

## Assessment of hearing loss as a potential complication of diabetes mellitus

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### Abstract

**Introduction:** High blood glucose levels are found to damage the vessels found in stria vascularis and adjacent nerves, this results into diminished ability to hear. To support this result, insufficient evidence of a significant relationship between diabetes and hearing impairment is there. Therefore, we aimed to assess hearing impairment in diabetic mellitus individuals as one of the potential complications.

**Material & Methods:** The study involved 150 type 2 Diabetes Mellitus patients. Diabetes Mellitus type 2 subjects 65-89 years of age, meeting the inclusion/exclusion criteria were included in the present study. The individuals with the diabetes had been followed up for 10 years.

**Results:** 89 patients of total 150 patients had duration of diabetes for more than 10 years. Among them mild hearing loss was found in 37 patients. Out of total 150 patients 61 patients in whom the duration of diabetes was less than 10 years, we could not find any detectable hearing loss. Duration of Diabetes mellitus and sensorineural hearing loss at 2000Hz, 4000Hz showed statistically significant correlation (Pearson coefficient  $r=0.981$  and  $r=0.90$  respectively) at 0.03 level.

**Discussion & Conclusion:** on the basis of results we came to conclusion that progressive bilateral high frequency sensorineural hearing loss can be considered as one of complication of type 2 DM. Periodical assessment of various organs of the body, including the hearing system, should be carried out carefully and regularly, so as to provide better life condition for the diabetic patients in the future.

**Keywords:** Complications, Diabetes Mellitus, Hearing problem, Presbycusis

### Introduction

The term diabetes, which means “siphon,” which explains the “liquefaction of the flesh and bones into urine” was coined by scientist Arateus. Diabetes mellitus (DM) is considered as genetically inherited disease in which glucose serum levels are found to be abnormally high due to relative or absolute insulin deficiency in the body.<sup>(1)</sup> Metabolic disorders, vascular and neuropathic complications are considered as the clinical manifestation of the DM. DM is listed as an incurable disease and management of diabetes mellitus should be focused on preventing chronic complications. Diabetes mellitus affects up to 7% of the population worldwide.<sup>(2)</sup>

There has been a rapid progression in advancing age in which chronic diseases and functional impairments become very common. One of all these there is age-related hearing loss also called as presbycusis, the most common of sensory deficit, & a significant chronic medical condition in the elderly person.<sup>(3)</sup> Presbycusis is the result of various types of physiological degeneration which is due to aging along with the accumulated effects of noise exposure, tobacco smoking, medical disorders & their treatment and hereditary susceptibility. It is characterized by the bilateral, symmetrical & slowly progressive reduced hearing sensitivity & speech understanding in noisy environments and slowed central processing of acoustic information & impaired localization of sound sources.<sup>(4)</sup>

Hearing is considered as one of the most important sense among the five senses gifted to mankind. Hearing is found to play an important role in the development of

speech, communication along with the development of cognitive, emotional and sociability of an individual. Being a hearing impaired puts a step backward in overall development of the child. Thus it is very essential to identify the impairment in the early stages and should be treated effectively.<sup>(5)</sup>

In diabetic microangiopathy there is diffuse thickening of the basal membranes, which is also found in vascular endothelium, is considered as one of the most prevalent morphologic findings in Diabetes Mellitus. Skin capillaries of skeletal muscles, retina, kidney glomeruli, and renal medulla are found to be affected by such thickening. The pathogenesis of this morphologic disorder is yet very unclear, but it is said to be directly related to the hyperglycemia. There are also morphologic disorders related to the involvement of lower extremity motor and sensorial nerves which is characterized by the injuries to Schwann cells, myelinic degeneration and the axonal damage. Controversy persist in the cause of this neuropathy but it is found to be related to the diffuse microangiopathy and consequent malnourishment of the peripheral nerves.<sup>(6,7)</sup>

The relationship between the hearing loss and the diabetes mellitus remains debated for many years. Diabetes mellitus is a chronic metabolic disorder characterized by high blood glucose in the context of insulin resistance and relative insulin deficiency. Diabetes mellitus is said to be associated with numerous complications. One of the lesser known complications of diabetes mellitus is the auditory organ dysfunction and tinnitus, which leads to a decreased quality of life among those which are affected.

