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Research Article

The Relationship between Diabetic Retinopathy and Sensori-neural Hearing Loss in Patients with Type 2 Diabetes Mellitus

Mohammad Hossein Davari[1]*, Ghasem Karimi[2] and Davood Alavi[3]

[1]*Assistant Professor, Ophthalmology Department, Birjand Cardiovascular Disease Research Center, Birjand University of Medical Sciences, Birjand, Iran*

[2]*Associated Professor, E.N.T Department, Faculty of Medicine, Birjand University of Medical Sciences, Birjand, Iran*

[3]*Birjand CardioVascular Disease Research Center, Birjand University of Medical Sciences, Birjand, Iran*

***Corresponding Author:** Mohammad Hossein Davari, Assistant Professor, Ophthalmology Department, Birjand Cardiovascular Disease Research Center, Birjand University of Medical Sciences, Birjand, Iran.

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Abstract

Background and Aim: Retinopathy is one of the major complications of diabetes mellitus. Microangiopathy beside neuropathy affects the hearing of diabetics. This study is aimed to identify the relationship between sensori-neural hearing loss (SNHL) and proliferative diabetic retinopathy in type II of diabetics.

Materials and Methods: We created a 72-member group of diabetics and a 36-member group of non -diabetics as control. Based on retinal examination, we separated diabetics into 2 subgroups as proliferative and non- proliferative diabetic retinopathy. By Pure Tone Audiometry of the two groups and based on audiograms we measured the average for three frequencies for all 108 cases and compared to normal measures. We classified cases into 4 subgroups, mild, moderate, moderate to severe and severe based on their audiogram drop.

Results: Our study showed there is relationship between diabetes and SNHL. More than 86% of the control group was good at hearing. 33.3% o the diabetics suffered from SNHL. In our study, similar to previous ones, SNHL was bilateral but only in right ear it seemed to be significant. We also studied how retinopathy and blood sugar control affect SNHL that we found these two parameters are irrelevant with SNHL.

Conclusion: Upon this study, hearing examination should be considered in diabetics. A based audiogram and routine audiograms seems to be necessary. Hearing aid devices may help these people not to suffer and morbid.

Keywords: *Proliferative Diabetic Retinopathy; Non Proliferative Diabetic Retinopathy; Sensori-Neural Hearing Loss; Audiogram*

Introduction

Type 2 diabetes mellitus is a complex disorder often featuring adiposity, hypertension, dyslipidemia and increased blood platelet aggregation, in addition to hyperglycemia [1]. Diabetes mellitus is a chronic metabolic disorder characterized by high blood glucose in the context of insulin resistance and relative insulin deficiency [2]. Patients with diabetes are at high risk of developing cardiovascular complications. These include microvascular dysfunction that contributes to clinically important complications such as retinopathy, nephropathy,

and neuropathy [3,4]. Neuropathy is associated with vascular and neuronal damage (commonly peripheral, but also autonomic), leading to impairment of sensation, movement or organ/gland function [5]. One of the lesser known complications of diabetes is auditory organ dysfunction and tinnitus, which leads to a decreased quality of life among those affected.

The effects of different variables such as duration of diabetes, blood sugar control, and presence of end-organ damage on hearing loss have yet not been clarified despite several studies on this topic. Although there is mounting evidence for a relationship between diabetes and hearing impairment the awareness of auditory organ involvement in the course of diabetes is still not widespread among healthcare providers involved in diabetes care. The hearing loss was reported to be bilateral progressive mild to moderate sensorineural affecting high frequencies in subjects with type 2 diabetes mellitus [6]. Diabetic retinopathy is divided into two main stages, including proliferative (PDR) and non -proliferative diabetic retinopathy (NPDR) [7]. In NPDR, microvascular changes is limited to the retina, and lesions do not exceed the internal limiting membrane (ILM). Specific findings in NPDR include Microaneurysm, lack of blood supply to the retina, nerve fiber layer infarcts, hemorrhages in the retina, edema of the retina, arterial abnormalities, and venous dilatation. proliferative retinopathy its characterized by persistent neovascularization and inflammation [8,9].

Measures that can be performed to prevent blindness in these patients are medical controls including control of blood sugar, blood pressure, lipids, and ophthalmic procedures such as laser photocoagulation and pars plana vitrectomy. every therapeutic agent with anti-VEGF property could be of great importance in the treatment of diabetic macular edema [10,11]. Avastin as an effective and novel therapeutic agent is a VEGF inhibitor, and it is used to control macular edema in patients with NPDR [10].

Understanding the association between different complications of diabetes could lead to a better understanding of the disease processes and subsequently better screening and management techniques [12].

Aim of the Study

The aim of this study was to determine the relationship between sensory neural hearing loss and diabetic retinopathy in patients with type 2 diabetes mellitus.

Methods

The study population included 72 subjects from all types of type 2 diabetic patients referred to the Diabetes Clinic of Vali e Asr Hospital in Birjand, which has previously been diagnosed with disease or is taking medication and 36 healthy people gathered as control group.

