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ASSESMENT OF AUDITORY FUNCTION USING PURE TONE AUDIOMETRY IN PATIENTS WITH TYPE II DIABETES MELLITUS

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ABSTRACT

Background & objective: The rate of diabetes has substantially increased over the past five decades. Hyperglycemia appears to have an effect on hearing loss. Hearing loss is a functional disability which affects person's day to day activities. The objective of the study was to evaluate auditory effects using pure tone audiometer in type II diabetic patients.

Materials & methods: Forty three type II diabetes mellitus patients in the age group of 35 to 55 years were included in this study. They were subjected to pure tone audiometry after assessing their glycemic status.

Results: The auditory thresholds in diabetic patients were higher in all the frequencies suggestive of sensorineural hearing loss. HbA_1C (6.74 ± 0.77) % strongly correlates with pure tone audiometry thresholds (46.53 ± 12.96) dB (r = 0.65, p = 0.001) which was highly significant. The duration of diabetes has no correlation with the PTA thresholds.

Conclusion: The audiograms of the diabetics were suggestive of mild to moderate sensorineural deafness and the hearing loss was more towards the higher frequencies. The glycemic status and duration of diabetes have no significant correlation with hearing loss.

Keywords: Audiometry, Hearing loss, Type II Diabetes Mellitus

INTRODUCTION

Hearing loss is a functional disability which affects person's day to day activities. Diabetes is a metabolic disorder characterized by high blood glucose, either because of insulin deficiency or resistance. The rate of diabetes has substantially increased over the past five decades from 30 million to 285 million people. Long term complications from high blood sugar include heart disease, stroke, diabetic retinopathy, kidney failure, poor circulation & hearing impairment. The mortality of diabetes is mainly due to long term micro and macro vascular complications affecting the blood vessels of eyes, kidneys, heart and nerves. Many studies have shown that the prevalence of hearing loss in diabetes has increased progressively & bilaterally [1-3]. Hearing loss severity may vary from mild to severe or profound and in general, hearing loss may be conductive, sensorineural or mixed. Diabetes mellitus has been implicated as an independent causative factor of sensorineural hearing loss. Unfortunately, hearing impairments often receive minimal attention. Since very few studies are available on the relation between diabetes & hearing impairment, the current study was undertaken to evaluate auditory effects using pure tone audiometer in type II diabetic patients (T2DM).

Diagnostic audiometry comprises of tests that detect conductive and sensorineural hearing losses. Pure tone audiometry involves the estimation of the threshold of hearing for certain standardized stimuli via the air and bone conduction routes. An audiometer, being a fundamental tool in the diagnosis of auditory capacities, has been employed in this study.

Fasting Blood Sugar (FBS): Blood glucose levels after fasting for at least 8 hours. Normal levels for this test are 70 to 100 mg/dL.

Post Prandial Blood Sugar (PPBS): Blood glucose levels after 2 hours of meal. Normal levels for this test are 140 mg/dL, level above 200mg/dL indicates diabetes.

HbA1C refers to glycated haemoglobin, which indentifies average plasma glucose levels. Normal levels for this test are 3.5-5.5%.

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Objectives

1. To record pure tone audiometry in diabetic patients.
2. To correlate glycemic status (FBS, PPBS), glycemic control (HbA1C), duration of type 2 diabetes on auditory acuity (pure tone thresholds).

MATERIALS & METHODS

Source of data

The study was conducted in a sample of forty three type II diabetic patients selected randomly from the Department of Medicine, Vinayaka Mission's Hospital, Salem, Tamil Nadu. Subjects were selected based on inclusion and exclusion criteria. Persons were classified as diabetic if they were currently taking diabetic medication. We studied all subjects diagnosed for T2DM in accordance with the established diagnostic criteria by American Diabetes Association. The sample size was determined after taking into consideration the methods used in other studies. Many published studies on the prevalence of hearing loss in diabetics used a similar sample size between 20 and 45 diabetic subjects [4,5].

Inclusion criteria

1. Type II Diabetes Mellitus patients of either sex in the age group of 35-55yrs.

Exclusion criteria:

1. H/O Usage of ototoxic drugs.
2. H/O Ear surgeries.
3. H/O Ear infection in the past.
4. H/O Recent infection of ear, nose, throat.
5. H/O Noise induced hearing loss.
6. H/O Hypertension.

METHODOLOGY

The subjects were selected by a detailed history & thorough physical examination. They were asked to fill a questionnaire to assess their diabetic status and hearing**.** The experimental protocol was fully explained to the participants to allay apprehension. Informed consent was taken from all the subjects. The study was approved by Institutional Ethical Committee, Vinayaka Mission's Kirupananda Variyar Medical College & Hospitals, Salem, Tamil Nadu, India.

Experimental design

They were subjected to pure tone audiometry after assessing their glycemic status. Data was collected by recording the pure tone audiometry. Subject's fasting blood sugar (FBS), post prandinal blood sugar (PPBS) and HbA1C were measured. All experiments were performed at room temperature.

Pure tone audiometer

An audiometer [ARPHI 500 MK 1] is an electronic device that produces pure tones, the intensity of which can be increased or decreased in 5-Db steps. Air conduction thresholds are measured for tones of 250, 500, 1000, 1500, 2000, 4000, 6000 and 8000 Hertz. Bone conduction thresholds and measured for 250, 500, 1000, 1500, 2000 and 4000 Hertz. The amount of intensity that has to be raised above the normal level is a measure of the degree of hearing impairment at that frequency. It is charted in the form of a graph called the “audiogram.” The thresholds of bone conduction are a measure of the cochlear function. The difference in the thresholds of air and bone conduction (A-B gap) is a measure of a degree of conductive deafness. The audiometer is so calibrated that hearing of a normal person, both of air and bone conduction is at 0 db and there is no A-B gap.

