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Evaluation of Sensorineural Hearing Loss in Type 2 Diabetics -Prevalence Study

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ABSTRACT

Aim of the study: The relationship between diabetes and sensorineural hearing loss has been highly controversial. The hearing loss is usually bilateral, progressive mainly affecting higher frequencies. This study is aimed to evaluate the prevalence of sensorineural hearing loss in type 2 diabetics and to establish the relationship between age, sex, duration and control of diabetes.

Materials and methods: 60 patients were subjected to pure tone audiometry and evaluation of random blood sugar, glycosylated hemoglobin, lipids, and creatinine. The prevalence of SNHL with relation to age, sex, duration and control of diabetes were aanalyzed.

Results and interpretation: The prevalence of SNHL in type 2 diabetics was found to be 60% with a mild increase in the prevalence among aged diabetics. Type 2 diabetic males had more prevalence of SNHL. Diabetic duration has a significant effect on the hearing threshold of the subjects. Long term sugar control is a decisive factor in altering the hearing threshold of diabetics.

Conclusion: The hearing threshold is increased in a diabetic mainly in high frequencies. There is a strong association between the hearing loss, duration of diabetes and long term sugar Control.

Keywords: Audiogram, Type 2 Diabetes, Sensorineural Hearing Loss, Pure Tone Audiometry.

INTRODUCTION

Man is a social animal. Of the many characters which delineate mankind from his animal cousins, is verbal communication of which hearing is the crux. Hearing forms the basis of developing and completing man's skills, which is altered by various diseases. From time immemorial man has been interested in trying to control those diseases. A new group of diseases, best termed as "disease of the plenty" has emerged as a tough challenge to the modern world's medical fraternity, of which diabetes mellitus is the foremost and notorious of all.

With 220 million diabetics worldwide, WHO rings an alarm that, the prevalence rate would be 5.4% in 2025? India is considered to be the Diabetes capital of the world as the total number of diabetic patients is around 40.9 million and by 2025 the number is expected to be 69.92 million. In developing countries majority of diabetics are in the productive period of their lives, which has a major implication in respect to health care needs. The goal of modern medicine is no longer treatment of diseases but also their prevention and control, thereby improving the quality of life of individuals and mankind as a whole.

Today's otorhinolaryngologists face a massive problem in securing modern man's hearing, of which diabetes mellitus is a hinder-stone. The hearing loss in a diabetic has a prevalence of 0-93%[1-7], characteristically a progressive, bilateral, sensorineural hearing loss predominantly in the higher frequencies by various studies[9].There are contradictory reports such as the hearing loss being unilateral, in mid and lower frequencies also[10].

And thus, this cross sectional study aims to interrogate the association of type 2 diabetes mellitus with sensorineural hearing loss and their influential factors.

MATERIAL AND METHODS

This is a prospective study carried out on **60** patients attending Diabetic clinic and ENT Outpatient department of Durgabai Desmukh Hospital and Research Centre, Vidyanagar, Hyderabad, Telangana; were subjected to pure tone audiometry and evaluation of random blood sugar, glycolslated hemoglobin, lipids, creatinine. The prevalence of SNHL with relation to age, sex, duration and control of diabetes were analysed over a period of 2 years from may 2016 to may 2018.

Inclusion criteria was known type 2 diabetics >5 years, on oral hypoglycemic drugs, age group 30-65 years, without any other major systemic illness at presentation like myocardial infarction, stroke, cardiac surgery.

Exclusion criteria was Type 2 diabetics on Insulin therapy, Hearing loss before onset of diabetes, Sudden onset of hearing loss, History of ear discharge, Family history of hearing loss, History of head trauma, ear surgery, Prolonged exposure to noise.

