ORIGINAL ARTICLE

Assessment of sensorineural hearing loss in well controlled and poorly controlled patients with diabetes mellitus

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Abstract

Background: The prevalence of diabetes and its adverse effects have snowballed through the world due to changes in lifestyle. Association of diabetes with hearing loss has been a topic of discussion for many years. *Aim and Objectives*: To assess the Sensorineural Hearing Loss (SNHL) in patients with diabetes and correlate it with the duration and severity of hyperglycemia. *Material and Methods:* This hospital based cross-sectional study was carried out from August 2017 to July 2018 among100 patients with diabetes aged between 31-60 years. Patients were grouped as per age, duration of Diabetes Mellitus (DM) and glycaemic control using HbA1c levels. The results were statistically analysed using Chi-square test and Pearson's coefficient to draw significance. *Results:* The incidence of SNHL in patients with diabetes was 79% and the correlation among different age group showed statistical significance ($p < 0.05$). There was no statistical association between the gender and hearing loss among patients with diabetes ($p = 0.70$). However, association of SNHL to the duration of DM was statistically significant when compared among all three duration groups. No statistical correlation was present with the glycaemic control of DM. Results showed high frequency SNHL with 41.8% patients with diabetes having moderate degree of hearing loss. *Conclusion:* Early referral for hearing assessment in patients with diabetes can be followed by clinicians aiming at improving quality of life with timely measures.

Keywords: Sensorineural Hearing Loss, Diabetes Mellitus, HbA1c, Hearing Impairment, Hypoglycaemic drugs

Introduction

Hearing empowers us and enriches our lives. Hearing enables us to socialise, work, interact, communicate, and even relax. It helps us to lead our everyday lives without limitations. Problems with hearing may lead to feelings of isolation and even depression. The depletion of social networks can cause a tangible decrease in our length and quality of life. Our ability to hear has an impact on almost every aspect of our lives. The sense of hearing, the perception of sound and its biological purposes, is not, therefore, a trivial consideration that can be lightly dismissed. Diabetes Mellitus (DM) is a common non-communicable metabolic disorder of multiple etiologies characterized by chronic hyperglycemia with disturbances of carbohydrate, fat and protein metabolism resulting from

defects in insulin secretion, insulin action or both [1]. It is a major and growing threat to global public health with around 220 million cases worldwide. According to World Health Organisation (WHO), the prevalence rate of DM would be 5.4% in 2025 [2]. The prevalence of DM and its adverse health effects have increased more rapidly in South Asia than in any other regions of the world [3]. This could be due to accelerated urbanisation, lifestyle changes, and diet heavy in fat, processed carbohydrates, with lack of fibre are becoming more popular. Over the past 200 years, the amount of fat and refined carbohydrates consumed per person has grown by 5 to 10 times, but the amount of fibre-rich grains consumed have decreased significantly [4].

India has an unpleasant distinction of being the world's diabetes capital, with 58 million people currently suffering from type II diabetes and this number is expected to rise to 79.4 million by 2030 [5]. Type 2 DM (T2DM) constitutes 90% of all the cases and varies in etiology, pathogenesis and predisposition to complications as compared to Type 1 DM (T1DM). Hyperglycemia causes oxidative and nitrosative stress which induces DNA damage and fastens atherosclerosis. The microangiopathy due to resultant endothelial damage has been linked to complication of DM. Vascular changes in neurons produces ischaemia and demyelination. Thickening of capillary basement membrane is a classical finding of diabetic microangiopathy. Atrophy of stria vascularis has also been reported in various studies. There have been conflicting results between the association of DM and hearing loss probably due to presence of confounding factors causing hearing loss. Microangiopathy related complication may be the first presentation of T2DM affecting quality of life of patients [6].

Glycosylated haemoglobin (HbA1c) is a widely used marker of chronic glycemia, reflecting average blood glucose levels over two to three months period. This test has been reported to play a critical role in the management of the patient with diabetes, since it correlates with both microvascular and, to a lesser extent, macrovascular complications and is widely used as the standard biomarker for the adequacy of glycemic management. The present study was undertaken to evaluate the incidence of sensorineural deafness in patients attending the Department of Medicine and Endocrinology for diabetes management and to study the severity of sensorineural hearing loss with severity of DM (as assessed with duration of DM and value of HbA1c). This could serve as a useful tool to screen disease complication i.e. hearing loss among patients with diabetes and take timely measures for providing better quality of life by taking necessary intervention for hearing impairment.

