

## Original Research Article

# Brainstem auditory responses in type-2 diabetes mellitus

Siddharth Suresh, Sharwak Ramlan\*, Gangadhara Somayaji, Nimalka Sequeira

Department of Otorhinolaryngology, Yenepoya Medical College Hospital, Mangalore, Karnataka, India

**Received:** 06 December 2017

**Revised:** 07 January 2018

**Accepted:** 09 January 2018

### \*Correspondence:

Dr. Sharwak Ramlan,

E-mail: [drsharwak@yahoo.com](mailto:drsharwak@yahoo.com)

**Copyright:** © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

## ABSTRACT

**Background:** Diabetes mellitus causes pathophysiological changes at multiple organs. Brainstem Evoked Response Auditory (BERA) represents a non-invasive tool to detect diabetes related sensorineural hearing loss. The aim was to assess diabetes related central auditory pathway involvement using BERA.

**Methods:** The study comprises two groups, (i) Diabetic group (n=15), (ii) Control group (n=15). The controls were matched for age and sex with the study group. BERA was done for all these patients after detailed clinical examination and relevant blood investigations.

**Results:** There was significant latency differences found in wave III, V and interpeak latencies I-III, III-V and I-V between control and study groups at 70 dBnHL and 80 dBnHL. At 90 dBnHL the diabetic group demonstrated significant latency differences in waves I, III and V and interpeak I-III, III-V and I-V compared to controls. The duration of DM was 5-10 years in 8 patients (53.3%) out of which 7 subjects (87.5%) had prolonged BERA. 7 patients (46.6%) were diabetic for more than 10 years of which all patients (100%) had prolonged latencies.

**Conclusions:** The wave I latency was found non significant which suggests that the pathway from 8<sup>th</sup> nerve to cochlear nucleus is not affected in diabetic patients. The delay in latencies III and V and interpeak latencies I-III, III-V and I-V in diabetic patients compared to the controls suggests brainstem and midbrain involvement. So the study suggests that BERA helps in early detection of central neuronal axis involvement in type-2 diabetes mellitus.

**Keywords:** Brainstem evoked response audiometry, Type-2 diabetes mellitus, Sensorineural hearing loss

## INTRODUCTION

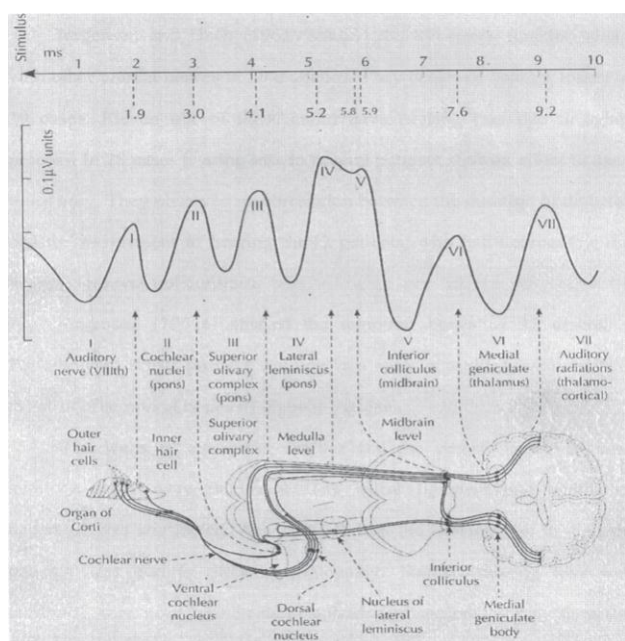
Diabetes mellitus (DM) is a systemic disease targeting multiple organs comprising of a group of metabolic disorders that share the phenotype of hyperglycaemia. Neuropathy is the most frequent late complication of diabetes mellitus. Histopathologic studies of inner ear in diabetic patients show microangiopathic changes.<sup>1,2</sup>

The hearing loss in diabetics is bilateral slowly progressive sensorineural hearing loss.<sup>3</sup> Brainstem evoked response audiometry is a procedure to detect both acoustic nerve and CNS damage based upon electric potentials generated by the auditory pathway in response to electric stimuli.<sup>2</sup> Seven waveforms (wave I-VII) are

formed, each designated to a specific site (Figure 1). The objective of the study was to find out central auditory pathway involvement in diabetes mellitus using BERA.

