

## An evaluative study of auditory brain-stem evoked response patterns in diabetic subjects with normal hearing

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### Abstract

Hearing impairment is a late complication of diabetes mellitus (DM). The present study was needed considering high incidence of diabetes in Indian population and its complications in the form of hearing loss. Delay in the neural conductance along the auditory pathway due to DM was assessed by means of Auditory Brainstem Response (ABR). The sample comprised of three groups, first group comprising of normal healthy 16 ears, the second group with type 1 DM and the third group with type 2 DM comprising of 16 ears each, respectively. ABR recordings showed that absolute latencies of waves I, III, and V that were significantly prolonged in the diabetic group compared to control ( $p < 0.05$ ). However, when two diabetic groups were compared with each other, the difference between latencies of waves I, V in the two diabetic groups was statistically significant ( $p < 0.05$ ). With increase of stimulus presentation rate from 20/s to 72/s in type 2 DM, there was a significant delay in absolute latencies of wave I, III, V as well as interpeak latencies of waves III-V, and I-V. There is a delay in neural conductance due to DM which can be measured using ABR even before manifestation of actual hearing loss. The prolongation of latency of ABR in diabetic patients should raise concern about damage to the auditory nerve. A close follow up will be required in these patients.

**Keywords:** Diabetes mellitus type 1 and type 2, Auditory Brainstem response, neural conductance

### Introduction

Diabetes mellitus (DM) is a progressive metabolic disorder, characterized by abnormalities in glucose utilization due to absolute or relative insulin deficiency.<sup>1</sup> The absolute or relative deficiency of insulin may evolve from interaction between genetic and environmental factors.

DM is the most common endocrine and metabolic disorders. The World Health Organization estimates that more than 180 million people worldwide had diabetes in 2005. This number is likely to more than double by 2030.<sup>2</sup> Over time, diabetes can damage the heart, blood vessels, eyes, kidneys, and nerves. Autonomic and peripheral neuropathy, nephropathy, retinopathy and hearing impairment are some of late complications of DM which are related to the type of diabetes, duration of pathology and instability in blood sugar regulation.<sup>3</sup>

The literature has described many different types of hearing loss in diabetic patients. These include progressive, gradual bilateral sensorineural loss, affecting especially high frequencies.

Diabetes has emerged as an epidemic throughout the world. Considering high incidence of diabetes in Indian population

and its complications in form of hearing loss and serious problems posed by it, a strong need is felt to undertake a present study like this.

The main objective of this study was to determine whether there is an abnormality of neural conductance which is seen as a reduction in amplitude and an increase in latency of certain components of ABR in DM patients with normal hearing sensitivity.

The typical hearing loss seen in diabetic patients is a progressive bilateral sensorineural hearing loss of gradual onset affecting predominantly the higher frequencies.

Al-Azzawi and Mirza<sup>4</sup> conducted a study on ABR findings in diabetics and concluded that the difference was highly significant in the increased latency of waves I, III and V, IPLs (I - III, I - V, III - V) and amplitude of waves V of each type of diabetes as compared to control. Comparison of the type and duration of diabetes between each other showed no significant difference.

### Methodology

#### Subject selection criteria:

The data comprised of three groups.