METHODOLOGY:

1. Method of Collection of data: On the basis of Inclusion and exclusion criteria subjects are selected and are subjected to Clinical examination including ENT examination, audiometric and laboratory assessment is done such as Lipid profile, Glycosylated haemoglobin, Serum Creatinine, Random blood sugar.
2. Medical history and clinical examination including ENT examination was done and Tuning fork tests such as Rinse's, Weber's and Absolute Bone Conduction tests were performed using 256, 512 and 1024 Hz.
3. Pure tone audiometry: Audiometric assessment was conducted in sound treated room delivering pure tone stimuli to one ear at a time in frequencies of 250Hz, 500Hz, 1000Hz, 2000Hz,4000Hz and 8000Hz at various selected intensities. The reference intensity level is designated 'I'd at each frequency, is the mean value of minimal audible threshold of pure tones in healthy individuals. Hearing threshold is taken as the least intensity of pure tone that was audible to the subject.

Bone conduction threshold is obtained by using bone vibrator placed on the skin over mastoid process and assessed to a maximum of 4000Hz.It is represented by symbols '[' and ']' for right and left bone respectively.

Masking is employed when the difference in right and left unmasked air conduction threshold is 40dB or more.

The hearing threshold grading is given by

0-25dB – normal hearing

26-40dB – mild hearing loss

41-55dB – moderate hearing loss

56-70dB – moderately severe hearing loss

71-90dB – severe hearing loss

>90dB – profound hearing loss

4. **Blood investigations:**

The patient's blood was assigned for the routine blood investigations as hemoglobin, total count, differential count and platelets to rule out anemia, leukemia and other disorders.

Random blood sugar levels were measured using glucometer. To assess the diabetic control of the patient in the last 3 months HbA1c was done and graded as

< 6.5% -good control

6.5-8%- moderate control

>8%- poor control

Pure Tone Audiometry

Measurement Of Auditory Threshold:

The subject was made to wear earphones for air conduction Assessment.

- First, sound at 1000 Hz was presented followed by 2000, 4000, 6000, and 8000 Hz and then again 1000 Hz, followed by 500 and 250 Hz.
- The intensity was increased in ascending order, 5 dB each time till the subject made a positive response by raising one hand.

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- When the subject could hear the faintest sound, again the intensity was decreased by 10 dB, and another ascending series begun.
- After testing for air conduction, subjects were assessed for bone conduction by making them wear a bone vibrator.
- The initial frequency tested was 1000 Hz, followed by test 2000, 3000, and 4000 Hz. Then a retest of 1000 Hz was done before testing 500 and 250 Hz.

Methodology Of Pure Tone Audiometry:

The method is based on **American Society for Speech and Hearing Association [ASHA] 2005 Guidelines for manual pure-tone threshold audiometry (PTA)** and is as follows:

Before conducting threshold testing, a complete case history should be obtained and horoscopy completed.

1. Ear examination: Visual inspection of the pinna and ear canal, including horoscopy, should precede audiometric testing to rule out active pathological conditions and the potential for ear canal collapse caused by audiometric earphones. The ear canal should be free of excessive crewmen before testing. Hearing aids should be removed. Testing should begin with the better ear when identifiable.

2 Participant seating: The participant should be seated in a manner to promote safety and comfort as well as valid testing.

3 Instructions: The test instructions should be presented in a language or manner appropriate for the participant. Interpreters (oral or manual) should be used when necessary. Supplemental instructions may be provided to enhance understanding, such as written directives, gestures, and demonstrations.

4. Response task: Overt responses are required from the participant to indicate when he or she hears the tone going on and off. Examples of commonly used responses are (a) raising and lowering the finger, hand, or arm, (b) pressing and releasing a signal switch, and (c) verbalizing —"yes".

5. Interpretation of response behavior: The primary parameters used by the audiologist in determining threshold are the presence of —"on" and —"off" responses, latency of responses, and number of false responses.

Threshold Measurement Procedure:

The basic procedure for threshold determination consists of

(a) Familiarization with the test signal and

(b) Threshold measurement

- Familiarization: The purpose of familiarization is to assure the audiologist that the participant understands and can perform the response task.

The following two methods of familiarization are commonly used:

(a) Beginning with a 1000-Hz tone, continuously on but completely attenuated, gradually increase the sound-pressure level of the tone until a response occurs, presented a 1000-Hz tone at a 30 dB hearing level (HL). If a clear response occurs, begin threshold measurement. If no response occurs, present the tone at 50 dB HL and at successive additional increments of 10 dB until a response is obtained.

