**Scholars Journal of Applied Medical Sciences (SJAMS)**
***Abbreviated Key Title: Sch. J. App. Med. Sci.***
**ISSN 2320-6691 (Online)**
**ISSN 2347-954X (Print)**

A Unit of Scholars Academic and Scientific Society, India
www.saspublisher.com

Physiology

# A Comparative Study of Brainstem Auditory Evoked Responses in Patients of Type 2 Diabetes Mellitus and Healthy Matched Controls at Tertiary Care Hospital, Bikaner, Rajasthan India

**Dr. B.K. Binawara[1], Dr. Usha Rani[2*], Dr. Mahendra kumar jalthania[3], Dr. Pramod Narnolia[4]**
[1]Professor & Head, Deptt of Physiology, S.P. Medical college, Bikaner, India
[2] Post graduate resident, Deptt of Physiology, S.P. Medical college, Bikaner, India
[3]Associate Professor, Deptt of General Surgery, S.P. Medical college, Bikaner, India
[4]Assistant Professor, Deptt of Physiology, S.P. Medical college, Bikaner, India

**Original Research Article**

***Corresponding author**
*Dr. Usha Rani*

**Article History**
*Received: 13.04.2018*
*Accepted: 23.04.2018*
*Published: 30.04.2018*

**DOI:**
10.21276/sjams.2018.6.4.68

**Abstract:** Diabetes Mellitus has been implicated as an independent causative factor of sensorineural hearing loss. The Brainstem auditory evoked responses (BAER) represent a useful, non invasive and simple procedure to detect both acoustic nerve and CNS damage. The study was conducted to compare Brainstem auditory evoked responses in patients of Type 2 diabetes mellitus with matched normal subjects. Effect of duration of diabetes on BAER and usefulness of this screening tool were also assessed. A Comparative Cross-sectional study was carried out to compare Brainstem auditory evoked responses in patients of type 2 Diabetes Mellitus (n=50) and matched healthy controls (n=50) at Department of Physiology in association with ENT Department at S.P. Medical College & P.B.M. hospital Bikaner, Rajasthan from June 2016 to May 2017 with Consecutive sampling technique. All BAER waves I to V & Interpeak latencies (I-III, III-V & III-V) of both ears showed statistically significant difference ($p<0.05$) among cases and controls except Interpeak latency of III-V of left ear. Cases had prolonged interpeak latencies which is an early sign of central neuropathy and can prove diagnostically important. Correlation coefficient among BAER Interpeak latencies among both right and left ears of cases showed only partial or weak correlation which depicts that interpeak latencies are not affected much by duration of disease. Therefore it is derived that BAER waves can act as a screening tool for central neuropathy.
**Keywords:** Diabetes Mellitus, Brainstem, neuropathy.

## INTRODUCTION

Diabetes Mellitus, a chronic multi-systemic metabolic disorder, is fast emerging as an epidemic in both developed and developing countries. The total number of people with diabetes worldwide is projected to rise from 171 million in 2000 to 366 million in 2030. Diabetes Mellitus has been implicated as an independent causative factor of sensorineural hearing loss[1]. Neuropathy, both central and peripheral, is an important complication of Type 2 DM [2]. Neuropathy is the more precocious and frequent late complication of DM. So far most of the clinical and diagnostic studies on diabetic neuropathy have concerned only peripheral and autonomic nerve but recently with the refinement of evoked potential techniques detailed exploration of sensory pathway in central nervous system has been possible. The electrophysiological testing reflects the bioelectric responses of the nervous system to sensory (somatosensory evoked potentials), auditory (brainstem auditory evoked potentials) or visual stimuli (visual evoked potentials) [3]. The Brainstem auditory evoked responses (BAER) represent a useful, non invasive and simple procedure to detect both acoustic nerve and CNS damage. Brainstem auditory evoked potentials (BAEP) are the potentials that are recorded in response to brief auditory stimulation to assess the conduction through the auditory pathway, up to the midbrain.

## MATERIALS AND METHODS

A Comparative Cross-sectional study was carried out to compare Brainstem auditory evoked response in Patients of type 2 Diabetes Mellitus and healthy controls at Department of Physiology in association with ENT Department at S.P. Medical College & P.B.M. hospital Bikaner, Rajasthan from June 2016 to May 2017 with Consecutive sampling technique. 50 patients of type 2 Diabetes Mellitus patients and 50- healthy controls were assessed. Both

cases and controls were matched according to age and sex.

