

Original Article

Effect of Diabetes Mellitus on Hearing

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Abstract:

Background: *Diabetes mellitus (DM) is a chronic systemic disease characterized by hyperglycemia due to absolute or relative deficiency of insulin and affects several systems including hearing. It was evidenced that hearing loss is twice as common in people with diabetes in comparison to other non-diabetic individuals. Although there is no epidemiological information available in Bangladesh, but it can assume that the number would not be less.*

Methods: *This study was a hospital based case-control study conducted at department of ENT & department of Endocrinology for 1.5 year following approval of the protocol. Total 110 people (55 cases and 55 controls) were selected and analysed in this study. All the patients were divided into two groups: Group A (all patients with Diabetes) and Group B (persons without diabetes). For analysis group A were considered as case and group B were as control. Written informed consent was taken from all case and control subjects. A detailed history taking including hearing loss, duration, onset, associated symptoms & diabetes duration, treatment were obtained from the subject. A detailed ENT examination including otoscopic examination and tuning fork test were also conducted for each patient. Moreover, audiometric assessment-PTA, blood investigation-RBS, HbA1C, & renal parameters like blood urea & serum creatinine were tested in each cases. Data analysis was done in the statistical program Statistical Package for Social Science (SPSS) version 16.0.*

Results: *Out of total 55 patients in each group, mean age of Diabetic and non-diabetic were 46.78±8.02 SD and 46.72±8.09 SD (years) with slight female predominance (45.5% vs 54.5% in diabetic group and 49.1% vs 50.9% in non-diabetic group). In group A, majority (80%) of*

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the cases had type 2 DM and rest of the cases had type 1 DM. Sensori- neural hearing loss was significantly higher in case group than non-diabetic control (43.6% vs 7.3%, $p < .001$). Majority of the subjects with SNHL had two-sided hearing problem (75%) and hearing difficulty was two sided in 70.8% diabetic patients and 100% non-diabetic controls which was not related with severity of the problem ($p > .05$).

Conclusion: *SNHL is more prevalent in diabetic individuals and was associated with duration of DM and blood glucose level.*

Key Words: *Sensorineural Hearing Loss, DM, Pure tone audiometry, HbA1c*

Introduction:

Diabetes Mellitus is a clinical syndrome characterized by hyperglycemia due to absolute or relative deficiency of insulin. Prevalence of sensorineural hearing loss in type 2 diabetes mellitus was 80%.¹ Another study showed prevalence rate of 66%.² Diabetes and sensorineural hearing loss among non-elderly people was 45%.³ Diabetes is usually classified as being of type 1 & type-2. In type-1 diabetes, the beta cells of pancreas no longer make insulin. In type-2 diabetes, pancreas continues to make insulin but a cellular impairment in sensitivity to insulin results in raised blood glucose levels. The pathophysiological explanation for diabetes related hearing loss is speculative. Diabetic neuropathies affect peripheral sensation & various autonomic functions.^{2,4} The pathological changes that accompany diabetes may similarly cause injury to the vasculature or the neural system of the inner ear. So the pathogenic effects of diabetes on the ear can be grouped into neuropathic, angiopathic and a combination of the two. The tissue effects of diabetes are thought to be related to the polyol pathway, where glucose is reduced to the sorbitol. Sorbitol accumulation is implicated in neuropathy by causing a decrease in myoinositol content, abnormal phosphoinositide metabolism & a decrease in Na⁺/K⁺ ATPase activity.²

Histopathological evidence of vascular or neurological involvement obtained from autopsied patients with diabetes includes sclerosis of the internal auditory artery, thicker vessel walls of the stria vascularis & of the basilar membrane, demyelination of the cochlear nerve and atrophy of spiral ganglion.⁵ Loss of outer hair cells has also been observed among patients with diabetes.⁶

As per American Diabetes Association, the rate of hearing loss is 30% higher in diabetic patient than in those with normal blood glucose. The association between maternal inherited diabetes & deafness and mitochondrial DNA (mt DNA) mutations is well recognized. Several mutations have been associated with this phenotype including the m.3243A>G & m14709T>C point mutations. The association is so strong with m.3243A>G thought to account for up to 1% of diabetes and 0.3% of deafness.⁷

