

## ORIGINAL ARTICLE

### HEARING LOSS IN CHILDREN WITH TYPE 1 DIABETES MELLITUS

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#### Abstract

**Objectives:** To study the prevalence and degree of hearing loss, its distribution in different frequencies and its risk factors in children with type I Diabetes Mellitus (DM). **Methods:** Sixty two children with type I DM were compared with 62 age & sex matched children without DM, for hearing assessment using pure tone audiometry. Both air and bone conduction were tested between 250-8000 Hz and 250 - 4000 Hz respectively. Risk factors for hearing loss such as age, gender, diabetic age, insulin requirement, age at onset, glycemic control and its other complications were analyzed. **Results:** Prevalence of hearing loss was 20 % in diabetic children. Hearing acuity was lower in all frequencies, and was significantly low in mid and high frequencies. Duration of diabetes and glycemic control were found to be the significant risk factors for hearing loss. Threshold for hearing was much higher in diabetic children without hearing loss in comparison to non diabetic children. The estimated mean diabetic age to develop hearing loss was five years. **Conclusion:** 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.

**Keywords:** Hearing loss, type I diabetic children, glycemic control

#### Introduction

Hearing loss as one of the complications has been reported more commonly in diabetic children than in non diabetic children (1), with prevalence varying between 20% and 35%. (2,3) Hearing impairment in diabetic patients is usually mild and subclinical, and can be detected early by accurate and objective audiometric methods.(4) Hearing loss is of the sensorineural type. (5) Diabetes also accelerates the age related hypoacusis (6), as evidenced in adults with DM. Studies do exist which didn't reveal any significant difference in audiometry between normal and diabetic children. (7,8) It was in such a scenario this study was undertaken to correlate hearing loss, its relationship to glycemic control and to identify the risk factors.

#### Subjects and Methods

This case control study was conducted at the Institute of Child Health & Hospital for Children, Chennai. A sample size of 62 was calculated for an alpha error of 5%, power of 90% with estimated hearing loss of 20% in type I DM based on literature and 0.1% in normal children. The study was approved by the Institutional review board. Sixty two children with Type I DM and equal number of age and sex matched non diabetic controls were recruited. Informed consent was obtained from the caregivers. Children aged more than 5years of age only were included as Puretone audiometry involves cooperation of the child to perform the test. Exclusion criteria were children with history of hearing impairment, ear discharge, head (or) ear trauma, family history of congenital deafness

and features suggestive of Wolfram syndrome. All recruited children were regularly followed up at the diabetic clinic every month. Their glycemic control was assessed by measuring glycosylated Hemoglobin (Hb) once in 3 months. Acute complications like hypoglycemia, Diabetic ketoacidosis (DKA) and chronic complications like nephropathy, retinopathy, thyroid dysfunction were investigated for and documented. Metabolic decompensations were recorded during follow up. Retinopathy was assessed by dilated fundus examination. Nephropathy was assessed by urine microalbumin excretion rate and albumin/creatinine ratio. Ear examination included physical examination and clinical tests of hearing namely Rinne's test, Weber's test, absolute bone conduction test, and otoscopic examination. All children were subjected to puretone audiometry in a sound proof room using Amplaid 300 clinical audio meter at frequencies between 250 - 8000 Hz and 250 -4000 Hz for air and bone conduction respectively. They were followed up for 1 year and all of them underwent hearing assessment at least thrice during the study period. Hearing loss was defined as present if the child had an average threshold of hearing more than 25 db, in any frequency by puretone audiometry. Degree of hearing impairment was classified as per WHO guidelines as mild degree when the average threshold of hearing was between 26 to 40 db, moderate if 41 to 55db, moderately severe if 56 to 70db, severe if 71 to 91db and profound if more than 91db in any frequency.

Results were tabulated and statistical analysis was done. Percentages of various proportions were calculated. Chi Square test, Mann-whitney U test were used to compare the risk factors. 95% Confidence intervals were calculated for the significant values and for the Odds ratio.

#### Results

Of the 62 diabetic children 13(20.9%) had hearing loss of sensorineural type compared to none in the control group ( $p < 0.001$ ). An assessment of the hearing loss in different range of frequencies viz low frequency (250 to 1000 Hz), mid frequency (1000 to 4000 Hz) and high frequency (4000 to 8000 Hz) revealed all the 13 diabetic children to have developed mild degree hearing loss. Of these 4 children (30.7%) developed hearing loss at all frequencies, 9 (69.2%) children developed hearing loss at mid and high frequencies. Hearing loss was statistically significant in all the three different ranges of frequencies ( $p < 0.05$ ) but hearing loss at mid and high frequency was higher than ( $p < 0.001$ ) at low frequency ( $p = 0.01$ )

The threshold of hearing was compared between the diabetic children without hearing loss and non diabetic children. It was found that in the former it was significantly higher than in the later with  $p < 0.001$ . During the follow up with strict glycemic control over 2 years of study period, none of them progressed from mild to higher degrees of hearing loss. They also did not show reversion to normal threshold of hearing ( $\leq 25$  db).

