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Clinical Evaluation of Sensorineural Hearing Loss in Diabetes Mellitus

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Abstract: *This study aims at unravelling the characteristics of SNHL in DM and its relation to age, sex, duration ,family history, type of anti diabetic medication and control of DM.A total of 200 cases, 150 type 2 diabetic patients and 50 non diabetic(controls) cases between the age group of 20-55years were enrolled in the study. FBS and PPBS and HbA1c of all the subjects were done and later subjected to PTA. Bilaterally symmetrical graph were observed for both cases andcontrols. 81.3%diabetics showed significant high frequency SNHL and only 58% of non diabetic individuals showed high frequency SNHL, in an age group of 50-55years, suggesting age related changes. Low and midfrequencies also showed increased incidence of SNHL among diabetics when compared to control group. Four frequency PTA threshold averages of 150 diabetic individuals were divided among Goodmann's (1965) classification of hearing loss, and it was seen that, 21.3% individuals showed slight hearing loss, 14.7% had mild SNHL and 2% had moderate SNHL. Mean age group among diabetic group was 45.21 and thatof controls were 42.52. It was seen that that as age progresses, the incidence of hearing loss among diabetics is more with higher incidence in the 41- 50yearsand 51-55groupage group.Femalediabeticshadmore preponderance to SNHL than males in our study. As duration of diabetes increases, the predisposition to SNHL also increases.*

Conclusion:*Type 2 diabetic subjects had a higher hearing threshold than the healthy controls. The diabetics showed significant high frequency, bilateral, mild to moderate sensorineural hearing loss as compared to controls of similar age. As the duration of diabetes increases the hearing threshold for all frequencies also increases, suggesting microangiopathy of cochlear vessels. Therefore the auditory and metabolic health of diabetic patients is to be more carefully followed up by health care professionals to diminish comorbidities among them and improve their quality of life.*

Keywords: *Sensorineural hearing loss (SNHL), diabetes mellitus (DM), pure tone audiometry(PTA).*

I. Introduction

Hearing is one of the most important among the five senses gifted to mankind. It plays an important role in the development of speech, communication and cognitive, emotional and social development of a human being.[1] Being an hearing impaired puts a step backward in the overall development of the child. Thus it is very essential to identify this impairment in early stages and treat effectively.[1,2] Diabetes mellitus is a multisystem disorder with abnormally high blood glucose level. It is a disease known since ages. It is said that 1 in 8 individuals is a diabetic. It affects almost all the systems in the body to its severity if left uncontrolled. Likewise, diabetes affects hearing by damaging the inner ear structures. The effect of diabetes mellitus on hearing is known since 1857, when Jordao first showed hearing loss in a patient with incipient diabetic coma.[2,3,4]
The typical hearing loss pattern in diabetics is progressive, bilateral sensorineural hearing loss affecting the higher frequencies.[1,3] But rarely, there are incidences where sudden onset, sensorineural hearing loss affecting lower frequencies are also noted.[2,5] The type of hearing impairment noted, is similar to that of presbyacusis, but those affected show a greater decrease in hearing than one would except at that age. Hence this case control study aims to find out whether diabetes mellitus causes hearing loss, and if so then its relation to age of patient, sex of patient, duration of diabetes, family history of diabetes, control of diabetes and type of medication taken.

II. Materials And Methods

This case control study was done from October2012 to October 2014 after ethical committee clearance from the instituition.A total number of 200 patients, of which 150 patients less than 55 years, diagnosed to be type 2 DM for more than 2 years, attending the out patient departments of ENT & General Medicine, at Justice K S Hegde Charitable Hospital, has been enrolled in this study. 50 were controls, who matched in all respects with the cases except in having diabetes. Written informed consent was taken from all.Inclusion criteria were

patients with Diabetes Mellitus on treatment, <55 years, diagnosed with DM for more than 2 years. Exclusion criteria included Patients with middle ear pathology, history of noise exposure and ototoxic drug intake, hearing Loss caused by Inner ear pathologies like Meniere's disease, Acoustic neuroma and age > 55 years.
Detailed history including age, gender, duration of diabetes mellitus, type of diabetes and previous medical history were noted. Detailed systemic examination to rule out any diabetic complications was done and complete ENT examination with emphasis on Otological examination and Tuning fork test is done to know the hearing status of the patient.

