Original Research Article

Evaluation of an association between type II diabetes mellitus and sensorineural hearing impairment in population<60 years age at tertiary care hospital

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Abstract

Background: Connection between type 2 Diabetes Mellitus with sensorineural hearing loss (SNHL) has been studied. Microangiopathy with neuronal degeneration are important factor. **Aims and Objectives:** To find out association of type 2 Diabetes Mellitus with SNHL along different frequencies in elderly population. **Materials and Method:** It is an Observational Case Control Study. Study is carried out in 200 patients. Out of these 100 cases of type 2 Diabetes Mellitus and 100 are Nondiabetic controls of age group 30 to 60 years at Tertiary Care Hospital. **Results:** There is strong association between (SNHL) and type 2 diabetes. Chi Square = 24.62, p value <0.0001. There is significant association between (SNHL) with Duration of diabetes, HbA1C, Triglyceride Levels, Low Density Lipoprotein, serum Creatinine and microalbuminuria independently. There is no significant association between (SNHL) with Age, Sex, Random blood sugar and Cholesterol levels. **Conclusion:** SNHL is prevalent in 64% of type II Diabetes Mellitus patients with male preponderance. Long term diabetics and elders with dearranged lipids and creatinine levels are having more hearing impairment as compared to newly detected diabetics. Short term sugar control is found to have a negligible effect on SNHL.

Key Words: type II diabetes mellitus, sensorineural hearing impairment.

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INTRODUCTION

Type 2 Diabetes mellitus leads to microvascular and macrovascular complications, like Diabetic Nephropathy, Neuropathy and Retinopathy. These complications has been routinely evaluated, diagnosed and treated by physician. While the connection between diabetes with vision loss and renal dysfunction is well known, unfortunately the statistics of diabetes related hearing loss among diabetics is not. Not too many physicians do ask for a Hearing test in Diabetics and thus patient live with undiagnosed hearing loss for quite some time. Microangiopathy along with neuronal degeneration considered to be the most important factor in long term complication of type 2 Diabetes Mellitus. Other causes may be degenerated glucose metabolism and hyperactivity of oxygen free radicals. Studies in diabetic animals have demonstrated thickening of Basement Membrane of the capillaries of Striae Vascularis. These vascular changes have been theorized to be important causative factor for neuronal degeneration in the auditory system. Other studies suggestive of 8th nerve myelin degeneration with fibrosis of perineurium leading to acoustic neuropathy. A mutation in mitochondrial t-RNA in a small subset of patients with maternally inherited diabetes with sensorineural hearing loss.

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MATERIALS AND METHODS

Study is carried out in 200 patients. Out of these 100 cases are suffering from type 2 Diabetes Mellitus and 100 are volunteers in the age group of 30 to 60 years attended the department of Medicine and ENT at Tertiary Care Hospital.

Type of Study: Observational Case Control Study

Calculation for Sample Size: Sample size is calculated on the basis of previously conducted study results (Santosh 2010 studies) using the standard statistical formula,

$N = (Z\alpha)^2 X\ p\ X\ q\ /\ d^2$

Where α error taken as 0.05 and with power of 95%,p value of 61.67, q value of 38 and absolute error of 10% resulting in 94.24. The sample size was taken as 100 diabetic patients of type 2.

Duration of Study

- Total Duration: 24 months
- Data Collection: 18 months (December 2015 to May 2017)
- Data Analyzing: 6 months (January 2017 to November 2017)

GROUP A (Control)

100 volunteers having following criteria

1. Age below 60 years
2. Normal Fasting and Postprandial Blood sugar and Glycosylated Haemoglobin
3. No family history of Diabetes Mellitus
4. No history of hearing impairment or other disorders

GROUP B (Cases)

100 patients of Type 2 Diabetes Mellitus selected randomly,

1. Age below 60 years
2. WHO Criteria of type 2 Diabetes Mellitus
3. Fasting Blood sugar >126mg/dl (7mmol/l) and
4. Postprandial Blood sugar >200mg/dl (11.1mmol/l)
5. Glycosylated Haemoglobin (HbA1C) > 6.4%
6. (Fasting is defined as no caloric intake for at least 8 hours)

