Research Article

Effect of glycated hemoglobin over auditory acuity in type 2 diabetes mellitus: a case control study in a tertiary care hospital

Bethiun S[1*], Chandra S[2]

[1]Post Graduate, [2]Professor, Department of Physiology, Sri Manakula Vinayagar Medical College and Hospital, Madhagadipet, Kalitheerthalkuppam, Puducherry-605107, INDIA.
Email: drbethiun@yahoo.co.in

Abstract

Introduction: The fact that Diabetes mellitus induced Hearing loss has been told since years. Long standing diabetes with sustained hyperglycemia results in sensorineural hearing loss. Chronic Hyperglycemia is the underlying pathology in producing diabetic complications. The main objective of this study was to study the auditory thresholds of uncontrolled diabetic subjects and controlled diabetic subjects with Pure Tone Audiometry and compares the differences regarding HbA_1c levels. **Material and Methods:** A hospital based case control study comprising 50 uncontrolled type 2 diabetic subjects and 50 controlled type 2 diabetic subjects. The data collected was entered and analysed using Epi-info (version 3.4.3) software package. **Results:** Significant effect was noted in uncontrolled type 2 diabetic subjects regarding HbA_1c levels on audiometric thresholds using Pure Tone Audiometry in all higher frequencies when compared to controlled type 2 diabetic subjects.
Keywords: Glycated hemoglobin, Type 2 diabetes mellitus, Sensorineural hearing loss.

*Address for Correspondence:
Dr. Bethiun S., Post Graduate, Department of Physiology, Sri Manakula Vinayagar Medical College and Hospital, Madhagadipet, Kalitheerthalkuppam, Puducherry-605107, INDIA.
Email: drbethiun@yahoo.co.in
Received Date: 01/08/2015 Revised Date: 20/08/2015 Accepted Date: 28/08/2015

Access this article online	
Quick Response Code:	Website: www.medpulse.in
	DOI: 02 Sept 2015

INTRODUCTION

Diabetes Mellitus is a multisystem disorder of impaired carbohydrate, fat, protein metabolism caused by either lack of insulin secretion (Type 1) or decreased sensitivity of tissues to insulin (Type 2).[1] The vascular complications are micro vascular (retinopathy, neuropathy, nephropathy) and macro vascular (coronary artery disease, peripheral vascular disease, cerebro vascular disease).[2] Long standing diabetes may be associated with hearing loss.[2] The pathologic changes that accompany diabetes injure the vasculature of inner ear, resulting in sensorineural hearing impairment.[3] The probable mechanism for hearing loss in diabetes is microangiopathy of inner ear resulting in thickened striavascularis and secondary degeneration of eighth cranial nerve, neuropathy of cochlear nerve or a combination of outer hair dysfunctions and disruption of endolymphatic potentials.[4] The prevalence of hearing loss in diabetes in Indian population has not been studied extensively. Earlier identification of diabetic complication prevents the degree of hearing loss and severity of hearing loss accompanying presbycusis.

OBJECTIVES

To compare auditory functions in uncontrolled type 2 diabetic subjects and controlled type 2 diabetic subjects in relation to glycemic control.

MATERIAL AND METHODS

Study was conducted in Sri Manakula Vinayagar medical college hospital, Pondicherry. It was done after getting informed consent. **Study Design:** Case control study, cases were uncontrolled cases of diabetes mellitus and

How to site this article: Bethiun S, Chandra S. Effect of glycated hemoglobin over auditory acuity in type 2 diabetes mellitus: a case control study in a tertiary care hospital. *MedPulse – Journal of Physiology* 2015; 1(1): 06-09. http://www.medpulse.in

controls were controlled diabetes mellitus. **Sample Size:** 50 uncontrolled type 2 diabetic subjects and 50 controlled type 2 diabetic subjects. They are divided into three groups according to age. (I: 35-45 years, II: 46-55 years, III: 56-65 years). **Inclusion Criteria**: Age between 35-65 years of age, Duration of diabetes greater than 5 years.