Then the patient is subjected to the following investigative procedures.-HbA1C (<6.5%), Fasting blood sugar(<110mg/dl) and Random blood sugar.Pure Tone Audiometry done usingGrason-Stadler GSI 61 - Dual channel clinical audiometer The air conduction testing was done using TDH 50P supra aural headphones across test frequencies in the order of 1KHz, 2KHz, 4KHz, 8KHz, 1K Hz, 500Hz and 250Hz. Bone conduction thresholds were estimated using Radioear B 71 bone vibrator. Thresholds were tracked to estimate for each of the frequencies if and only if 2/3 correct response was observed. Masking was done to prevent participation of the non test ear whenever necessary.

Table 1: The thresholds was categorized under the following normative established by Goodmann's (1965)

Degree of hearing loss	Hearing loss range (dB HL)
Normal	–10 to 15
Slight	16 to 25
Mild	26 to 40
Moderate	41 to 55
Moderately severe	56 to 70
Severe	71 to 90
Profound	91+

Data management and statistical**a**ssessment was done using students 'T' test for comparing tests and controls of categories of age, frequencies-250Hz, 500Hz, 1Khz, 2Khz, 4Khz, 6Khz, 8Khz, PTA average, Low and High frequency average. And age, duration, gender, family history and medication was done using Chi Square Test. P Value of <0.05 was considered statistically significant. SPSS statistics 20 software was used for the assessment.

III. Results

The present study was a prospective case conrol comparative study conducted in the Department of Otorhinolaryngolog, at Justice K S Hegde Charitable Hospital, Mangalore with 150 diagnosed type 2 DM patients and 50 non-diabetic control group.

It was seen that the audiograms of all patients were bilaterally symmetrical (for right anf left ears) with no air bone gap. Frequencies 250Hz, 500Hz, 1Khz, 2Khz, 4Khz, 6Khz, 8Khz were tabulated and PTA averages were calculated for low(250Hz, 500Hz), mid (500Hz, 1Khz, 2Khz, 4Khz) and high(6Khz, 8Khz) frequencies for both cases and control group. PTA averages calculated in dBHL, and the cutoff threshold for an individual to be considered hearing impaired was 20dBHL.The occurrence of sensorineural hearing loss in diabetic patients was compared with those of non-diabetics. It was compared under the following parameters.

1. Characteristicsof Hearing Loss among Diabetics and Non Diabetic

On comparing the mean hearing thresholds of diabetic and non diabetic individuals at different frequencies[250Hz, 500Hz, 1Khz, 2Khz, 4Khz, 6Khz and 8Khz] it was noted that, the mean hearing threshold for diabetic individuals were more when compared to non diabetics. And there was significant difference in hearing thresholds at higher frequencies-4Khz, 6Khz and 8Khz between diabetic and non diabetics. Figure 1 and Figure 2 depicts it.

On comparing the 4 frequency PTA averages(average hearing thresholds of mid frequencies-500Hz,1Khz,2Khz, and 4Khz) of cases and control group, it was seen that 57 out of 150(38%) diabetes mellitus patients had SNHL and none from the control group had hearing loss. P value of 0.001 clearly signifies the incidence of SNHL among diabetic group. Shown in Figure 2.

1.1 Degree ofHearing Loss amongDiabetics

Four frequency PTA threshold averages of 150 diabetic individuals were divided among Goodmann's (1965) classification of hearing loss, and it was seen that, 32(21.3%) individuals showed slight hearing loss, 22 (14.7%) had mild SNHL and 3 (2%) had moderate SNHL. Shown in table 2.

