MÆDICA - a Journal of Clinical Medicine

ORIGINAL PAPER

MAEDICA – a Journal of Clinical Medicine
2020; 15(1): 32-36
https://doi.org/10.26574/maedica.2020.15.1.32

Prevalence of Hearing Disorders among Type 2 Diabetes Mellitus Patients with and without Vitamin D Deficiency

Mahbobeh Sadat HOSSEINI[a], Masoumeh SAEEDI[b], Seyed Alireza KHALKHALI[a]

[a]Health Research Center, Lifestyle Institute, Baqiyatallah University of Medical Sciences, Tehran, Iran

[b]New Hearing Technologies Research Center, Baqiyatallah University of Medical Sciences, Tehran, Iran

ABSTRACT

Most of the previous studies have marked hearing loss as another complication of diabetes mellitus, while some other authors had different ideas. The relation between diabetes mellitus and sensorineural hearing loss has been under investigation for a century. However, it has remained controversial. Changing in the metabolism of glucose alters inner ear function and leads to hearing and vestibular disorders. We performed a study on type 2 diabetes mellitus patients with vitamin D deficiency, vitamin D insufficiency and with normal levels of vitamin D in an attempt to find out the prevalence of hearing loss among them. Prevalence of hearing loss was significantly higher in the group with vitamin D insufficiency/deficiency based on X2 test. Results showed that diabetic patients with abnormal levels of vitamin D had a higher risk to develop hearing loss compared to those with normal levels. There was a significant difference between subjects with normal and abnormal levels of vitamin D in terms of hearing loss degree based on the X2 test. In general, hearing loss was more prevalent in patients with abnormal levels of vitamin D, the severity of the loss mostly including slight and mild degrees. The results of the present study suggest that abnormal levels of vitamin D may be associated with a higher risk of hearing loss.

Keywords: hearing disorders, diabetes mellitus, vitamin D.

INTRODUCTION

Diabetes mellitus (DM) is a metabolic disorder resulted from complete or partial insulin deficiency. As a genetically inherited disease, DM is characterized by chronic hyperglycemia and changes in the metabolism of lipids, carbohydrates, and proteins (1). Involving approximately 9% of the world population, type 2 DM patients account for 80% to 90% of all cases, while the remaining 10% are afflicted by type 1 DM and gestational diabetes (1, 2). Diabetes is accompanied by higher mortality rates, lower quality of life, decrease in life expectancy, increase in healthcare expenses as well as increased micro and macrovascular complications

Address for correspondence:
Masoumeh Saeedi, New Hearing Technologies Research Center, Baqiyatallah University of Medical Sciences, Tehran, Iran
Email: m.saeedi67@gmail.com

Article received on the 28th of November 2019 and accepted for publication on the 12th of March 2020

such as retinopathy, nephropathy, neuropathy and cardiovascular diseases (3, 4).

Most of the previous studies have marked hearing loss as another complication of DM, while others provided a different perspective (5-8). The relation between DM and sensorineural hearing loss (SNHL) has been under investigation for a century. However, it has remained controversial. Changing in the metabolism of glucose alters inner ear function and leads to hearing and vestibular disorders.

Some researchers have shown that vitamin D is effective on insulin secretion, sensitivity to insulin, the incidence of DM II, glucose intolerance, hyperinsulinemia and obesity (9, 10). Bone demineralization, raised from metabolic bone disorders such as vitamin D deficiency, may lead to decreased bone mass in the cochlea and middle ear ossicles (11, 12). Vitamin D deficiency may be related to hearing disorders either directly or indirectly by alteration in calcium metabolism (13). It has been reported that correction of vitamin D levels resolves hearing loss in the majority of cases.