Globally, as for 2013, an estimated 382 million people have been suffering from diabetes worldwide, with type 2 diabetes making up about 90% of the cases. Diabetes mellitus has been implicated as an independent causative factor of sensorineural hearing loss.<sup>(8)</sup>

Hearing impairment has been found of many causes. The most common of which is presbycusis, which is followed by noise exposure, ototoxic drugs & various viral infections. In addition to these factors, the association of hearing impairment with diabetes is controversial. It is believed that over time high blood glucose levels can damage the vessels in the stria vascularis and associated nerves which diminished the ability to hear. However, no sufficient evidence is present of a significant relationship between the diabetes mellitus and hearing impairment from the epidemiological. So in the present study we aimed to compare the prevalence of hearing impairment in diabetic mellitus adults.<sup>(9)</sup>

### Materials & Methods

This study was planned at the Department of Otorhinolaryngology and Head and Neck Surgery Gujarat Adani Institute of Medical Science, Bhuj, Kutch, Gujarat. Declaration of Helsinki on biomedical studies which involved human subjects was kept in view while performing the investigations. All the participating individuals were informed about the study and the written informed consent was obtained from all the participating subjects. Before conducting the study the ethical clearance was obtained by us from the ethical committee of the institute.

Exclusion criteria were individuals with a history of noise damage, middle ear hearing loss, and history of cognitive function disability. Also excluded were those who had been treated with ototoxic medications, exhibited serious medical health problems or neurological medical conditions, were diagnosed with Meniere's disease or labyrinthitis.

The present study involved total of 150 type 2 Diabetes Mellitus patients and the period was of 4 months. The current study included type Diabetes mellitus 2 subjects 65-89 years of age who did meet the above inclusion/exclusion criteria discussed with the monitors of the study. Participants with diabetes mellitus had been followed up for at least for 10 years.

The two methods used for hearing assessment used were by general ear examination and Pure Tone Audiometry. These were used to determine the hearing function and if any hearing loss is present than the degree, type and configuration of a hearing loss. For ear examination and pure tone audiometry method for hearing assessment the guidelines from The British society of audiology were used. Otoscopy was used for general ear examination this was followed by pure tone audiometry in which manual audiometry was used. The instrument was made to deliver the pure tone of different variable frequency & various intensity using

ear phones. Assessment was done at 1000 Hz, 2000Hz, 4000Hz, 8000Hz, 500Hz & 250 Hz in the similar order. The intensity was varied for each of the frequency & the patients were instructed to signal when he/she hears any sound. Patient's hearing threshold was taken as intensity at which patients hears any sounds. Both air & bone conduction testing was done on all the participants. The results were charted as different audiograms and were classified based on hearing threshold as mild (20 to 30 dB), moderate (31 to 60dB) moderately- severe (61 to 70dB), severe (71 to 90dB), profound (>91dB) and total deafness (no hearing).

### Results

Out of 150 patients with type 2 diabetes mellitus, 63 patients were found to be females and 87 patients were found to be males. Mean age was calculated as 49 years. Out of 150 type 2 diabetic mellitus individuals 84 patients were found to have bilateral sensorineural hearing loss in the higher frequency (2000hz, 4000hz). Among the total 84 individuals Severe hearing loss (71 dB to 90dB) was seen in the 13 patients, moderately severe hearing loss (61dB to 70dB) was found in the 26 patients and moderate hearing loss (30dB to 60 dB) was seen in 45 patient. 12 patients who were between the age of 30- 40years; 18 patients who were between the age 40- 50years; 21 patients who were between the age of 50-60 years; & 27 patients who were between the age of 60 -70 years had some or the degree of hearing loss among them. Out of the total 150 patients 89 patients had duration of diabetes mellitus for more than 10 years. Among them 37 patients did show that they were suffering from least mild hearing loss. Out of 150 DM patients who had duration of diabetes less than 10 years 61 individuals did not have any detectable hearing loss. Duration of DM and sensorineural hearing loss at 2000Hz, 4000Hz was found to be statistically significant (Pearson coefficient  $r = 0.981$  and  $r = 0.90$  respectively) at 0.03 level.

