

# Incidence of Hearing Loss, Tinnitus and Vertigo among Diabetes Patients

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## ABSTRACT

**Background:** Diabetes mellitus has been a cause of many a health ailment. The relationships between inner ear manifestations, hearing loss (HL), tinnitus and vertigo as well as diabetes are not established.

**Objective:** To assess prevalence of HL, tinnitus and vertigo among diabetic patients in a typical Indian tertiary care hospital in a cross-sectional study.

**Methods:** 240 patients were categorized according to their age (< 60 years and > 60 years), gender, chronicity of diabetes mellitus (<10 years and >10 years), related complications (hypertension, nephropathy and retinopathy) and modalities of diabetic treatment taken by patients. Detailed examinations of their ears with an otoscope and the tuning fork test, including the pure tone audiometry were done in a sound proof room at frequencies of 500-8000 Hz.

**Results:** Ear manifestations were found among 240 diabetes patients: HL in 148 cases (61.67%), tinnitus in 70 cases (29.17%) and vertigo in 17 cases (7.08%). The association of age ( $p=0.21$ ) and sex ( $p=0.58$ ) with HL, tinnitus and vertigo were not statistically significant. Nevertheless, the duration of diabetes as well as the treatment modalities for it, in relation to these ailments were statistically significant ( $p=0.07$ ) and ( $p=0.05$ ), respectively.

**Conclusion:** HL, tinnitus and vertigo were better controlled by intake of insulin than oral hypoglycemic agents and diet regulation.

**Keywords:** Diabetes, hearing loss, tinnitus, vertigo

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## INTRODUCTION

As estimated, hearing impairments are known to occur with more than 250 million people in the world as a sensory deficit. The relationship between diabetes mellitus (DM) and inner ear complications has been debated for many years. Nonetheless, medical

conditions, hypothyroidism, DM, hyperlipidemia and a few associated comorbidities have been recorded to worsen the problem, by potentially affecting the inner ear.<sup>1</sup> According to another survey, the frequency of sensorineural hearing impairment ranged from 10 to 80%.<sup>2</sup> Moreover, the vascularity of the inner ear being complex, it remains as a potential target of hyperglycemic damage, as neuropathic and microvascular complications occur in diabetics in the inner ear.<sup>3</sup>

Tinnitus was reported to affect chronically about 10-15% of general populations in industrial countries and it sometimes becomes

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so distressing that a loss of quality of life often occurs.<sup>4</sup> Indeed, about 85% people with tinnitus were suffering virtually from hearing loss (HL), due to occupational and leisure noise loads with the consequent cochlear damage.<sup>5</sup> Other than sound pollution, hypertension (HTN) and arteriosclerosis could potentially affect the inner ear, resulting in the risk of manifestations of HL, tinnitus and vertigo.<sup>6</sup> These are common complaints among population, especially in persons older than 40 years of age due to numerous agents/factors and DM is one of them.<sup>7</sup> The association between type II DM and HL was at first unknown and unresolved but, less recent surveys supported the assumption of association.<sup>8,9</sup> Additionally with a large size of patients (1,490 cases), it was established that there is a link between a higher blood lipid level and sensorineural hearing loss (SNHL).<sup>10</sup>

A gradual onset typical HL is described as a progressive, bilateral, sensorineural deafness by the aging process.<sup>6</sup> However, DM may be a part of a genetically inherited syndrome in which, it is merely a cause of one of the symptoms including, Wolfram syndrome, optic atrophy and deafness, as known.<sup>11</sup> However, most audiometric studies on hearing in patients with DM with a higher threshold of blood sugar showed a mild to moderately high frequency SNHL.<sup>12,13</sup> However, no difference in speech discrimination scores among diabetic patients in a normal population was recorded,<sup>12</sup> implicating no hearing problem by hyperglycemia. Effects of different variables such as, duration of DM, intake of blood sugar controlling medicine and the presence of any end-organ damage on HL have not yet been clarified, despite several studies on this topic. Thus, the correlation between HL and DM is controversial and has later been related to problems of other vital organs, so it was intuitive to carry out this survey-based study. This study aimed to investigate the relationship between inner ear problems, HL, tinnitus and vertigo due to DM, along with several related modalities and associated complications promoting hearing ailments. This study could help assess cited