To the best of our knowledge, there is no similar study assessing the relation between vitamin D deficiencies and hearing loss among diabetic patients. So, in the present study, we aimed to determine the prevalence of hearing disorders among type 2 DM patients with and without vitamin D deficiency who were attending our hospital. ❑

MATERIALS AND METHODS

This cross-sectional study was conducted between March 2016 and December 2017 at Baqiyatallah University Hospital, Tehran, Iran. The study protocol was registered at the Ethics Committee of Baqiyatallah University of Medical Sciences. All patients with a confirmed diagnosis of type 2 DM attending Baqiyatallah Hospital were assessed for eligibility. Those with a history of trauma, hearing disorders, renal or liver failure, treatment based on ototoxic drugs such as gentamicin or streptomycin, or use of vitamin D supplements as well as those not willing to participate were excluded from the study. Demographic information together with disease duration, drug history and previous history of audiometry were all recorded in a pre-designed checklist.

Hearing threshold range (dB)	Hearing loss severity
25-40	Mild
40-55	Moderate
55-70	Moderate to severe
70-90	Severe
90+	Profound

TABLE 1. Hearing loss severity based on hearing thresholds

Fasting blood sugar, two-hour-post prandial glucose test, HbA_{1c}, and vitamin D level were measured in each subject after eight hours of fasting. Patients with vitamin D levels under 10 mg/dL were considered to have vitamin D deficiency and those with 10 to 30 mg/dL vitamin D insufficiency. Levels between 30 and 100 mg/dL were deemed sufficient.

Patients were divided into two groups: one with vitamin D deficiency and one with vitamin D non-deficiency. Both groups underwent pure tone audiometry (PTA), which was performed by a single audiologist using Madsen I Tera II device at audiometric frequencies (500, 1000, 2000, 4000 Hz). Normal hearing threshold was defined as 25 dBHL or lower. Hearing loss classification has been summarized in Table 1. Audiometry results were compared between the two groups.

Data were analyzed using IBM SPSS Statistics for Windows, Version 22.0. (Armonk, NY: IBM Corp). Normally distributed variables (approved by 1-sample Kolmogorov-Smirnov test) were compared using independent sample t-test between the groups. The chi-square test was used to compare categorical variables in the two groups. Mean and standard deviation (14) were used for describing categorical variables. ❑

RESULTS

All the 200 selected patients, including 108 (54%) females and 92 (46%) males, underwent analysis. Eighty five percent of patients were affected by a kind of hearing disorder: 20 (10%) had unilateral sensorineural hearing loss (SNHL), 149 (74.5%) bilateral SNHL and one (0.5%) bilateral conducting hearing loss (CHL). The prevalence of hearing disorder was 89.1% in men and 81.5% in women. There was no significant difference between females and males in terms of hearing status (p=0.131). Table 2 sum-

Type of hearing disorders	Males (N=92)	Females (N=108)	Total (N=200)	Fischer's test P-value
Unilateral SNHL	11 (12%)	9 (8.3%)	20 (10%)	
Bilateral SNHL	71 (77.2%)	78 (72.2%)	149 (74.5%)	0.272
Bilateral CHL	0	1 (0.9%)	1 (0.5%)	
None	10 (10.9%)	20 (18.5%)	30 (15%)	

TABLE 2. Prevlence of hearing disorders in two genders

		Vitamin D level		X^2 test
		Sufficient	Insufficient/deficient	P-value
Hearing loss	Slight and mild	58 (72.5%)	70 (80%)	
	Moderate and moderate to severe	14 (17.5%)	15 (14.7%)	
	Severe and profound	8 (10%)	5 (5.3%)	0.003

TABLE 3. Degree of hearing the loss in relation to vitamin D level

		Duration of diabetes		X^2 test
		Less than 10 years	More than 10 years	P-value
Hearing loss	Yes	18 (66.7%)	152 (87.9%)	0.006
	No	9 (33.3%)	21 (12.1%)	

TABLE 4. Distribution of hearing disorders based on disease duration

marizes the detailed data on the prevalence of hearing disorders between the two genders. Also, there was no significant difference between the two genders regarding the types of hearing disorders (p=0.272).

