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Assessment of auditory functions in type 1 diabetic children

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Abstract
Background: Diabetes mellitus is believed to be a chronic metabolic disorder. Its characteristics are hyperglycemia and numerous abnormalities in metabolism of fat and protein. As hearing loss is a one of the complications of DM, it usually develops over time and can worsen over a period of years.
Aim: To examine the auditory functions in type 1 diabetic children.
Materials and methods: The study was conducted in the Department of Pediatrics of the medical institution. For the study we selected 40 children and adolescents with type 1 diabetes mellitus that reported to outpatient department. Other 40 normal healthy students were selected as controls. Patient's demographic data such as age, sex, insulin dosage, duration of diabetes and HbA1C levels were recorded. The assessment of hearing threshold was done by pure tone audiometric test. The statistical analysis of the data was done using SPSS software.
Results: A total of 40 diabetic and 40 normal healthy control subjects participated in the study. The age of subjects ranged from 5-18 years with mean age being 11.38+4.1 years. The mean hearing threshold of diabetic group patients was significantly higher as compared to control group with respect to all frequencies. Also, the mean threshold of poor controlled diabetic patients was higher as compared to well controlled diabetic patients. The results were significant with respect to frequencies 250 Hz, 500 Hz, 1000 Hz and 4000 Hz.
Conclusion: From the results of current study, type 1 diabetic children have hearing loss at middle and high frequencies as compared to control group children. The complications can be prevented by controlling the diabetes with strict diabetic diet.

Keywords: Children, diabetes, insulin, hearing loss

Introduction
Diabetes mellitus is believed to be a chronic metabolic disorder. Its characteristics are hyperglycemia and numerous abnormalities in metabolism of fat and protein. Its association with a number of microvascular complications has been known for long, most commonly affecting eyes and kidneys. Neuropathy, involving somatic and autonomic nerve fibers is one of the many microvascular complications of diabetes mellitus [1]. As hearing loss is a one of the complications of DM, it usually develops over time and can worsen over a period of years [2]. Three main theories have been postulated to explain etiopathogenesis of hearing impairment in DM, including microangiopathy of the cochlea, auditory neuropathy, and a combination of both [3]. Histological studies have exhibited a range of neural abnormalities including VIIIth nerve demyelination and spiral ganglion cell loss [4]. Since the hearing disability has antagonistic outcomes on instructive fulfillments, a convention for screening of sound-related limits in kids experiencing type 1 diabetes mellitus ought to be molded [5]. Hence, the current study was planned to examine the auditory functions in type 1 diabetic children.

Materials and methods
The study was conducted in the Department of Pediatrics of the medical institution. The ethical clearance for the study was obtained from the ethical committee of the institution. For the study we selected 40 children and adolescents with type 1 diabetes mellitus that reported to outpatient department. These patients were grouped into Diabetic patients group. Other 40 normal healthy students were selected as controls. The subjects in control group were matched to diabetic group patients regarding age and sex.

A signed informed written consent was obtained from the guardians of the patients after explaining to them about the procedure of the study. Patients that had positive family history of deafness, history of ear surgery, previous history of ear trauma with loss of consciousness, ototxic medications administration history were excluded from the study.

Diabetic patients were prescribed insulin (combination of short acting and intermediate acting) to be taken twice daily. Patient's demographic data such as age, sex, insulin dosage, duration of diabetes and HbA1C levels were recorded. The assessment of hearing threshold was done by pure tone audiometric test. Patients with mean value of HBa1C <7.5%was classified as well controlled and HbA1c≥7.5% was classified as poor controlled. Testing of bone conductions thresholds was done at frequencies between 250-4000 Hz and for air conductions thresholds was done at and 250-8000 Hz. The mean of the thresholds of both the ears for each frequency was calculated. Hearing threshold more than 25 dB was predefined to be hearing threshold.

The statistical analysis of the data was done using SPSS software (version 20.0) for windows. Chi- square test and Student's t-test were used to verify significance of the data. P value <0.05 was predefined to be statistically significant.