Inclusion Criteria was only proven or diagnosed cases of Type 2 diabetes by history, clinical examination, and blood investigations. The patients with conductive deafness, severe anemia, cardiovascular complications, respiratory diseases, renal failure, patients with past history of neurological disorders, smokers, alcoholic and patients taking any other drugs except for diabetes were excluded. Neurosoft Auditory Evoked Potential (AEP) software was used. Start testing at 70 dB normal Hearing Loss (nHL) and as per response we can increase or decrease the intensity for next recording. Procedure was started by collecting an average of 2000 clicks per intensity. Duration of wave I, II, III, IV and V in milliseconds and Interpeak latencies I-III, I-V and III-V in milliseconds were recorded. The findings were recorded on a predesigned Proforma and statistically analyzed with the help of SPSS 22.0 software.

## RESULTS

In this study 31 (62%) were males and 19 (38%) were females in both groups- diabetics (cases) and control. In both group the age range was of 42-78 years (both groups were matched in terms of age and sex). In control group Mean BMI was 30.27±2.06; Mean fasting blood sugar was 72.22±2 mg/dl; Mean HbA1c level was 4.78±1.47. Among diabetics Mean BMI was 39.68±4.18; Mean HbA1c 10.56±3.42 and mean duration of disease was observed to be 10.4 years.

In comparison of waves of BAER in Left ear of both controls & cases (table 1) the difference was statistically significant among all type of waves ($p<0.001$). and interpeak latencies I-III, I-V showed statistically significant difference ($P<0.01$) whereas III-V interpeak latency had no statistically significant difference ($p>0.05$). Comparison of waves & interpeak latencies of Right ear of both controls & cases (table 2) showed that the all BAER waves and all interpeak latencies of statistically significant difference ($p<0.05$). Correletion coefficient among BAER waves of Left and Right ears with duration of disease among Cases (table 3) shows that only wave II of Right ear is showing moderately positive correlation with duration of disease among cases. All other waves have weak or partial positive correlation ($r<0.3$). Table 4 shows Correlation coefficient among BAER Interpeak latencies among both right and left ears of cases. This shows only partial or weak correlation which depicts that interpeak latencies are not affected much by duration of disease.

**Table-1: Comparison of waves and interpeak latencies of BAER in Left ear of both controls & cases**

| Waves | Cases Mean ± SD | Controls Mean ± SD | Value Of 't' | Inference |
|---|---|---|---|---|
| I (ms) | 1.59 ± 0.30 | 1.25 ± 0.15 | 7.17 | P<0.001 |
| II (ms) | 2.61 ± 0.23 | 2.39 ± 0.30 | 4.11 | P<0.001 |
| III (ms) | 4.08 ± 0.43 | 3.44 ± 0.22 | 9.37 | P<0.001 |
| IV (ms) | 4.59 ± 0.25 | 4.30 ± 0.18 | 6.66 | P<0.001 |
| V (ms) | 6.11 ± 0.62 | 5.43 ± 0.26 | 7.15 | P<0.001 |
| I-III (ms) | 2.49 ± 0.53 | 2.19 ± 0.27 | 3.57 | P<0.001 |
| I-V (ms) | 4.52 ± 0.72 | 4.18 ± 0.31 | 3.07 | P = 0.003 |
| III-V (ms) | 2.03 ± 0.66 | 1.98 ± 0.36 | 0.47 | P = 0.64 |

(Non-Significant: $p>0.05$, Significant: $p<0.05$)