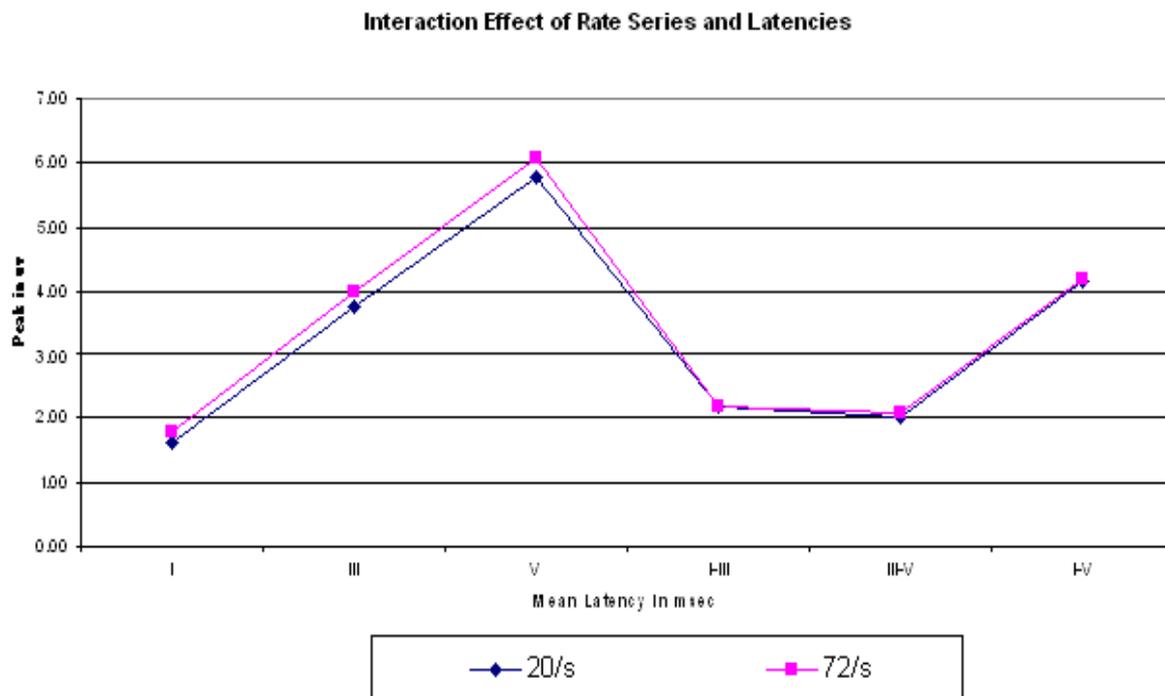
1. One group consisted of 8 subjects with type 1 diabetes
2. Second group consisted of 8 subjects with type 2 diabetes
3. Third group consisted of 8 age and sex matched control subjects for comparison.

The diabetic patients selected for the study essentially had well controlled blood sugar levels for 3 months prior to the date of testing.

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**Figure 1:** Interaction effect of rate series and latencies

**Table 1:** ABR Procedural considerations

<ul style="list-style-type: none"> <li>Type of Stimulus: click</li> <li>Number of stimuli: 2000 clicks</li> <li>Stimulus intensity: 70 dBnHL</li> <li>Filter setting: 100-3000 Hz.</li> <li>Amplifier gain- 100.0 K</li> </ul>	<ul style="list-style-type: none"> <li>Time window/analysis window-12 ms</li> <li>Transducer: Insert receiver (EAR3A)</li> <li>Repetition rate: 20/sec and 72/sec</li> <li>Polarity: alternating</li> </ul>
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**Table 2:** ABR results from patients with type 1 DM and type 2 DM and control group

Absolute and inter-peak latencies (in msec)	Control (n = 16)	Type1 DM (n=16)	Type 2 DM(n=16)	P 1-3	P 2-4	P 3-4
I	1.52 (.13)	1.60 (.06)	1.69(.06)	<0.05	<0.05	<0.05
III	3.62(.18)	3.80(.15)	3.89(.07)	<0.05	<0.05	>0.05
V	5.54(.14)	5.85(.11)	5.94(.03)	<0.05	<0.05	<0.05
I-III	2.08(.1)	2.18(.25)	2.19(.08)	<0.05	<0.05	>0.05
III-V	1.96(.06)	1.98(.06)	1.98(.05)	<0.05	<0.05	>0.05
I-V	4.05(.10)	4.21(.20)	4.18(.08)	<0.05	<0.05	>0.05

**Table 3:** T-test to find out if there is significant difference in the ABR findings with stimulus presentation rates of 20/sec and 72/sec in type 1 and type 2 DM groups

Pair	Comparison	t	Df	Sig. (2-tailed)
Pair 1	I 20/s - I 72/s	-11.71	47	.000
Pair 2	III 20/s - III 72/s	-32.52	47	.000
Pair 3	V 20/s - V 72/s	-39.43	47	.000
Pair 4	I-III 20/s - I-III 72/s	-.06	47	.95
Pair 5	III-V 20/s - III-V 72/s	-5.74	47	.000
Pair 6	I-V 20/s - I-V 72/s	-2.27	47	.03