Inclusion Criteria

- Cases with type 2 Diabetes Mellitus confirmed by WHO Criteria with
- Fasting Blood sugar >126mg/dl (7mmol/l) and
- Postprandial Blood sugar >200mg/dl (11.1mmol/l)
- Glycosylated Haemoglobin (HbA1C) >6.4%
- (Fasting is defined as no caloric intake for at least 8 hours)

Exclusion Criteria

1. Age <30 years and>60 years
2. No history of noise exposure of > 85 db
3. No history of hearing impairment caused by other disorders like,
   - Chronic suppurative otitis media
   - Cholera –malaria –jaundice –meningitis
   - Small pox –chicken pox –autoimmune disease
4. No history of head or ear trauma
5. No history of chemical exposure
6. No history of ototoxic drug intake like
   - Gentamycin or tobramycin
   - Cisplatin or carboplatin
   - Furosemide or ethacrynic acid
   - High dose aspirin or salicylates
   - Heavy metal like mercury or lead
7. No history of ear surgery

Following investigations to be done in all patients:

1. Random Blood Sugar
2. Blood urea and serum creatinine
3. Complete Blood Count (CBC)
4. Fasting lipid profile
5. Glycosylated Haemoglobin
6. Urine for Microalbuminuria
7. Tuning fork tests like, –Rinne test –Weber test –Absolute Bone Conduction test
8. Pure tone audiometry

Pure tone audiometry: Audiometric assessment is 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 'X' dB 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 is audible to the subject.

The hearing threshold grading is given by,

1. 0-25dB –normal hearing
2. 26-40 dB –mild hearing loss
3. 41-55dB –moderate hearing loss
4. 56-70dB –moderatel to severe hearing loss
5. 71-90dB-severe hearing loss
6. >90dB- profound hearing loss

OBSERVATION AND RESULTS

Table 1: Gender wise distribution in both Diabetic and Non Diabetic patients

	Male	Female	`Total
Diabetic	64	36	100
Non Diabetic	62	38	100

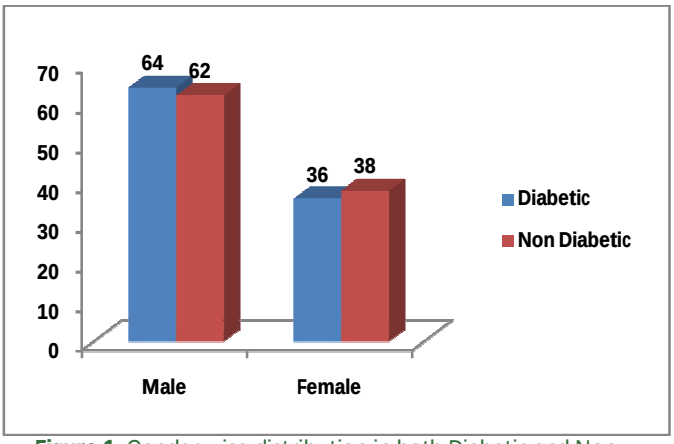

Figure 1: Gender wise distribution in both Diabetic and Non Diabetic patients

Table 2: Distribution of Deafness in both Diabetic and Non Diabetic patients

	SNHL	Normal	`Total
Diabetic	64	36	100
Non Diabetic	29	71	100

There is strong association between deafness (SNHL) and presence of diabetes Chi Square = 24.62, p value < 0.0001

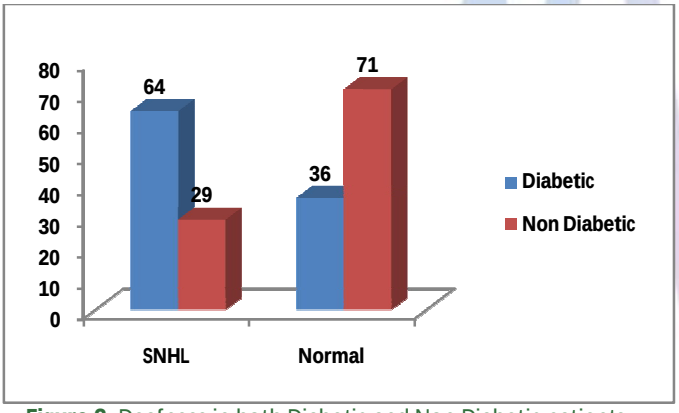

Figure 2: Deafness in both Diabetic and Non Diabetic patients

Table 3: Gender wise distribution of Deafness in both Diabetic and Non Diabetic patients

