Hearing loss in Diabetes Mellitus

Pemmaiah K.D, Srinivas D.R

International Journal of Collaborative Research on Internal Medicine & Public Health
Vol. 3 No. 10 (October 2011)

International Journal of Collaborative Research on Internal Medicine & Public Health (IJCRIMPH)

ISSN 1840-4529 | Journal Type: Open Access | Volume 3 Number 10

Journal details including published articles and guidelines for authors can be found at:
http://www.iomcworld.com/ijcrimph/

To cite this Article: Pemmaiah KD, Srinivas DR. Hearing loss in Diabetes Mellitus. *International Journal of Collaborative Research on Internal Medicine & Public Health*. 2011; 3(10):725-731.

Article URL: http://iomcworld.com/ijcrimph/ijcrimph-v03-n10-03.htm

Correspondence concerning this article should be addressed to Pemmaiah K.D; M.S.Ramaiah Medical College, Bangalore – 570054, Karnataka, India / Email: dr.pemmaiah@yahoo.com

Paper publication: 10 October 2011

Hearing loss in Diabetes Mellitus

Pemmaiah K.D [*], Srinivas D.R

M.S. Ramaiah Medical College, Bangalore, India

** Corresponding author; Email: dr.pemmaiah@yahoo.com*

ABSTRACT

Background: The complex arrangement of inner ear makes it potential target of hyperglycaemic damage. A study was conducted to identify the probable occurrence of hearing loss as a complication of Diabetes Mellitus (DM).

Aims and objective:

- To assess the hearing loss in type 2 diabetic patients and correlate with age, duration of diabetes, HbA1C.
- To correlate hearing loss with nerve conduction study.

Design: Cross sectional study was done involving randomly 110 Type 2 DM patients. Data regarding their age and duration of diabetes was collected. Pure tone Audiometry and Nerve conduction study was done. HbA1c level determined. Data statistically analysed using Pearson correlation coefficient.

Results: Out of 110 patients 48 patients (43.6%) had bilateral Sensorineural hearing in higher frequency (2000hz, 4000hz). Among them Severe hearing loss (71 dB to 90dB) was seen in 7 patients (6.36%), moderately severe hearing loss (61dB to 70dB) in 16 patients (14.54%) and moderate hearing loss(30dB to 60 dB) in 25 patients (22.7%). Among 47 patients who had diabetes for more than 10 years, 29 patients (61.7%) showed at least mild hearing loss. Duration of DM and sensorineural hearing loss at 2000Hz and 4000Hz showed statistically significant correlation (Pearson coefficient r= 0.561 and r= 0.727 respectively) at 0.01 level. In other frequencies no significant correlation was found. Coefficient of determination was r^2=0.31(31%) and r^2=0.52(52%) respectively between duration of DM and hearing loss at 2000Hz and 4000Hz. The correlation of hearing loss in lower frequency with HbA1c did not show any statistical significance. However HbA1c and hearing loss in higher frequency (2000 hz and 4000hz) showed statistically significant correlation (Pearson coefficient r= 0.282 and r= 0.385) respectively. The correlation of hearing loss with Nerve conduction study did not show any statistical significance.

Study Limitation: Longitudinal study involving larger sample size and wide geographical area would confirm the above results.

Conclusion: We concluded that progressive bilateral high frequency sensorineural hearing loss is a complication of DM and probably due to involvement of inner ear structures particularly hair cells with preservation of vestibulocochlear nerve functions. However hearing loss is unrelated to development of peripheral neuropathy. Further study needs to be conducted to confirm the mechanism of hearing loss.

Keywords: Diabetic chronic complications, Hearing loss, Nerve conduction study, Presbycusis

Introduction

Prevalence of Diabetes Mellitus (DM) is increasing worldwide and it is more pronounced in India. According to the estimation total number of diabetes patients in India is around 40.9 million and by 2025 the number would be around 69.92 million[1,2]. New cases relates to the development of chronic complications. Chronic complications of Diabetes Mellitus can be attributed to number of changes occurring at variable time period involving the vascular system, nerves, skin and lens. These complications are the cause of considerable morbidity and mortality and negatively affect the quality of life in individuals with diabetes[3]. Hence it becomes important that chronic complication is recognized early and necessary interventions made.