## METHODS

The study was conducted in the Department of ENT, Yenepoya Medical College Hospital from June 2016 to June 2017 after obtaining clearance from the institutional ethics committee. The study comprises two groups, (i) Diabetic group (n=15), (ii) Control group (n=15). All patients were enrolled for the study after obtaining written informed consent. A detailed clinical examination was performed. Fasting, post prandial blood sugars and HbA1c were checked.



**Figure 1: Anatomy of BERA waveforms.<sup>2</sup>**

The controls were matched for age and sex with the study group. The equipment used for recording evoked response audiometry was Neuroaudio BERA.

BERA was recorded by placing inverting electrode at the testing mastoid process and non inverting electrode at the opposite mastoid process. One more earthing electrode is placed over the forehead. This earthing electrode is important for proper functioning of preamplifier. Its threshold has been found to be within 10dB as elicited by conventional audiometry. The stimulus was a 100 microsecond clicks in response to which recording in the form of waves were generated. The recordings were done

at intensities 70, 80 and 90 dBnHL. In both the study and control groups, testing was done at each intensity twice to check for replicability of the waveforms.

**Inclusion criteria**

Inclusion criteria were age group 30 years and above; patients with Type II DM according to WHO diagnostic criteria (a random blood sugar equal to or greater than 200 mg/dl or a fasting blood sugar equal to or greater than 126 mg/dl or with a HbA1c of 6.5% or higher) with a duration of five years or more.

**Exclusion criteria**

Exclusion criteria were patients who gave history of ear disease, exposure to prolonged loud noise, intake of ototoxic drugs, stroke, head injury and family history of deafness; patients taking any medication which might be expected to interfere with the functioning of the central nervous system.

**Statistical analysis**

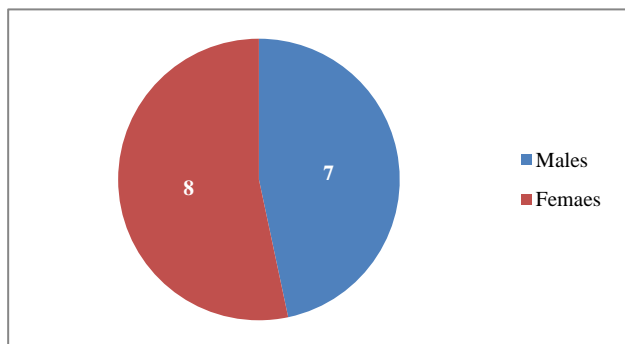
An independent t-test was used to compare the BERA findings of diabetic and control subjects. A p<0.05 was considered statistically significant.

**RESULTS**

The BERA testing was performed on 15 diabetic subjects, 8 (53.3%) females and 7 (46.6%) males (Figure 2). The mean age of the study group was 50.6 years. 15 patients with a mean age of 48.7 years were taken as control. The pattern of the latencies III and V and interpeak latencies, I-III, III-V and I-V were estimated at 70 dBnHL, 80 dBnHL and 90 dBnHL (Table 1).

**Table 1: Comparative BERA results of diabetic and control groups.**

Wave latencies	Intensity (in dBnHL)	Control group Mean±S.D. (ms)	Diabetic group Mean±S.D. (ms)	P value
I	70	1.58±0.15	1.59±0.14	0.795
III	70	3.92±0.40	4.06 ±0.39	0.021
V	70	5.73±0.53	6.15±0.54	<0.001
I-III	70	1.93±0.27	2.08±0.30	0.047
III-V	70	1.80±0.14	1.96±0.18	0.008
I-V	70	3.62±0.33	3.86±0.57	0.046
I	80	1.72±0.35	1.74±0.49	0.838
III	80	3.74±0.41	3.91±0.27	0.002
V	80	5.64±0.30	5.86±0.52	0.021
I-III	80	2.00±0.41	2.31±0.26	<0.001
III-V	80	1.79±0.16	1.93±0.24	0.009
I-V	80	3.78±0.44	4.09±0.46	<0.001
I	90	1.43±0.19	1.56±0.51	0.190
III	90	3.57±0.42	3.75±0.21	0.045
V	90	5.38±0.65	5.62±0.35	0.045
I-III	90	2.12±0.24	2.22±0.21	0.049
III-V	90	1.76±0.25	1.91±0.23	0.021
I-V	90	3.89±0.26	3.97±0.34	0.035



**Figure 2: Study group sex distribution.**

There was significant latency differences found of wave III and interpeak I-III, III-V and I-V and highly significant difference in wave V between control and study group at 70 dBnHL.