		SNHL	Normal	Total
Diabetic	Male	45(70.31%)	19(29.68%)	64(100%)
	Female	19(52.77%)	17(47.22%)	36(100%)
Non Diabetic	Male	17(27.41%)	45(72.58%)	62(100%)
	Female	12(31.57%)	26(68.42%)	38(100%)

There is no association between sex of diabetic patients and deafness. Chi Square =3.0747, p value = 0.079 There is no association between sex of non-diabetic patients and deafness. Chi Square =0.198, p value = 0.6563

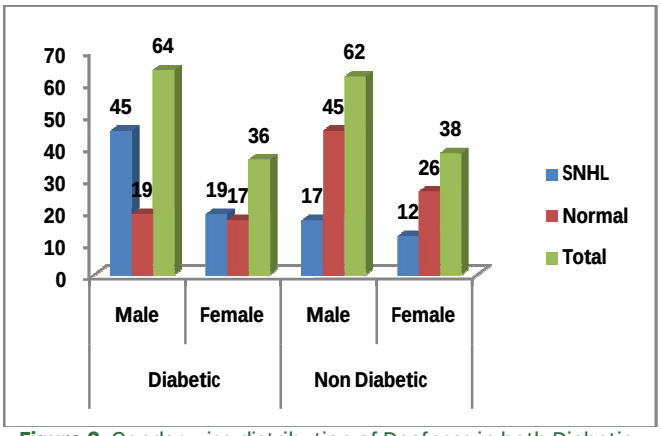

Figure 3: Gender wise distribution of Deafness in both Diabetic and Non Diabetic patients

Table 4: Severity of deafness in both Diabetic and Non Diabetic patients

SNHL	Diabetic		Non Diabetic	
	Male	Female	Male	Female
Mild	7(15.55%)	3(15.78%)	3(17.64%)	2(16.66%)
Moderate	15(33.33%)	7(36.84%)	6(35.29%)	4(33.33%)
Moderate to severe	12(26.66%)	6(31.57%)	4(23.52%)	3(25.00%)
Severe	8(17.77%)	2(10.52%)	3(17.64%)	2(16.66%)
Profound	3(6.66%)	1(5.26%)	1(5.88%)	1(8.33%)
Total	**45(100%)**	**19(100%)**	**17(100%)**	**12(100%)**

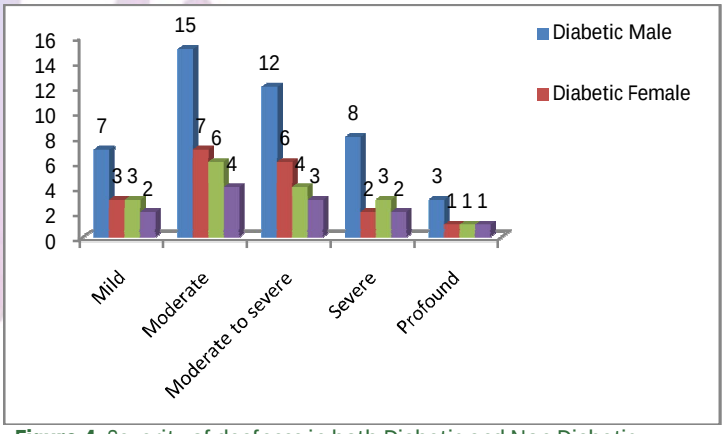

Figure 4: Severity of deafness in both Diabetic and Non Diabetic patients

Table 5: Age wise distribution of SNHL among Diabetic patients

Group	Age in years	SNHL	Normal	Total	Proportion
A	30 to 40	15	14	29	51.72
B	41 to 50	29	16	45	64.44
C	51 to 60	20	06	26	76.92

(Last two rows from table number 5 have been clubbed for analysis) There is no any association between age and SNHL in Diabetic patients. Chi Square =2.54, p value = 0.11

