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Original Research Paper ENT

"Audiological evaluation in Diabetes Mellitus" for publication in your journal.

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ABSTRACT

Sensorineural hearing loss (SNHL) has been established as a definite long term complication of Diabetes Mellitus(DM). However, site and mechanism involved remains a topic of controversy. This study was carried out to confirm the existence of sensorineural hearing loss in DM and to find its relationship to age, duration of disease, glycaemic control and to determine the site of involvement in the ear.

Method: 200 diagnosed patients of Diabetes Mellitus(group 2) were audiologically evaluated for any hearing loss. 25 healthy volunteers (group1) were also studied as controls. Acoustic reflex test and the Acoustic reflex decay test were also carried out for cochlear or retrocochlear involvement.

Results: 55.5% patients Of DM had bilateral symmetrical low and mid frequency SNHL , showing a significant difference in the mean hearing threshold at all frequencies (p< 0.001). Involvement was both both cochlear and retrocochlear. Significant correlation was found between age, duration of disease and glycaemic control.

KEYWORDS

Diabetes Mellitus is a chronic multisystem disease characterized by a deficient or defective insulin secretory response that translates into disordered carbohydrate, fat and protein metabolism.[1] The fascinating history of Diabetes Mellitus dates back to as early as 400 B.C, when Sushrutacharacterised the disease by an "excess of honeyed urine- *Madhumaya*''. The prevelance of Diabetes Mellitus has been steadily rising over the years .[2] The WHO *Global report on diabetes* demonstrates that the number of adults living with diabetes has almost quadrupled since 1980 to 422 million adults in 2014.[3] The brunt of metabolic derangements in Diabetes Mellitus is borne by many organs of the body including the human ears. *Jorado* in 1857 first reported a case of hearing impairment associated with a case of incipient diabetic coma. Thus, the first description in medical literature appeared on the association of hearing loss and Diabetes Mellitus.[4,5] Over the years, bilateral and symmetrical sensorineural hearing loss (SNHL) involving mainly middle and higher frequencies has been established as a definite long term complication of Diabetes Mellitus. However, the exact mechanism involved and it's site of action has been a topic of controversy. Most studies report it to be due to a microvascular damage to the cochlea. But studies have also been carried out which suggest a primary neuronal damage of the eighth nerve to play an important role. This study was carried out to confirm the existence of sensorineural hearing loss as a definite complication of diabetes mellitus and to find its relationship to age, duration of disease and glycaemic control as well as to determine the site of involvement in the ear in Diabetes associated hearing loss.

Method

200 diagnosed patients of Diabetes Mellitus(group 2) were studied. 25 healthy volunteers (group1) were also studied as controls. Group 2 patients were diagnosed cases of Diabetes Mellitus either admitted in the endocrinology ward or attending the endocrinology outpatient clinic of a tertiary care hospital. Group 2 patients were further classified as group2A(DM type 1) and group 2B (DM Type II).Each patient was subjected to a complete general physical examination and ear, nose and throat examination. Subjects suffering from any ear pathology other than SNHL were excluded from the study. Diabetic patients suffering from any other systemic disease such as hypertension thyroid disorders or renal disease were excluded from the study. Those above the age of 60 were excluded due to the possibility of coexisting presbycusis which would interfere with the test results. Blood sugar levels, Hb1Ac levels, Hb, CBC, lipid profile, serum urea and creatinine, and urine sugar and ketones and fundus examination were carried out in each patient. All the patients of Diabetes Mellitus and the healthy volunteers were then subjected to pure tone audiometry using an ELKON 3N3 diagnostic audiometer. Masking was used whenever necessary. Severity of hearing loss was assessed as per WHO guidelines.(6) Those patients showing a SNHL were then subjected to the Acoustic reflex test and the Acoustic reflex decay test. Patients showing an acoustic reflex threshold of 60 dB less than his pure tone hearing threshold were considered to be suffering from cochlear damage due to the presence of recruitment. The acoustic reflex decay test was done at 500 and 1000 Hz . The sound stimulus was presented at an intensity of 10 dB above the acoustic reflex threshold for that particular frequency for a period of 10 seconds, during which the reflex amplitude was measured by the Impedence meter. An abnormal decay to less than 50% within 5 seconds was interpreted as due to neural or Retrocochlear pathology.

