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ORIGINAL ARTICLE

Association Between Type 2 Diabetes Mellitus and Hearing Loss Among Patients in a Coastal City of South India

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Abstract Diabetes mellitus (DM) is a metabolic culprit known to perpetuate several disease processes. The relationship between hearing loss (HL) and type 2 DM (T2DM) remains unclear despite the vast volume of research devoted to this topic. We conducted this study with the aim to evaluate HL among T2DM patients and to assess the relationship between severity of HL, glycosylated hemoglobin (HbA1c) levels and duration of T2DM. Design: a time bound descriptive crosssectional study. Setting: tertiary care hospital of South India. Subjects: subjects with T2DM, aged from 40 to 60 years (excluding hypertension, chronic noise exposure and history of smoking or ototoxicity) were included. Methods: Non-random convenience sampling. Details were gathered using a self-administered, semistructured questionnaire and the hearing was assessed by pure tone audiometry. Data was analysed using SPSS. A large proportion of the sampled population had audiological assessments suggestive of SensoriNeural HL (SNHL). 90.2% had a bilateral distribution of HL; however, only 39% of patients reported having any associated ear complaints. No statistically significant associations were obtained between severity of HL, glycaemic control, duration of diabetes or gender. Bilateral SNHL is a complication associated with T2DM. Duration and glycaemic control are independent variables and do not statistically influence the severity of HL. However, this study demonstrated that many patients with SNHL had no symptoms and also lacked awareness of HL in DM. Therefore routine assessment of hearing should be considered in the diabetic population.

Keywords Type-2 diabetes mellitus · Hearing loss · SensoriNeural hearing loss · HbA1c · South India

Introduction

Diabetes Mellitus (DM) is defined as a disorder of metabolism characterized by hyperglycaemia due to inadequate insulin production, action or both [1]. Statistics have indicated a recent increase in the prevalence of DM worldwide, making it a global health concern. As a result, there has been a vast amount of on-going research devoted to DM and complications associated with the disease. Type 2 Diabetes Mellitus (T2DM) is usually a long standing metabolic disorder, which cannot be cured but only managed therapeutically; hence, complications usually evolve over time. Chronic complications occur as a result of pathological changes affecting the lens, skin, nerves and vascular system; therefore, the disease is not confined to a single organ system rather it affects multiple systems [2]. Microvascular abnormalities complicating DM have been proposed to affect the auditory system and ultimately hearing. Various studies have been conducted to identify the relationship between DM and hearing loss (HL); however, discrepancies in literature have emerged and the verdict remains unclear. Few studies have reported no correlation between HL and DM [3, 4], whereas, other studies have found a positive correlation between the variables [2, 5, 6]. Furthermore, the biggest challenges that investigators face in investigating the association between DM and HL is the presence of confounding variables and the complexity of the auditory system. Limited research on

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this topic has been conducted in India, which is known to be the diabetic capital of the world [7]. The main aim of this study was to assess the association between T2DM and HL and determining whether duration of diabetes and glycosylated hemoglobin (HbA1c) levels are reliable indicators in predicting the extent of HL. Studies conducted on this topic are important in order to establish a relationship between DM and HL in order to ensure proper health measures are taken for early identification and prevention of complications.

Objectives

1. To study the relationship between severity of HL and duration of DM.
2. To study the relationship between severity of HL and HbA1c levels.

Materials and Methods

Study design and setting: A time bound, institution based descriptive cross-sectional study was conducted in our tertiary hospitals in a coastal city of south India. Study population, Sample size and sampling technique: The study population was composed of 41 T2DM patients aged between 40 and 60 years. This cut-off range was selected on the basis that, T2DM is known to commonly affect individuals after the age of 40 and age-related hearing loss is more prevalent after 60 years of age. Patients with hypertension, chronic noise exposure, history of smoking or ototoxicity were also excluded from the study. Participants were selected by non-random convenience sampling methodology. Data collection: Data was collected using self-administered semi-structured questionnaire. Approval to conduct the study was taken from the Institutional Ethics Committee. The objectives of the study were explained to the participants involved in the study, following which written informed consent was taken. Investigators completed the questionnaires and trained personnel conducted hearing assessment. Variables like age, gender of the patients, ear related complaints, family history, duration of DM, treatment of DM (with Oral Hypoglycemic Agents or Insulin or both) and HbA1c levels (up to 6% = normal, 6.1–7% = good control, 7.1–8% = fair control, > 8% = poor control) were noted down. Pure Tone Audiometry (PTA) was done to assess the extent and type of HL, if present. Hearing assessment was determined at 1 kHz, 2 kHz, 4 kHz, 8 kHz, 0.5 kHz and 0.25 kHz in that order. Testing for both air and bone conduction was done. The audiogram chart results were classified based on hearing threshold (in dB) as mild, moderate, moderately-severe, severe, profound and total deafness. Data analysis: SPSS version 16.0 was used for data analysis. Chi-Square test was used to find associations between the independent and dependent variables and $p < 0.05$ was considered as statistically significant.