1.2 Comparing High Frequency (6,8khz) Pta Averages in Diabetics and Non Diabetics

122 out of 150 (81.3%) diabetic patients showed high frequency(6Khz, 8Khz) SNHL, while 58 % showed high frequency SNHL in control group, showing increased incidence among diabetic.

1.3 Comparing Low Frequency (250,500 Hz) Pta Averages in Diabetics and Non Diabetics

PTA average was taken for low frequencies 250Hz and 500Hz for both cases and control group to study low frequency hearing loss among diabetics. It is seen that 21 out of 150 diabetics has low frequency SNHL while all control group people had normal hearing. P value of 0.005 is significant, which suggestd the incidence of low frequency SNHL among diabetics.

2. Age Distribution

Mean age group among 150 diabetic patients were 45.21 and that of non diabetic controls were 42.52 Out of 150 patients in the study group, 57 patients had hearing loss(PTA average of >20dB) and 93 patients with normal hearing(PTA average <20dB). Out of 10 patients in the 21-30years age group, none had hearing loss. In the 31-40 age group, there were total of 28 patients, out of which 8 had hearing loss and 20 patients had normal hearing. There were 73 patients in the 41-50 year age group, of which 25 had hearing loss and 48 had normal hearing. 51-55 year group had 39 patients of which 24 had hearing loss and 15 with normal hearing. Obtained P value of <0.001 was statistically significant. It was noted that as age progresses, the incidence of hearing loss among diabetics is more.(Table 3)

3. Sex Distribution

Of the total 150 diabetic patients, 57 were females and 93 were males. Of the 57 female patients, 29 had normal hearing loss and 28 had hearing loss. Of the 93 male patients, 64 had normal hearing and 29 had hearing loss. P value of 0.028 is suggesting significance. It was also observed that, there were fewer females in study group compared to males. (Table 4)

4. Duration of Diabetes

There were 86 patients in the who were diagnosed diabetic for less than 5 years, out of which 16 had hearing loss and 70 had normal hearing. Total of 41 patients in the 6-10 year duration, of which 23 had hearing loss and 18 with normal hearing. 13 patients in the 11-15 year duration group, of which 9 had hearing loss and 4 patients with normal hearing. 9 out of 10 patients had hearing loss in the 16-20 year duration group and only 1 had normal hearing. P value of 0.001 is significant. It is clearly seen that as duration of diabetes increases, the predisposition to SNHL also increases.(Table 5)

5. Family History of Diabetes

Out of 150 diabetic patients, 46 had no family history of diabetes, of which 17 had hearing loss and 29 had normal hearing.104 patients out of 150 had positive family history, of which 40 had hearing loss and 64 had normal hearing.P value of 0.861 is non significant. It was seen that family history of diabetes had no effect on predisposition to SNHL in diabetes.(Table 6)

6. Control of Diabetes

Control of DM was assessed using HbA1c value which summarizes the average control of blood sugar level for past 3 months. According to American Diabetes Association 2011, values above HbA1c values above 6.5% are considered uncontrolled diabetes. There were 124 out of 150 (82.7%) uncontrolled diabetics, of which 49(39.5%) cases had SNHL and 26(17.3%) controlled diabetics, of which 8(30.7%) had SNHL. P value of 0.403 is insignificant. This proves that there is no relation between control of diabetes and onset of sensorineural hearing loss.(Table 7)

7. The Prevalence Of Hearing Loss According To The Type Of Anti Diabetic Medication

Of the 150 diabetic patients, majority ie 101(67.3%) were on oral hypoglycaemic medication, in which 39 showed hearing loss and 62 had normal hearing. 28 out of 150(15.8%) were on insulin injection, of which 9 had hearing loss, 15(10%) were on both insulin and OHA of which 7 had SNHL. 5(3%) cases were on diet control of which 1 had SNHL. P value of 0.522 is insignificant, suggesting no correlation on type of anti diabetic medication taken over hearing loss.(Table 8)

8. Association Of SNHL With Other Complications Of DM

Out of 150 cases 24 cases were associated with other complications of diabetes like retinopathy, neuropathy, nephropathy and ketoacidosis and all those cases were associated with SNHL indicating strong association.(Table 9)