Highly significant differences was seen in latencies of interpeak I-III and I-V while significant differences were seen in latencies of waves III and V and interpeak III-V between control and study at 80 dBnHL.

Between control and study group at 90 dBnHL, there was significant latency differences in waves I, III and V and interpeak I-III, III-V and I-V.

The duration of DM was 5-10 years in 8 patients (53.3%) and among these patients BERA was delayed in 7 subjects (87.5%). 7 patients (46.6%) were diabetic for more than 10 years out of which all patients (100%) had BERA delay.

## DISCUSSION

BERA is a reliable, non-invasive test for diagnosis of lesions ranging from 8<sup>th</sup> nerve to the auditory cortex. Diabetic patients are more prone to develop sensorineural hearing loss. A study conducted by Rosen et al showed that 152 out of 265 diabetic patients had bilateral symmetrical high frequency sensorineural hearing loss. Friedman et al demonstrated symmetrical sensorineural deafness in 55% diabetic patients with neuropathy.<sup>4,5</sup>

The latency difference of wave I in study and control group in all the three intensities was not significant which suggests that the 8<sup>th</sup> nerve transmission till the level of the cochlear nucleus was not altered in diabetics. BERA in 20 diabetic patients recorded by Mehra et al found that the 8<sup>th</sup> cranial nerve transmission till the level of cochlear nucleus was normal in diabetic patients.<sup>6</sup>

In this study, a statistically significant prolongation was observed in wave III latency at 70, 80 and 90 dBnHL in diabetic group compared to the control group. Similarly the latency of wave V was delayed in 70, 80 and 90dBnHL in diabetic group as compared to the controls. This finding was also established in a study done by Virtaniemi et al, who found that wave V latency was

delayed in diabetic subjects. This indicated central pathway involvement.<sup>7</sup>

In this study it was found out that there was a delay in interpeak latencies I-III, III-V, I-V in the diabetic group which suggests delayed transmission of the auditory stimulus in the auditory pathway of diabetics at the level of brainstem and midbrain. Fidele et al found the latencies of ABR waves were significantly impaired in diabetic subjects compared to control. The central transmission time (Wave I-V) was significantly delayed in diabetic patients.<sup>8</sup>

Kurien et al did pure tone audiometry in 30 diabetic patients and 30 controls and found that diabetics had poorer hearing threshold than non diabetics. All diabetic age groups showed significant high frequency hearing loss as compared to control population.<sup>9</sup>

Out of 15 diabetic patients, 6 patients (40%) had peripheral neuropathy and BERA was delayed in 5 patients (83.3%). Sharma et al studied 25 diabetic patients and found using audiometry that peripheral neuropathy in 85.71% with abnormal brainstem response while 36.6% subjects without neuropathy had abnormal brainstem response.<sup>10</sup>

In this study, 7 patients had diabetes for more than 10 years, among these BERA was delayed in all the cases. Hence we could infer that longer duration of diabetes is a definitive risk factor for development of central neuropathy. Another study conducted by Gupta et al showed that 12 out of 25 diabetic patients had diabetes for more than 10 years of which 11 (91.66%) cases had a delay in BERA. However Bayazit et al found out in their study that the chances of having a diabetic complication increases as the ABR results become abnormal.<sup>2,11</sup>

## CONCLUSION

So we concluded that diabetic patients who suffer from central neuropathy and the CNS involvement can be associated with the duration of the disease.

Thus BERA is of clinical importance for diabetes as it reflects the degree of neural involvement in the auditory pathway. The latency of wave I was found to be non significant which suggests that the pathway from 8<sup>th</sup> nerve to cochlear nucleus is not affected in diabetic patients. The prolongation in latencies III and V and interpeak latencies I-III, III-V and I-V in diabetic patients compared to controls suggests brainstem and midbrain involvement. So the study suggests that BERA helps in the early detection of central neuronal axis involvement in patients with type-2 diabetes mellitus and may alert them for adequate glycemic control.