Results

In Group I, 70% patients were males and 30% were females. In Group IIa showed 65% males v/s 35% females while in Group IIb, 64% males v/s 36% females. All the patients of diabetes mellitus and healthy volunteers were divided into 6 age groups i.e. 0-10 years, 11-20 years, 21-30 years and 31-40 , 41 -50 years 50-60. Majority of the patients in group IIa were in the age group of 40-60- years, while In group IIb, majority of patients were between 20-40 years. **(Table 1).**

Out of 200 patients of DM (group2) studied, 111 patients(55.5%) were found to be suffering from bilateral symmetrical SNHL mainly involving the mid and higher frequencies. The difference in the mean hearing threshold amongst the diabetic patients and the non diabetic healthy volunteers were highly significant at all frequencies (p< 0.001). Patients with type II(64.86%) diabetes had a higher incidence of hearing loss than patients with type I diabetes (43.8%) as shown in **Table 2.**

Majority of the patients in both Group IIa (53.8%) and in Group IIb (44.4%) showed mild hearing loss (26-40 dB). 30.7% in Group IIa and 33.3% in Group IIb showed moderate loss(41-60 dB). 15.3% in Group IIa and 20.8% in Group IIb showed moderately severe loss(56-80 dB). The degree of hearing loss in diabetics was found to be mild to moderate with only 21 patients showing severe hearing loss. Only one patient showed profound deafnes.(**Table 3)**

Statistically highly significant association was seen to exist between the age and hearing threshold, ($p<0.001$) maximum patients of hearing impairment being in the higher age group of 41-60yrs(51.25%). Hearing threshold showed increase with increasing age of the subjects. Significant statistical correlation was present between duration of disease and type-I diabetes mellitus, but no correlation was present between type-II diabetes mellitus and duration of disease. **(Table 4)**

Sensorineural hearing loss was seen to exist in 93% of the patients showing any coexisting microvascular complication of DM which includedDiabetic Retinopathy,Diabetic Nephropathy,Diabetic Neuropathy,Vascular edema,Cataract and Glaucoma. The incidence of hearing loss was found to be higher in patients with increasing Hb1AC levels translating to poor glycaemic control. (**Table 5**)

51 patients showed presence of recruitment suggesting a cochlear pathology with no abnormal decay in the acoustic reflex decay test while 48 patients showed no recruitment but presence of an abnormal decay. 12 patients showed both abnormal decay of the acoustic reflex test as well as presence of recruitment suggesting presence of both cochlear and retrocochlear pathology in sensorineural hearing loss in Diabetes Mellitus

Discussion

Diabetes Mellitus comprise a group of common metabolic disorders that share the phenotype of hyperglycaemia. The pathogenic mechanism by which hyperglycaemia arise differ widely and are caused by a complex interaction of genetic, environmental factors and lifestyle choices. The literature is limited regarding the effect of diabetes on hearing loss. However, knowledge of the anatomy and physiology of the ear suggests the association should be obvious. Anatomic dissection of all compartments of the ear reveals a rich network of vasculature, all of which are vulnerable to the detrimental effects of prolonged elevated blood sugar. The stria vascularis of the cochlea and nephron of the kidney share physiologic, ultrastructural and antigenic similarities. Renal insufficiency and failure commonly occur secondary to vasculopathy associated with uncontrolled diabetes. It would be reasonable to posit similar changes in the cochlea could lead to hearing loss in diabetic individuals. Sudden sensorineural hearing loss is an otologic emergency. Diabetes is a well-known risk factor and poor prognostic indicator for sudden sensorineural hearing loss. [7]

Our study finds a statically significant correlation between SNHL and DM both type I and II. These findings are in contention with the studies reported by Tay et al[8], Mozaffari et al[9], *Kurien et al*[10], and *Sharma et al*[11] all of which reported high frequency hearing loss among the diabetic population. The degree of hearing loss in diabetics was found to be mild to moderate. *Lisowska et al*[12] also reported that hearing impairment in diabetes is usually mild and subclinical and can be detected early by accurate and objective audiometric methods.

In our study a higher incidence of hearing impairment was observed in type II diabetes mellitus (64.86%) than type I diabetes in this study (43.82%). *Gomez et al*[13] in a population based study of the Mexican American population reported that an association between diabetes and decreased hearing acuity in the higher frequencies were present only amongst diabetic Mexican-Americans who do not use insulin irrespective of Type I or Type II diabetes mellitus. This suggest that glycaemic control is perhaps better in patients who use insulin rather than those on dietary control or those on oral hypoglycaemics. It was observed that glycemic control was better I in type than in those with type II diabetes. However, further research is required before such conclusions can be made.