**Table-2: Comparison of waves and interpeak latencies of BAER in Right ear of both controls & cases**

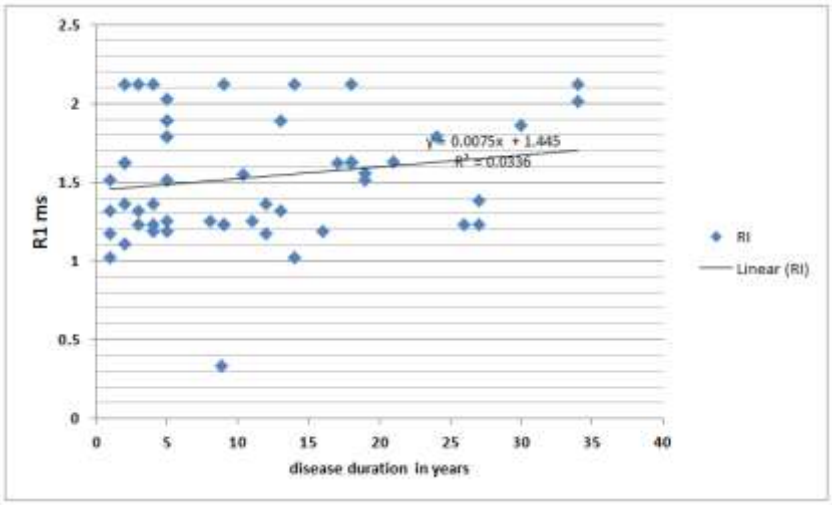
| Waves | Cases Mean ± SD | Control Mean ± SD | Value Of 't' | Inference |
|---|---|---|---|---|
| I (ms) | 1.55 ± 0.33 | 1.18 ± 0.15 | 7.22 | P<0.001 |
| II (ms) | 2.59 ± 0.23 | 2.42 ± 0.30 | 3.18 | P= 0.002 |
| III (ms) | 3.58 ± 0.43 | 3.45 ± 0.21 | 1.92 | P< 0.05 |
| IV (ms) | 4.43 ± 0.21 | 4.30 ± 0.20 | 3.17 | P= 0.002 |
| V (ms) | 6.25 ± 0.61 | 5.36 ± 0.28 | 9.38 | P<0.001 |
| I-III (ms) | 2.03 ± 0.47 | 2.27 ± 0.26 | -3.16 | P= 0.002 |
| I-V (ms) | 4.70 ± 0.66 | 4.17 ± 0.32 | 5.11 | P<0.001 |
| III-V (ms) | 2.67 ± 0.81 | 1.90 ± 0.36 | 6.14 | P<0.001 |

**Table-3: Correlation coefficient among BAER waves of Left and Right ears with duration of disease among Cases**

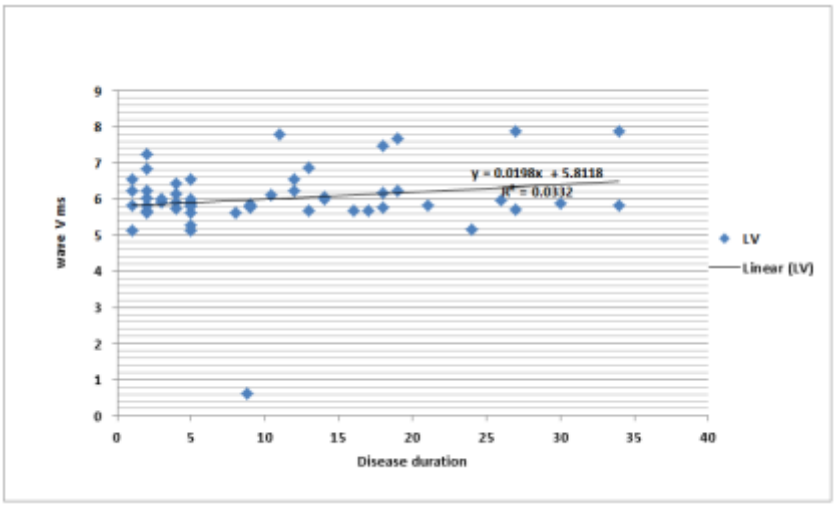
| Parameters (waves) | Duration of disease ('r') value | Inference |
|---|---|---|
| I (ms) Lt | 0.082 | Weakly positive |
| II (ms) Lt | 0.202 | Weakly positive |
| III (ms) Lt | -0.271 | Weakly negative |
| IV (ms) Lt | -0.21 | Weakly negative |
| V (ms) Lt | 0.101 | Weakly positive |
| I (ms) Rt | 0.089 | Weakly positive |
| II (ms) Rt | 0.341 | Moderately positive* |
| III (ms) Rt | 0.049 | Weakly positive |
| IV (ms) Rt | 0.078 | Weakly positive |
| V (ms) Rt | 0.146 | Weakly positive |

**Table-4: Correlation coefficient among BAER interpeak latencies (ms) of Left and Right ears with duration of disease**

| Parameters (interpeak latencies) | Duration of disease ('r') value | Inference |
|---|---|---|
| I-III (ms) Lt | -0.26 | Weak negative correlation |
| I-V (ms) Lt | 0.05 | Very weak positive correlation |
| III-V (ms) Lt | 0.275 | Partial positive |
| I-III (ms) Rt | -0.01 | Weak negative |
| I-V (ms) Rt | 0.26 | Weakly positive |
| III-V (ms) Rt | 0.22 | Weakly positive |