(b) Threshold determination: The method described, an ascending technique beginning with an inaudible signal, is recommended as a standard procedure for manual pure-tone threshold audiometry.

1. Tone duration: Pure-tone stimuli of 1 to 2 seconds' duration.
2. Interval between tones: The interval between successive tone presentations shall be varied but not shorter than the test tone.
3. Level of first presentation: The level of the first presentation of the test tone shall be well below the expected threshold.
4. Levels of succeeding presentations: The level of each succeeding presentation is determined by the preceding response. After each failure to respond to a signal, the level is increased in 5-dB steps until the first response occurs. After the response, the intensity is decreased 10 dB, and another ascending series is begun.

5. Threshold of hearing: Threshold is defined as the lowest decibel hearing level at which responses occur in at least one half of a series of ascending trials. The minimum number of responses needed to determine the threshold of hearing is two responses out of three presentations at a single level.

Standard procedure of air conduction measures:

1. Earphone placement: Supra-aural or circum-aural earphones shall be held in place by a headband with the earphone grid directly over the entrance to the ear canal. After visual inspection of the outer ear, the audiologist should place the earphones on the participant and adjust them to fit her or his head properly.
2. Stimuli: Continuous or pulsed pure-tone signals should be used. Pulsed tones have been shown to increase a test participant's awareness of the stimuli.

3. Frequency: The frequencies tested differ, depending on the technique used.

- Monitoring technique. Threshold assessment should be made at 500, 1000, 2000, 3000, 4000, 6000, and 8000 Hz when monitoring as part of hearing loss prevention programs.

- Diagnostic technique. Threshold assessment should be made at 250, 500, 1000, 2000, 3000, 4000, 6000, and 8000 Hz, except when a low frequency hearing loss exists, in which case the hearing threshold at 125 Hz should also be measured.

4. Order: When appropriate information is available, the better ear should be tested first. The initial test frequency should be 1000 Hz. Following the initial test frequency, the audiologist should test, in order, 2000, 3000, 4000, 6000, and 8000 Hz, followed by a retest of 1000 Hz before testing 500, 250, and 125 Hz. A retest at 1000 Hz is not necessary when testing the second ear.

Standard Procedure For Bone Conduction Measures:

Standard bone-conduction vibrator placement should allow mastoid or forehead placement with proper force applied.

1. Frequency: Thresholds should be obtained at octave intervals from 250 to 4000 Hz and at 3000 Hz. Testing at frequencies below 500 Hz demands excellent sound isolation for cases with normal or near normal sensitivity but may be accomplished when such an environment is available.
2. Order: The initial frequency tested should be 1000 Hz. After the initial test frequency, the audiologist should test 2000, 3000, and 4000 Hz followed by a retest of 1000 Hz before testing 500 and 250 Hz.

Record keeping

1. Recording of results: Results may be recorded in graphic or tabular form or both. Separate forms to represent each ear may be used. Results must be legible and should be of sufficient quality to allow copying and electronic storage and communication.

   The privacy and confidentiality of audiometric records must be maintained and protected.

2. Audiogram form: For conventional audiometry, the vertical scale is to be designated hearing level in decibels; the horizontal scale is to be labeled frequency in hertz.

Interpretation Of Audiogram

1. Conductive hearing loss: bone conduction thresholds are better (more sensitive) than air conduction thresholds by 10 dB or more and are in normal range.
2. Sensorineural hearing loss: bone conduction thresholds are same as air conduction thresholds and neither of them is in normal range.
3. Mixed/ combined hearing loss: bone conduction thresholds are raised but are still better than air conduction thresholds by 10 dB or more.