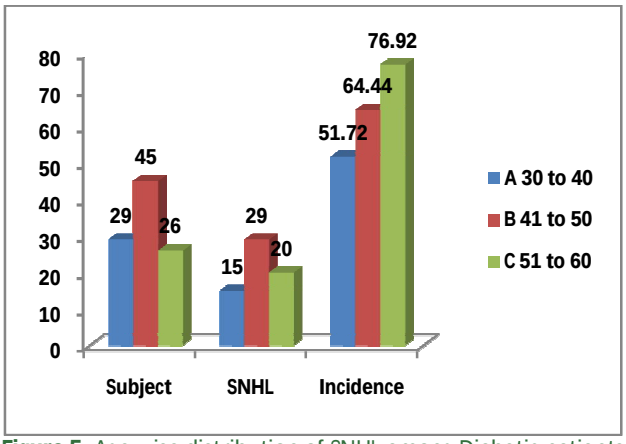

Figure 5: Age wise distribution of SNHL among Diabetic patients

Table 6: Relation of duration of Diabetes and SNHL

Duration in Years	SNHL	Normal	Total	Proportion
1 to 7	18	28	46	39.13
8 to 14	33	08	41	80.48
15 to21	13	00	13	100

(Last two rows from table number 6 have been clubbed for analysis). There is strong association between deafness (SNHL) and duration of diabetes. Chi Square = 22.86, p value < 0.0001

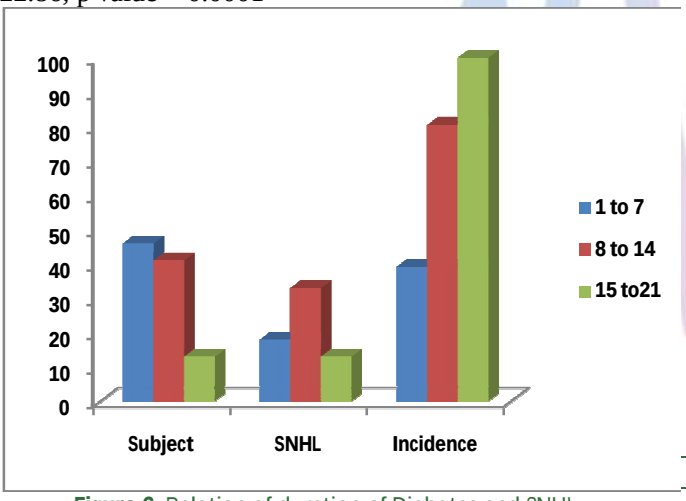

Figure 6: Relation of duration of Diabetes and SNHL

Table 7: Association of SNHL and random blood sugar levels

Blood Sugar mg/dl	SNHL	Normal	Total	Proportion
<140	19	13	32	59.37
140 to 170	16	09	25	64
>170	29	14	43	67.44

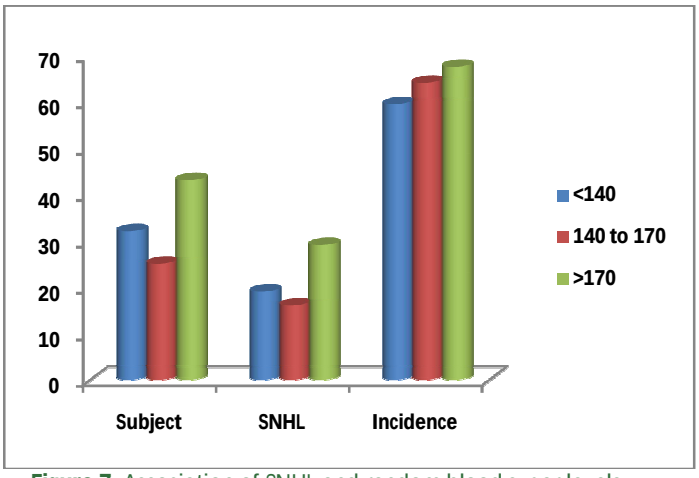

Figure 7: Association of SNHL and random blood sugar levels

Table 8: Association of SNHL and HbA1c

HbA1c	SNHL	Normal	Total	Proportion
<7	11	14	25	44
7-8	22	13	35	62.85
>8	30	10	40	75

(Last two rows from table number 8 have been clubbed for analysis) There is significant association between deafness (SNHL) and HbA1c levels. Chi Square = 5.16, p value = 0.02