**Graph-1: Correlation of Wave I of Rt ear with disease duration**




**Graph-2: Correlation of WaveV of Lt ear with disease duration**

## DISCUSSION

Different waves of BAER have different source of generators and hence these waves reflect activity of their generators. Wave I represents peripheral nervous system involvement as any change in it depicts the effect of diabetes on auditory nerve. Other absolute waves represent central nervous system involvement as any change in them depicts effect of diabetes on brain stem as generators of waves II, III, IV and V cochlear nucleus, superior olivary nucleus, lateral lemniscuses and inferior colliculus respectively. IPL I-III measures neuronal conduction of acoustic nerve across subarachnoid space into core of lower pons. IPL I-V measures central neuronal conduction from proximal acoustic nerve through pons to midbrain. IPL III-V measures or indirectly reflects neuronal conduction from lower pons to midbrain. It helps in exploring early sub clinical neurological dysfunction in metabolic disorders. BAER might be useful diagnostic tool in detecting central diabetic neuropathy. Controls displayed almost similar values of Mean duration of waves in right and left ears. Brainstem auditory evoked potentials of Left and Right ears among cases show a slight variation among mean values of right and left ear wave duration. Left ear waves have slightly higher peaks than right ear among cases. While comparing BAER waves I-V & Interpeak latencies among cases and controls left ear all five waves duration and interpeak latencies I-III, I-V showed statistically significant difference as cases had prolonged interpeak latencies which is an early sign of central neuropathy and can prove diagnostically important ($P<0.001$) whereas III-V interpeak latency had no statistically significant difference ($p>0.05$) which may be explained by observer variation in measurement tool. While all BAER waves and all interpeak latencies of Right ear of both cases and controls showed statistically significant difference ($p<0.05$) with higher values in right ear of cases showing that BAER may prove a sensitive tool for early diagnosis of neuropathy. Dolu *et al*. [4], Al-Azzawi *et al*. [5], Gupta R *et al*. [6], C Huang *et al*. [7], observed similar results in their study. Whereas Ologe *et al*. [8] did BAER on children of age group 9 – 19 years with family history of Type 2 diabetes and found no difference of audiogram in children without genetic predisposition. Gupta S. *et al*. [9] in their cross-sectional study observed no significant difference between diabetic and control subjects as regards to the latency of wave IV unilaterally in the left ear and the latencies of waves I, II and interpeak latency I-III bilaterally. Baweja P *et al*. [10] in their case control study observed significant difference in right ear values but not in left ear values. Shatdal *et al*. [11] in their cross-sectional study observed that Mean peak latency of waves I, III, V and interpeak latency of I-III, III-V, I-V were prolonged in group 1, but were not statistically significant. Siddiqui SS *et al*. [12] also observed similar results as ours. Similarly, Mahalik D *et al*. [13] found that type 2 DM patients showed significant prolonged absolute latencies of I, III ($P = 0.001$) and interpeak latencies I-III, III-V and I-V in left ear ($P = 0.001$) and absolute latencies of I, V ($P = 0.001$), interpeak latencies III-V was statistically significant in right ear. Sushil MI [14], Bhattarai U *et al*. [15], Anshul sharma *et al*. [16], Praveen S. Yousuf *et al*. [17] , R.K. Murugeshan *et al*. [18], Dr K Kanaan [19] observed similar results as our study. Similar to our results, Baweja P *et al*. [10] in their case control study observed that none of the BAEP latencies were significantly correlated with either the duration of disease or with fasting blood glucose levels in diabetics. Shatdal *et al*. [11] in their cross-sectional study also observed no significant relation between abnormal BAEP response with age, sex, type of diabetes, duration of diabetes since detection, fasting plasma sugar level, postprandial plasma sugar level, glycosylated haemoglobin, presence of retinopathy, nephropathy and peripheral neuropathy. Whereas Anshul sharma *et al*. [16] observed a positive correlation between prolongation of latencies and duration of diabetes mellitus. The latencies were also found to be prolonged with altered blood glucose levels.

## CONCLUSION

Therefore it is derived from results that BAER waves as well as interleaf latencies durations are affected among type 2 diabetic patients and can act as a screening tool for central neuropathy whereas duration of diabetes does not prove to have an impact on BAER responses. Hence regular blood glucose monitoring and timely check-up the otorhinolaryngology's and audiologist can resolve many associated problems at an initial stage. Which can certainly improve the quality of life of the individual?