In Diabetes Mellitus Patients all the cells of the body are exposed to high levels of plasma glucose but it is observed that symptoms of complication are arising only in few cell types. This may be because many of such complications are unrecognized or only particular cells are affected by hyperglycemia. The sense organ of hearing- the organ of corti has complex components and arrangement which makes it a potential target for hyperglycemic damage. Damage to any part of the hearing mechanism can lead to hearing loss. Hearing loss is one of the chronic conditions which are highly prevalent and associated with depression and functional decline. Still it is one of chronic conditions which is often underdiagnosed[4]

Earlier studies conducted showed weak correlation or no correlation between diabetes and hearing loss[5, 6]. But some studies have shown positive correlation between hearing loss and Diabetes Mellitus [7]. Conflicting results on hearing function in diabetic patients are described in medical literature. More over such study was not done in the Indian subcontinent. We conducted a study with aim to identify the probable occurrence of hearing loss as a chronic complication of Diabetes Mellitus by assessing the hearing loss in type 2 diabetic patients with respect to particular auditory frequency and further correlate with age, duration of diabetes, HbA1C and peripheral nerve conduction study.

Materials and methods

A cross-sectional case study was conducted involving 110 type 2 Diabetes Mellitus patients for a period of 2 months. It was proposed to include 110 subjects based on the literature findings that 35% of diabetics have hearing loss. With α error of 10% and power of the test of 80% the above number of 110 subjects is estimated. Previously diagnosed type 2 diabetes Mellitus by WHO criteria[8] between the age of 20 to 75 years attending for routine checkup were consecutively selected for the study. They were randomized and 110 patients were selected from them. Written consent for the study was obtained. Patients with occupational noise exposure, ototoxic and chemotherapy drug usage, severe head injury, family history of deafness, presence of ear infection, ear surgery, head or neck radiotherapy, upper respiratory tract infection in the past 1 month were excluded from the study. Detailed information on the age, sex and duration of diabetes and treatment history, was obtained from a self-administered questionnaire.

Hearing assessment was done by general ear examination and Pure Tone Audiometry so as to determine hearing function, the degree, type and configuration of a hearing loss if any. The guidelines from The British society of audiology were used for ear examination[9] and pure tone audiometry[10]. General ear

examination was done using otoscopy followed by Pure tone audiometry using manual audiometry. The instrument was made to deliver pure tone of variable frequency and intensity using earphones. Assessment was made at 1000 Hz, 2000Hz, 4000Hz, 8000Hz, 500Hz and 250 Hz in that order. The intensity was varied for each frequency and the patient was instructed to signal when he hears the sound. Intensity at which patients hears the sound was taken as patient's hearing threshold for that frequency. Both air and bone conduction testing was done. The results were charted as audiograms and classified based on the hearing threshold as mild (20 to 30 dB), moderate (31 to 60dB), moderately- severe (61 to 70dB), severe (71 to 90dB), profound (>91dB), total deafness (no hearing).

Peripheral neuropathy assessment was done using clinical scoring system (Diabetic Neuropathy Symptom Score-DNS). DNS was used as it was more sensitive[11] than other clinical scoring systems. Using questionnaire DNS was evaluated which included unsteadiness in gait, pain or burning or aching sensation of the feet or legs, prickling sensation of the feet or leg, numbness in feet or legs. It has maximum 4 points, and if DNS≥ 1 it was labeled as neuropathy. Nerve conduction study is a noninvasive and objective test used to measure the nerve function. Nihon Kohedn Electromyography machine was used throughout. The study room temperature was kept at 23±2°C. The simplified nerve conduction studies protocol[12] was followed in recording amplitudes. It involved recording the amplitudes, velocity and latencies of three sensory nerves (sural, ulnar, and median). Nerve conduction study procedure[13] was explained to the patient. Limb was placed in relaxed and comfortable position. Limb temperature noted and if cold, it was warmed. Recording and stimulating electrodes were placed on the correct sites using anatomical guide. Antidromic method was used in which recording of compound nerve action potential was done distally and stimulation of the nerve proximally. The proximal nerve fibers were stimulated. Latency measured from the onset of stimulus to the peak of the major negative deflection of the sensory compound nerve action potential. Peak to peak amplitude of the evoked nerve potential was measured. Length of the nerve was measured and conduction velocity calculated by ratio of length of the nerve and latency. Results were tabulated and compared with normal values.

Then HbA1c level were determined in all the subjects. 5ml of blood was drawn for analysis of serum concentration of HbA1c by standard laboratory methods. Results were tabulated. Data was statistically analyzed using Pearson correlation coefficient.

Results

Out of 110 type 2 diabetes mellitus patients 45 patients were females and 65 patients were males. Mean age was 46 years. 48 of 110 type 2 diabetic patients (43.6%) had bilateral sensorineural hearing loss in higher frequency (2000hz, 4000hz). This was seen as Hearing threshold raised for both bone and air conduction.

Among them Severe hearing loss (71 dB to 90dB) was seen in 7 patients (6.36%), moderately severe hearing loss (61dB to 70dB) in 16 patients (14.54%) and moderate hearing loss(30dB to 60 dB) in 25 patient (22.7%).

