Effect of Type II Diabetes Mellitus on the 8th Cranial Nerve: A Prospective Study

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Abstract: *Objective*: To establish the effect of type II diabetes mellitus on the 8th cranial nerve and to analyse the association of degree of hearing loss with the factors such as duration of diabetes, age and gender of the subject and glycaemic control. *Study Design*: Prospective comparative type of study conducted on 100 cases and 100 age and gender matched controls. *Results*: Hearing loss was more prevalent and of a higher degree among the diabetics as compared to the non-diabetics. The hearing loss was significantly more among males and in those with higher post prandial blood sugar levels.

Keywords: Diabetes mellitus, type II, 8th cranial nerve.

INTRODUCTION

The prevalence of diabetes is rapidly rising all over the globe at an alarming rate. Over the past 30 years, the status of diabetes has changed from being considered as a mild disorder of the elderly to one of the major causes of morbidity and mortality affecting the youth and middle aged. India leads the world with largest number of diabetic subjects earning the dubious distinction of being termed the “diabetes capital of the world” [1]. Diabetes mellitus is a metabolic disorder associated with vascular and neurologic complications [2].

The relationship between diabetes mellitus and hearing loss has been debated for many years. Jordao 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 in a diabetic patient [3]. The literature exhibits many contradictions concerning the correlation between hearing impairment and diabetic manifestations [4]. The characteristic finding in diabetes mellitus is a bilateral symmetrical sensorineural hearing loss particularly in the higher frequencies. Further, hearing impairment seems to be dependent upon the severity and duration of diabetes; however some workers do not find any association between hearing loss and diabetes [5].

In the current study we have analysed the audiological features of the non elderly diabetic subjects and compared it with those of non diabetics in an attempt to understand the prevalence of hearing loss due to diabetes mellitus and to deduce any significant relationship between the degree of hearing loss and factors such as age, gender, duration of diabetes and glycaemic control.

METHODOLOGY

This comparative prospective study was conducted over a period of 5 years from January 2008 to December 2013.

Sample Selection

The cases and controls were selected by random sampling method. In order to prevent any bias exclusion criteria were specified. Any subject above 60 years of age or with history of hypertension, renal disease, consumption of ototoxic drugs, prolonged noise exposure, head injury or previous ear diseases (chronic otitis media / permanent perforation syndrome/ trauma to ear) were excluded from the study. We selected 100 cases with diagnosed diabetes mellitus type II in group1 and 100 age and gender matched non-diabetic controls in group 2.

Data Collection

The demographic data and details regarding the duration of diabetes, nature of treatment, family history and data regarding the symptoms such as difficulty in hearing, tinnitus or giddiness were obtained through a questionnaire. The glycaemic control of these subjects (both cases and controls) was assessed based on the fasting and post prandial blood sugar levels. The audiological picture was analysed based on the Pure Tone Audiometry (PTA) and Speech Discrimination Score of the cases and controls. We defined hearing loss as having pure-tone average thresholds greater than 25 dB in the worse ear at 0.5, 1, 2 and 4 kHz frequencies [6].

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Statistical Analysis

Descriptive and inferential statistical analysis has been carried out in the present study. Chi-square and Fisher Exact test has been used to find the significance of study parameters on categorical scale between two groups. The findings were considered statistically significant at p values < 0.05.

OBSERVATION AND RESULTS

Since the cases and controls were age and gender matched, there were 58 male and 42 female subjects in both the groups. The age of the subjects ranged from 28 to 59 years with the average age being 48.67 years. The subjects in group1 had diabetes for an average duration of 6.23 ± 3.77 years (Table **1**).