The incidence of hearing loss was found to be higher in patients with poor glycaemic control. Various studies reported a positive association between glycaemic control and the presence of sensorineural hearing loss in diabetics[14,15,16]. *Dalton et al*[5] however did not find any association between glycaemic control and hearing loss. They concluded that hearing loss is a gradual process developing over several years and hence it is unlikely that a single glycated haemoglobin measure concurrent with hearing evaluation would be associated with hearing loss. In this regard it was noted that the diabetes control and complication trial (DCCT)[17] provide definite proof that reduction in chronic hyperglycemia can prevent many of the early complications of diabetes mellitus type I. Considerable debate has emerged as to whether the DCCT findings are applicable to type 2 diabetes in whom insulin resistance, obesity and hyperinsulinemia predominate. However, most available data support extrapolation of the result of DCCT to individuals with type II diabetes mellitus also[2]. The United Kingdom Prospective Diabetes Study (UKPDS)[18] results establish that retinopathy, nephropathy, and possibly neuropathy are benefited by lowering blood glucose levels in type 2 diabetes with intensive therapy, which achieved a median HbA_{1c} of 7.0% compared with conventional therapy with a median HbA_{1c} of 7.9%. The overall microvascular complication rate was decreased by 25%.

In our study, 31out of 29 (93%) of patients showing microvascular complications also showed some degree of hearing loss. Daltonet al[5] reported a statistically significant association between nephropathy and hearing loss, but suggested that this might not reflect an association between micro vascular complications as nephrotoxic agents could also be ototoxic leading to hearing loss. Also, drugs used for treatment of nephropathy might lead to hearing loss. *Li et al*[19] in a clinical trial observed that in patients with co-existing hearing loss and nephropathy, rheological agents used to improve microcirculation and drugs for nourishing the kidney improved the hearing of many patients with diabetes mellitus. *Tay et al*[8] and *Espana et al*[20] however did not find any correlation between the presence of diabetic complications such as retinopathy and hearing loss. Hence the relationship between hearing loss and microvascular complications in diabetes mellitus remains equivocal.

A highly significant statistical correlation was also found between the age of the patients and the presence of hearing loss. Patients of increasing age group showed a higher incidence of hearing loss. *Espana et al*[20] , *Tay et al*[8] also reported a significant correlation between the age of the patient and hearing impairment. *Kurien et al*[10] however did not find any correlation between the duration of diabetes mellitus and hearing loss.

A significant correlation was also found between the duration of diabetes mellitus type I to hearing loss. No statistically significant correlation was however found between the duration of type II diabetes mellitus and hearing loss. *Boomsma*[21] reported that patients with hardness of hearing had a longer duration of diabetes than diabetic patients with normal hearing (10.5 years versus 6.9 years). He concluded that hearing impairment is frequent in elderly patients with diabetes mellitus type-II which may be due to diabetic neuropathy.

We concluded that hearing impairment in diabetes mellitus is due to a combination of cochlear and retrocochlear cause, the incidence of cochlear pathology being slightly higher. Our findings are supported by the works of *Lisowska et al*[12] (2001) and *Parving et al*[22] (1990) albeit using different methods. *Lisowska* et.al[12] carried out distortion product auto acoustic emission to study cochlear function and ABR to detect retrocochlear damage . He concluded that both cochlear and retrocochlear damage occurred in Diabetes Mellitus.

Conclusion

SNHL is an established complication of DM both type I and II. SNHL increases with increase in duration of the disease and is related to poor glycaemic control. Site of involvement in such cases may be both cochlear and retrocochlear. Hence it is assumed that intensive glycemic control and avoidance of neurotoxins such as alcohol can go a long way in reducing if not preventing SNHL in patients of Diabetes Mellitus. However in the absence of a clear cause effect

correlation , large multicentric longitudinal studies are required with large populations and strict inclusion and exclusion criterion before such conclusion can be made.

Legends: (total 5 tables)

Table 1: Categorisation of subjects

Groups	Total no. of patients	Male	Female	Age groups in years					
				0-10	11-20	21-30	31-40	41-50	51-60
Group I	25	18	7	1	1	7	5	5	6
Group II	200	128	72	6	17	21	45	51	60
Group II (a)	89	58	31	6	17	14	20	12	20
Group II (b)	111	70	41	0	0	7	25	39	40

Table 2: Comparison of mean hearing threshold in patients of Diabetes Mellitus & healthy volunteers showing significant SNHL among the patients of DM(group II) at all frequencies tested.

Frequency	Group I	Group II	p value
125	3.9 ± 4.9	9.0 ± 8.1	<0.001
250	4.6 ± 5.6	11.5 ± 7.9	<0.001
500	5.3 ± 5.8	14.2 ± 8.2	<0.001
1000	5.8 ± 5.5	17.2 ± 8.8	<0.001
1500	6.3 ± 6.1	20.0 ± 9.5	<0.001
2000	7.0 ± 8.2	22.7 ± 10.1	<0.001
3000	7.2 ± 8.3	25.1 ± 10.9	<0.001
4000	7.5 ± 8.3	27.7 ± 12.2	<0.001
6000	7.7 ± 8.3	29.7 ± 13.6	<0.001

Table 3: Comparison of Severity of hearing impairment in patients of Diabetes Mellitus type I & II as per WHO classification