## REFERENCES

1. Maia CA, Campos CA. Diabetes mellitus as etiological factor for hearing loss. Braz J Otorhinolaryngol. 2005;71:208–14.
2. Jali MV, Kambar S, Jali SM, Gowda S. Familial early onset of type 2 diabetes mellitus and its complications. N Am J Med Sci. 2009;1:377–80.
3. Imam M, Shehata OH. Subclinical central neuropathy in type 2 diabetes mellitus. Bull Alex Fac Med. 2009;45:65–73.
4. Dolu H, Ulas UH, Bolu E, Ozkardes A, Odabasi Z, Ozata M. Evalution of central neuropathy in Type 2 diabetes mellitus by multimodel evoked potentials. Acta Neurol Belg. 2003; 103:206-11.
5. Al-azzawi LM, Mirza KB. The usefulness of the brainstem auditory evoked potential in the early diagnosis of cranial nerve neuropathy associated with diabetes mellitus. Electromyogr Clin Neurophisio 2004; 44: 387-94.
6. Gupta R, Aslam M, Hasan SA, Siddiqi SS. Type-2 diabetes mellitus and auditory brainstem responses-a hospital based study. Indian journal

of endocrinology and metabolism. 2010 Jan;14(1):9.
7. Huang CR, Lu CH, Chang HW, Tsai NW, Chang WN. Brainstem auditory evoked potentials study in patients with diabetes mellitus. Acta Neurol Taiwan. 2010 Mar 1;19(1):3340.
8. Ologe FE, Okoro EO, Oyejola BA. Hearing function in Nigerian children with a family history of type 2 diabetes. International journal of pediatric otorhinolaryngology. 2005 Mar 1;69(3):387-91.
9. Gupta S, Baweja P, Mittal S, Kumar A, Singh KD, Sharma R. Brainstem Auditory Evoked Potential Abnormalities in Type 2 Diabetes Mellitus. North American Journal of Medical Sciences. 2013;5(1):60-65. doi:10.4103/1947-2714.106211.
10. Baweja P, Gupta S, Mittal S, Kumar A, Singh KD, Sharma R. Changes in brainstem auditory evoked potentials among North Indian females with Type 2 diabetes mellitus. Indian journal of endocrinology and metabolism. 2013 Nov;17(6):1018.
11. Picton T, Hunt M, Mowrey R, Rodriguez R, Maru J. Evaluation of brain-stem auditory evoked potentials using dynamic time warping. Electroencephalography and Clinical Neurophysiology/Evoked Potentials Section. 1988 May 1;71(3):212-25.
12. Siddiqi SS, Gupta R, Aslam M, Hasan SA, Khan SA. Type-2 diabetes mellitus and auditory brainstem response. Indian journal of endocrinology and metabolism. 2013 Nov;17(6):1073.
13. Mahallik D, Sahu P, Mishra R. Evaluation of auditory brain-stem evoked response in middle: Aged type 2 diabetes mellitus with normal hearing subjects. Indian Journal of Otology. 2014 Oct 1;20(4):199.
14. Sushil MI, Muneshwar JN, Afroz S. To study brain stem auditory evoked potential in patients with type 2 diabetes mellitus-a cross-sectional comparative study. Journal of clinical and diagnostic research: JCDR. 2016 Nov;10(11):CC01.
15. Bhattarai U, Thakur D, Limbu N, Paudel BH, Sharma SK. Brainstem Auditory Evoked Potentials in Type 2 Diabetes Mellitus. Nepal Med Coll J 2016; 18 (1-2): 1-4
16. Sharma A. *A comparative study of brainstem evoked response audiometry in diabetic and nondiabetic subjects* (Doctoral dissertation).
17. Yousuf PS, Batham C. Type-2 diabetes mellitus and brain stem evoked response audiometry: a case control study. J. Evolution Med. Dent. Sci. 2016;5(8):359-362
18. Kumaran R, Munusamy G, Kannan R. Evaluation of brainstem auditory evoked potential in type 2 diabetes mellitus individuals. International Journal of Research in Medical Sciences. 2016 Dec 18;4(9):3939-44.
19. Kanaan K. Study of brainstem auditory evoked potentials in type 2 diabetic patients .Indian Journal of Basic and Applied Medical Research; September 2017: Vol.-6, Issue- 4, : 341-349