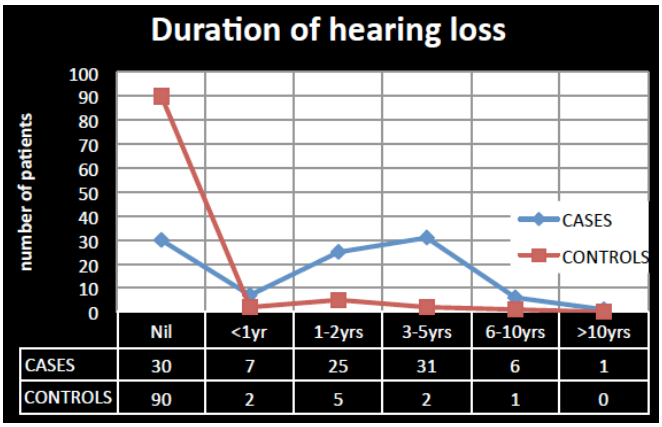
Table 1: Showing the Duration of Diabetes Mellitus in Group 1

Duration of diabetes	Number of patients
<2yrs	11
2-5yrs	41
5-10yrs	39
>10	9
Total	100

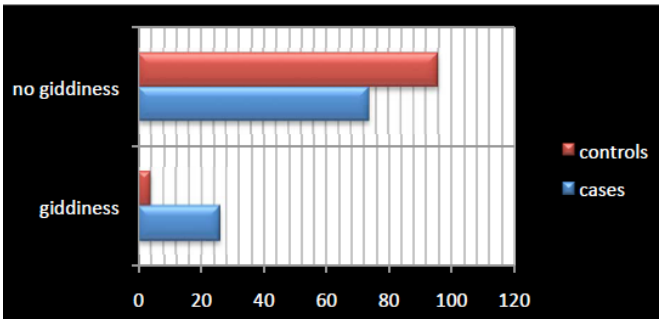
Out of the 100 cases 93 were on oral hypo-glycaemic drugs, 5 on a combination of insulin and oral hypoglycaemic drugs while 2 were advised only life style and diet modifications.

The mean duration of difficulty in hearing in group1 was found to be 2.26 ± 2.51 years (Mean ± SD) while that of the control group was 0.23 ± 0.82 years (Mean ± SD). The duration of hearing difficulty was significantly more in cases with p<0.001. In group 1, 30 patients did not notice any difficulty in hearing while in group 2, 90% had no difficulty in hearing. Of the 70 cases, 55 patients (i.e. 78.57% of cases with difficulty in hearing) complained of bilateral difficulty in hearing (Graph **1**). Tinnitus is an important complaint associated with decreased hearing. In our study we found that in group 1, 54 cases complained of tinnitus while among group 2, 14 subjects complained of tinnitus. There was significantly more tinnitus among group 1 with a p value <0.001.

The data regarding the history of giddiness was analysed and 26% of the cases and 4% of controls complained of giddiness (Graph **2**).



Graph 1: Showing the duration of difficulty in hearing in cases and in controls.

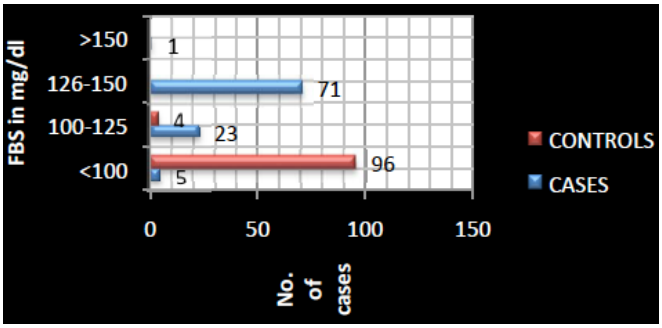


Graph 2: Showing the distribution of giddiness in cases and in controls.

The fasting blood sugar and post prandial blood sugar levels of all the 200 subjects were analysed and our findings were as depicted in the following table (Table **2** and **3**, Graph **3** and **4**).