Material and Methods

This hospital-based cross-sectional study was carried out over a period of one year from August 2017 to July 2018. The study was conducted at outpatient sections of Department of Otorhinolaryngology, Medicine and Endocrinology in the Medical College. The approval of the Institutional Ethics Committee was taken prior to the study. Informed consent was obtained from the enrolled patients in their own language. Random sampling method was done to obtain 100 known patients with diabetes fulfilling the inclusion and exclusion criteria. The inclusion criteria were subjects aged between 31–60 years and diagnosed with T2DM as per the American Diabetes Association diagnostic

criteria [7]. The exclusion criteria were patients with history of taking ototoxic drugs/occupational noise exposure/ head and ear injury/family history of hearing loss, conductive and mixed hearing loss, congenital/structural deformity of ear and ear infections, abnormal otoscopy findings and diagnosis of other systemic illness (hypertension, thyroid disorder, coronary artery disease).

Patients attending the Department of Medicine and Endocrinology for diabetes management were referred to Department of Otorhinolaryngology for hearing assessment irrespective of the hearing status in random manner to obtain a total of 100 patients. A detailed history was obtained including hearing loss – onset, duration and to rule out exclusion criteria. Patients were grouped into three groups as per age: Group 1: 31-40 years, Group 2: 41-50 years and Group 3: 51-60 years. History regarding the diabetes status was noted from all patients which included duration of DM, diabetic treatment received by the patients. Patients were grouped according to duration of DM as: Group 1: < 5 years, Group 2: 5-10 years and Group 3: >10 years. Patients were also further grouped according to the treatment for DM as: Group 1: patients on Oral Hypoglycaemic Agents (OHA), Group 2: patients on Insulin and Group 3: patients on treatment with both, OHA and Insulin.

Screening of hearing loss was done using tuning fork test. Patients were subjected for audiological assessment using Pure Tone Audiometry (PTA). Assessment of the hearing status was done using a pure tone audiometer (AC40 Clinical Audiometer) standardized according to the manufacturer's instructions. Earphones were used to test hearing by air conduction and a small vibrator placed over the mastoid was used to test hearing by bone conduction. Audiometric assessment was conducted in soundproof room delivering pure tone stimuli to one ear at a time, which was increased in 5 dB and decreased in 10 dB steps fashion according to Hughson Westlake method in frequencies of 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz and 8000 Hz at various selected intensities. Hearing threshold was taken as the least intensity of pure tone that was audible to the subject. The subject was advised to signal on hearing the least sound of any sort till it ceases. The subject was presented with various selected tones for 1 to 3 seconds and for a minimum gap of 1 to 3 seconds between successive presentations. Air conduction thresholds in the right and left ears were marked by 'Ó' and 'X' respectively. Bone conduction threshold was obtained by using bone vibrator placed on the skin over mastoid process and it was assessed to a maximum of 4000 Hz. It was represented by symbols '[' and ']' for right and left bone respectively. Masking was employed, when the difference in right and left unmasked air conduction threshold was 40 dB or more.

Patients having conductive and mixed hearing loss on audiometry were excluded from the study. Conventionally, average of speech frequency i.e., 500 to 2000 Hz was taken to assess hearing loss average. As high frequencies are involved early in DM induced hearing loss, the average of all frequencies i.e., 250 to 8000 Hz were taken to calculate the hearing loss. Average of hearing loss in two ears was taken as hearing loss in that patient. Hearing threshold was interpreted into various degree of hearing loss as below (Table 1) [8].

Table 1: Clark's grading of hearing loss [8]

Degree of hearing loss	Hearing loss in decibel (db)
Normal	10-15
Minimal	16-25
Mild	26-40
Moderate	41-55
Moderately severe	56-70
Severe	71-90
Profound	91+

The blood samples (5 ml) were collected in EDTA tube from all the patients by venipuncture under aseptic precautions and were sent for HbA1c analysis. Estimation of HbA1C was done in the Department of Biochemistry, using enzymatic method and expressed as percentage HbA1c certified by National Glycohemoglobin Standardization Program (NGSP). Patients were grouped depending on HbA1c levels into: Group 1: Well controlled (HbA1c <7%), Group 2: Moderately controlled (HbA1c 7-8%) and Group 3: Poorly controlled (HbA1c >8%). Obtained values for the tests conducted and demographic data were collectively compiled and analyzed using SPSS 14 with chi square test as statistical tool. Pearson's coefficient ($p < 0.05$) was considered statistically significant.