2 of 8 (25%) patients between the age of 30-40years; 9 of 20(45%) between age 40-50years;

10 of 18 (55.55%) between age 50-60years; and between the age of 60 -70years 25 of 36

(69.44%) patients had some degree of hearing loss. 47 patients of 110 patients had duration of diabetes more than 10 years. Among them 29 patients(61.7%) showed at least mild hearing loss. 63 of 110 who had duration of diabetes less than 10 years did not have any detectable hearing loss. Duration of DM and sensorineural hearing loss at 2000Hz, 4000Hz showed statistically significant correlation (Pearson coefficient r= 0.561 and r= 0.727 respectively) at 0.01 level. Coefficient of determination was r2=0.31(31%) and r2=0.52(52%) respectively between duration of DM and hearing loss at 2000Hz and 4000Hz. In lower frequencies no significant correlation was found. In the scatter graph (Figure 1) showing correlation between threshold of hearing and duration of Diabetes Mellitus indicates that as the duration of DM increases patients develop mild to moderate hearing loss.

The correlation of hearing loss in lower frequency with HbA1c did not show any statistical significance. However HbA1c and hearing loss in higher frequency (2000 hz and 4000hz) showed statistically significant correlation (Pearson coefficient r= 0.282 and r= 0.385 respectively). No statistically significant correlation was found between hearing loss (both higher and lower frequency) with Diabetic Neuropathy Symptom Score-DNS; or average nerve conduction velocity independently.

Discussion

We observed statistically significant correlation between hearing loss and type 2 Diabetes Mellitus. Significant correlation of hearing loss with glycemic control as evidenced by HbA1c indicates that hearing loss as a complication of diabetes. The Hearing impairment was sensorineural type because hearing loss was found in both air and bone conduction. Hence the Pathophysiology involves the inner ear component and/or Cochlear part of vestibulocochlear nerve. Since sensorineural hearing loss was present only in higher frequency it can be argued that cochlear part of 8th cranial nerve is not affected. Possible pathophysiology lies in the inner ear components. This points towards involvement of inner ear blood vessels and/or stria vascularis and/or hair cell. Sensorineural hearing loss was found in higher frequency similar to of sensory Presbycusis. In sensory Presbycusis there is loss of sensory elements in the basal end (high-frequency end) of cochlea with preservation of neurons resulting in high frequency sensorineural hearing loss. So it can be argued that the mechanism of hearing loss in DM probably would be as that of Presbycusis. Loss of stria vascularis cannot be ruled out, as it requires speech discrimination test and further research in this regard needs to be done.

Correlation of duration and HbA1C of type 2 Diabetes Mellitus and hearing loss stresses the role of chronic hyperglycemic exposure. Results showed prevalence of hearing loss in type 2 Diabetes Mellitus patients increases as age advances. HbA1c level and hearing loss correlation indicates that good glycemic control can modify the progression of hearing loss in type 2 Diabetes Mellitus patients. No correlation was found between peripheral sensory neuropathy and hearing loss. This shows that the pathology involved is different and presence or absence of other microangiopathy complications cannot be considered for assessing hearing loss in DM patients. Hearing loss is one of the chronic complications which is undetected and under detected. There is strong evidence which supports that treatment of hearing loss improves quality of life[14]. Hence it is suggested that hearing loss be recognized as one of the chronic complications of Diabetes Mellitus. As per the implication of this study,

it becomes important for physicians to refer all diabetic Mellitus patients for assessment of hearing and screen for hearing impairment.

Study Limitation

More extensive study involving larger sample size and wide geographical area is necessary. Longitudinal study would confirm the above results. Pure tone audiometry which was used to determine the hearing loss relies on patient response and hence is a subjective test. This raises the question of accuracy of audiograms. Objective hearing tests need to be conducted to confirm the results. Many patients with diabetes Mellitus did not show any hearing impairment. But subclinical hearing impairment cannot be excluded. Hence further studies need to be conducted in this regard using auditory brainstem responses.

Conclusion

We concluded that progressive bilateral high frequency sensorineural hearing loss is a complication of type 2 DM. The Hearing loss pattern was found to be similar to Presbycusis seen only in higher frequency(2000hz,4000hz). Hence we concluded that hearing loss in diabetes is not due to cochlear nerve neuropathy.

As duration of diabetes and glycemic control (HbA1C) independently showed positive correlation with hearing loss, we stress on the importance of early detection and treatment of diabetes and strict glycemic control to prevent hearing impairment. Nerve conduction study and hearing loss showed no correlation and we conclude that Hearing loss should be assessed irrespective of presence or absence of other complications of diabetes.

As there is widespread prevalence of type 2 diabetes in our population[1,2], prevalence of hearing loss would increase in future. Diabetes treating physicians have referred patients regularly for Nerve studies and Ophthalmology evaluation. These patients also require hearing assessment done as a routine.

Conflict of interest: None declared.