Results

Forty-one patients were selected for the study. Demographically, there was a significant difference in the ratio between male and female participants. Table 1 illustrates the gender and age profile of the study subjects. Majority were male and between 40 and 50 years of age. Table 2 summarizes the relative proportions of the clinical characteristics evaluated in each subject namely, family history, duration of DM, type of treatment for DM, HbA1c and ear complaints. Majority of our patients had positive family

Table 1 Gender and age profile of the subjects

Characteristics	n = 41	%
Gender		
Male	28	68.3
Female	13	31.7
Age group (years)		
40–50	22	53.7
51–60	19	46.3

Table 2 Clinical characteristics of DM subjects

Characteristics	n = 41	%
Family history of DM +	24	58.5
Family history of DM −	17	41.5
Duration of DM (years)		
< 5	25	61.0
> 5	16	39.0
Treatment of DM		
OHA	24	58.5
Insulin	14	34.2
OHA + insulin	3	7.3
HbA1c%		
Good	13	31.7
Fair	12	29.3
Poor	16	39.0
Ear complaints		
Yes	16	39.0
No	25	61.0

DM diabetes mellitus, *OHA* oral hypoglycemic agents, *HbA1c* glycosylated haemoglobin (up to 6% = normal, 6.1–7% = good control, 7.1–8% = fair control, > 8% = poor control)

Table 3 Laterality versus degree of SNHL among DM patients

SNHL	Right ear		Left ear	
	Value	%	Value	%
Normal	3	7.3	6	14.6
Mild	31	75.6	27	65.9
Moderate	7	17.1	8	19.5
Severe	0	0	0	0

SNHL sensorineural hearing loss, *DM* diabetes mellitus

history, DM for less than 5 years, only on Oral Hypoglycemic Agents, poor control of DM (high HbA1c) and no ear complaints. Among the 41 participants tested, 90.2% of patients had bilateral SensoriNeural Hearing Loss (SNHL) and 9.8% had unilateral SNHL. Table 3 describes the laterality versus degree of SNHL among DM patients. Majority had right sided SNHL and it was of mild degree in most of them. Table 4 describes association between degree of SNHL and variables of interest namely, family history, duration of DM, type of treatment for DM, HbA1c and ear complaints.

Discussion

Many studies have proposed that DM may exacerbate HL and extensive investigations have been conducted in order to identify the cause. The proposed mechanisms of HL in DM reported in literature include microangiopathy of the inner ear, neuropathy of the cochlear nerve, outer hair dysfunction and disruption of the endolymphatic potential [8, 9].

In this study we found that 40 of the 41 (97.6%) DM patients examined had some degree of SNHL, which is consistent with findings in literature. Previous studies conducted report an incidence of HL ranging between 0 and 90% [5–8, 10]. Tay et al. [5] reported a higher incidence of HL among DM patients as compared to non-diabetics. Karkarlapudi et al. [9] also stated that HL was seen more often in DM cases (13.3%) than the subjects without DM. Alvarenga et al. [3] reported a 73% more HL among cases of DM when compared to the non-diabetics.

Furthermore, among the patients with HL, 90.2% had bilateral SNHL indicating that the hearing complications implicated in DM have a bilateral distribution. This result is consistent with similar studies; however, the proportion of the population with bilateral SNHL was highest in our study in comparison to others [6, 8, 9].