Table 2: Showing Fasting Blood Sugar Levels in Cases and in Controls

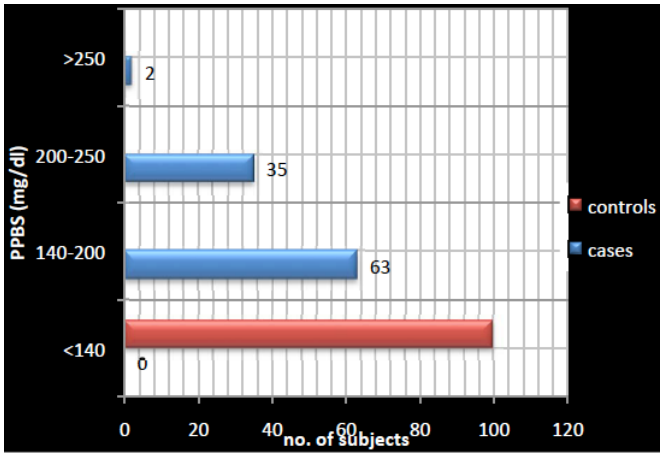
Fasting Blood Sugar	Cases	Controls
<100mg/dl	5	96
100-125mg/dl	23	4
126- 150mg/dl	71	0
>150mg/dl	1	0
Total	100	100



Graph 3: Fasting blood sugar levels in cases and in controls.

Table 3: Post Prandial Blood Sugar in Cases and in Controls

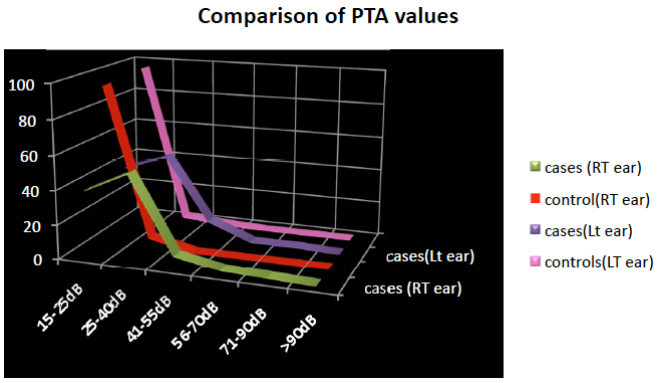
Post Prandial Blood Sugar	Cases	Controls
<140mg/dl	0	100
140-200mg/dl	63	0
200-250mg/dl	35	0
>250mg/dl	2	0
Total	100	100



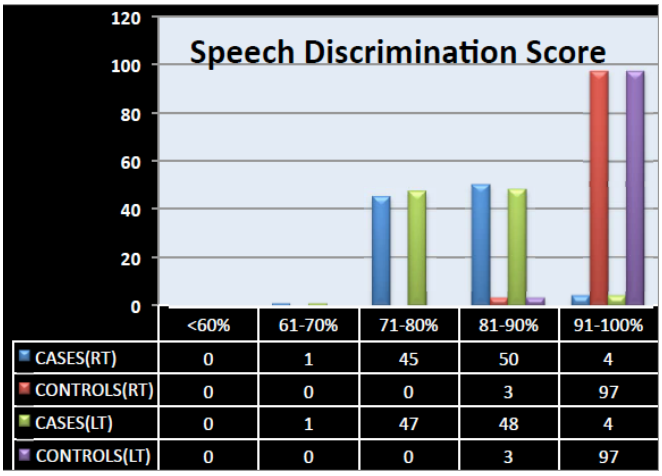
Graph 4: Post prandial blood sugar levels in cases and in controls.

The subjects in both the groups underwent pure tone audiometric analysis (Table **4**, Graph **5**). The average threshold of the speech frequencies that is 500, 1000 and 2000 Hz was noted. When the hearing threshold of group 1 and group 2 were compared, it was found that there was a statistically significant ($p<0.001$) difference in the hearing threshold between the age and gender matched groups. Among the non-diabetic group, patients with only minimal and mild hearing loss were identified. The mean PTA levels were significantly more associated with the cases with p value <0.001.

The speech discrimination score was analysed and our findings are demonstrated in (Graph **6**).



Graph 5: Showing comparison of PTA values in cases and in controls.