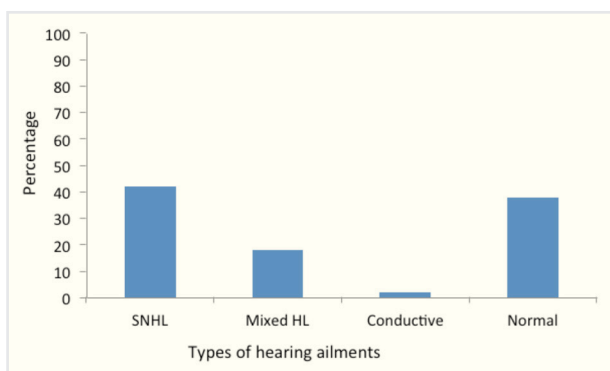
problems, among diabetic patients attending this tertiary care hospital.

## MATERIALS AND METHODS

The study was carried out for two years, from October 2010, at the Department of ENT and Endocrinology, IMS and Sum Hospital, Bhubaneswar. The details of audio-logical history of 240 diabetic patients (144 males and 96 females) between 35 and 80 years of age were taken into consideration, with the duration of suffering from diabetes and associated complications and treatment modalities. Detailed examinations of ear with an otoscope and the tuning fork test, including the pure tone audiometry were done in a sound proof room at frequencies of 500-8,000 Hz. The number of patients with complained HL, tinnitus and vertigo were also documented. However, diabetics with other diseases in external or middle ear were excluded from this study. Patients who used an ototoxic drug therapy or had a history of cranial trauma were excluded. Patients with giddiness underwent vestibular assessments. The data were analyzed in terms of audiometric findings for the presence of tinnitus and vertigo.

## RESULTS

Seventy-two (30%) patients were affected with both DM and HTN, 24 (10%) patients were suffering with DM and retinopathy, and 28 (11.7%) patients were with DM, HTN and nephropathy. There were 17 (7.08%) patients suffering from vertigo. The treatment already taken by diabetic patients were considered for insulin intake, oral hypoglycemic agents (OHA) and suitable diet regulation. The results obtained from the audio-logical history were 148 cases of HL, 70 cases of tinnitus and 17 cases of vertigo. The pure tone audiometry tests identified the following types of hearing ailments: sensorineural (42%), mixed (18%) and conductive (2%); and 38% of the audiograms in this group were deemed normal (Fig 1).



**Fig 1.** Type of hearing loss (HL) among diabetic patients expressed as percentages.

The pure tone average among HL patients was 56 decibels. SNHL mostly affected high frequency in 67% cases ranging from mild to severe degrees. Correlations of DM with HL, tinnitus and vertigo with respect to age, sex, duration of the disease, treatment modalities and other complications, respectively, were ascertained. With respect to age (<60 years and >60 years), the association of the ailments were not considered to be statistically significant ( $\chi^2=3.12$ ,  $p=0.21$ ) (Table 1). Sex had no significant role in causing HL, tinnitus and vertigo, among all diabetic patients ( $\chi^2=1.08$ ,  $p=0.58$ ) (Table 1). The duration of DM (chronicity) (>10 years and <10 years) in relation to these ailments were statistically significant ( $\chi^2=5.2$ ,  $p=0.07$ ) (Table 2).

The treatment modalities of these ailments were carried out with insulin, OHA and diet regulations. Patients with no treatments were affected at a maximum percentage, but the treatment modalities were statistically significant for incidences of each ailment described ( $\chi^2=11.97$  and  $p=0.01$ ). Additionally, it was found that no treatment of a diabetic

**TABLE 1.** Correlation of DM with HL, tinnitus and vertigo with respect to age and sex.\*

Disease	<60 years (158)	>60 years (82)
	Male (Female)	Male (Female)
HL	50 (42)	42 (14)
Tinnitus	33 (19)	11 (7)
Vertigo	6 (5)	4 (2)
Not affected	2 (1)	1 (1)

\*In parenthesis, number of females is presents.