This can be done on an annual basis which will help the physician to update their diabetic patient's hearing status so necessary guidance can be given to control it.

## ACKNOWLEDGMENTS

I express my sincere thanks to all my teachers Dr. NA Mohammed, Dr. Vijayalakshmi S, Dr. Sai Manohar, Dr. Sheetal Rai, Dr. Mubeena, Dr. Subodha and Dr Nayana for helping me with their constant encouragement and timely advice.

I thank Dr Ghulam Jeelani Quadiri, Principal, Yenepoya Medical College Hospital and Dr Mohammed Amin Wani, Medical Superintendent, Yenepoya Medical College hospital for allowing me to conduct such a study and for providing the necessary materials for the study.

I am thankful to my colleagues for their co-operation and support.

I would like to thank Mrs. Megha H Nair, Statistician, Yenepoya Medical College for helping me with assessing the results of my study and the statistical analysis.

I thank Ms. Safa Mumtaz and Ms Shraddha Hegde, Audiologists, Yenepoya Medical College for their valuable help and support.

I thank Ms. Shilpa Poojary, for her valuable help and support in the department.

I want to specially thank my patients who were willing to cooperate with me for the various procedures and tests employed in the study.

Last but not the least; I thank my parents, Mr Suresh Babu and Mrs Komalam Suresh, my brother Mr Sreejith Suresh and my wife Dr Swetha for their help, encouragement, love and support.

*Funding: No funding sources*

*Conflict of interest: None declared*

*Ethical approval: The study was approved by the Institutional Ethics Committee*

## REFERENCES

1. Reske NE, Lundbeak K, Rafaelsen O. Pathological changes in the central and peripheral nervous system of young long term diabetics (Diabetic encephalopathy). *Diabetologia*. 1965;01:233–41.
2. Gupta R, Aslam M, Hasan SA, Siddiqi SS. Type-2 diabetes mellitus and auditory brainstem responses – A hospital based study. *Indian J Endocr Metab*. 2010;14:9-11.
3. Axelsson SF, Fagerberg. Auditory function in diabetes. *Acta-otolaryngologica*. 1968;66:49–64.
4. Rosen Z, Yanko L, Cohen AM. Diabetic Labyrinthopathy and Retinopathy. *Isr J Med Sci*. 1972;8:781-2.
5. Friedman SA, Schulman RH, Weiss S. Hearing and Diabetic neuropathy. *Arch Intern Med*. 1975;135:573-6.
6. Mehra YN, Sharma Y. Brain stem evoked response Audiometry in diabetes Mellitus. *Indian J Otolaryngol*. 1987;39:163-6.
7. Virtaniemi J, Laakso M, Nuutinen J, Karjalainen. Quoted by Booth JB. *Scott Brown's otolaryngology*. 6th ed, Vol 3. Butterworths, London; 1997: 95.
8. Fedele D, Martini A, Cardone C, Comacchio F, Bellavere F, Molinari G, et al. Impaired auditory brainstem-evoked responses in insulin-dependent diabetic subjects. *Diabetes*. 1984;33:1085-9.
9. Kurien M, Thomas K, Bhanu TS. Hearing threshold in patients with diabetes mellitus. *J Laryngol Otol*. 1989;103:164-8.
10. Sharma R, Gupta SC, Tyagi I, Kumar S, Mukherjee K. Brain stem evoked responses in patients with diabetes mellitus. *Indian J Otolaryngol Head Neck Surg*. 2000;52:221-9.
11. Bayazit Y, Yilmaz M, Kepekci Y, Mumbuc S, Kanlikama M. Use of the auditory brainstem response testing in the clinical evaluation of the patients with diabetes mellitus. *J Neurol Sci*. 2000;181(1-2):29-32.

**Cite this article as:** Suresh S, Ramlan S, Somayaji G, Sequeira N. Brainstem auditory responses in type-2 diabetes mellitus. *Int J Otorhinolaryngol Head Neck Surg* 2018;4:522-5.