RESULTS

The study on prevalence of SNHL in type 2 diabetics was carried out in the Diabetic Clinic & Dapartment of otorhinolaryngology & head and neck surgery, at Durgabai Desmukh Hospital & Research Centre, Hyderabad, considering the various aspects of sensorineural hearing loss with type 2 diabetics as prevalence of sensorineural hearing loss in relation to

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A. Age of the subject
B. Sex of the subject
C. Duration of diabetes
D. Random blood sugar level
E. Control of diabetes as measured by HbA1c
F. Lipid profile variations
G. Creative variations

The mean age of study population is 44.5yrs± 6.25standard deviation.53.3% of study population belongs to 41-50 yrs.31.7% of study population belongs to 31-40yrs whereas only 15% of study population belongs to 51-60yrs age group. (Table 1)

Table no 2 describes gender distribution among study participants, 65% of the study population are males. 35% of the study populations are males.

Table no 3 describes duration of hearing loss in the study participants. 65% (39) of study population doesn't have hearing loss. 30% (18) of patients suffering from hearing loss since 1 to 5 yrs. 5% of patients suffering from hearing loss since 6 to 10 yrs.

Table no 4 describes the duration of diabetes among the study population. Patients with diabetes more than 10 years are about 26.7%.majority of study population suffering from diabetes since 6 to 10 years. 23.3% of patients had diabetes less than 5 years.

Table no 5 random blood sugar levels among study population varies from less than 100mg/dl to more than 200mg/dl.75%(45) of study population sugar levels falls in between 100-200mg/dl. Only 5% (3) of study population has sugar levels below 100mg/dl. 20% (12) of patients had sugar levels more than 200mg/dl.

Table no 6 describes HbA1c levels in study population, 38.3% (23) of patients had HbA1C levels more than 8, same percentage (38.3) of study population falls between 6.5to 8% levels of HbA1c.HbA1c below 6.5 % have only 23.3% (14) of study population.

Table no 7 total cholesterol level among the study population varies. Only 30 % (18) of study population are having normal levels of cholesterol where as 41.7% (25) are study population has cholesterol levels between 200 to 280 mg/dl. 28.3 % (17) of study population has cholesterol levels beyond 280mg/dl.

Table no 7 indicates triglycerides levels of study participants. (100%) All the patients have triglycerides levels in between 150 to 500 mg/dl.

Table no 7 describes High density lipoproteins among the study population. 70% (42) of study participants had their HDL levels between 35-60mg/dl. 18.3% (11) has their HDL levels below 35mg/dl. Only 11.7% (7) of study participants has their HDL levels more than 60mg/dl.

Table no 7 depicts low density lipoproteins in study population. 85% (51) of study participants had LDL levels between 70-190mg/dl.15% (9) of study participants had LDL levels beyond 190mg/dl.

Table no 8 describes serum creatinine levels in study population. 51.7% (31) of study population has serum creatinine levels more than 1.1 Patients with serum creatinine less than or equal to 1.1 present in 48.3% (29).

Table no 9 describes types of hearing loss in study population.40% of study population doesn't have hearing loss. Nearly 48% of study population has mild to moderately severe hearing loss. Only 3.3 % of patients have profound hearing loss.

Table no 10 and graph no 1 describes the hearing loss among various age groups of study population. Majority (33.3%) of patients with hearing loss falls in the 41-50yrs age group. There is no significant association between age and hearing loss as P Value= 0.637 which is more than 0.05.

Table no 11 and graph no 2 describes affects of blood glucose levels on hearing loss among study population. 48.3% of study population with hearing loss has blood glucose levels between 100-200mg/dl. Only 8.33% of patients with hearing loss have blood glucose levels above 200mg/dl.

Table no 12 and graph no 3 depicts the relation between HbA1C levels in patients and hearing loss 25% of study population with hearing loss have HbA1c levels more than 8. 20% of study population with hearing loss has HbA1c levels in between 6.5 – 8.

Table no 13 and graph no 4 indicates relation between Total cholesterol levels and hearing loss among the study Population. There is significant

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association is present Between Total cholesterol and hearing loss as P value is <0.05(0.006).

Table no 13 and graph no 5 shows relation between triglycerides levels and hearing loss in study population. The association between triglycerides levels and hearing loss in study population is strongly significant as P value <0.001 which is less than 0.05.

Table no 13 and graph no 6 shows relation between High density lipoproteins with hearing loss. The association between HDL and Hearing loss is not significant as p Value is more than 0.05(0.073).