Methodology of pure tone audiometer

The method is based on American Society for Speech and Hearing Association (ASHA) 1978 guidelines for manual pure tone audiometry (PTA). Masked pure tone audiometry is done if there is a difference of more than 40 dB between air conduction threshold of the test ear and the bone conduction threshold of the opposite ear, or when the air bone gap of the poorer ear under test is more than 10 dB.

Subjects were initially acquainted with the instrument. The patient was instructed that he would hear tones of short duration in either the left or the right ear to start with and the tones might become very faint. He was instructed to signal by raising his finger corresponding to the side of the ear, as soon as the tone was heard and keep it raised as long as it is heard, no matter how faint it was. Ear phones were used to test hearing by air

conduction and a small vibrator placed over the mastoid was used to test hearing by bone conduction. All audiometers incorporate a calibration circuit, which allows the output sound level to be set at each frequency. The signals presented to the subject by an audiometer are characterized by its frequency, sound pressure level and wave form which are all controlled. An assessment of the hearing status using a pure tone audiometer [ARPHI 500 MK 1] was done.

Statistical analysis

The results were expressed as mean ± standard deviation (SD). A p value of <0.05 was considered statistically significant. Statistical analysis was performed using the statistical package for social & sciences. Pearson's correlation was applied to compare between the parameters.

RESULTS

Forty three type II diabetic patients in the age group of 35 and 55 (46.12 ± 4.36) years were subjected to pure tone audiometry. The auditory thresholds (46.53 ± 12.96) dB in diabetic patients was higher in all the frequencies suggestive of sensorineural hearing loss. Table 1 shows HbA_1C (6.74 ± 0.77) % strongly correlates with pure tone audiometry (PTA) thresholds with (r = 0.65, p = 0.001) which was highly significant. Table 2-4 shows correlation between FBS, PPBS duration of diabetes & PTA thresholds. FBS (121.56 ± 17.31) mg/dl, PPBS (206.65 ± 39.32) mg/dl & duration of diabetes (6.09 ± 2.63) years had no correlation with the PTA thresholds.

Table 1: Correlation between HbA1C & PTA

HbA_1C (%) (mean±sd)	**PTA (dB)** (mean±sd)	r	p value
6.74 ± 0.77	46.53 ± 12.96	0.65	< 0.0 01

Table 2: Correlation between FBS & PTA

FBS (mg/dl) (mean±sd)	**PTA (dB)** (mean±sd)	r	p value
121.56 ± 17.31	46.53 ± 12.96	0.24	0.10

Table 3: Correlation between PPBS & PTA

PPBS (mg/dl) (mean±sd)	**PTA (dB)** (mean±sd)	r	p
206.65 ± 39.32	46.53 ± 12.96	0.07	0.65

Table 4: Correlation between duration of Diabetes & PTA

Duration of Diabetes (yrs) (mean±sd)	**PTA (dB)** (mean±sd)	r	p
6.09 ± 2.63	46.53 ± 12.96	0.16	0.28

r = Correlation coefficient

DISCUSSION

A number of clinical studies have investigated the possible association of diabetes mellitus and hearing loss [6]. Audiometric data obtained in our study revealed that hearing became worse as glycated haemoglobin increased in subjects. As reported in many studies, the present study shows a strong association between hearing loss and diabetes mellitus [7-9].

Our study has evaluated the hearing loss in the patients with diabetes and the influence of hyperglycemia or uncontrolled diabetes. In Uncontrolled diabetes, HbA_1C (6.74 ± 0.77) % strongly correlates with pure tone audiometry (PTA) thresholds. 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 haircell 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 [10]. Makishima and Tanaka [11] 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 [12] observed thickening of the walls of the vasa

nervorum of 8th nerve, leading to acoustic neuropathy. Wackym and Linthicum [13] observed microangopathic changes in the endolymphatic sac, stria vascularis and basilar membrane.

The present study supports the hypothesis that duration of diabetes does not alter hearing thresholds [14-17]. It is now being understood that the degree of hypergylcemia and the duration of uncontrolled hyperglycemia is more important than the duration of the disease itself.

Though the sensorineural hearing loss is irreversible, the possible intervention would be to have strict control of diabetes.

CONCLUSION

1. Hyperglycemia raises auditory threshold in all frequencies between 250 Hz and 8000 Hz.
2. Patients with poor control of their glycemic status have raised auditory thresholds.
3. The glycemic status of diabetes affect auditory thresholds significantly.
4. The duration of diabetes does not affect auditory thresholds significantly.

LIMITATIONS

There are some limitations in our study that must be acknowledged. Firstly sample size was inappropriate to assess the prevalence of hearing loss in diabetes. Secondly, study was carried out in the hospital population having a different socioeconomic status compared to the community based study.

SCOPE FOR THE STUDY

Many possible mechanisms have been postulated in relation to diabetes & hearing loss. It is a well known fact that, one of the common complications of diabetes is neuropathy. Further the study can be extended at molecular level regarding the exact mechanism that how hyperglycemia affects hearing loss.

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