Original Article

Study of sensorineural hearing loss in children with type 1 diabetic mellitus and the corelation with the duration of the disease in a tertiary care center

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ABSTRACT

Background: Annual type 1 diabetes cases in children under the age of 15 are estimated to be around 96,000 worldwide. The pathophysiological explanation for diabetes-related hearing loss is speculative. Usually, hearing loss is bilateral, gradual onset, affecting higher frequencies. It is a well-known entity in type 2 diabetic mellitus. This study aims at knowing the prevalence of hearing loss in children with type 1 diabetic mellitus with respect to duration of diabetic mellitus. **Materials and Methods:** A hospital-based comparative study was conducted involving 60 diabetic children and 60 healthy (control) children. Brainstem evoked response audiometry test was done in both groups. Reports were compared and prevalence of sensorineural hearing loss in diabetic children and the corelation with the duration of disease were analyzed. **Results:** The mean age among cases was 11.93±2.9 years and the mean age among controls was 9.08±1.92 years. Among diabetic group, 25 (41.7%) were male, 35 (58.3%) were female. Among non-diabetic group, 33 (55%) were male, 27 (45%) were female. Although none of the diabetic children had hearing loss, the differences in absolute latency waves I, II, III, IV, and V between diabetic group and non-diabetic group in the right ear and waves I and II and III and V between diabetic group and non-diabetic group in the left ear was found to be statistically significant ($p<0.05$). The difference in interpeak latency values of wave I and wave V between diabetic and non-diabetic group in right ear and between wave I–V and wave III–V in the left ear was found to be statistically strongly significant ($p<0.001$). This indicates prolonged absolute latency and interpeak latency among diabetics than non-diabetics. Since none of the diabetic children had hearing loss, the corelation of hearing loss with the duration of the disease was unable to obtain. **Conclusion:** This study stresses on the need for frequent follow-up and hearing evaluation of the type 1 diabetic children for the early detection of hearing loss.

Key words: Children, Hearing loss, Type 1 diabetes mellitus

The term "Diabetes Mellitus (DM)" refers to a variety of metabolic conditions marked by chronic hyperglycemia brought on by abnormalities in insulin secretion, actions, or both. Deficient insulin action on target tissues as a result of insufficient insulin secretion and/or insufficient end organ responsiveness causes problems in the metabolism of carbohydrates, fats, and proteins. In the same patient, impaired insulin secretion and/or action may coexist [1].

Typical signs of diabetes in young people include polyuria, polydipsia, nocturia, enuresis, and weight loss. Chronic hyperglycemia may also be linked to impaired somatic growth and increased susceptibility to infections of many kinds [1]. Diabetic keto acidosis and non-ketotic hyperosmolar syndrome are two severe forms of type 1 DM, which requires prompt treatment to prevent the mortality [1].

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The affection of blood vessels which supply the inner ear and vascular striae has been reported as physiopathological cause of sensorineural hearing loss in type 1 diabetic mellitus patients. Treatment with insulin, maintaining on average HbA1c of 7.2%, reduces the onset and progression of microangiopathic complications [2].

Although the role of DM in sensorineural hearing loss has been extensively studied among many population groups, not many studies are available regarding this in India particularly in south India. Hence, this study is of relevance that is evaluating the brainstem evoked response audiometry (BERA) values among pediatric patients with type 1 DM in comparison with age and gender matched controls in general pediatric population. The objectives of this study were to know the prevalence of sensorineural hearing loss in children aged <18 years with type 1 diabetic mellitus, by comparing BERA values with that of non-diabetic children and also to corelate the prevalence of hearing loss with the duration of the disease.

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MATERIALS AND METHODS

A hospital-based comparative study was conducted involving 60 diabetic children and 60 healthy (control) children. All the cases and controls were submitted to electrophysiological evaluation, BERA. Medicaid neurostim machine was used for the electrophysiological assessment. Brief acoustic rarefaction clicks created by transmitting monophasic square pulses with a length of 10 ms to headphones at a frequency of 11 Hz were used to elicit brainstem auditory evoked potentials. The sensory threshold for hearing was established for each subject's ear, and BAEP was recorded at an intensity of 80 dBSL. White noise that was 40 dB loud and continuous was used to disguise the other ear. Silver chloride disc electrodes captured the bioelectrical impulses. After using a spirit swab to clean the electrode placement location, electrode paste is used to insert the electrodes. Waves I, III, and V's absolute peak latencies and their respective interpeak latencies were measured in milliseconds. Reports were compared and prevalence of sensorineural hearing loss in diabetic children and the corelation with the duration of disease were analyzed.