Results

A total of 40 diabetic and 40 normal healthy control subjects participated in the study. The age of subjects ranged from 5-18 years with mean age being 11.38±4.1 years. The male subjects in diabetic group were 22 and female subjects were 18. In control group, male subjects were 26 and female subjects were 14. Table 1 shows the comparative analysis of hearing thresholds between diabetic and control group. We observed that mean hearing threshold of diabetic group patients were significantly higher as compared to control group with respect to all frequencies (p<0.05) [Fig 1]. Table 2 shows the mean hearing threshold of well controlled and poor controlled diabetic patients. We observed that mean threshold of poor controlled diabetic patients was higher as compared to well controlled diabetic patients. The results were significant with respect to frequencies 250 Hz, 500 Hz, 1000 Hz and 4000 Hz (p<0.05) [Fig 2].

Table 1: Comparative analysis of hearing thresholds between diabetic and control group

	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Diabetic group	19.25±8.43	17.24±8.02	17.1±8.31	16.25±7.14	20.04±8.83	23.59±9.02
Control group	10.9±5.29	8.79±5.02	9.02±3.89	9.26±4.11	9.89±4.78	10.02±5.28

*P value= 0.000 for all frequencies

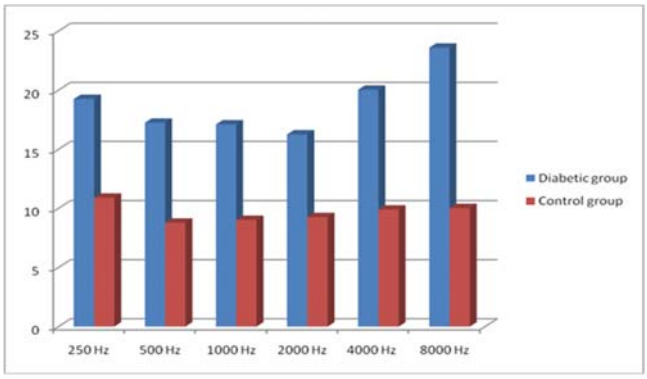

Fig 1: Showing comparative analysis of hearing thresholds between diabetic and control group

Table 2: mean hearing threshold of well controlled and poor controlled diabetic patients

	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Well control	14.23±7.2	12.06±5.98	12.94±4.91	13.03±6.11	14.22±5.49	16.22±6.52
Poor control	16.51±7.91	14.26±7.33	13.82±6.85	14.29±6.02	16.54±7.65	19.29±7.02
P value	0.02*	0.003*	0.001*	0.078	0.024*	0.069

*P value <0.05 - Statistically significant

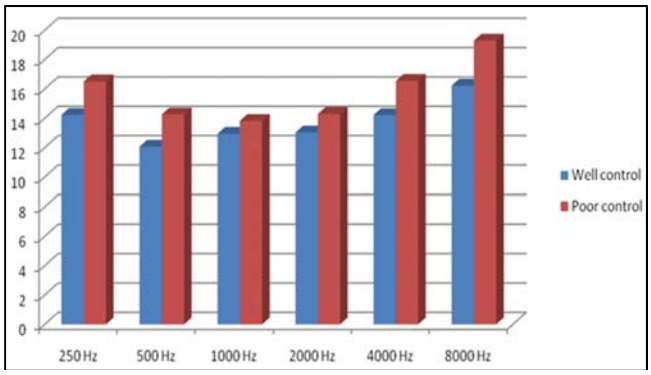

Fig 2: Showing comparison of mean hearing threshold of well controlled and poor controlled diabetic patients

Discussion

Hearing impairment has long been observed in patients with diabetes mellitus, but its casual relationship with the disease has been disputed. Several studies have addressed the questioned association in adults; screening both type 1 and type 2 diabetic patients. Most of these reports have documented presence of significant hearing loss in patients with either type of diabetes, being more prevalent in non-insulin treated patients, and is related to age and microvascular complications [6-8]. However, similar findings have also been reported from the studies, which examined hearing loss in patients with insulin-dependent diabetes mellitus indicating that it is not only the type of treatment, which dictates the degree of hearing impairment in diabetics, but some other additional factors [9-11].