Table no 13 and graph no 7 depicts the relation between Low density lipoproteins with hearing loss in study population. There is no significant association between LDL levels and hearing loss in study population.

Table no 14 and graph no 8 describes the association between serum creatinine with hearing loss. There is no significant association between serum creatinine levels and hearing loss in study participants as P value 0.522 which is more than 0.05.

DISCUSSION

The relationship between diabetes mellitus and sensorineural hearing loss is complex and under debate since many years supported by the bulk of conflicting literature. The crux about the effect of diabetes in SNHL lies centered around the cochlea and the neural pathways, which has been studied throughout the years in relation to age, sex, and duration and glycemic levels.

Diabetes mellitus is a common metabolic disease affecting almost all age groups which is frequently associated with hearing loss. The hearing loss associated with diabetes mellitus is characteristically bilaterally symmetrical, gradual in onset and progressive in nature. The relationship between diabetes mellitus and sensorineural hearing loss is complex and not well explained. There also has been debatable opinion amongst various studies where some studies show strong association whereas some studies show no relation between diabetes mellitus and sensorineural hearing loss.

The two factors that found to affect hearing in diabetic patients are - Diabetic angiopathy and diabetic neuropathy[41].

Diabetes mellitus causes increased rate of triglyceride production due to insulin resistance. There is endothelial proliferation and accumulation of glycoproteins with thickening of the capillary vessels in basement membranes. This results in impaired nutrient transportation through these thickened vessels resulting in decreased blood flow through narrowed vessels leading to secondary degeneration of the vestibule-cochlear nerve.

Activation of polio pathway causes accumulation of sorbitol within the neurons thereby reducing the inositol content and Na+/K + ATPase activity intracellularily leading to osmotic damage and swelling.

Protein kinase C is implicated in increased production of cytokines, regulation of vascular permeability, flow, and increased synthesis of basement membranes which is seen to increase in diabetes. In addition to increased formation of advanced glaciation products in collagen, DNA also contributes to tissue damage leading to cellular hypertrophy and hyperplasia.

This study showed a prevalence of sensorineural hearing loss in 60% of type 2 diabetics. This results were comparable with previous studies like to that of **Friedman et al**[3] (55%) and **Aggarwal et al**[21] (64.86). Other studies reveal low prevalence rates. The wide variation in prevalence of sensorineural hearing loss in diabetics may be due to difference in methodology including inclusion and exclusion criterias.

In the present study hearing loss was found to be typically bilateral symmetrical, progressive and gradual in onset, asymmetry was also noted in some of the patients. The hearing loss was more in higher frequencies 4 to 8 kHz and approximately 5-30dB difference was noted in the hearing threshold. These results were comparable with that of studies by **Cullen R ET al**[4] **and Kurien Met al**[45]**.**

In the present study of diabetic population with respect to age specific distribution of hearing loss, majority of patients with hearing loss fall in age group 41-50 years with 33.3% patients, followed by age group 31-40 years with 15% patients, with age group 51-60 years with 11.1% patients which was comparable with studies by **Friedman et al**[3]**, Cullen R et al**[4]. However effects of age related cause for hearing loss – presbycusis was minimized as the

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patients included in the study were below 60 years of age.

In the present study majority of study population are males accounting for 65% out of which 27 males have sensorineural hearing loss constituting 69.23 %, with females accounting for 35%, out of which 10 females have sensorineural hearing loss constituting 47.61 %

In the present study 25% patients have sensorineural hearing loss with glycosylated hemoglobin HbA1c levels more than 8%, 20% patients have sensorineural hearing loss with HbA1c levels between 6.5-8%, 15% patients have sensorineural hearing loss with HbA1c levels less than 6.5%.

In the present study 35% patients have sensorineural hearing loss with serum creatinine more than 1.1 mg/dl, 25% patients have sensorineural hearing loss with serum creatinine less than or equal to 1.1 mg/dl which was supported by **Kakarlapudi et al**[9] which shows strong association sensorineural hearing loss with micro angiopathy.

Lipid profile comprising total cholesterol, triglycerides, high and low density lipoproteins were considered in the study of sensorineural hearing loss in diabetics and as an indirect measure of the metabolic control on a long term.