Children aged <18 years of age diagnosed as DM according to ISPAD 2018 were included in this study [1]. Participants with a family history of deafness, use of ototoxic medications, and presence of otitis media and history of previous ear surgery were excluded from the study.

Statistical Analysis

The statistical software, namely, SPSS 22.0, and R environment ver.3.2.2 were used for the analysis of the data and Microsoft Word and Excel have been used to generate graphs, tables, etc**.** Descriptive and inferential statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean SD (Min-Max) and results on categorical measurements are presented in Number (%). Significance is assessed at 5% level of significance.

Student t-test (two-tailed, independent) has been used to find the significance of study parameters on continuous scale between two groups (Inter-group analysis) on metric parameters. Leven's test for homogeneity of variance has been performed to assess the homogeneity of variance.

The paired t-test is used to test the null hypothesis that the average of the differences between a series of paired observations is zero. Chi-square/Fisher Exact test has been used to find the significance of study parameters on categorical scale between two or more groups, non-parametric setting for qualitative data analysis. Fisher exact test used when cell samples are very small.

RESULTS

The mean age in diabetic group was 11.93±2.9 years and mean age in non-diabetic was 9.08±1.92 years. The difference in age between two groups was statistically strongly significant (p≤0.001 value) [Figures 1 and 2].

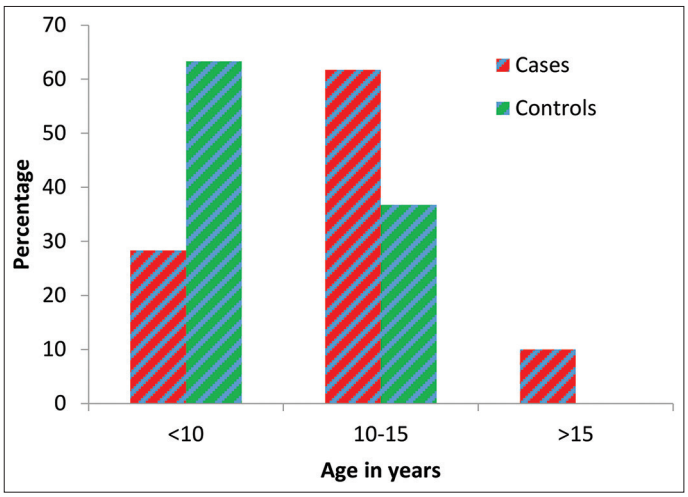

Figure 1: Age in years-frequency distribution in two groups studied

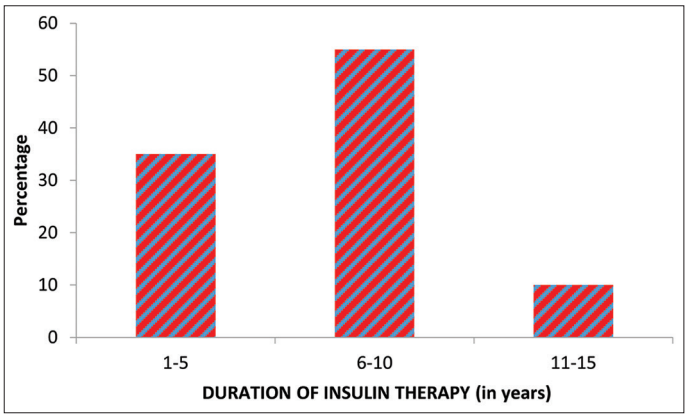

Figure 2: Duration of insulin therapy

Among diabetic group, 25 (41.7%) were male and 35 (58.3%) were female. Among non-diabetic group, 33 (55%) were male and 27 (45%) were female. The difference in the proportion of gender between two groups was statistically not significant.