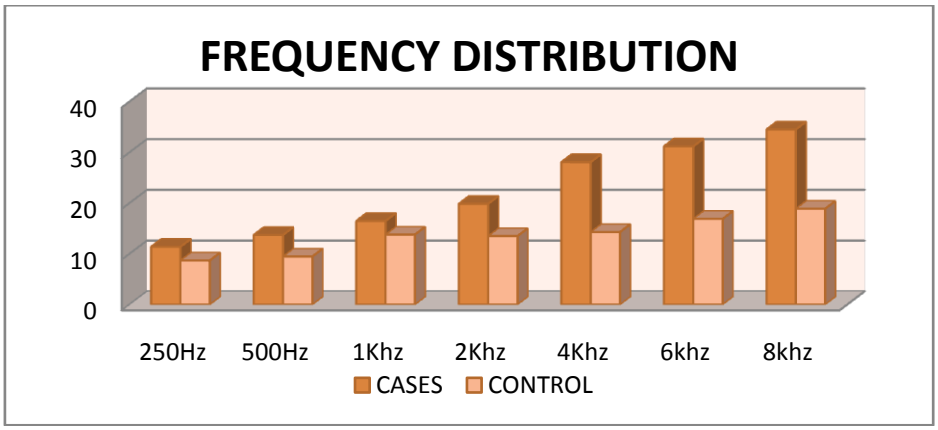

FIGURE 11 : COMPARING AUDIOGRAM FREQUENCIES OF DIABETIC AND CONTROL GROUPS

Figure 2: Hearing tresholds at mid, low and high frequencies

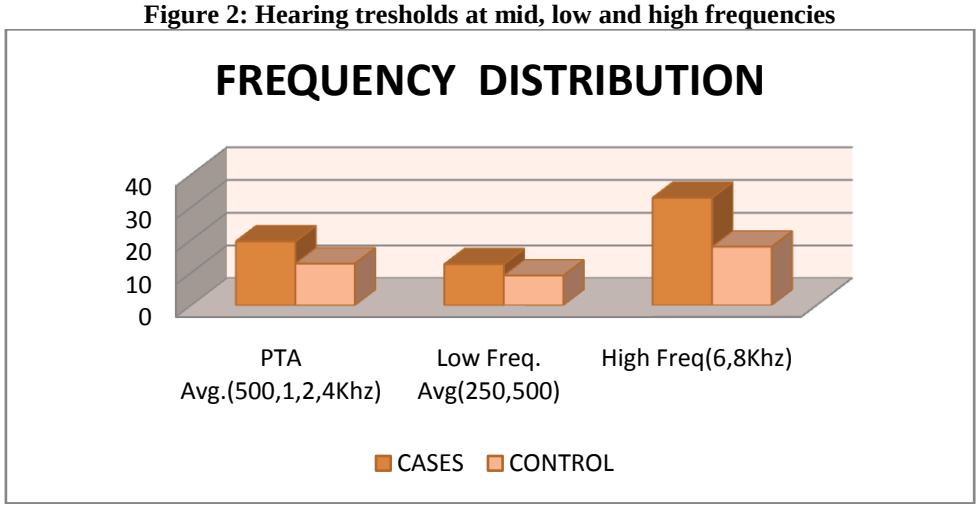

Table 2: Degree of Hearing Loss among Diabetics

Degree of hearing loss	**Hearing loss range (dBHL)**	**Total no. of Patients (150)**	**Incidence (%)**
Normal	-10-15	93	62%
Slight	16-25	32	21.3%
Mild	26-40	22	14.7%
Moderate	41-60	3	2%
Severe	61-80	0	0%
Profound	>81	0	0%