Among the risk factors analyzed for hearing loss diabetic age and glycemic control, had a positive correlation and other risk factors did not show any correlation. (Table-1) Acute and chronic complications of DM like hypoglycemia, DKA, nephropathy, retinopathy and thyroid dysfunction did not show any correlation to hearing loss. The relationship between hearing loss at different frequencies and metabolic control revealed that poorer glycemic control lead to hearing loss at all frequencies but much higher in mid and high frequencies. This was found to be statistically significant. ( $p < 0.001$ ). Of the 49 children without hearing loss, 39 children had Glycosylated Hb value less than 8% and remaining had values more than 8%. All the 13 diabetic children with hearing loss had Glycosylated Hb value, more than 10%. (Table 1)

**Discussion**

Hearing loss is one of the complications of DM and is secondary to diabetic microangiopathy of cochlea or diabetic auditory neuropathy. (9,10) Three main theories have been postulated by Hisaki Fuskushima et al (11) to explain the pathogenesis of hearing impairment in Diabetes Mellitus- Microangiopathy of cochlea, auditory neuropathy and combination of the above. Elamin et al favors Microangiopathic theory which was supported by the histopathological findings on the temporal bones and the inner ear by Hisake Fuskushima et al (11).

Auditory neuropathy have been demonstrated to cause hearing loss in diabetic patients and animal models by Durmus et al on 1980 (12).The type of hearing loss identified was sensorineural. The threshold for hearing was higher for children with diabetes than the normal population indicating that diabetes does affect hearing and should be considered a complication of diabetes. Hearing loss was demonstrated significantly in mid and high frequencies in this study and can be explained by the fact that diabetic microangiopathy of Cochlea affects mainly the basal turn of cochlea initially. As the diabetic age advances, it is expected to progress further affecting the apical turn also, producing hearing

loss at low frequency. The same has been brought out by De Espana et al (13) in their study.

All the 13 children with hearing loss were followed up with hearing evaluation. These children had poor glycemic control (HbA1c) initially and subsequently with better glycemic control, the hearing loss did not progress, indicating the need to maintain the optimal glycemic control. It is also pertinent to point out that good glycemic control did not reverse the hearing loss indicating the permanent nature of change in the cochlea. This study validates the study done by Doyle K J et al (14) that Micro-angiopathy of cochlea is irreversible. Ideal HbA1c level is considered a tool for good metabolic control. HbA1c of 8 % was taken as the cut off in these children >5 years of age. (15)

Longer the duration of diabetes the chances of hearing loss is more across all ranges of frequencies. Brown et al (16) in their study proved this point and also calculated the mean diabetic age at which hearing loss was demonstrated to be 7 years. This study showed the mean diabetic age for hearing loss to occur to be 5 years. A calculation of the odds ratio also has shown the risk to increase 5 times if diabetic age is more than 5 years. While Celik et al (17) demonstrated a positive correlation of hearing loss with nephropathy and retinopathy in 205 adults with diabetes, no such correlation existed in our study. Two of the children with nephropathy did not develop hearing loss. Retinopathy was not demonstrated in our study.

**Conclusion**

Hearing loss is more common in diabetic children predominantly in the mid and high frequency. Threshold for hearing is much higher in diabetic children in comparison to non diabetic children. Hearing loss is related to the duration of diabetes and degree of glycemic control. Screening of diabetic children for hearing loss after 5 years from the onset of diabetes and maintaining them on good glycemic control is essential to avoid this complication.

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**Table 1: Risk factors and hearing loss in diabetic children(n -62)**

Risk Factors	Hearing Loss Present	Hearing Loss Absent	p value*
<b>Gender:</b> Male	6(46.1%)	22 (44.8%)	0.94
Female	7(53.8%)	27 (55.1%)	
<b>Age</b> 5-10 yrs	4(30.7%)	10 (20.4%)	0.43
11-15 yrs	9(69.2%)	39 (79.5%)	
<b>Age at onset of DM</b> < 5 yrs	7(53.8%)	34(69.38%)	0.3
5-10 yrs	6(46.1%)	15 (30.6%)	
<b>Diabetic age</b> < 5yrs	9(69.2%)	45 (91.8%)	0.03
5-10 yrs	4 (30.7)	4 (8.1%)	
<b>HbA1c Level</b> > 8%	13 (100%)	35	0.03
< 8%	0	14	

Note: \* (chi square test)  $p < 0.05$  significant, DM = Diabetes Mellitus

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