**Table 1: Classified based on the hearing threshold**

Sr. No.	Decibels	Characteristics
1.	20 – 30	Mild
2.	31 – 60	Moderate
3.	61 – 70	Moderately Severe
4.	71 – 90	Severe
5.	> 91	Profound
6.	No Hearing	Total deafness

**Table 2: Patients with type 2 DM**

Sr. No.	Sex	Number
1.	Male	87
2.	Female	63
3.	Total	150

**Table 3: Distribution of patients having hearing problem**

Sr. No.	Hearing problem	No. Patients
1.	Moderate	45
2.	Moderate Severe	26
3.	Severe	13
4.	Total	84

**Table 4: Distribution of DM patient having some levelling hearing problems**

Sr. No.	Age	No. of Patients
1.	30 – 40 years	12
2.	41 – 50 years	18
3.	51 – 60 years	21
4.	61 – 70 years	27
Total	Total	84

## Discussion

Aging of any individual most of the time is associated with two major conditions likes hearing impairment and diabetes. Hence there is a possibility that the relationship observed between hearing impairment and that of diabetes is due to aging. However, owing to the stratified analyses, the stronger association was observed in the studies of younger participants as compared with the studies of the older participants.<sup>(10)</sup>

In the research done by Diniz and Guidu,<sup>(11)</sup> they carried out on 50 diabetic patients, as a case group & they compared them with non - diabetic subjects, it was observed that the scale of their results was higher than that of our results. This difference noticed or observed were might be attributed to the younger population in our present study. They did found that in 38% of their diabetic patient and 2.4% of non- diabetic subjects there was hearing loss.<sup>(12)</sup> In a study by Rege, Hearing loss was also reported among the children with the diabetes. In our study, the increasing hearing loss showed to have the direct correlation with the duration of the diabetes in patients, but this observation was not statistically significant. It seems that age, in the addition to diabetes, can cause the hearing loss.<sup>(12)</sup>

The pathophysiology underlying diabetes-associated hearing loss may involve the effect of diabetes-related microvascular disease on the cochlea. Few microscopic studies sclerosis of internal auditory artery, thicker vessel walls of stria vascularis & of the basilar membrane, damage to the outer sheath of the cochlear nerve and atrophy of a spiral ganglion.<sup>(13)</sup>

We observed that there was statistically significant correlation between hearing loss and that of type 2 Diabetes Mellitus. Significant correlation was found in comparison of hearing loss with that of glycemic control. The hearing impairment was that of sensorineural type because there was hearing loss was found in both air & the bone conduction. Since sensorineural hearing loss was present only in the

higher frequency it can be argued that the cochlear part of 8th cranial nerve is not affected. Sensorineural hearing loss was found in the higher frequency similar to that of sensory Presbycusis.<sup>(14)</sup>

More extensive study involving larger sample size and the wide geographical area is necessary for the study. Longitudinal study would always confirm the above results. Pure tone audiometry which was used to determine the hearing loss relies on the patient response & hence is the subjective test. This does raises the question of accuracy of the audiograms. Objective hearing tests need to be conducted to confirm the results. Many of the patients with diabetes mellitus did not show any of the hearing impairment.

## Conclusion

We concluded that the progressive bilateral high frequency sensorineural hearing loss is one of the complication of type 2 DM. The Hearing loss pattern was found to be similar to be that of Presbycusis seen only in the higher frequency. In regard to the incidence of chronic and irreversible complications among the diabetic patients, periodical assessment of various organs of the body, including hearing system, should be carried out very carefully, to provide the better life condition for the diabetic patients.

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