Sensorineural hearing loss accounts for about 90% of all hearing loss. It is found in 23% of the population older than 65 years of age. The term sensorineural is used to indicate that there is either a cochlear or an eight nerve lesion. Sensorineural deafness is more common in patients with diabetes than nondiabetic and severity of hearing loss seemed to correlate with progression of disease as reflected in serum creatinine. This

may have been due to micro-angiopathic disease in the inner ear.⁸ The diagnosis of sensorineural pattern of hearing loss is made through audiometry which shows a significant hearing loss without the air bone gap. In other words, air conduction is equal to bone conduction. According to WHO and Nelson *et al.*, global prevalence of disabling hearing loss in adults was 16%, which may vary from 7% to 21% in various sub-regions of the world, and was attributable mainly due to occupational noise.⁹ Considering the scarcity of the literature in this topics in our country context, this case-control study was designed to find the prevalence of sensorineural hearing loss in diabetic patients & to study the association of hearing loss with diabetes.

Methods:

This is a case-control study and was conducted at Department of Otolaryngology-Head & Neck Surgery and Department of Endocrinology, Dhaka Medical College Hospital, Dhaka from January 2017 to June 2018. Total 55 patients will be included in the study. 55 cases and 55 controls were

included by Purposive sampling. All the diabetic patients attending in Endocrinology department & patients and their attendants without ear problem in ENT department, DMCH were considered as study population. Patients aged below 60 years of age, without any other possible cause of hearing loss were included in the study. Persons with any other possible cause of hard of hearing such as tympanic membrane perforation, secretory otitis media, otosclerosis, otitis media, sudden/repeated exposure to noise without adequate protection, trauma to the head or neck, and ototoxicity were considered for exclusion criteria. After taking history and completing relevant clinical examination, all the subjects were included and divided into two groups (Group A: Diabetic persons; Group B: Non-diabetic persons). PTA were accomplished in both group of the patients and all test were done by 'AC 33 Audiometer' (Interacoustics, Denmark). All the data were recorded in a structured questionnaire. Statistical analysis were done with the help of Microsoft Excel and Statistical Package for the Social Sciences (SPSS) software version 16.0.

Results:

Table I
Duration of diabetes and HbA1c profile of diabetic patients (n=55)

Variable	Type 1 DM(n=11)	Type 2 DM (n=44)	Total(n=55)
	Mean ± SD	Mean ± SD	Mean ± SD
Duration of diabetes (years)	8.54 ± 3.98	6.61 ± 3.24	7.0 ± 3.45
HbA1c (%)	7.55 ± 0.85	7.20 ± 0.64	7.27 ± 0.69

Mean duration of diabetes of all patients was 7.0±3.45 years. Type 1 DM patients had higher mean duration of diabetes than type 2 DM patients (8.54±3.98 vs 6.61±3.24). Mean HbA1c of type 1, type 2 and all diabetic patients were respectively 7.55±0.85, 7.20±0.64 and 7.27±0.69.

Table II :
Prevalence of SNHL among study population (n=110)

Presence of SNHL	Diabetic (n=55)	Non-diabetic (n=55)	Total (n=110)	p value*
	n(%)	n(%)	n(%)	
Present	24 (43.6)	4 (7.3)	28 (25.5)	<.001
Not Present	31 (56.4)	51 (92.7)	82 (74.5)	

* p determined by Chi-Square test

Sensory neural hearing loss was present in 43.6% diabetic patients and 7.3% non-diabetic controls. The difference was statistically significant ($p < .001$).

Table III :
Distribution of SNHL types among study population (n=36)

SNHL type	Diabetic (n=24)	Non-diabetic (n=12)	Total (n=36)	p value*
	n(%)	n(%)	n(%)	
One sided	7 (29.2)	0	7 (25)	.212
Two sided	17 (70.8)	4 (100)	21 (75)	

* p determined by Chi-Square test

Majority of the subjects with SNHL had two sided hearing problem (75%) Hearing difficulty was two sided in 70.8% diabetic patients and 100% non-diabetic controls. The difference was statistically non-significant ($p > .05$).

Table IV :
SNHL severity among study population (n=110)

SNHL severity	Diabetic (n=24)	Non-diabetic (n=12)	Total (n=36)	p value*
	n(%)	n(%)	n(%)	
Mild	14 (58.3)	4 (100)	18 (64.3)	.11
Moderate	10 (41.7)	0	10 (35.7)	

* p determined by Chi-Square test

SNHL severity was mild in 58.3% diabetic and 100% non-diabetic subjects and severe in 41.7% diabetic. The difference was not statistically significant ($p > .05$).