In the present study out of 17 patients, 14 patients have sensorineural hearing loss constituting 82.35% with Total Cholesterol levels more than 280 mg/dl, followed by 64% sensorineural hearing loss with Cholesterol levels between 200-280 mg/dl, 33.3% sensorineural hearing loss with Cholesterol levels less than 200 mg/dl indicating higher levels of Total Cholesterol leading to increased prevalence of sensorineural hearing loss. Triglyceride levels between 150-500 mg/dl constituted 60% sensorineural hearing loss.

High density lipoproteins (HDL) levels below 35 mg/dl constituted 81.81% sensorineural hearing loss followed by 54.7% sensorineural hearing with HDL levels between 35-60 mg/dl indicating lower HDL levels more prevalence of hearing loss implying that HDL levels which is protective in nature against angiopathy is found reduced in the diabetics overall, which may contribute to the pathogenesis involved in hearing loss in diabetics.

Low density lipoproteins (LDL) levels between 70-190 mg/dl have 62.74% sensorineural hearing loss followed by 44.44 % sensorineural hearing loss with LDL levels more than 190 mg/dl indicating that LDL levels were not found contributing to the changes in hearing threshold of the subjects involved.

CONCLUSION

Sensorineural hearing loss is prevalent in 60% of type II diabetic patients. Bilateral, symmetrical & progressive hearing loss was noted in all frequencies but characteristically affecting more in higher frequencies and also with increasing age and higher in male.

The duration of diabetes affect auditory thresholds significantly in this study.

A strong association was found between blood sugar levels, glycosylated hemoglobin and severity of hearing loss which showed sensorineural hearing loss was more prevalent in patients with poor diabetic control.

Progression of Sensorineural hearing loss can be slowed down by glycemic control in diabetics (Random blood sugar and HbA1c levels), by Control of Serum Lipid levels by Dietary management, Physical exercise and Medication, Regular follow up and control of Serum Creatinine levels and use of antioxidants.

Screening of diabetics for hearing loss would help in early detection and use of amplification devices for slowing down the progression of hearing loss.

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TABLES AND GRAPHS

Table no 1: Age wise distribution of study population

AGE	FREQUENCsY	PERCENTAGE
31-40	19	31.7
41-50	32	53.3
51-60	9	15
TOTAL	60	100

Table No: 2 Gender wise distribution of study population

Age	Female	Male	Total	Percentage
31-40	7	12	19	31.7
41-50	11	21	32	53.3
51-60	3	6	9	15
Total	21(35%)	39(65%)	60	100

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Table No 3: Distribution of hearing loss in study population

Hearing loss(yrs.)	no of patients	percentage
nil	39	65
1--5	18	30
6--10	3	5
>10	0	0
Total	60	100

Table No 4: Distribution of Diabetes duration in study population

Diabetes Duration	No of patients	Percentage
1-5yrs	14	23.3
6-10yrs	30	50
>10yrs	16	26.7
Total	60	100

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Table No 5: Random blood sugar levels among study population

RBS	No of Patients	Percentage
<100mg/dl	3	5
100-200mg/dl	45	75
>200mg/dl	12	20
Total	60	100

Table No: 6 Distribution of HbA1c levels in study population

HbA1C%	No of Patients	Percentage
<6.5	**14**	**23.3**
6.5-8	**23**	**38.3**
>8	**23**	**38.3**
Total	**60**	**100**

Table No: 7 Lipid profile levels in study population

Lipid profile	No of patients(n=60)	Percentage
Total cholesterol(mg/dl)		
<200	18	30
200-280	25	41.7
>280	17	28.3
Triglycerides(mg/dl)		
<150	0	0
150-500	60	100
>500	0	0
HDL(mg/dl)		
<35	11	18.3
35-60	42	70
>60	7	11.7
LDL(mg/dl)		
<70	0	0
70-190	51	85
>190	9	15

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Table 8: Serum creatinine levels in study population

Serum creatinine	No of Patients	Percentage
≤1.1	29	48.3
>1.1	31	51.7
Total	60	100