Table 3: Hearing loss among diabetics at different age groups

AGE DISTRIBUTION					
			PTA (CUTOFF 20)		Total
			NORMAL	WITH SNHL	
AGE CATEGORY(years)	21-30	NUMBER	10	0	10
		% within PTA (Cutoff 20dB)	10.8%	0.0%	6.7%
	31-40	NUMBER	20	8	28
		% within PTA (Cutoff 20dB)	21.5%	14.0%	18.7%
	41-50	NUMBER	48	25	73
		% within PTA (Cutoff 20dB)	51.6%	43.9%	48.7%
	51-60	NUMBER	15	24	39
		% within PTA (Cutoff 20dB)	16.1%	42.1%	26.0%
Total		NUMBER	93	57	150
		% within PTA (Cutoff 20dB)	100.0%	100.0%	100.0%
X^2=16.794, p value=0.001(significant)					

Table 4: Hearing loss among males and females with DM

SEX DISTRIBUTION AMONG DIABETICS					
			PTA Avg. (Cutoff 20)		Total
			NORMAL	WITH SNHL	
Gender	F	NUMBER	29	28	57
		% within PTA (Cutoff 20dB)	31.2%	49.1%	38.0%
	M	NUMBER	64	29	93
		% within PTA (Cutoff 20dB)	68.8%	50.9%	62.0%
Total		NUMBER	93	57	150
		% within PTA (Cutoff 20dB)	100.0%	100.0%	100.0%

X^2=4.828, p value=0.028(significant)

Table 5: ASSOCIATION OF SNHL WITH DURATION OF DM

DURATION OF DM					
			PTA (CUTOFF 20)		Total
			NORMAL	WITH SNHL	
DURATION	0-5	Count	70	16	86
		% within PTA (CUTOFF 20)	75.3%	28.1%	57.3%
	6-10	Count	18	23	41
		% within PTA (CUTOFF 20)	19.4%	40.4%	27.3%
	11-15	Count	4	9	13
		% within PTA (CUTOFF 20)	4.3%	15.8%	8.7%
	16-20	Count	1	9	10
		% within PTA (CUTOFF 20)	1.1%	15.8%	6.7%
Total		Count	93	57	150
		% within PTA (CUTOFF 20)	100.0%	100.0%	100.0%

X^2=36.290, p value=0.001(significant)

Table 61: ASSOCIATION OF SNHL WITH FAMILY HISTORY OF DM

Family History of Diabetes Mellitus					
			PTA (CUTOFF 20)		Total
			NORMAL	WITH SNHL	
Family History	no	NUMBER	29	17	46
		% within PTA (Cutoff 20dB)	31.2%	29.8%	30.7%
	yes	NUMBER	64	40	104
		% within PTA (Cutoff 20dB)	68.8%	70.2%	69.3%
Total		NUMBER	93	57	150
		% within PTA (Cutoff 20dB)	100.0%	100.0%	100.0%

X^2=0.031, p value=0.861

Table 7: ASSOCIATION OF SNHL WITH GLYCAEMIC CONTROL

CONTROL OF DM					
			PTA (CUTOFF 20)		Total
			NORMAL	HEARING LOSS	
Control	CONTROLLED (HbA1c -<6.5%)	Count	18	8	26
		% within PTA (CUTOFF 20)	19.4%	14.0%	17.3%
	UNCONTROLLED (HbA1c ->6.5%)	Count	75	49	124
		% within PTA (CUTOFF 20)	80.6%	86.0%	82.7%
Total		Count	93	57	150
		% within PTA (CUTOFF 20)	100.0%	100.0%	100.0%

X^2=0.698, p value=.403

Table 82: **Prevalence of hearing loss according to the type of Anti diabetic medication**

TYPE OF MEDICATION WITH SNHL					
			PTA (CUTOFF 20)		Total
			NORMAL	WITH SNHL	
Medication	Both	NUMBER	8	7	15
		% within PTA (Cutoff 20dB)	8.6%	12.3%	10.0%
	Diet	NUMBER	4	1	5
		% within PTA (Cutoff 20dB)	4.3%	1.8%	3.3%
	Insulin	NUMBER	19	9	28
		% within PTA (Cutoff 20dB)	20.4%	15.8%	18.7%
	OHA	NUMBER	62	39	101
		% within PTA (Cutoff 20dB)	66.7%	68.4%	67.3%
Total		NUMBER	93	57	150
		% within PTA (Cutoff 20dB)	100.0%	100.0%	100.0%