Among the diabetic group, duration of insulin therapy was <5 years in 35% cases, between 6 and 10 years in 55% cases and 11–15 years in remaining 10% of cases, with mean duration of insulin therapy being 6.90±2.92 years.

The difference in absolute latency values of waves I, II, III, IV, and V between diabetic group and non-diabetic group in the right ear was found to be statistically significant (p<0.05), though all the individual values were within normal limits.

The difference in absolute latency value of wave II in the right ear between diabetics and non-diabetics was found to be statistically strongly significant with p<0.001.

The difference in interpeak latency values of wave I and wave V between diabetic and non-diabetic group in the right ear was found to be statistically strongly significant (p<0.001).

The difference in absolute latency values of waves I, II, and III between diabetic group and non-diabetic group in the left ear was found to be statistically significant (p<0.05), though all the individual values were within normal limits.

The difference in absolute latency value of wave II in the left ear between diabetics and non-diabetics was found to be statistically strongly significant with p<0.001 [Tables 1 and 2].

The difference in interpeak latency values of wave I–V and wave III–V between diabetic and non-diabetic group in the left ear was found to be statistically strongly significant (p<0.001).

The difference in absolute latency values of waves II, III, IV, and V between right and left ear of the diabetic group was found to be statistically significant (p<0.05). The difference in absolute latency value of wave IV and V between left and right ear in diabetics was found to be statistically strongly significant with p<0.001 [Table 3].

The difference in interpeak latency values between right and left ear in diabetics was found to be statistically insignificant.

The difference in absolute latency values of waves IV and V between right and left ear of the non-diabetic group was found to be statistically strongly significant (p<0.001) [Table 4].

The difference in interpeak latency values of wave I–V and III–V between right and left ear in non-diabetics was found to be statistically strongly significant (p<0.001) [Table 5].

Table 1: Gender-frequency distribution in two groups studied

Gender	Cases (%)	Controls (%)	Total (%)
Female	35 (58.3)	27 (45)	62 (51.7)
Male	25 (41.7)	33 (55)	58 (48.3)
Total	60 (100)	60 (100)	120 (100)

p=0.200, Not significant, Chi-square test

Table 2: Comparison of absolute/interpeak latency in case–controls studied (right ear)

Variables	Cases	Controls	Total	p-value
Absolute latency (in milliseconds)				
I	1.51±0.39	1.35±0.3	1.43±0.36	0.015*
II	2.33±0.48	2.08±0.33	2.2±0.43	<0.001**
III	2.96±0.46	2.78±0.33	2.87±0.41	0.016*
IV	3.66±0.47	3.48±0.35	3.57±0.43	0.015*
V	4.34±0.5	4.15±0.33	4.24±0.43	0.014*
Interpeak latency (in milliseconds)				
I-III	1.45±0.25	1.43±0.15	1.44±0.2	0.575
I-V	2.83±0.33	1.33±1.07	2.08±1.09	<0.001**
III-V	1.38±0.29	1.37±0.2	1.37±0.25	0.755

** - significant values

Table 3: Comparison of absolute/interpeak latency in case–controls studied (left ear)

Variables	Cases	Controls	Total	p-value
Absolute latency (in milliseconds)				
I	1.5±0.39	1.35±0.3	1.42±0.35	0.020*
II	2.34±0.47	2.07±0.33	2.21±0.43	<0.001**
III	2.97±0.45	2.78±0.33	2.88±0.4	0.010*
IV	3.68±0.46	3.68±0.46	3.68±0.46	1.000
V	4.36±0.5	4.36±0.5	4.36±0.49	1.000
Interpeak latency (in milliseconds)				
I-III	1.47±0.27	1.43±0.15	1.45±0.22	0.347
I-V	2.86±0.33	3.01±0.46	2.94±0.4	0.043*
III-V	1.39±0.29	1.58±0.46	1.48±0.4	0.010*