References

1. Huizinga MM, Rothman RL. Addressing the diabetes pandemic: A comprehensive approach. Indian J Med Res 2006; 124: 481-4.
2. Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes: Estimates for the year 2000 and projections for 2030. Diabetes Care 2004; 27: 1047-53.
3. Zhao Y, YeW, Boye KS,et al. Health care charges and utilization associated with diabetes neuropathy : Impact of type 1 diabetes and presence of diabetes complications and comorbidities. Diabet Med 2009; 26(1):61-9.
4. Bevan Yueh,Nina Shapiro,Catherine H. MacLean, et al. Screening and Management of Adult Hearing Loss in Primary Care:A Scientific review. JAMA 2003;289(15): 1976-85.
5. D S Dalton, K J Cruickshanks, R Klein et al. Association of NIDDM and hearing loss. Diacare. 1998 September (21): 1540-44.
6. F. Salvinelli, A. Miele, M. Casale et al. Hearing thresholds in patients with

diabetes. Internet Journal of Otorhinolaryngology. 2004 volume 3.

7. U.S Department of health and human services. National institutes of health news. Hearing Loss Is Common in People with Diabetes. Available at http://www.nih.gov/news/health/jun2008/niddk-16.htm accessed on December 1st, 2010.

8. World Health Organization: Diabetes Mellitus: Report of a WHO Study Group. Geneva, World Health Org., 1985 (Tech. Rep. Ser., no. 727).

9. The British Society of Audiology. Recommended Procedures and Publications. Recommended procedure for ear examination 2010. Available at http://www.thebsa.org.uk/docs/RecPro/RecProc_EarExam_25Jan2010.pdf accessed on December 1st 2010.

10. The British Society of Audiology. Recommended Procedures and Publications. Pure tone air and bone conduction threshold audiometry with and without masking and determination of uncomfortable loudness levels.2004. Available at http://www.thebsa.org.uk/docs/RecPro/RecProc_EarExam_25Jan2010.pdf accessed on December 1st 2010.

11. Asad A, Hameed MA, Khan UA et al. Reliability of the neurological scores for assessment of sensorimotor neuropathy in type 2 diabetics. J Pak Med Assoc. 2010 Mar;60(3):166-70

12. Perkins BA, Vera Bril, Diabetic neuropathy a review emphasizing diagnostic methods. Clin Neurophysiology 2003;114:1167-75.

13. Shin J Oh. Clinical electromyography nerve conduction study: general guidelines for performing nerve conduction studies. 3rd edition. Philadelphia PA, Lippincott Williams and Wilkins; 2003:37-53.

14. Mulrow CD, Aguilar C, Endicott JE, et al. Quality-of-life changes and hearing impairment: a randomized trial. Ann Intern Med. 1990;113:188-194.

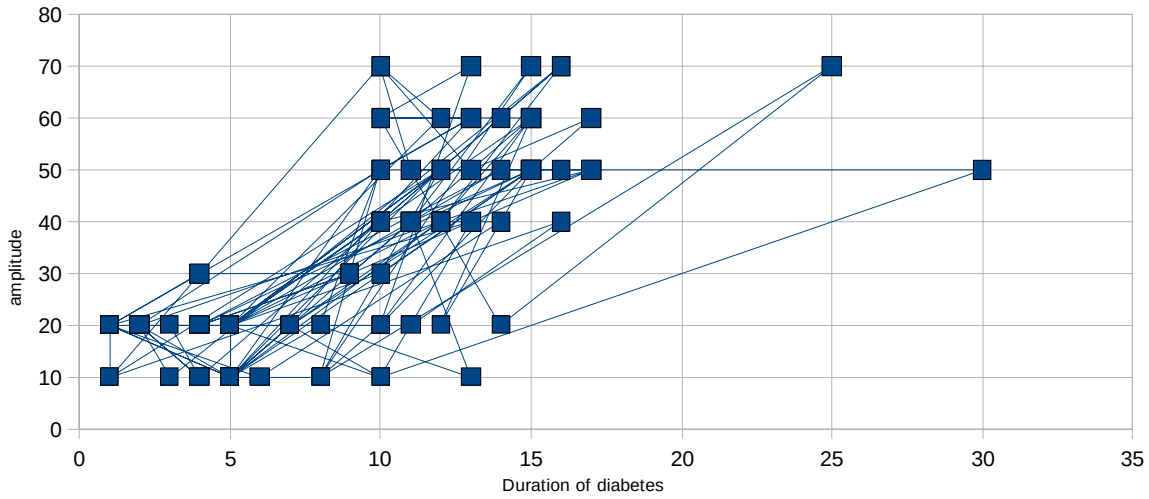

Figure 1: Scatter graph showing correlation between hearing loss (seen as increase in hearing threshold) and duration of diabetes.