X^2=3.221, p value=.522

Table 9: Association of SNHL with other complications of DM

COMPLICATIONS OF DM					
			PTA (CUTOFF 20)		Total
			NORMAL	HEARING LOSS	
COMPLICATIONS	ABSENT		93	33	126
	PRESENT		0	24	24
Total			93	57	150

X^2=40.058, p value=.000(significant)

IV. Discussion

The relationship between diabetes mellitus and hearing loss has been debated for many years. Jordao[32] in 1857 published a case report of a diabetic patient with hearing loss. Edgar in 1915 was the first to report a high-frequency sensorineural hearing loss (SNHL) in a diabetic patient.The typical hearing loss in diabetics is progressive, bilateral sensorineural hearing loss affecting the higher frequencies.[1,3] In this case control study the occurrence of sensorineural hearing loss in diabetic patients was compared with those of non-diabetics. It has been discussed under the following headings.

1. CharacteristicsofSNHL among Diabetics and Non Diabetic

In our study, there were total number 150 patients diagnosed with type 2 DM between the age of 20-55 and 50 non diabetic age matched controls. Frequencies 250Hz, 500Hz, 1Khz, 2Khz, 4Khz, 6Khz, 8Khz were tabulated and PTA averages were calculated for low(250Hz, 500Hz), mid (500Hz, 1Khz, 2Khz, 4Khz) and high(6Khz, 8Khz) frequencies for both cases and control group.

In a study by Rajendraet al[19] shows that the diabetics had a 73% incidence of deafness when compared to the non- diabetics of the same age group. Friedman et al [13] showed a 55% incidence of hearing loss in diabetic patients. Kakarlapudi et al [15] found that hearing loss was more common in diabetic patients (13.1% prevalence) than the control non diabetic healthy subjects. Weng et al [34] noted that among the 67 diabetic subjects examined, 44.8% of them had profound hearing loss.

In our study, the incidence of SNHL(4 frequency PTA avg.) among diabetics was 38% which is similar to above studies.

Many studies suggested that diabetes causes hearing loss. Many have tried to identify the cause and based on their conclusions, the probable mechanisms are microangiopathy of the inner ear, neuropathy of the cochlear nerve, a combination of both, outer hair dysfunction and distruption of endolymphatic potential. The tissue effects of diabetes are thought to be related to the polyol pathway, where glucose is reduced to sorbitol. Sorbitol accumulation is implicated in neuropathy by causing a decrease in myo inositol content, abnormal phosphoinositide metabolism and decrease in Na+ K+ ATPase activity[35]. Makishima and Tanaka(1971)[36] observed severe atrophy of the spiral ganglion in the basal and middle turns of the cochlea in diabetic patients with sensorineural hearing loss. They also observed that 8th nerve showed changes of myelin degeneration with fibrosis of perineurium. Jorgensen (1961) [37] observed thickening of the walls of the vasa nervorum of 8th nerve,

leading to acoustic neuropathy. Wackym and Linthicum (1986)[38] observed microangopathic changes in the endolymphatic sac, striavascularis and basilar membrane. Van den Ouweland et al [39] observed a mutation in mitochondrial tRNA in a small subset of patients with maternally inherited diabetes with sensorineural hearing loss. Lisowskaet al[40] demonstrated abnormalities of outer hair cell function and abnormal auditory brain stem responses in patients with diabetes. Fukushima et al [41] concluded that Type 2 Diabetes results in changes in cochlea, such as significant atropy of striavascularis&otic loss in basal turn, which likely results in hearing loss.

