriers between perilymph and endolymph, which can lead to altered cochlear ionic homeostasis. [13] Three main mechanisms have been proposed to explain pathogenic mechanism of Diabetic neuropathy.

- Alteration of endoneural vessels leading to widespread anoxia or multiple infarcts.
- Metabolic abnormalities that include reduction of free myoinositol, Na+ K+ ATPase & rate of protein synthesis.
- Direct alteration of protein by nonenzymatic glycosylation.

Each or a combination of these mechanisms could lead to axonal degeneration by impairing axonal transport or causing a direct injury to axon. [14] So patients with type 2 diabetes can have subclinical hearing loss & impaired auditory brainstem responses, independent of peripheral neuropathy. Central neuropathy in type 2 DM is not uncommon even in absence of peripheral neuropathy. Our study showed delay in left side latency III, both right and left interpeak latency III - V and right side amplitude V in patients with type 2 DM with duration of more than 5yrs, which is a sign of central neuropathy. Early diagnosis of central neuropathy is recommended for proper management. BAER is a simple, non-invasive procedure helps in detecting central neuropathy. So BAER could be useful tool in the early diagnosis and proper management of SNHL in type 2 DM with duration of more than 5yrs.

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