Table V :

Association of SNHL with diabetes related characteristics among patients with DM

Variable	DM duration	HbA1c level
	(years)	(%)
	Mean \pm SD	Mean \pm SD
Presence of SNHL		
Present	9.91 \pm 2.3	7.88 \pm 0.49
Not present	4.74 \pm 2.3	6.79 \pm 0.37
	p* = <.001	p* = <.001

*p determined by Student's *t* test

Presence of SNHL was significantly associated with longer duration of diabetes and higher HbA1c level (p<.001).

Table VI :

Association of SNHL type with diabetes related characteristics among patients with DM

Variable	DM duration	HbA1c level
	(years)	(%)
	Mean \pm SD	Mean \pm SD
SNHL type		
One sided	8.42 \pm 1.81	7.70 \pm 0.61
Two sided	10.52 \pm 2.23	7.96 \pm 0.44
	p* = .03	p* = .24

*p determined by Student's *t* test

Two sided SNHL was associated significantly with higher duration of diabetes (p<.05). No association between SNHL type and HbA1c level was noted.

Table VII :

Association of SNHL severity with diabetes related characteristics among patients with DM

Variable	DM duration	HbA1c level
	(years)	(%)
	Mean \pm SD	Mean \pm SD
SNHL severity		
Mild	9.28 \pm 2.52	7.81 \pm 0.54
Moderate	10.80 \pm 1.68	7.99 \pm 0.42
	p* = .11	p* = .40

*p determined by Student's *t* test

SNHL severity was associated with higher duration of diabetes and higher level of HbA1c level. But the association was not statistically significant (p>.05).

Among diabetic patients SNHL was significantly more common in them who had diabetes for more than 10 years (p<0.05). So occurrence SNHL was associated with duration of DM.

Table VIII :

Frequency of SNHL in relation to DM duration

Variable	SNHL		p value*
	Present (n=24)	Not present (n=31)	
DM duration (years)			
0 - 5	4	17	0.001
6 - 10	7	10	
> 10	13	5	

Table IX :
Comparison of SNHL type and severity among patients with DM by type

Variable	DM type		p value*
	Type 1 n(%)	Type 2 n(%)	
Presence of SNHL			
Present	7 (63.6)	17 (38.6)	.13
Not present	4 (36.4)	27 (61.4)	
SNHL type			
One sided	1 (14.3)	6 (35.3)	.30
Two sided	6 (85.7)	11 (64.7)	
SNHL severity			
Mild	3 (42.9)	11 (64.7)	.32
Moderate	4 (57.1)	6 (35.3)	

No significant association between type of diabetes mellitus and SNHL type and severity was noted in this study ($p > .05$).

Discussion:

Association between diabetes mellitus and hearing loss has been debated since it was first reported by Jordao in 1857.¹⁰ However, there is controversy regarding the etiopathogenesis of hearing loss, as some researchers support that it develops due to neuropathy, others say it is due to angiopathy, or even a combination of both. Yet, some researchers believe diabetes mellitus and hearing loss are part of a genetic syndrome. An extensive bibliographic review to determine whether there is cause-effect relationship between diabetes mellitus and hearing loss has been conducted by Maia and de Campos.¹¹ They concluded that there is still a great deal of controversy. The present case control study was designed to explore the association between hearing loss and diabetes mellitus to add to that endeavor. Total 110 subjects were enrolled in this study. Among them 55 cases had diabetes mellitus (DM) and another 55 age and sex matched non-diabetic controls were taken. Patients' sex was matched with controls in the current study to diminish its confounding role.¹²

Mean age of the cases were 46.78 ± 8.02 years and majority belonged to age group 51 - 60 years. This was affected by study design. As patients aged more than 60 years were excluded from the study to minimize the effect of age related hearing loss as a confounding factor. Also patients with co-morbid disease like HTN, chronic kidney disease, with history of ototoxic drug use, with smoking and tobacco chewing habit were excluded to control for factors affecting hearing. Cigarette smoking has been linked to hearing loss in a large epidemiological study by Cruickshanks *et al.*¹³ HTN has also been found to be associated with hearing loss.¹⁴ Use of ototoxic drug, chronic exposure to occupation noise had also been explored as possible associates in hearing loss by Helzner *et al.*¹²

Of all majority subjects were females (52.7%). Among diabetic patients, 54.5% were females and non diabetic control, 50.9% were females.