Methodology

A prepared questionnaire is put forth to all the subjects included in this study. **Parameters**: HbA_1c, Tuning fork tests, Pure tone audiometry. **Estimation of Glycated Haemoglobin:** HbA_1c:[5, 6.] It is the reflection of the mean blood glucose levels during the 6-8 weeks. It will be done by Ion exchange resin method using glycosylated haemoglobin kit. **Procedure And Principle Of Glycosylated Hemoglobin**[5,6.] **(GHb):** Hemolysate preparation: 0.5 ml lysing reagent is dispensed in to control and test tubes and 0.1 ml of blood sample is mixed till hemolysis is evident and made to stand for 5 min. Glycosylated hemoglobin separation: 0.1ml of hemosylate prepared is added to exchange resin tubes. (Control and test tubes).then resin separator is inserted into each tube and is kept in rotater for 5 minutes. Resin is allowed to settle till it's firmly packed by pushing resin separator. The supernatant is poured in to a cuvette and each absorbance is measured against distilled water. Total hemoglobin fraction (THb): 5ml of distilled water is dispensed into tubes. (Control and test tubes) Then hemosylate 0.02 ml is added and mixed well and read each absorbance against distilled water. Glycosylated haemoglobin is formed continuously by adduction of glucose by covalent bonding to the amino-terminal valine of haemoglobin beta chain irreversibly throughout the life of RBC. Ghb are the fast fraction hemoglobins HbA_1 (HbA_1a, A_1b, A_1c) which elute first during column chromatography. It reflects the metabolic control of glucose level over a period of time unaffected by a diet, insulin, other drugs or exercise on the day of testing. It is the reflection of the mean blood glucose levels during the last 6-8 weeks, and is expressed in % of total hemoglobin. Normal levels of HbA_1c - 4.5-6%.Well controlled diabetes mellitus – 6-7%.Average control of diabetes – 7-8%.Inadequately controlled diabetes - >8%. **Audiological parameters:** a) Tuning fork tests. b) Pure tone audiometry.

Audiological tests

In all subjects nose, throat will be completely examined and a detailed ear examination will be performed to rule out external and middle ear abnormalities. Then Preliminary screening is done by tuning fork tests.

Tuning fork tests[7]

These tests are done by three methods Rinne's, Weber's and Absolute bone conduction test using a tuning fork of frequency of 512 Hz and analysed as Air conduction and Bone conduction. Air conduction (AC) test is a measure of both conduction mechanism and cochlear function. Bone conduction is a measure of cochlear function. **Rinne's test:** In this test air conduction of the ear is compared with its bone conduction. Normally AC is 2 times better than BC. In sensorineural deafness AC > BC. **Weber's test:** Vibrating tuning fork is placed on middle of forehead or the vertex and the patient is asked in which ear the sound is heard. Normally, it is heard equally in both ears and it is lateralised to better ear in sensorineural deafness. **Absolute bone conduction (abc) tests:** In ABC test, patient's bone conduction is compared with that of examiner. In sensorineural deafness, the patient hears the tuning fork for a shorter duration.

Pure tone audiometry: Instrument

LABAT AUL 11036. An assessment of the hearings status using a pure tone audiometer (LABAT AUL 11036) is done. Ear phones are used to test hearing by air conduction and a small vibrator placed over the mastoid is used 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.[7.] **Principle:**[7] An audiometer 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 are measured for 250, 500, 1000, 1500, 2000, 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 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 audiometry

The subject is instructed regarding the audiometry procedure clearly. And they were instructed to press the button when sound is heard and release the button when sound is stopped. They made to wear earphones. Hair should not be trapped under earphones and earrings should be removed if it becomes obstacle. The subject is told that right ear is tested first and then the next left ear is tested. The subject is familiarized with the tone by one of the two times and asked to wave the hand when they didn't hear any sound. The tone is presented at 30 db hearing level is increased in 10 db steps until a response

occurs. The duration of tone is 1-2 seconds. 'Threshold' is defined as the lowest intensity at which the subject hears the sound frequencies at 250, 500, 1000, 2000, 4000 and 8000 hertz 8.