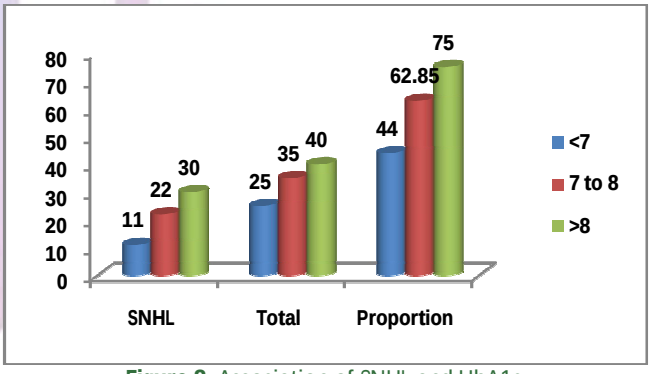

Figure 8: Association of SNHL and HbA1c

Table 9: Association of SNHL and Cholesterol levels

Cholesterol levels mg/dl	SNHL	Normal	Total	Proportion
<200	20	17	37	54.05
200 to 240	20	13	33	60.60
>240	24	06	30	80.00

(Last two rows from table number 9 have been clubbed for analysis). There is no significant association between deafness (SNHL) and Cholesterol levels. Chi Square = 2.52, p value = 0.112

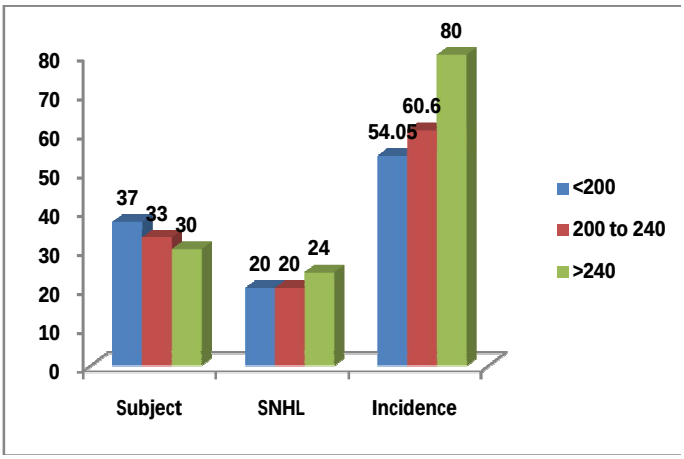

Figure 9: Association of SNHL and Cholesterol levels

Table 10: Association of SNHL and Triglyceride levels

Triglyceride mg/dl	SNHL	Normal	Total	Proportion
<200	9	15	24	37.50
200 to 250	18	17	35	51.40
>250	37	04	41	90.24

(Last two rows from table number 10 have been clubbed for analysis) There is significant association between deafness (SNHL) and Triglyceride levels. Chi Square = 9.625, p value = 0.002

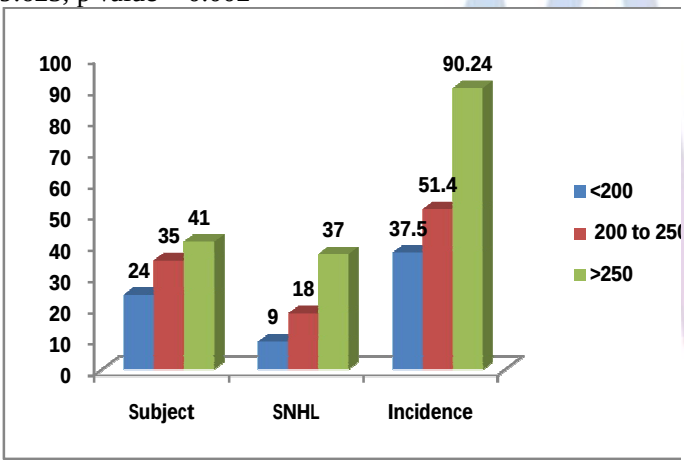

Figure 10: Association of SNHL and Triglyceride levels

Table 11: Association of SNHL and Low Density lipids

Low Density lipids mg/dl	SNHL	Normal	Total	Proportion
<130	14	17	31	45.16
130 to 190	25	11	36	69.44
>190	25	08	33	75.75

(Last two rows from table number 11 have been clubbed for analysis) There is significant association between deafness (SNHL) and low density lipids levels. Chi Square =6.92, p value = 0.008