Among all patients majority completed high school (50%) followed by intermediate (22.9%). Patients completing graduation and

post-grad only constituted 10.9% study population. This could be linked to awareness of the importance of diabetes control among higher educated people. As this group is more likely to control their diabetes as well as consult physician as soon as any complication arise they are less likely to develop long term complication like SNHL. This could have been the reason for lower prevalence of higher education group in this study.

In this study a significant association between DM and sensorineural hearing loss (SNHL) was found ($p < .05$). This is similar to the findings reported by Mozaffari *et al.* in Iran.³ Their findings showed a relationship between some aspects of SNHL and DM. This is also similar to findings reported by Kakarlapudi, Sawyer and Staecker, in the United States.¹⁵

Most previous surveys on this subject have been carried out among patients of all ages, whereas this study was performed only in non-elderly subjects aged < 60 years. Mozaffari *et al.* conducted a similar study among non-elderly individuals entitled "Diabetes mellitus and sensorineural hearing loss among non-elderly people" and found higher proportion of hearing loss among middle aged diabetic patients than non-diabetic patients.³ Sakuta *et al.* reported a statistically significant higher prevalence of hearing loss among diabetic middle-age men in comparison to non-diabetic middle-aged men (60.2% vs 45.2%, $p = 0.006$).¹⁶

DM had no statistically significant correlation with the severity of SNHL, suggesting that DM only may act as an initiating factor and that the progression of hearing loss is related to other features. Presence of SNHL was significantly associated with higher HbA1c level ($p < .001$). This implies that glycaemic control was associated with the occurrence

of SNHL. But, severity of SNHL was not found to be associated with glycaemic control. In comparison, Mozaffari *et al.* (2010) found no association between glycaemic control with occurrence and severity of hearing loss.³ They found that FBG level was higher in diabetic patients with SNHL (175.3 versus 157.7 mg/dL) and the proportion with SNHL was higher among subjects with uncontrolled DM (55.9% versus 44.1%), but these differences were not statistically significant. Therefore they suggested that glucose metabolism may not be the most important issue in the development of SNHL and perhaps only acts as an aggravating factor. But, this study disagree with that suggestion as occurrence of SNHL has been found to associated with poor glycaemic control.

The insulin level of patients were not measured in this study, but it has been reported that neither insulin resistance nor decreased insulin secretion are association with SNHL.¹¹

Twenty percent cases in this study had type 1 DM and 80% had type 2 diabetes. No association was found between SNHL occurrence, type and severity; and type of DM. Despite the small number of patients with type 1 DM in the current study, these patients were more likely to have a moderate grade of SNHL than patients with type 2 DM. However, there was no significant correlation. This is also supported by the findings of Mozaffari *et al.*³ They found no significant association between SNHL occurrence and type of DM. But, in contrast to this study, they found a significant relationship between severity of SNHL and DM. They found that type 1 DM was associated with severe SNHL then type 2 DM. Dalton *et al.* showed a higher incidence of hearing loss among diabetic subjects compared with a control group, but they

reported no significant association between hearing loss and DM type 2.¹⁷

It was also found that duration of DM were associated with occurrence and type of SNHL. Therefore, the role of DM progression and ageing on hearing loss should be considered more carefully.¹⁸ In the current study the severity of SNHL was found higher among patients with longer duration of diabetes but there association was not significant ($P = .11$). This suggests that the role of disease progression should be investigated more precisely.

Among diabetic patients, sensorineural hearing loss was significantly more common in them who had diabetes for more than 10 years ($p < 0.05$).

This study showed that hearing loss can be considered to be a consequence of diabetes. Therefore, a metabolic assessment may be useful for patients presenting with hearing loss. Also, routine screening for hearing loss in diabetic patients may also be helpful to diminish comorbidities among these patients, with a consequent improvement in their quality of life. Determining the cause of SNHL in diabetic patients may lead to development of better treatment options for both conditions.

Conclusion:

Sensorineural hearing loss is more common in diabetic individuals with an average age of forty to sixty years. It is more common in diabetes individuals who had longer duration of diabetes and less controlled blood sugar level. It was seen that about half of the diabetic patients had been suffering from SNHL which was about 7% of the non-diabetic patients. Whereas presence or absence of SNHL and involvement of unilateral or bilateral hearing loss were associated with duration of diabetes but this

difference were note associated with age and gender variation. However, this study findings should be used with cautions as this study was confined into a tertiary level hospital and therefore, larger cohort is suggested to finalize the comment.

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