** - significant values

DISCUSSION

Children with type1 DM are prone for microvascular and neuropathic complications, hearing loss is one among them. In our study, though there was no sensorineural hearing loss in diabetic children, the absolute latency and interpeak latency of the BERA waves were prolonged compared to the BERA waves of healthy children, and it was found to be statistically significant. There are studies supporting the role of type 1 DM in the sensorineural hearing loss [3-5]. A meta-analysis by Mujica-Mota *et al.* "Hearing loss in type 1 diabetes: Are we facing another microvascular disease?" concluded that patients with type 1 DM (T1DM) have a significantly greater prevalence of hearing loss compared to the control group. A study conducted by Poovazhagi *et al.* on "hearing loss in children with T1DM," concluded that the hearing loss is more common in diabetic children predominantly in mid and high frequencies and is associated with the duration of diabetes and degree of glycemic control. A study conducted by Goyal *et al.* in 2019 on auditory brainstem evoked responses in type 1 and type 2 DM patients concluded that there was no hearing loss among type 1 diabetic mellitus patients, but a significant delay in absolute latency of wave I, III, IV, and V and interpeak latencies I–V and III–V was seen in type 1 diabetic patients. No relation was found with the duration of diabetes [6]. There are few studies with similar results, where the children with type 1 DM had no sensorineural hearing loss, but the latency of the waves were prolonged compared to the control group [6,7]. Some studies

Table 4: Comparison of absolute latency/interpeak latency in the right and left ears in cases studied

Variables	Right ear	Left ear	Difference	95% Confidence interval of the difference		t-value	p-value
				Lower	Upper		
Absolute latency (in milliseconds)							
I	1.51±0.39	1.5±0.39	0.012	−0.025	0.049	0.643	0.523
II	2.33±0.48	2.34±0.47	−0.011	−0.021	−0.001	−2.188	0.033*
III	2.96±0.46	2.97±0.45	−0.009	−0.019	0.001	−1.722	0.090*
IV	3.66±0.47	3.68±0.46	−0.013	−0.022	−0.003	−2.720	0.009**
V	4.34±0.5	4.36±0.5	−0.017	−0.026	−0.007	−3.629	<0.001**
Interpeak latency (in milliseconds)							
I-III	1.45±0.25	1.47±0.27	−0.021	−0.060	0.018	−1.075	0.287
I-V	2.83±0.33	2.86±0.33	−0.028	−0.066	0.009	−1.501	0.139
III-V	1.38±0.29	1.39±0.29	−0.008	−0.017	0.002	−1.505	0.138

Table 5: Comparison of absolute latency/interpeak latency in the right and left ears in controls studied

Variables	Right ear	Left ear	Difference	95% Confidence interval of the difference		t value	p-value
				Lower	Upper		
Absolute latency (in milliseconds)							
I	1.35±0.3	1.35±0.3	0.004	−0.003	0.011	1.146	0.256
II	2.08±0.33	2.07±0.33	0.002	−0.002	0.007	0.970	0.336
III	2.78±0.33	2.78±0.33	0.000	−0.001	0.000	−1.000	0.321
IV	3.48±0.35	3.68±0.46	−0.201	−0.322	−0.080	−3.321	0.002**
V	4.15±0.33	4.36±0.5	−0.208	−0.311	−0.106	−4.071	<0.001**
Interpeak latency (in milliseconds)							
I-III	1.43±0.15	1.43±0.15	−0.004	−0.011	0.003	−1.192	0.238
I-V	1.33±1.07	3.01±0.46	−1.682	−1.949	−1.416	−12.630	<0.001**
III-V	1.37±0.2	1.58±0.46	−0.208	−0.310	−0.106	−4.073	<0.001**

** - significant values

showed conflicting results of no significant relationship between diabetes and hearing loss [8]. A study on "Hearing Impairment and type 1 diabetes in the diabetes control and complications trial/epidemiology of diabetes interventions and complications Cohort" found no significant difference in the prevalence of hearing impairment between the group with type 1 diabetes and the spousal control group. Need for follow-up for repeat BERA is the limitation of our study.

CONCLUSION

Hearing loss in type1 DM can be due to microvascular or neuropathic complication of the disease process. As seen in our study, the latency of the BERA waves was prolonged in diabetic children in comparison with the healthy children. This stresses on the need for frequent follow-up and hearing evaluation of the type1 diabetic children.

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