In our study, among the diabetics 82.3% showed significant SNHL in high frequencies(4Khz,6Khz and 8Khz) while only 58% of non diabetic individuals showed high frequency SNHL, that too observed in individuals of 50-55years age group, suggesting age related changes. Low(250,500Hz) and mid(500Hz,1Khz,2Khz,4Khz) frequencies also showed increased incidence of SNHL among diabetics when compared to control group. Four frequency PTA threshold averages of 150 diabetic individuals were divided among Goodmann's (1965) classification of hearing loss, and it was seen that, 21.3% individuals showed slight hearing loss, 14.7% had mild SNHL and 2% had moderate SNHL. This result was in concordance with previous studies.[22,35, 36]. But Fangchao Ma et al [42] and Friedman et al [13] observed the strongest association of hearing loss at lowest frequency at 500 Hz.

Gibbin and Davis [43] found a statistically significant incidence of type II tone decay in the overall group of diabetics at 2000Hz. According to Frisina et al [44] the greatest deficit of hearing in the diabetics tended to be at low frequencies.. Vaughan et al [45] suggest that diabetic patients 60 years old or younger may show early high frequency loss similar to early presbyacusis.

Our study reports that the incidence of sensorineural deafness is increased in diabetics. The hearing loss is a progressive, bilateral, sensorineural deafness which affects predominantly the higher frequencies. The decrease in hearing acuity is similar to presbyacusis but those affected show a hearing loss greater than could be expected at that age.

2. Age Distribution

The mean age in Group A was 45.21 and group B was 42.52. There were 10 patients in the 21-30years age group,of which none had hearing loss. In the 31-40 age group, there were total of 28 patients, out of which 8 had hearing loss and 20 patients had normal hearing. 73 patients in the 41-50 year age group, of which 25 had hearing loss and 48 had normal hearing. 51-55 year group had 39 patients of which 24 had hearing loss and 15 with normal hearing. Obtained P value of <0.001 was statistically significant. It was noted that as age progresses, the incidence of hearing loss among diabetics is more.

In the study by Diniz and Guide [27]which reported higher Prevalence of hearing loss among patients with older age it means in addition to diabetes age also plays an important role in hearing loss [27]. A study by Donald et al, indicated that the patient with < 50 years of age, has lower risk of hearing loss [16].

Our study showed increased incidence of SNHL in 50-55 age group which correlates with above study.

Friedman et al [13] showed a 55% incidence of hearing loss in diabetic patients. Kakarlapudi et al [15] found that hearing loss was more common in diabetic patients (13.1% prevalence) than the control non diabetic healthy subjects. Weng et al [20] noted that among the 67 diabetic subjects examined, 44.8% of them had profound hearing loss.

Our study correlates with the above studies, on comparing the PTA average of cases and control group, it is seen that 57 out of 150 diabetes mellitus patients had SNHL and none from the control group had hearing loss.

3. Gender Distribution

According to Cullen and Cinnamond[2], male patients with diabetes had worse hearing than female patients with diabetes. They surmised that this may have been due to occupational noise exposure. However, Taylor and Irwin [10] observed that female patients with diabetes had significantly greater hearing loss than male patients with diabetes. Most studies in the literature reported no differences between the sexes.

Our study correlates with the Taylor and Irwin study, with higher incidence of SNHL in females compared to males.

4. Duration of DM

Some studies state that the hearing threshold increases with increase in duration of diabetes mellitus [3,23,28]. While others state that there is no relation between hearing threshold and diabetes mellitus [1,2,15]. The increase in hearing threshold is attributed to microvascular angiopathyoccuring in capillaries of striavascularis which make these vessels thicker than normal. These changes can occur in vessels supplying other parts of auditory system as well [4].

In our study, it was noted that, there was increase in hearing threshold with increase in duration of

diabetes mellitus which was correlating with the studies done by Virteniemi J et al[3] ,Celik et al[23] and Fangcha MA et al[28].

5. Family History

The relation between family history of diabetes and sensorineural hearing loss was evaluated. This was studied to know any genetic factor of diabetes that might influence on the occurrence of sensorineural hearing loss. Diabetics with a positive family history do not have any variation in hearing threshold levels[2].