In terms of vitamin D level, 17 (8.5%) patients were vitamin D-deficient, 83 (41.5%) vitamin D-insufficient and 10 (50%) had normal levels. Prevalence of hearing loss was 90% among those with abnormal (deficient and insufficient) levels of vitamin D and 80% in subjects with normal levels. Prevalence of hearing loss was significantly higher in the group with vitamin D insufficiency/deficiency based on X2 test (p=0.04). Results showed that diabetic patients with abnormal levels of vitamin D had a 2.25-fold increased risk for developing hearing loss (OR 2.25, 95% CI 0.99 to 5.09). There was a significant difference between patients with normal and abnormal levels of vitamin D regarding the degree of hearing loss based on the X2 test. In general, hearing loss was more prevalent in those with abnormal levels of vitamin D, the severity of loss having mostly slight and mild degrees (Table 3).

Duration of the disease was another risk factor for hearing disorders. Patients with a diabetes duration of more than 10 years (173 cases) had a significantly higher rate of hearing disorder than those who were living with diabetes since less than 10 years (p=0.006, Table 4). Prevalence of hearing disorder was 92.6% among patients with poor control diabetes (HbA_{1c} > 7%) and 68.75% among those with good control diabetes. Hearing loss was significantly more prevalent in the group with abnormal HbA_{1c} based on X2 test (p=0.001). ❑

DISCUSSION

In the present study, we found that hearing loss was highly prevalent among patients with diabetes and it became more prevalent in those with uncontrolled blood glucose and longer disease duration. The Framingham trial showed an association between glucose levels and hearing loss in women (15). In 1997, the central and peripheral auditory pathways of diabetic patients were analyzed, and it was found that the cochle-

ar receptor is the main structure was affected in diabetic patients, while there was no involvement of the central auditory pathways (6). Angiopathy occurs mainly in the stria vascularis and on the spiral ligament (6, 16). Studies in diabetic rats suggest that hearing impairment is primarily caused by the reduction in the number of spiral ganglion cells and secondarily by edema in the stria vascularis (17-21). In one study, the incidence of SNHL was 85.71% among poorly controlled patients with a glycosylated hemoglobin (HbA_{1c}) level >8, 62% among those with moderate control and HbA_{1c} 7–8, and 38% in well-controlled subjects with HbA_{1c}<7. It was shown that poorly controlled diabetic patients had a significant hearing loss in all frequencies, which was in agreement with our findings. This could be explained by the cumulative effects of advanced glycation end products and their effects on the inner ear. There was no sex differentiation. Patients with poor control of their glycemic status (HbA_{1c}>8%) had raised auditory thresholds. Researchers have also established a positive association between the duration of diabetes and SNHL (22-24). In another study (25), SNHL prevalence in the diabetic population was 14.3% and had a higher frequency among patients with a diabetes duration longer than five years. Authors suggested that more studies were required to confirm that there is a relation between time spent with the disease and SNHL.

The present study shows that diabetic patients with vitamin D deficiency/insufficiency are more prone to hearing loss and their degree of hearing loss is higher than diabetic patients with vitamin D sufficiency. The effects of a vitamin D deficiency on insulin and glucagon release was determined in rats (26). Studies show that there is a high prevalence of hearing loss in diabetic patients with vitamin D deficiency (27, 28). It seems that there is an unrecognized causal correlation between vitamin D deficiency and cochlear deafness. Impaired vitamin D (a kind of metabolic impairment) activity may be important in the etiology of otosclerosis and presbycusis (29) and it can accelerate hearing loss in diabetic patients (26, 27). The impact of vitamin D and metabolic syndromes which influences hearing loss is not fully understood (30, 31). ❑

CONCLUSIONS

The results of the present study suggest that abnormal levels of vitamin D may be associated with a higher risk of hearing loss. It is important to monitor the hearing threshold in patients with diabetes. Also, it seems rational to perform a regular evaluation of vitamin D level and keep it within the normal range to decrease the risk of hearing loss in diabetic patients. Further studies are needed to generalize the results. ❑

Acknowledgments: The authors are deeply thankful to all colleagues of Baqiyatallah University of Medical Sciences, Tehran, Iran, for their kind help.

Conflicts of interest: none declared.

Financial support: none declared.

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