**TABLE 2.** Correlation of DM with HL, tinnitus and vertigo with respect to duration of the disease and sex.\*

Disease	<10 years (152)	>10 years (88)
	Male (Female)	Male (Female)
HL	48 (44)	44 (26)
Tinnitus	20 (24)	19 (7)
Vertigo	6 (5)	4 (2)
Not affected	3 (2)	0 (0)

\*In parenthesis, number of females is presents.

patient might cause increased impairments of all hearing ailments (Table 3). Further, the DM associated complications, HTN, retinopathy and nephropathy were significantly associated with HL, tinnitus and vertigo ( $\chi^2 = 8.42$ ;  $p = 0.08$ ) (Table 4).

Among the 17 vertigo patients, it was found that 6 had benign paroxysmal positional vertigo (BPPV), i.e., its symptoms were repeated episodes of positional vertigo, or of a spinning sensation caused by changes in the position of the head. Four patients had vestibular neuronitis, a type of unilateral vestibular dysfunction which may be associated with nausea, vomiting, with a previous episode of

**TABLE 3.** Correlation of DM with HL, tinnitus and vertigo with respect to treatment modalities.

Treatment modalities	No. of patients (240)	HL (148)	Tinnitus (70)	Vertigo (17)	Not affected (5)
Insulin	70 (29.16)	44 (62.85)	22 (31.42)	2 (2.85)	2 (2.85)
OHA	80 (33.33)	52 (65)	23 (26.13)	4 (5)	1 (1.25)
Diet regulation	46 (19.16)	27 (58.69)	12 (26.08)	5 (10.86)	2 (4.34)
No treatment	44 (18.33)	25 (56.81)	13 (29.54)	6 (13.63)	0

Abbreviation: OHA: Oral hypoglycemic agents; in parenthesis, percentile of the disease

**TABLE 4.** Correlation of DM with HL, tinnitus and vertigo with respect to complications.

	DM (97)	DM + HTN (80)	DM + HTN + retinopathy (33)	DM + HTN + nephropathy (30)	Total (240)
HL	64	52	16	16	148
Tinnitus	26	22	12	10	70
Vertigo	3	5	5	4	17
Not affected	4	1	0	0	5

**Abbreviation:** HTN: Hypertension; in parenthesis percentile of the disease are given.

upper respiratory tract infections. Two patients had labyrinthitis, severe vertigo with viral or bacterial infection. One patient had Meniere's disease and fluctuating HL rather than with a permanent ailment. Further, 4 patients had central vestibular causes.

## DISCUSSION

Most studies in the literature reported no difference of hearing ailments between the sexes. However, male diabetics had worse hearing ailments due to noise than female diabetics in a study,<sup>14</sup> while female patients with diabetes had significantly greater frequency of HL.<sup>15</sup> However, HL, tinnitus and vertigo were more common among male diabetics in this study, but the association was not significant. Moreover, pure tone HL increased with age in patients with diabetics corroborated herein as described previously,<sup>6</sup> even after a correction for presbycusis. Both processes involve progressive high frequency losses in hearing efficiency. This study recorded that with DM, hearing ailments were more in people with ages above 60 years, in comparison to those with ages less than 60 years. However, the relationship of hearing ailments with aging were not statistically significant in this study.

In this study, HL, tinnitus and vertigo were common among diabetic patients with more than 10 years duration than patients with less than 10 years of DM occurrence, but the association was not significant. When the duration of DM increased to 15 years, the incidence of HL was reported increasing.<sup>13</sup> Further, diabetics taking insulin had better hearing capacities than those taking OHA or treated with the diet

regulation alone in this study which corroborated another study on DM treated with diet regulation or the intake of OHA.<sup>17</sup> This finding lead to the belief that an aggressive therapy of DM lead to the decrease of HL. The data collected from the audio-logical interviews indicated that the main complaint from the DM group members was dysacusis, followed by tinnitus herein. Thus, HL, tinnitus and vertigo were better controlled by insulin than OHA and diet regulation. The association among treatment modalities with HL, tinnitus and vertigo were statistically significant.