Results

In this study, youngest patient was 32 and oldest patient was 60 years old. Highest percentage of patients with diabetes belonged to the age group 51 to 60 years (54.5%). Gender-wise, 56 male and 44 female patients were included. When the time since diagnosis of diabetes was noted among 100 patients, 46 patients had diabetes of duration less than 5 years, 32 patients had duration 5-10 years, 22 patients had duration more than 10 years. The glycaemic control was categorized into well controlled, moderately controlled, and poorly controlled based on HbA1c values of < 7%, 7 - 8% and > 8% having 20, 27 and 53 patients respectively. Among 100 patients with diabetes, 61 patients were on treatment with Oral Hypoglycaemic Agents (OHA) alone, 22 patients were on insulin therapy and 17 patients were on treatment with both.

In the present study the incidence of SNHL among the 100 T2DM patients was 79%. The correlation of incidence of SNHL with different age groups showed statistical significance ($p < 0.05$) among all the age groups. The incidence of SNHL was lowest among 31-40 age (62.5%) and highest among 51-60 age group (89%) (Figure 1) indicating that there is a progressive increase in the incidence of SNHL with the age of the patient.

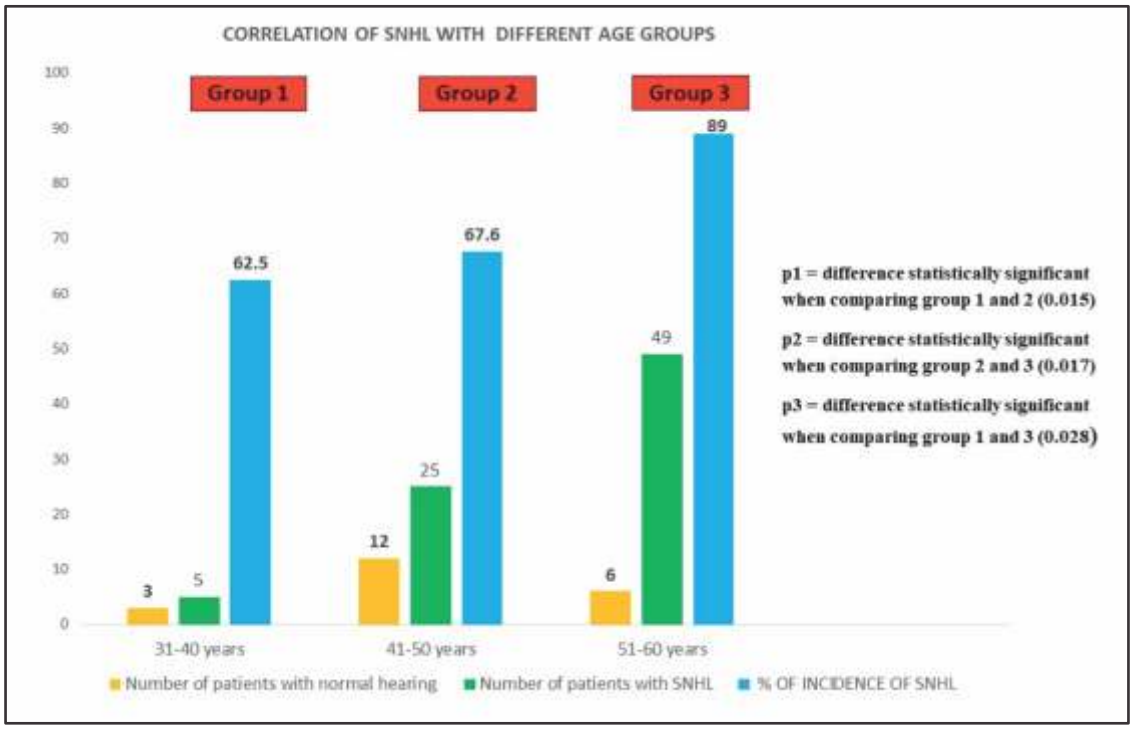

Figure 1: Correlation of SNHL with different age groups