In the present study, we examined the auditory functions in diabetic children. We observed that mean hearing threshold of diabetic group patients were significantly higher as compared to control group with respect to all frequencies. Also, the mean threshold of poor controlled diabetic patients was higher as compared to well controlled diabetic patients. Results are consistent with other studies. Ferrer JP *et al* performed audiometric studies in 46 consecutive patients. 13 with newly diagnosed type 1 diabetes mellitus (group 1) and 33 with type 1 diabetes mellitus of more than 3 years of duration (group 2), of 14 to 40 years of age. The results were compared to an age-matched control group. Pure-tone auditory thresholds were significantly higher in all frequencies 250-8,000 Hz in both groups when compared to the control subjects. Ten patients, all of which belonged to group 2, had auditory thresholds above 30 dB in at least one frequency, showing a conversational hearing loss that ranged between 11 and 44%. However, none of them referred subjective hypoacusia. Univariate analysis revealed significant associations between auditory thresholds and age, duration of disease as well as retinopathy, but not with neuropathy, HbA1c or hypoglycaemic episodes. Only age and duration of disease independently correlated with an auditory threshold using multiple regression. They concluded that type 1 diabetes mellitus can cause mild sensorineural hearing impairment which correlates with age and duration of disease. Celik O *et al* examined the relationship between diabetes mellitus and hearing loss. Pure tone audiometry was performed in 75 patients with insulin-dependent diabetes mellitus, aged between 14 and 60 years (45 males and 30 females; average age 45.3 years), and in 40 randomly selected sex- and age-matched non-diabetic control subjects, using an Interacoustics Clinical Computer Audiometer Model AC5. The mean duration of diabetes in the study group was 15 ± 7 years. Complications such as retinopathy, nephropathy, and neuropathy had developed in 64% of the diabetics. Statistical analyses showed that the hearing of the diabetic patients was significantly worse than control subjects. Complications were found to have a significant effect on sensorineural hearing loss in diabetics. The influence of duration of diabetes was noticed on hearing threshold at mid and high frequencies, especially after the first decade of the disease [12, 13].

Rance G *et al* evaluated sound detection, auditory neural function and binaural processing ability in a group of school-aged participants with Type 1 diabetes and to assess their functional hearing and general communication ability. A range of electroacoustic, electrophysiological and behavioral test techniques were used to evaluate both cochlear and auditory neural function in 19 affected children. A cohort of matched controls was also assessed. Although all of the participants with Type 1 diabetes enjoyed normal sound detection, 9 of the 19 (47%) showed evidence of auditory pathway abnormality with evoked potential latencies and/or amplitudes beyond age-related norms. Auditory brainstem response interpeak latencies were longer than in matched controls and wave V amplitudes were reduced. Binaural speech perception in noise was also impaired and perceptual ability was correlated with degree of neural disruption in the auditory brainstem. The authors concluded that hearing deficits severe enough to restrict communication and threaten academic progress were common on their group of school-aged children with Type 1 diabetes. Abd El Dayem SM *et al* evaluated auditory function in a group of Egyptian type 1 diabetic children. This was a cross sectional observational study, which included 40 patients with type 1 diabetes and 40 controls. HbA1, urinary albumin/creatinine ratio, and auditory assessments (including dizziness questionnaire, pure tone audiometry, speech audiometry, tympanometry, and auto-acoustic cochlear emission) were completed for all patients and controls. Mann-Whitney U-test, $\chi 2$-test and Spearman's correlation were used for statistical analyses. Assessment of pure tone audiometry revealed that the diabetics had a significantly higher reading in high frequency at 8000 Hz, 16,000 Hz, 17,000 Hz, and 18,000 Hz on the right side and at 4000 Hz, 8000 Hz, 16,000 Hz, 17,000 Hz, and 18,000 Hz on the left side. There was a significantly lower level in speech reception threshold, repetition of words, and masking level of diabetics on the left side. Evaluation of transient otoacoustic emission revealed that diabetics recorded significantly lower signal to noise ratio at 4000 Hz on the right side and at 1000, 1500, 4000, and all Hz on left side. There was significant lower emission amplitude in the right side of the diabetics group at 1500 and 4000 Hz and at 1000, 1500, and 4000 Hz on the left side. Patients with failed otoacoustic emission were significantly higher in disease duration >10 years. So, the authors concluded that Type 1 diabetes is associated with high/extended high frequency hearing loss, more prominent on the left side and with longer disease duration [14, 15].

Conclusion

From the results of current study, type 1 diabetic children have hearing loss at middle and high frequencies as compared to control group children. The complications can be prevented by controlling the diabetes with strict diabetic diet.

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