The pathogenic effects of DM on the ear can be broadly grouped into neuropathic or angiopathic origin, and a combination of the two. The tissue effects of DM are thought to be related to the polyol pathway, where glucose is reduced to sorbitol. As it is known, the sorbitol accumulation induces neuropathy by causing a decrease in myoinositol content, abnormality in phosphoinositide metabolism and a decrease in  $^{+}Na/^{+}K$  ATPase activity.<sup>18</sup> Further, severe atrophy of the spiral ganglion in the basal and middle turns of the cochlea in diabetic patients with SNHL was reported and the VIIIth nerve was recorded to have signs of myelin degeneration, with fibrosis of the perineurium<sup>19</sup> — leading to hearing ailments. It was also observed that atherosclerosis, a well documented consequence of diabetes and HTN, was responsible for neuronal degeneration in the inner ear.<sup>20</sup> Histopathologic properties of temporal bones in diabetics with HL were reported with thickening of the walls of the vasa nervorum of the VIIIth nerve, leading to acoustic neuropathy and microangiopathic changes in the stria vascularis and basilar mem-

brane. Moreover, microangiopathic changes were reported in the endolymphatic sac, stria vascularis and basilar membrane.<sup>16</sup> Diabetics with microangiopathic changes in the endolymphatic sac had the greatest degree of HL. A priori, genetic factors could cause a role in SNHL development in a small subset of the maternally inherited diabetic population with HL with a mutation in mitochondrial tRNA<sup>21</sup>, and a similar mutation in mitochondrial DNA in the same type of patients was too reported.<sup>22</sup> Recently, a study demonstrated abnormalities of outer hair cell function and abnormal auditory brainstem response in diabetics.<sup>23</sup> There was partial degeneration of the vestibular nerves, which was interpreted to represent the pathological sequela of acute diabetic vestibular neuritis.<sup>24</sup>

The mechanism of tinnitus generation remains unclear, but this could be attributed to pathological changes in the central nervous system.<sup>4</sup> In literature recently, cortical map reorganization is suggested to explain the emergence of tinnitus which needs verification.<sup>25,26</sup> In a tinnitus patient, the alpha band power was significantly reduced in a study with a significant increase a delta band power in temporal region of the brain. Several studies confirmed that pathological neuronal synchronization was related to the perception of tinnitus.<sup>27</sup> Indeed, non-auditory areas, amygdala, cingulate cortex and par-hippocampus are reported to play a crucial role in tinnitus.<sup>28</sup>

In the present study, the relationship between subclinical ailments, neuropathy or retinopathy to DM was not established, because the level of HbA1c was not established, nor fasting and post-prandial hyperglycemia levels were monitored. However, the linkages between HL and DM with or without HTN or insulin intake or diet regulations were based on personal interviews. On the other hand, we established here that the majority of cases with DM in the wide range of ages (young to old diabetics) had HL. Thus, this study corroborates the Japanese study with regards to ageing having a role in HL.<sup>29</sup> From our study based

statistical estimation, it could be concluded that HL is more prevalent among diabetics. Another study from USA clarified that intake of vitamins, C, E, B-12 and beta-carotene did not aid to reduce HL in men only <60 years of age, but a higher foliate intake too could reduce the risk of HL.<sup>30</sup> Another study in the USA on age related HL elucidated that people with healthy lifestyle had reduced risks of HL.<sup>30</sup>

Vertigo offers a bewildering situation for clinicians, because of vestibular disturbances ranging from true vertigo to slight postural instability. Further, the link between vertigo and DM has not been established in this study or in the study from Nigeria.<sup>31</sup> In a recent study in Italy, it was demonstrated that there was a significant association of tinnitus and high frequency SNHL, suggesting that the auditory pathway reorganization included by HL could be one of the main causes of tinnitus sensation.<sup>32</sup> In a study with HL as an occupational health hazard, it was reported that chronic low levels of lead exposure was an important factor in the development of age related HL in patients working in some industries.<sup>33</sup> Thus, it could be that other polluting heavy metals or chemicals of environmental concern could have a role in the development of hearing ailments.

## CONCLUSION

The results obtained in this study favour the existence of a relationship between HL and tinnitus with DM. Therefore, the auditory status of DM patients could be thoroughly screened for conformity. This study demonstrated that data identified poorly defined disease relationships and suggested that the screening of diabetic patients for HL, tinnitus and vertigo, in a prospective manner may be useful for a clearer understanding of this disease process.

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