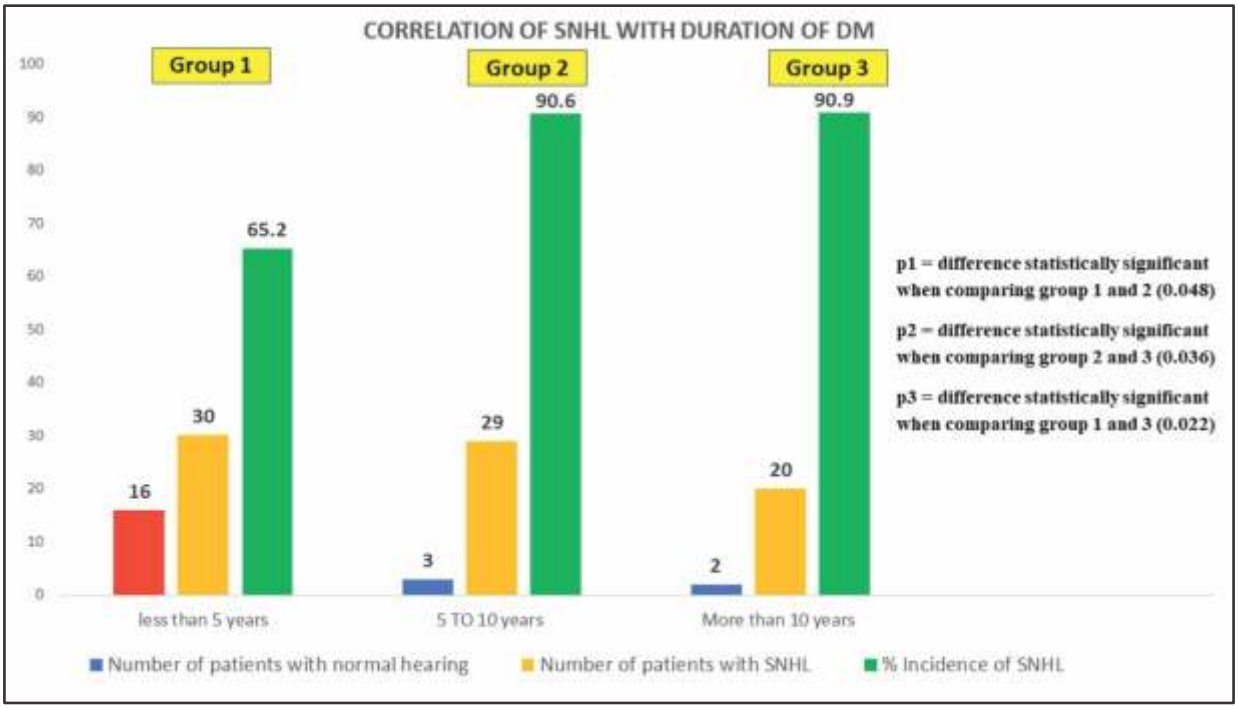

Figure 2: Correlation of SNHL with duration of diabetes mellitus

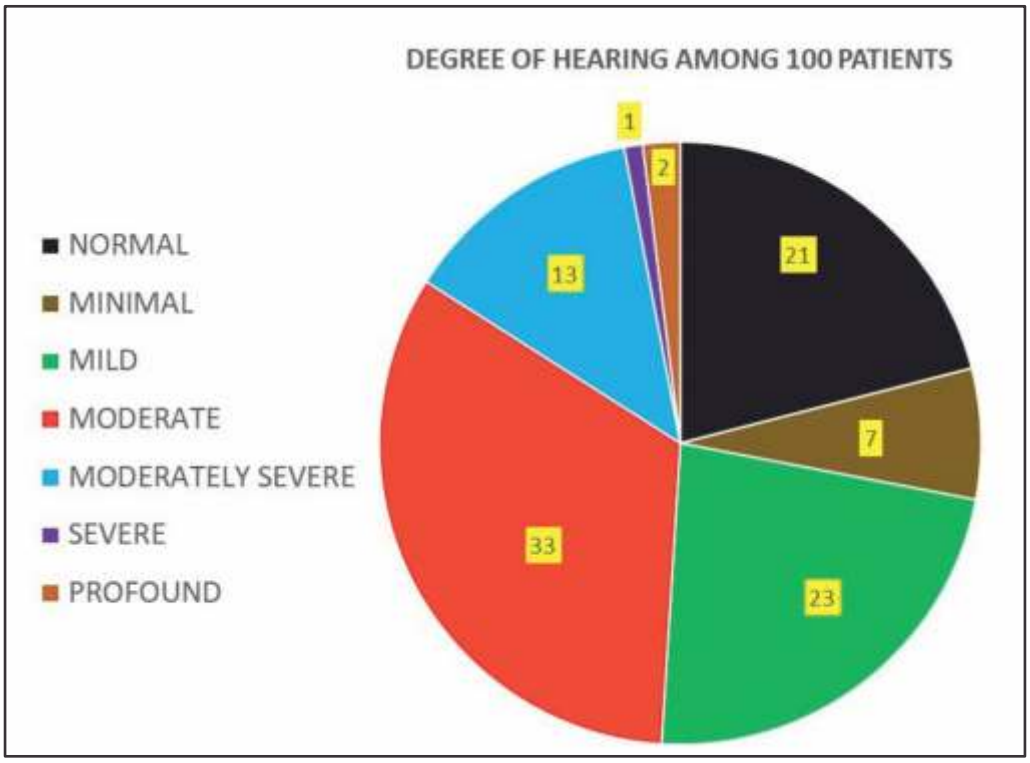

Figure 3: Various degree of hearing among 100 patients

Discussion

DM is a multisystem disorder affecting carbohydrate metabolism. Long term microvascular and macrovascular complications affecting ocular, renal, nervous and cardiovascular system is the reason for morbidity in DM. Likewise, DM affects auditory system thus affecting hearing by altering the inner ear functioning. The relationship between DM and SNHL is complex and has been debated for many years.

In the present study, hearing loss was observed in 79% patients which was similar to study done by Taylor and Irwin (70%), Rajendran *et al*. (73%) and Bhaskar *et al*. (78.2%) [9-11]. However, Somogyi *et al*. (34%) and Saini *et al*. (30%) reported lesser incidence [12-13]. Dalton *et al.* reported a higher incidence of hearing loss among subjects with diabetes compared with a control group, but it was statistically not significant [14]. Further, a study by Axelsson *et al*. failed to report any association between diabetes and hearing loss [15]. There are conflicting observations regarding the relationship between age and hearing impairment in patients with diabetes. A positive correlation had been reported by various studies. Vigi *et al*. observed that 33.3% patients were affected in the age group of 41-50 years and 66.7% were having hearing impairment in group of 51-60 years [16]. Axelsson *et al*. noticed worsening of hearing loss with increasing age even after correction of presbycusis [15]. Harkare *et al*. observed higher incidence of hearing impairment in older patients which was statistically not significant [17]. Diniz, Guida & Donald *et al*. observed increased hearing loss in older patients [18-19].

Negative association between age and hearing impairment were depicted in studies done by Kurien *et al*., Cullen *et al*. and Tay *et al*. [20-22]. In the present study, patients were selected upto the age of 60 years thus, minimizing the influence of presbycusis on hearing. The highest incidence of hearing impairment was seen in 51 to 60 years (55%) however the degree of SNHL did not correlate to the increasing age.

The incidence of SNHL among male patients was 80.3% compared to 77.3% among female patients but was statistically insignificant when genders were compared (p = 0.70). The hearing loss in patients with diabetes, if any, should be ideally equal in both males and females. Cullen *et al*. reported more males to be affected, while Taylor and Irwin observed more females being affected [9, 21]. This difference can be attributed to exposure to environmental or occupational sounds besides diabetes.