The age range of diabetic as well as control group was 15 to 60 years. The patients were subjected to audiological

evaluations comprising of:

1. Pure tone audiometry
2. Auditory Brainstem Evoked Responses.

Electrode montage (Conventional): A1/A2 (inverting)-negative, Fz/Cz (non-inverting)-positive, FPz-Ground. Analysis was carried out by determining the absolute latencies of waves I, III, V and the interpeak intervals I-III, III-V and I-V

### Results

The absolute latencies for waves I, III, V and the interpeak latencies (IPL) were identified for the right and left ears separately for each patient. The values for the right as well left ears were taken as different values.

ABR morphology was normal in all groups. The mean values of the latencies of the 16 ears in each group are shown in table 1. These values were then subjected to statistical analysis using One Way ANOVA.

ABR results from patients with type 1 DM and type 2 DM and control group are shown in Table 2. It can be concluded that diabetic patients have significantly delayed absolute as well as interpeak latencies when compared to control group ( $p < 0.05$ ). On comparing the absolute as well as interpeak wave latencies between types I DM group as well as type II DM following results were obtained: The difference between the latencies of wave I and wave V in two diabetic groups was statistically significant. Latency prolongation was more prominent in type 2 DM ( $p < 0.05$ ). However, the difference between the latencies of wave III was not significant ( $p > 0.05$ ).

For interpeak latencies there was no significant difference between the interpeak latencies of I-III, III-V, and I-V in two diabetic groups, although the latency delay was more prominent in type II DM group.

### Effect of rate (20/sec vs. 72/sec)

T-test was administered to find out the difference in absolute and interpeak latencies between the two diabetic groups with stimulus presentation rates of 20/sec and 72/sec. The ABR findings with stimulus presentation rates of 20/sec and 72/sec in type 1 and type 2 DM groups are shown in Table 3.

Table 3 shows that with increasing stimulus rate from 20/s to 72 /s there is a significant delay in the absolute latencies of wave I, III, V as well as interpeak latencies of waves III-V, and I-V ( $p < 0.05$ ). However, no significant delay was observed in interpeak latency of wave I- III ( $p < 0.05$ ). The effect of absolute latencies as well as interpeak latencies between the diabetic groups type 1 DM group as well as type 2 DM has been shown in the graph 1.

### Discussion

Bilateral, symmetric and progressive high frequency sensorineural hearing loss with gradual onset is usually found in patients suffering from diabetes.<sup>5</sup> This is probably due to cochlear, retrocochlear or combined cochlear – retrocochlear involvement of the acoustic nerve.

The recording of electrical potentials occurring along the auditory pathway evoked by repeated stimuli is an

objective, reliable and non-invasive method to detect even subclinical involvement of neural conduction, which appears at an early stage of the disease and tends to persist over time (Virtaniemi et al, 1993). The results of the present study showed that all parameters of ABR components measured in two different types of diabetic groups were delayed in comparison with those of healthy controls. However, prolongation in absolute latency of wave I was least pronounced among other parameters. It can be speculated that the involvement of neural tissue at an early stage is more central than peripheral.

### Conclusions

The analysis of results revealed that the diabetic patients had significantly delayed absolute as well as interpeak latencies when compared to control group. It indicates that there is abnormality in the neural conduction in DM patients. There was more central and a less peripheral effect of diabetes on the conduction velocity of the auditory nerve. A substantial delay in absolute wave V latency and interpeak latencies I-V and III-V shows that the diabetic neuropathy is particularly evident at the level of the upper brainstem. These findings are similar to the results of a study by Coskun Durmus *et al.*<sup>6</sup> It seems that a latent period is needed for the development of clinically detectable hearing loss. In view of this study, it is clear that diabetic patients should be evaluated individually, and for those patients with abnormal evoked potentials, identified early in the course of the disease, special care should be paid to the metabolic regulation of the DM before a permanent disturbance along the 8<sup>th</sup> nerve takes place. At this point, the importance of ABR testing in the clinical evaluation of the diabetes is crucial in the absence of specific symptoms.

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