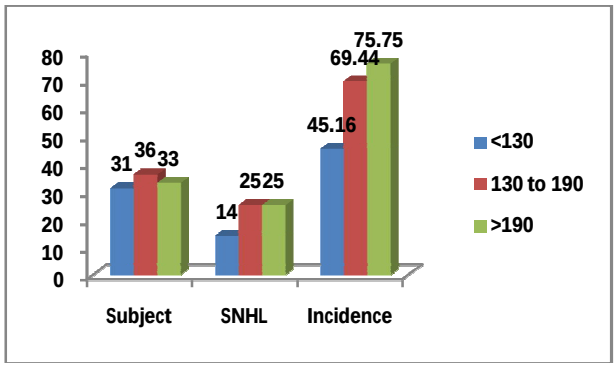

Figure 11: Association of SNHL and Low Density lipids

Table 12: Association of SNHL and Serum Creatinine

Creatinine levels mg/dl	SNHL	Normal	Total	Proportion
0.7 to 1.5	49	34	83	59.03
> 1.5	15	02	17	88.23
Total	**64**	**36**	**100**	**64.00**

There is significant association between deafness (SNHL) and serum creatinine levels. Chi Square (Yate's Correction) =4.031, p value = 0.044

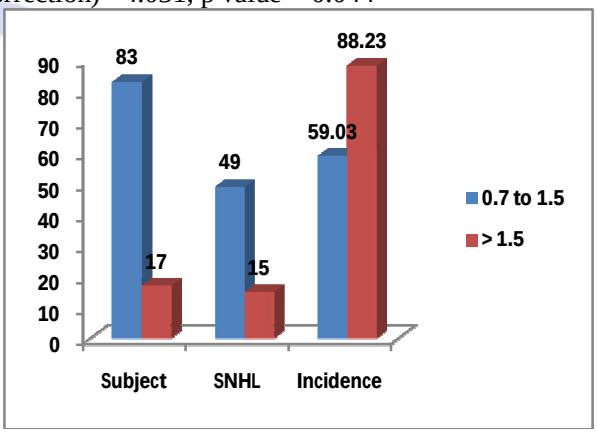

Figure 12: Association of SNHL and Serum Creatinine

Table 13: Association of SNHL and Microalbuminuria

Microalbuminuria	SNHL	Normal	Total	Proportion
Present	18	03	21	85.71
Absent	46	33	79	58.22
Total	**64**	**36**	**100**	**64.00**

There is significant association between deafness (SNHL) and microalbuminuria. Chi Square (Yate's Correction) =4.31, p value = 0.037

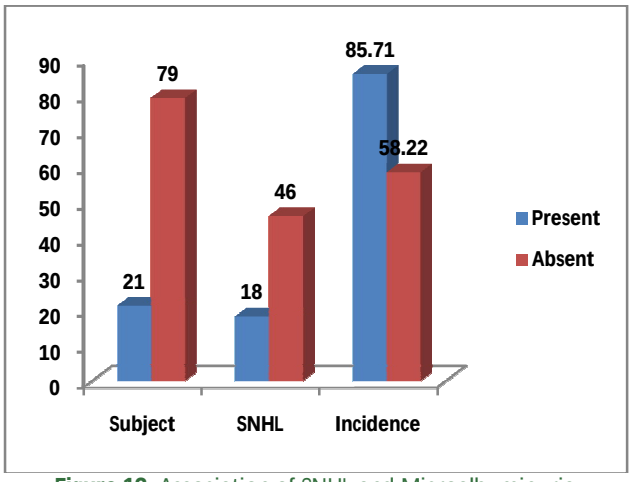

Figure 13: Association of SNHL and Microalbuminuria

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, duration and glycemic controls. In our study involving 100 patients of type 2 diabetics and 100 nondiabetic patients with no other major systemic disease, the prevalence of sensorineural hearing loss among diabetics is found to be 64% which is of gradual onset and progressive type. The results approximates to those that of Friedman (55%) and Aggarwal (64.86%). There is wide variation of results regarding the prevalence of SNHL in diabetics due to different inclusion and exclusion criteria, methodology and diagnostic approaches, while prevalence of sensorineural hearing loss among nondiabetics is found to be 29%.