In the present study the degree of sensorineural hearing loss among 79 patients was assessed and it was found that 41.8% (33 patients) had moderate degree of hearing loss (Figure 3). However, when comparing the degree of SNHL with various age groups and gender, no correlation was noted. Similarly, no correlation was noted between the degree of SNHL and the duration or glycaemic control of DM ($p > 0.05$). Similarly, 21.7% of the patients had mild or moderate hearing loss in the study by Lerman *et al*. and Srinivas *et al*. [23] and 54% patients with diabetes had mild hearing loss and 12% patients had moderate hearing loss [24] respectively.

The possible factor that influences the severity of hearing impairment in diabetes is the duration since its first diagnosis. Nagraj *et al*. established that longer duration of DM was associated with more number of hearing impaired patients [25]. Patients with DM more than 5 years had higher incidence (79%) as compared to freshly diagnosed patients with diabetes (42%). Virtaniemi *et al*. reported a higher incidence of impaired hearing in patients with insulin dependent DM of more than 18 years duration of DM [26]. Increased impairment of hearing with duration of DM was similarly observed by Sachdeva *et al*. [27]. Contradictory results were also seen in other studies where no association between the 2 parameters was observed [20-21, 28].

In the present study, among 46 subjects with <5 years duration of DM, 30 subjects had SNHL (65.2%); among 32 subjects with 5-10 years duration of DM, 29 subjects developed SNHL (90.6%); while 22 subjects with more than 10 years duration of DM, 20 subjects developed SNHL (90.9%). The association of SNHL to the duration of DM was statistically significant ($p < 0.05$) when compared among all three duration groups. It is clearly seen that as duration of diabetes increases, the predisposition to SNHL also increases (Figure 2) which can be attributed to microvascular angiopathy occurring in capillaries of stria vascularis making the vessels thicker. Though, more number of patients with DM had hearing loss but no statistically significant relationship could be established between the duration of DM and degree of hearing loss. This could be due to smaller sample size in the present study.

Glycaemic control can be analyzed using different parameters such as fasting and post prandial blood sugar along with HbA1c levels. Patients with

diabetes not aware about their illness would have already developed long-term complications at the time of diagnosis, which could be attributed to chronic hyperglycemia and cumulative effects of advanced glycation end products. Studies have confirmed that intensive glycaemic control decreased the rate of microvascular complications by achieving HbA1c target of < 7% (53 mmol/mol) [29]. Analysis also demonstrates a curvilinear relationship between HbA1c and microvascular complications. It is suggested that large number of microvascular complications can be decreased by taking patients from a state of poor glycemic control to a good glycaemic control [29].

Advantages of using HbA1c values for glycaemic control is that it is well standardized method giving a better index of glycaemic exposure and risk for long term complications. It gives an idea about the glycaemic control of patients in the earlier three months relatively unaffected by acute levels of glucose [29]. It is a sensitive test and has several advantages over fasting blood glucose levels including greater convenience. It can also be performed at any time of the day, does not require special pretest preparation such as fasting and has less day-to-day perturbation during stress and illness. HbA1c level ⩾ 6.5% (48 mmol/mol) is recommended as the cut off point for diagnosis of DM [7].

There are studies stating that a better control of diabetes delays the onset of SNHL [20-22, 26]. Harkare *et al*. reported higher rate of SNHL in uncontrolled diabetes using FBSL and PPBSL values for glycaemic control [17]. Under the correlation of SNHL with HbA1c levels, out of 79 patients with SNHL, 42 (79.2%) patients had poor glycaemic control, 22 (84.6%) patients had moderate glycaemic control and 15 (71.4%) patients had good glycaemic control. In contradiction to above studies, present study was unable to establish any statistical correlation between different values of HbA1c and hearing loss since patients were assessed according to the last HbA1c values and patients were not followed up for a long duration. However, this result was supported by studies done by Rajendran *et al*. and Dalton *et al*. where glycemic control was assessed using HbA1c values [10, 14]. It was also observed that patients with SNHL had high frequencies (4 Khz to 8 Khz) involved supported by studies done in the past [10, 17, 21]. The probable explanation to this could be that the basal turns of cochlea, which is predisposed to the effects of vascular damage, being more vascularized [30].

Conclusion

A significant correlation between severities, duration of DM in elderly patients were observed. A larger study with longer follow up of patients would be required to establish statistically significant association between hearing impairment in patients with diabetes with HbA1c levels to decrease the cases of undetected diabetes related hearing loss and improve quality of life by timely management of the same.

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