Severity of hearing impairment (WHO)		Group II a showing SNHL n=39/89	Group II b showing SNHL n=72/111
Mild	26 - 40 dB	21(53.8%)	32(44.4%)
Moderate	41 – 60 dB	12(30.7%)	24(33.3%)
Severe	61 – 80 dB	6(15.38)	15(20.83%)
Profound	>81 dB	0	1(1.3%)

Table 4: Correlation of hearing impairment in patients of Diabetes Mellitus with duration of disease

Duration of disease (yrs)	Total no. of patients of Group IIa	Patients of DM Group IIa with hearing loss	Total no. of patients of Group IIb	Patients of DM Group IIb with hearing loss
0 – 5	10	0	39	23
6 – 10	22	3	47	31
11 – 15	39	22	22	17
16 - 20	18	14	3	1

Table 5 : Showing te correlation of hearing loss and Glycaemic control in patients of Diabetes Mellitus.

Hearing loss was found to be higher in patients of poor glycaemic control than in well controlled cases.

HbA1c levels	***Total no. of patients***		Patient with hearing loss	
	Type IIa	Type IIb	***Type IIa***	Type IIb
<6.5% (Excellent control)	56	46	19	20
6.5-7%(Good control)	28	38	15	28
7.5-8.9%(Moderate control)	5	25	5	25
>9.0 % (Poor control)	0	2	0	2

References:

1. Endocrine Pancreas : In Kumar et al. Editors, Basic Pathology, Fifth Edition: 1992 : 17. 569-573.
2. Krall LP; The history of Diabetes. In: Khan CR et al. Editors, Joslins Diabetes Mellitus; 13th edition; 1-13.
3. Global report on diabetes. World Health Organization, Geneva, 2016
4. Kutly SR. Hazarika P. Rajshekhar B; Hearing loss in Diabetes Mellitus. Indian Journal of otology : 1998:4(3);
5. Dalton DS et al. Association of NIDDM and hearing loss. Diabetic care 1998(21); 1540-1544.
6. Hearing loss grades: Prevention of blindness and deafness programme(PDB): World Health Organization(WHO)
7. Pamela P. Diabetes and Hearing loss. Audiology Practices : Dec 2010 Vol. 2,(4): 22-23
8. Tay HL, Ray N, Ohri R; Diabetes mellitus and hearing loss. Clinical otolaryngology: 1995(2) 2: 130-134
9. Mozaffari M, Tajik A, Ariaei N, Ali-Ehyaii F, Behnam H. Diabetes mellitus and sensorineural hearing loss among non-elderly people. East Mediterr HealthJ. 2010 Sep;16(9):947-52.
10. Kurien N. et al: Hearing threshold in patients with Diabetes Mellitus. J of Larynology& Otology :1989 (103); 164- 168
11. Sharma et al. Audionestileulas changes in Diabetes mellitus. Indian Journal of otolaryngology and Head and neck surgery 15(2). 40-44 1999
12. Lisowska et al. Early identification of hearing impairment in patients with type I diabetes Mellitus. OtolNeurotol 22(3):3 16-20. May 2001.
13. Gomez et al. Diabetes and hearing impairment in Mexican American adults; a population based study. LaryngolOtol 112(9): 835-9; Sep 1998.
14. Celik et al. Hearing loss in insulin dependent diabetes mellitus; Auris Nausus Larynx. 1996; 23:127-32.
15. Cruickshanks KJ, Nondahl DM, Dalton DS et.al Smoking, central adiposity, and poor glycemic control increase risk of hearing impairment. J Am Geriatr Soc. 2015 May;63(5):918-24
16. A. Elamin, M. Fadlallah and T. Tuvemo Hearing loss in children with type 1 diabetes. Indian Pediatrics 2005; 42:15-21
17. David M. Nathan. The Diabetes Control and Complications Trial/Epidemiology of Diabetes Interventions and Complications Study at 30 Years: Overview Diabetes Care Volume 37, January 2014
18. Implications of the United Kingdom Prospective Diabetes Study. American diabetes association. Diabetes Care 2002 Jan; 25(1): 28-32
19. Li et al. Treatment of diabetic hearing loss – an audiological and rheological observations tradit chin Med; 20(3):176-9; Sep 2000
20. Espana et al. Hearing and diabetes. OtorhinolaryngolRelat Spec; 57(6):325-7 Nov-Dec 1995.
21. Boomsma . The frequency of hearing impairment in patients with diabetes mellitus type 2. (Article in Dutch) Necl. TijdschrGeenskd: 8; 142(32):1823-5 Aug 1998.
22. Parving A et al. Hearing disorders in patients with insulin dependent diabetes mellitus. Audiology 29(3): 113-21; 1990.