In terms of the correlational studies conducted, no significant association was found between any of the variables of interest. Similarly, a study conducted by Rajendran et al. [3] also reported similar findings in which glycaemic control and duration of DM did not affect the incidence of HL. However, discrepancies in literature exist and other investigators have reported positive correlations between duration of DM, glycaemic control and SNHL [2]. Furthermore, some studies have reported that female diabetics

Table 4 Association between variables of interest and degree of SNHL

Variable	Normal hearing	Mild SNHL	Moderate SNHL	SPSS analysis
F/h/o of DM +	8.3	79.2	12.5	Chi square = 1.825
F/h/o of DM −	5.9	64.7	29.4	$p = 0.402$
DM duration (years)				Chi square = 0.516
< 5	8.0	76.0	16.0	$p = 0.773$
> 5	6.3	68.8	25.0	
Treatment of DM				Chi square = 3.327
OHA	4.3	70.8	25.0	$p = 0.505$
Insulin	14.3	76.8	7.1	
OHA + insulin	0	66.7	33.3	
HbA1c				Chi square = 4.786
Good	0.0	76.9	23.1	$p = 0.310$
Fair	8.5	58.3	33.3	
Poor	12.3	81.3	6.3	
Ear complaints				Chi square = 3.843
Yes	12.5	56.3	31.3	$p = 0.146$
No	4.0	84.0	12.0	

F/h/o family history of, *OHA* oral hypoglycemic agents, *HbA1c* glycosylated haemoglobin (up to 6% = normal, 6.1–7% = good control, 7.1–8% = fair control, > 8% = poor control)

develop a more severe form of HL [10]. On the contrary, literature has also reported that male diabetics having a greater deterioration of hearing as compared to females [11]. In this study we observed no gender differences in regards to HL. This finding is consistent with other studies published in literature where no gender differences were observed amongst participants [6]. Perhaps, these associations were not identified due to the relatively small sample size chosen for this project. Moreover, our study was unique because the exclusion criteria eliminated a large number of confounding factors known to exacerbate hearing loss. Thus, we were able to study and evaluate diabetes as the single agent responsible for SNHL in the population. Possibly, factors such as hypertension or smoking superimposed on DM may influence and exacerbate microvascular changes and ultimately disease progression [12, 13].

Study Limitations

A more extensive study including a larger sample size and wide geographical area may help in generalizing the results. PTA was utilized to determine and quantify the HL among DM patients; however, this test is subjective in nature. Thus, usage of more objective tests would have given more reliable results.

Conclusion

Bilateral SNHL is a complication associated with T2DM. However, the results from our study reported that duration of T2DM and glycaemic control are independent variables and do not statistically influence the severity of HL. However, this study demonstrated that many patients with SNHL had no symptoms and also lacked awareness of HL in DM. Further research is required to identify the exact mechanism of HL in DM patients and routine assessment of hearing should be considered in the diabetic population.

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Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

References

1. American Diabetes Association (2010) Report of the expert committee on the diagnosis and classification of diabetes mellitus. Diabetes Care 33(suppl I):62–69
2. Pemmaiah KD, Srinivas DR (2011) Hearing loss in diabetes mellitus. Int J Collab Res Intern Med Public Health 3(10):725–731
3. Alvarenga KF, Duarte JL, Silva DPC, Agostinho-Pesse RS, Negrato CA, Costa OA (2005) P300 cognitive potential on subjects with diabetes mellitus. Braz J Otorhinolaryngol 71(2):202–207
4. Maia CAS, Campos CAH (2005) Diabetes mellitus as etiological factor of hearing loss. Braz J Otorhinolaryngol 71(2):208–214
5. Tay HL, Ray N, Ohri R, Frootko NJ (1995) Diabetes mellitus and hearing loss. Clin Otolaryngol 20:130–134
6. Malucelli DA, Malucelli FJ, Fonseca VR, Zeigeboim B, Ribas A, da Trotta F et al (2012) Hearing loss prevalence in patients with diabetes mellitus type 1. Braz J Otorhinolaryngol 78(3):105–115
7. Joshi SR, Parikh RM (2007) India diabetes capital of the world: now heading towards hypertension. J Assoc Physicians India 55:323–324
8. Panchu P (2008) Auditory acuity in type 2 diabetes mellitus. Int J Diabetes Dev Ctries 28(4):114–120
9. Kakarlapudi V, Sawyer R, Staecker H (2003) The effect of diabetes on sensorineural hearing loss. Otol Neurotol 24(1):382–386
10. Taylor IG, Irwin J (1978) Some audiological aspects of diabetes mellitus. J Laryngol Otol 92:99–113
11. Cullen R, Cinnamond NJ (1993) Hearing loss in diabetes. J Laryngol Otol 107:179–182
12. Dawes P, Cruickshanks KJ, Moore DR, Jones ME, McCormack A, Fortnum H et al (2014) Cigarette smoking, passive smoking, alcohol consumption and hearing loss. J Assoc Res Otolaryngol 15(4):663–674
13. Marchiori L, Filho E, Matsuo T (2006) Hypertension as a factor associated with hearing loss. Rev Bras Otorrinolaringol 72(4):533–540