Table 9: Types of hearing loss among the study population

Hearing loss	No of patients	Percentage
Normal	24	40
Mild	7	11.7
moderate	15	25
Moderately severe	7	11.7
Severe	5	8.3
Profound	2	3.3
Total	60	100

Table 10: Age specific distribution of hearing loss among study population

	HEARING LOSS						
Age	**Normal**	**Mild**	**Moderate**	**Moderately severe**	**Severe**	**Profound**	**Total**
31-40yrs	10	1	4	2	1	1	19 (31.7%)
41-50yrs	12	5	9	3	3	0	32 (53.3%)
51-60yrs	2	1	2	2	1	1	9 (15%)
Total	24 (40%)	7 (11.67%)	15 (25%)	7 (11.67%)	5(8.33%)	2 (3.3%)	60 (100%)

P=0.637, not significant, fisher exact test

Graph 1: Age specific distribution of hearing loss among study population

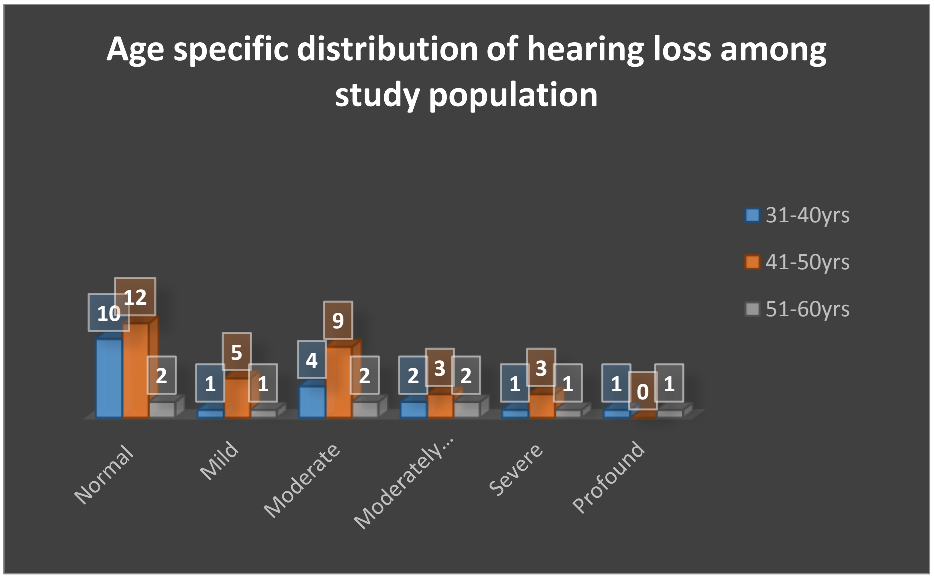

Table No: 11 Effects of random blood sugar levels on severity of hearing loss

	HEARING LOSS						
RBS	Normal	Mild	Moderate	Moderately severe	Severe	Profound	Total
<100mg/dl	1	0	1	0	1	0	3(5%)
100-200mg/dl	16	7	10	6	4	2	45(75%)
>200mg/dl	7	0	4	1	0	0	12(20%)
Total	24(40%)	7(11.6%)	15(25%)	7(11.7%)	5(8.33%)	2(3.3%)	60(100%)