Table 13: Percentage of SNHL in diabetes mellitus

Sr. No	Year of Study	Authors	Percentage of SNHL
1	1975	Friedman[5]	55 %
2	2011	Pemmaiah	43.6 %
3	2011	Rajuendran	73.3 %
4	2013	Kamire Nitesh	78.2 %
5	2010	Santosh	61.67 %
6	1998	Aggarwal[25]	64.86 %
7	2013	Krisnappa	73.58 %

The hearing loss is characteristically bilaterally symmetrical and progressive with gradual onset, however asymmetry in the hearing loss is also noticed. The hearing loss is more in the higher frequencies 4 to 8 kHz and approximately 5 to 30dB difference in the hearing threshold is observed. This result is supported by Cullen R and Kurien M. The study results stand contrast to the results published by Tay HL in 1998, who reported hearing loss more in the mid and low frequencies[38]. As all of patients are under 60 years of age the effects of presbycusis was minimized. On correlating sensorineural hearing loss in three age groups the incidence is more pronounced in the 51-60 age group (76.92%), 41-50 age group(64.44%) when compared to the 30-40 age group (51.72%) clarifying the strong association between increased age and SNHL which shows contrast to the earlier studies carried out by Friedman and Cullen.R[5,6]. The male gender is found more afflicted by SNHL (70.31%) when compared to the female counter parts (52.77%) in the study. The difference can be attributed to the sedentary life style of men in comparison to the women population. The male-female ratio is found to be 1.3:1. There is a strong correlation between the duration of diabetes and SNHL in our study, where diabetics with more than 7 years of disease are found to be affected as (80.48%) and those of more than 14 years of disease are found to be (100%) when compared to the younger diabetics. This is supported by the study carried out by Mehra while contradicting the other studies by Axelsson and Wilson *et al*[8]. The increase in hearing threshold may be attributed to the microvascular angiopathy in the capillaries of stria vascularis. The control of blood sugar levels and SNHL has been the most controversial and to ponder over this the random blood sugar levels and glycated haemoglobin (HbA_1C) has been taken in to account. HbA1C is taken in to consideration since it directly gives an idea about the blood sugar control of the patient in the earlier 3 months. The relation between the random blood sugar levels and the hearing threshold in our study is inconclusive as random blood sugar gives idea of present sugars but it does not signify about longterm sugar control hence cannot prove the effect on the pathology involved and may be attributed to the absence of diagnostic means to directly measure the metabolic control on long term. On the other hand there is strong association between HbA1c and SNHL in our study, where diabetics with HbA1c more than 7% are found to be affected as (69.33%) while compared to those of less than 7% found to be (44%). Lipid profile comprising total cholesterol, triglycerides, high and low density lipids is considered in the study to probe into the pathogenesis of sensorineural hearing loss in diabetics and as an indirect measure of the metabolic control on a long term. There is a significant correlation between the increased levels of triglycerides and SNHL, as 41 subjects with increased TGL level more than 250 mg/dl out of which 37(90.24%) are suffering from SNHL and the least level of TGL is found associated with less prevalence of SNHL. Increased LDL levels are also found to raise the

hearing threshold in a significant manner in the subjects with 72.46% of them with LDL more than 130mg/dl have been proven with hearing loss. Cholesterol levels are not found contributing to the changes in hearing threshold of the subjects involved. 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. Serum Creatinine levels which is indicative of the long term diabetic control is found in high or border line levels in the increased hearing threshold patients. The good control group is found to have less prevalence of SNHL (59.03%) when compared to the uncontrolled group (88.23%). This result is supported by the study carried out by Kakarlapudi *et al*, which strongly advocates the association of SNHL with microangiopathy[11]. Microalbuminuria is found in raised levels in the hearing loss group (85.71%) when compared to the reduced prevalence of hearing loss in patients with no microalbuminuria. This group of patients are mostly in the second decade of their diabetic duration.

CONCLUSION

- Sensorineural hearing loss is prevalent in 64% of type II diabetic patients.
- There is a mild increase in the prevalence of SNHL as the age of the patient increases.
- Male patients are found to be more affected by the sensorineural hearing loss than the female counterparts.
- Long term diabetics are having more hearing impairment as compared to newly detected diabetics, probably due to long duration of diabetes and hearing threshold increases as the duration of diabetes increases.
- Short term sugar control is found to have a negligible effect on the sensorineural hearing than the long term sugar controls which severely affects the neural component, as depicted by the lipid and creatinine levels.

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