In our study, 46/150 diabetic patients had no family history of diabetes, of which 17 had hearing loss. And 104/ 150 diabetics had positive family history, of which 40 had hearing loss. It was seen that family history of diabetes had no effect on predisposition to SNHL in diabetes which was similar to the study conducted by Cullen et al.

6. Control of Diabetes

Occurrence of sensorineural hearing loss in diabetics depends on the control of the disease. Most of the studies have stated that a better control of diabetes delays or prevents the onset of sensorineural hearing loss in that person[1,2,4]. But different studies have used different parameters of diabetic control to analyse the result. The blood sugar levels, FBS and PPBS dictate the control of diabetes and they have a highly significant variation in higher frequencies but insignificant variation in low frequencies[1].

Glycated hemoglobin (HbA1C) is also one of the indicator for control of diabetes. But its elevated levels were not systematically associated with increased thresholds of hearing. Thus, direct evidence that poor metabolic control in diabetes causing sensorineural hearing loss remains to be proven[3]. According to study done by Rajendra et al [19] , the control of diabetes did not show any significance in the incidence of hearing loss in the diabetic group

In the present study, control of DM was assessed using HbA1c value which summarizes the average control of blood sugar level for past 3 months. There were 124 out of 150 (82.7%) uncontrolled diabetics, of which 49(39.5%) cases had SNHL and 26(17.3%) controlled diabetics, of which 8(30.7%) had SNHL. This proves that there is no relation between control of diabetes and onset of sensorineural hearing loss. This also shows that diabetes might cause some specific changes in the inner ear that may not be attributable to the microvascular changes of diabetes.

7. The Prevalence Of Hearing Loss According To The Type Of Anti Diabetic Medication

In our study, of the 150 diabetic patients, majority ie 101(67.3%) were on oral hypoglycaemic medication, of which 39(38.6%) showed hearing loss. 28/150(15.8%) were on insulin injection, of which 9(32.14%) had hearing loss, 15(10%) were on both insulin and OHA of which 7(46.6%) had SNHL. 5(3%) cases were on diet control of which 1(20%) had SNHL. P value of 0.522 is insignificant.

Study done by Taziki Mohammad H et al[29] indicates that diabetic patient on Insulin therapy do not loose their hearing ability. Also a study by Chon et al[30] indicated that the control of diabetes with insulin can have a better prognosisfor hearing loss, for diabetic patients.But no correlation was found between type of anti diabetic medication taken and hearing loss in our study probably due to the lesser number of patients on insulin medication in the study group.

8. Association Of SNHL With Other Complications Of DM

According to the study conducted by Harkare, *et al*[26] Diabetics with one or more complications had high incidence of sensorineural hearing loss (60 patients out of 67) than those without diabetic complications (14 patients out of 33). Kurienet al[1] also found that patients without complications had relatively lower level of sensorineural hearing loss as compared to patients with diabetic complications. Taylor and Irwin[10] reported that almost 70% of their adult diabetics had hearing impairment. This occurred more commonly when retinopathy was present. Parving A[31] in his study of 20 patients with diabetic microangiopathy did not find correlation between hearing impairment and angiopathy as well as neuropathy.

In our study, out of 150 cases 24 cases were associated with one or more complications of DM like retinopathy, neuropathy, nephropathy and ketoacidosis and all those cases were associated with SNHL, indicating strong association, which is similar to the above studies.

V. Conclusion

Type 2 diabetic subjects had a higher hearing threshold than the healthy controls. The diabetics showed significant high frequency, bilateral, mild to moderate sensorineural hearing loss as compared to controls of similar age. As the duration of diabetes increases the hearing threshold for all frequencies also increases, suggesting microangiopathy of cochlear vessels. Glycemic status and family history had no significant co-relation with hearing loss while female diabetic showed preponderance to SNHL . Therefore the auditory and metabolic health of diabetic patients is to be more carefully followed up by health care professionals to diminish comorbidities among them and improve their quality of life.

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