RESULTS AND ANALYSIS

Student t test was applied to analyze the data and to identify significant differences between uncontrolled diabetic subjects and controlled diabetic individuals. a p value of less than 0.05 was considered to be statistically significant.

Table 1: Effect of Auditory Thresholds (dB) with HbA_1c levels in diabetics

Frequency in Hertz	Ear	HbA_1c				t-test	p-value (2-tailed)
		6-8%		>8%			
		Mean	SD	Mean	SD		
250Hz	Right	28.54	7.73	31.73	9.38	-1.306	0.198
	Left	**24.79**	**8.91**	**31.92**	**8.13**	**-2.960**	**0.005****
500Hz	**Right**	**30.00**	**6.59**	**35.00**	**7.75**	**-2.448**	**0.018**
	Left	28.75	7.11	32.69	7.65	-1.884	0.066
1000Hz	Right	27.50	10.22	32.69	8.97	-1.913	0.062
	Left	25.62	8.64	29.81	8.06	-1.771	0.083
1500Hz	Right	25.42	8.71	28.27	8.24	-1.190	0.240
	Left	**22.50**	**8.97**	**28.65**	**8.78**	**-2.450**	**0.018**
2000Hz	Right	26.87	9.76	31.54	7.97	-1.857	0.069
	Left	**26.46**	**9.26**	**33.46**	**9.46**	**-2.641**	**0.011**
3000Hz	**Right**	**23.75**	**9.81**	**30.00**	**8.37**	**-2.430**	**0.019**
	Left	**21.67**	**8.68**	**33.85**	**9.31**	**-4.774**	**0.001**
4000Hz	**Right**	**29.17**	**10.39**	**39.42**	**10.89**	**-3.400**	**0.001**
	Left	**28.96**	**10.21**	**39.04**	**10.87**	**-3.373**	**0.001**
6000Hz	**Right**	**34.38**	**12.28**	**43.85**	**14.37**	**-2.495**	**0.016**
	Left	**29.17**	**11.95**	**43.46**	**11.56**	**-4.300**	**0.001**
8000Hz	**Right**	**30.62**	**13.21**	**42.69**	**11.68**	**-3.427**	**0.001**
	Left	**27.29**	**11.98**	**42.31**	**13.28**	**-4.185**	**0.001**

In Table 1, there was a highly significant difference in frequencies from 250- 8000 Hz between uncontrolled hyperglycemic diabetic type II patients, except for few frequencies. The P values are significant and this shows that there is HbA_1c levels have greater impact on audiometric thresholds. In uncontrolled diabetes with poor glycemic controls, sensorineural hearing loss was higher in higher frequencies than controlled diabetes with good glycemic status.

DISCUSSION

Hearing loss in diabetes is debated for many years. Both type1 and type 2 diabetes mellitus and its hyperglycemic status produce impairment in hearing. Diabetes-related hearing loss is a progressive, bilateral, sensorineural impairment with gradual onset predominantly affecting the higher frequencies[3,10-12.] Sensorineural hearing loss is mainly caused by chronic and sustained hyperglycemia[2,10,13-15] When this hyperglycemic status is controlled in diabetic individuals, severity of hearing loss is minimal when compared to uncontrolled glycemic diabetic subjects. Hearing loss should be assessed earlier in diabetic individuals to prevent the severity of hearing loss in diabetes accompanying the severity co associated with age related hearing loss. This case control study is undertaken for a clear study of audiometric thresholds regarding glycemic control. In this study 50 uncontrolled diabetic individuals and 50 controlled individuals are taken according to inclusion criteria. Analyzes done with statistical tests and conclusions can be drawn with regarding to HbA_1C. Our results showed that the auditory thresholds tested in all frequencies showed statistically significant in poorly controlled diabetics when compared with the auditory thresholds of good glycemic controlled diabetics. This study agree with Panchu P (2008)[14], Lasisi et al (2003)[17], Kurien et al (1989)[16], that poorly controlled diabetics have significant hearing loss in all frequencies tested. Ferrer (1991)[18] revealed non-significant associations between auditory thresholds with HbA_1C. Dalton et al (1998)[19]. Bainbridge (2011)[3] and Salvanelli et al (2004)[20.] did not show an association between glycated hemoglobin levels and hearing loss. The present study does not agree with the above conclusions because HbA_1c levels cause direct impact on audiometric thresholds.