Graph 6: Showing Speech discrimination Score in cases and in controls.

DISCUSSION

According to the Diabetes Atlas 2006 published by the International Diabetes Federation, the number of people with diabetes in India, currently around 40.9 million, is expected to rise to 69.9 million by 2025 [1]. Sensorineural hearing loss could result from the pathological changes that damage the vasculature or neural system of inner ear owing to high sugar levels [7]. Hyperglycemia initiates a cascade of metabolic

Table 4: Showing PTA Findings in both Ears, in Cases and in Controls

Category	PTA	Cases(Rt)	Controls(Rt)	Cases(Lt)	Controls(Lt)
Minimal Hearing Loss	15-25dB	39	94	39	96
Mild Hearing Loss	26-40dB	51	6	48	3
Moderate Hearing Loss	41-55dB	7	0	11	1
Moderately Severe loss	56-70dB	2	0	1	0
Severe Hearing Loss	71-90dB	1	0	1	0
Profound Loss	>90dB	0	0	0	0

changes in the human body. The auditory system requires glucose and high-energy utilization for its complex signal processing. This suggests that the cochlea may also be a target organ for the ill effects of hyperglycemia. Studies have noted that reactive oxygen species (this term includes both oxygen free radicals and non-radical derivatives of oxygen) are generated in the cochlea and are involved in the pathogenesis of acoustic injury of the cochlea [8]. Diabetes mellitus may lead to derangement in the metabolism of glucose associated with the production of oxygen free radicals and increased oxidative stress. The toxic effects that ensue, affect the inner ear and may result in the early auditory dysfunction seen in diabetes mellitus [8]. Another mechanism through which diabetes affects hearing is related to the polyol metabolic pathway, where glucose is reduced to sorbitol. The accumulation of sorbitol is believed to propagate neuropathy by causing a decrease in myoinositol content, abnormal phosphoinositide metabolism, and a decrease in Na^+/K^+ ATPase activity [3]. Hyperglycemia triggers the production of increased metabolic by-products such a diacylglycerol (DAG) that activate the protein kinase C (PKC) gene family, affecting intracellular signal transduction pathways. This leads to increased thickening of the basement membrane along with porosity of endothelium. Such changes in the stria vascularis can lead to changes in auditory electrolyte homeostasis within the endolymph thus resulting in impaired signal transduction from the hair cells [9]. Activation of the PKC gene also mediates the deposition of Advanced Glycation End products (AGEs) into Type IV collagen which is found in the tectorial and basilar membranes, thereby reducing their flexibility and eventually leading to poor signal transduction [9]. Prolonged hyperglycemia also elicits endoneural hypoxia, nerve energy deficits and decreased neurotropism. The study of the histopathology of temporal bones of diabetics has revealed marked atrophy of the spiral ganglion in the basal and middle turns of the cochlea. It has also been observed that the VIIIth nerve showed fibrosis of the perineurium and degeneration of the myelin sheath [10]. Microangiopathy is yet another detrimental effect of diabetes.

In our study we found a male dominance among the diabetics, constituting 59% of the study population. The study conducted by Donald *et al.* [2] also found a similar male dominance among diabetics. The hearing loss is significantly more in males with a p value of 0.002. These observations are contrary to Shaia and Sheehy (1976), Taylor and Urwin (1978) who observed more hearing loss in females than in males. Camisca (1950) and Dietzel (1964) found more deafness in males [4]. According to Cullen and Cinnamond, male patients with diabetes had worse hearing than female patients with diabetes [3]. The influence of the duration of diabetes on hearing loss is found to be statistically not significant, with a p value of 0.114. The duration of diabetes in relationship to hearing loss has also been investigated by other studies, with no clear conclusion. Venkata Kakarlapudi *et al.* observed that as the duration of diabetes increased to 15 years, the incidence of hearing loss increased. After 15 years of diabetes, the influence on hearing loss was not significant [3]. In a study conducted by Wackim and Linthicum they noticed that among diabetic patients, the least hearing loss was found in those patients taking insulin injections while those taking oral hypoglycemic agents had slightly worse hearing loss and those who were treated with life style modifications alone had more severe hearing loss [3]. A significant relationship between post prandial blood sugar levels and hearing loss with a p value of 0.014 has been deduced from our study. However there was no significant relationship between fasting blood sugar levels and hearing loss. A significant relationship between post prandial blood sugar levels and giddiness was also found in this study. In a study regarding the vestibular dysfunction and its relation to diabetes, conducted by Lin Chung et al they observed that the rate of vestibular dysfunction in patients with diabetes mellitus was 68.4% and that of the controls was 8.3%. There was significant difference between these two groups. Vertigo or dizziness occurring in patients with diabetes mellitus might be related to vestibular dysfunction. ENG test could be used as one of the objective clinical examination in patients with diabetes mellitus [11].