Graph 2: Effects of random blood glucose levels on severity of hearing loss

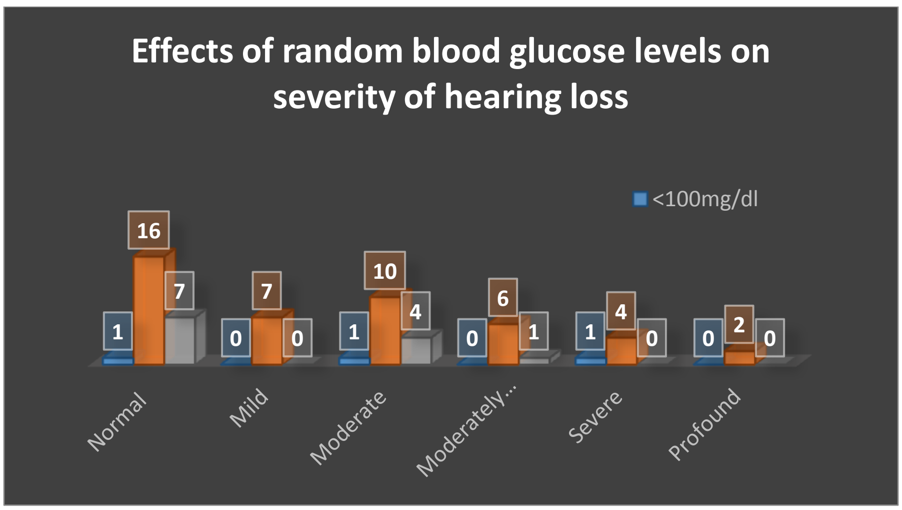

Table No: 12 Relationship between HbA1C and Severity of hearing loss

	HEARING LOSS						
HbA1C (%)	Normal	Mild	Moderate	Moderately severe	Severe	Profound	Total
<6.5	5	2	4	2	1	0	14(23.3%)
6.5-8	11	0	4	3	4	1	23(38.3%)
>8	8	5	7	2	0	1	23(38.3%)
Total	24(40%)	7(11.6%)	15(25%)	7(11.7%)	5(8.33%)	2(3.3%)	60(100%)

Graph 3: Relationship between HbA1C and Severity of hearing loss

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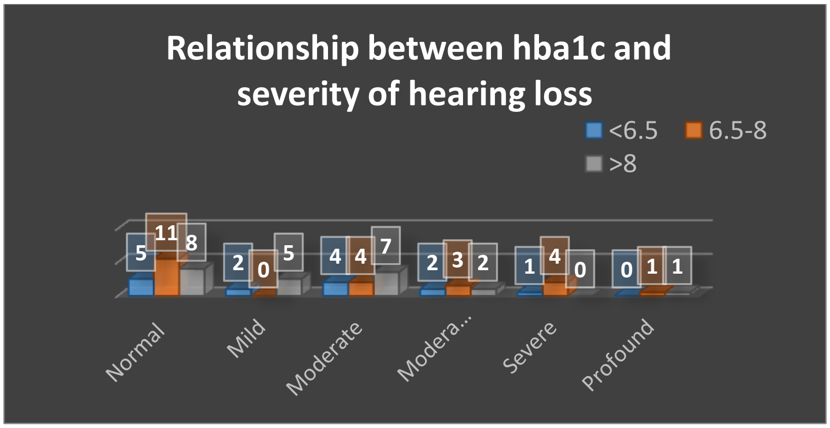

Table no 13: Relation between hearing loss and lipid profile of study population

	HEARING LOSS							
Lipid profile	**Normal**	**Mild**	**Moderate**	**Moderately severe**	**Severe**	**Profound**	**Total**	**P Value**
Total cholesterol								
<200mg/dl	12	4	1	0	1	0	18	0.006*
200-280mg/dl	9	1	10	2	2	1	25	
>280mg/dl	3	2	4	5	2	1	17	
Triglycerides								
<150mg/dl	0	0	0	0	0	0	0	<0.001
150-500mg/dl	24	7	15	7	5	2	60	
>500mg/dl	0	0	0	0	0	0	0	
HDL								
<35mg/dl	2	2	2	1	2	2	11	0.073
35-60mg/dl	19	3	12	5	3	0	42	

>60mg/dl	3	2	1	1	0	0	7	
LDL								
<70mg/dl	0	0	0	0	0	0	0	0.959
70-190mg/dl	19	6	14	6	4	2	51	
>190mg/dl	5	1	1	1	1	0	9	

Chi square test/fisher exact test

Table No: 14 Relation between serum creatinine and hearing loss in study population

Serum creatinine	Normal	Mild	Moderate	Moderately severe	Severe	Profound	Total
≤1.1	14	3	8	3	1	0	29(48.3%)
>1.1	10	4	7	4	4	2	31(51.7%)
Total	24(40%)	7(11.67%)	15(25%)	7(11.67%)	5(8.33%)	2(3.3%)	60(100%)

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