CONCLUSION

Diabetes mellitus type 2 raises auditory threshold in all frequencies equally between 250Hz to 8000 Hz in both groups in this study. Diabetes mellitus type 2 subjects with poor control [HbA_1c greater than 8%] of their

glycemic status have raised auditory thresholds. These results which show the effect of sustained hyperglycemia on auditory acuity may be explained by diabetic micro angiopathy and neuropathy of the inner ear.

REFERENCES

1. Guyton AC, Hall JE. Text Book of Medical Physiology. 11th ed. Noida: Elsevier; 2006; p 972-7.
2. Fauci et al. Harrison's principles of internal medicine. 17th ed. volume2.USA: McGrawHill; 2005; p2275-304.
3. Bainbridge KE, Hoffman HJ, Cowie CC. Diabetes and hearing impairment in the United States; Audiometric evidence from the National Health and Nutrition Examination Survey, 1999 to 2004.Ann Intern Med 2008;149:1-10.
4. Dąbrowski M, Mielnik-Niedzielska G, Nowakowski A. Involvement of the auditory organ in type 1 diabetes mellitus. Endokrynol Pol. 2011; 62(2):138-44.
5. Trivelli L.A, Ranney H.M, Lai HT. New Eng.J.Med.1971; p284- 353.
6. Bunn HF.Diabetes.198; p130-613.
7. Allen G Kerr, John B Booth. Scott-Brown's Otolaryngology: Otology; 6th ed. volume 3. Butterworth Heinemann; 1997; p 1-15.
8. Zelenka J, Kozac P. Disorders in blood supply of the inner ear as early symptom of diabetic angiopathy. J Laryngology and Otology 1965; 79: 314-319.
9. Rosner Bernard. Fundamentals of biostatistics. 5th edition, Duxbury, 2000.
10. Diniz TH, Guida HL. Hearing loss in patients with diabetes mellitus. Braz J Otorhinolaryngol 2009 Jul-Aug; 75(4):573-8.
11. William Larsen, Kronenberg, Melmed. William's Textbook of Endocrinology.10th ed, Elsevier; 2003; p1427-1583,
12. Taylor IG, Irwin J. Some audiological aspects of diabetes mellitus. J Laryngol Otol.1978; 92:99-113.
13. Maia CA, Campos CA. Diabetes mellitus as etiological factor of hearing loss. Braz J Otorhinolaryngol. 2005 Mar-Apr; 71(2):208-14.
14. Panchu P. Auditory acuity in type 2 diabetes mellitus.Int J Diabetes DevCtries. 2008; 28(4):114-120.
15. Greene DA, Sima AA, Stevens MJ, et al. Aldose reductase inhibitors: an approach to the treatment of diabetic nerve damage. Diabetes Met Rev. 1993; 9:189–217.
16. Kurien M, Thomas K, Bhanu TS. Hearing threshholds in patients with diabetes mellitus. J Laryngol Otol.1989; 103:164-8.
17. Lasisi OA, Nwaorgu OGB, Bella AF. Cochleovestibular complications of diabetes mellitus in Ibedan, Nigeria. International Congress Series1240 (2003); 1325-1328(2003) International federation of otorhinolaryngological societies [IFOS].
18. Ferrer JP, Biurrun O, Lorente J, Conget JI, de España R, Esmatjes E,et al. Auditory function in young patients with type 1 diabetes mellitus.Diabetes Res ClinPract 1991 Jan;11(1):17-22.
19. Dalton DS, Cruickshanks KJ, Klein R, Klein BE, Wiley TL. Association of NIDDM and hearing loss. Diabetes Care 1998 Sep; 21(9):1540-4.
20. Salvenelli F, Miele A, Casale M, Greco F, D'Ascanio L, Firrisi L et al. Hearing thresholds in patients with diabetes. The internet journal of otorhinolaryngology 2004; 3(1).

Source of Support: None Declared
Conflict of Interest: None Declared