CONCLUSIONS

The average age of the subjects in our study was 48.67 years. Our study has indicated that there is significantly higher prevalence of hearing loss among diabetics. There is also a higher prevalence of vertigo among the diabetics. The degree of hearing loss was primarily in the mild category. The speech discrimination score analysis indicated that in majority of diabetics hearing loss was due to cochlear pathology. This study showed that the post prandial blood sugar levels are significantly related to degree of hearing loss among the diabetics.

REFERENCES

[1] Mohan V, Sandeep S, Deepa R, Shah B, Varghese C. Epidemiology of type 2 diabetes: Indian scenario. Indian J Med Res 2007: 217-30.

[2] Donald FA, Dawn K, Susan G, Garnett P. M, *et al.* Diabetes-related changes in hearing. Laryngoscope 2009; 119: 1788-796. http://dx.doi.org/10.1002/lary.20570

[3] Venkata K, Robert S, Hinrich S. The effect of diabetes on sensorineural hearing loss. Otol Neurotol 2003; 24: 382-86. http://dx.doi.org/10.1097/00129492-200305000-00006

[4] Sharma DR, Gupta AK, Saxena RK, Mohan C, Sharma ML. Audiovestibular changes in diabetes mellitus. Indian J Otolaryngol Head Neck Surg 1999; 51(2): 40-45.

[5] Vilas M, Agarwal CG, Bhatia N, Shukla GK.Sensorineural deafness in patients of type 2 Diabetes mellitus in Uttar Pradesh: a pilot study. Indian J Otolaryngol Head Neck Sur DOI 0.1007/s12070-011-0442-0

[6] Mozaffari M, Tajik A, Ariaei N, Ali-Ehyaii F, Behnam H. Diabetes mellitus and sensorineural hearing loss among non-elderly people. Eastern Mediterranean Health Journal 2010; 16(9): 947-53.

[7] Kathleen EB, Howard JH, Catherine 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. http://dx.doi.org/10.7326/0003-4819-149-1-200807010-00231

[8] Aladag AE, Atis MV¸ Erkokmaz U. Role of oxidative stress in hearing impairment in patients with type two diabetes mellitus. J Laryngol Otol 2009; 123: 957-63. http://dx.doi.org/10.1017/S0022215109004502

[9] Susan T. Frisina, Frances Mapesa, Sung Hee Kimc, D. Robert Frisin, and Robert D. Frisina. Characterization of hearing loss in aged type II diabetics. Hear Res 2006; 211(1-2): 103-13. http://dx.doi.org/10.1016/j.heares.2005.09.002

[10] Jorgensen MB. The inner ear in diabetes mellitus. Arch Otolaryngol 1961; 74: 373-81. http://dx.doi.org/10.1001/archotol.1961.00740030382003

[11] Li J, Zhang T, Shen J, Gong J, Wang H, Zhang J, Pang Y. The changes in vestibular function in patients with diabetes mellitus and its clinical significance. J Clin Otorhinolaryngol Head Neck Surg 2008; 22(1): 10-3.

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