Inclusion criterion for entering the study were diabetic patients under the age of 60 years of type 2 referred to the Diabetes Clinic of Valiasr Hospital in Birjand were selected. Exclusion criteria including: Age over 60 years of age, taking an ototoxic drug in the past or present, sensory neural hearing loss or any ear illness in the past or present, history of trauma to the head or ear or family history of deafness and background of using Ototoxic drugs, the background of ear tumors and intracranial tumors, and the background of working in noisy environment.

All Patients underwent full ophthalmic examination by eye specialists who had visual acuity, intraocular pressure and examination with ophthalmoscope and slit lamp and other ophthalmic examinations.

Among them, patients with retinopathy diagnosis were selected and invited to perform audiometry. Healthy people participants who were similar to the intervention group regarding age and gender and had inclusion criteria were selected randomly and entered into the study after giving consent and invited to perform audiometry.

Diabetic and non-diabetic patients differentiated with fasting blood glucose and HbA1C and entered the study.

Before implementation of the design, its protocol was approved in research committee of Medical School and then in research committee of University of Medical Sciences/Ethics Committee. Then all research units were informed about the objectives of the plan and if participants were willing to take part in the research, they would give informed consent after which they entered into the study.

Checklist designed based on objectives including age, gender, FBS, Proliferative diabetic retinopathy, Non proliferative diabetic retinopathy, Sensori-neural Hearing Loss, as well as control and intervention group was completed for all research units through clinical examination and blood test.

Then All Patients underwent full ear examination by ENT specialists and Each patient got an audiogram with two methods of aerial and bone guidance and interpreted.

Based on The resulting audiogram is an average of 3 frequencies 500.1000.2000 the hearing loss level was determined. We classified cases into 4 subgroups, mild, moderate, moderate to severe and severe based on their audiogram drop.

Accordingly, Frequencies of 26 - 40 in mild category, 41 - 55 moderate, 56 - 70 moderate to severe, and 71 - 90 in severe category divided, Then Hearing loss and its association with retinopathy were measured.

Results

72 diabetic patients (66.6%) and 36 healthy subjects (33.3%) were evaluated.

36 diabetic patients had non - proliferative retinopathy and 36 had proliferative retinopathy.

In the control group, 63.6% were women and 36.1% male, and in the non-proliferative diabetic group, 75% were women and 25% male, and in the proliferative group, 63.6%, were women and 36.1% male.

The control group was between 48 - 58 years old, the diabetic group with non-proliferative retinopathy was between 47 - 57 years old and the proliferative group was between 50 - 58 years old.

The duration of diabetes in patients without proliferative retinopathy is 5 - 15 years and in proliferative diabetic patients is 7 - 19 years.

There was a significant relationship between diabetes and hearing loss in the right ear. More than 86% of the control group had normal hearing and a higher percentage of diabetics had hearing loss.

There was a significant relationship between hearing loss in the left ear and the control group. The correlation between sensory neural hearing loss with proliferative retinopathy and HBA1c quality was found, but no significant relationship was found.

	Groups	SNHL Have not	SNHL Have	Total	Statistical test result
Right ear	Control	31 (86.1%)	5 (13.9%)	36 (100%)	P = 0.03
	Case	48 (66.7%)	24 (33.3%)	72 (100%)	
	Total	79 (73.1%)	29 (26.9%)	108 (100%)	
Left ear	Control	30 (83.3%)	6 (16.7%)	36 (100%)	P = 0.20
	Case	52 (72.2%)	20 (27.8%)	72 (100%)	
	Total	82 (75.9%)	26 (24.1%)	108 (100%)	

Table 1: *Comparison of relative frequency of sensory-nerve hearing loss (SNHL) in diabetic and healthy subjects.*

Chi-square test was used to investigate the relationship between sensory neural hearing loss and diabetes. The results showed that there was a significant relationship between hearing loss in right ear and diabetes. More than 86% of the controls were normal for hearing loss. A greater percentage of the diabetic group had NSI hearing loss. No significant relationship was found between hearing loss in the left ear and the control group.

	Groups	Normal	Mild	Medium	Severe	total	Statistical test result
Right ear	Control	33 (86.1%)	1 (2.8%)	1 (2.8%)	1 (2.8%)	36 (100%)	Fisher Exact Test = 13.28
	Case	48 (66.7%)	20 (27.8)	3 (4.2%)	1 (1.4%)	72 (100%)	P = 0.002
	total	79 (73.1%)	21 (19.4%)	4 (3.7%)	4 (3.7%)	108 (100%)	
Left ear	Control	30 (83.3%)	4 (11.1%)	1 (2.8%)	1 (2.8%)	36 (100%)	Fisher Exact Test = 2.53
	Case	52 (72.2%)	13 (18.1%)	6 (8.3%)	1 (1.4%)	72 (100%)	P = 0.47
	Total	82 (75.9%)	17 (15.7%)	7 (6.5%)	2 (1.9%)	108 (100%)	

***Table 2**: Comparison of frequency distribution of sensory-nerve hearing loss in diabetic patients with healthy group.*

Chi-square test was used to compare the frequency distribution of sensory-nerve hearing loss in diabetic patients with healthy group. Two groups of diabetic patients without proliferative retinopathy with p proliferative retinopathy diabetic were combined and compared with control group. The results showed that there was a significant relationship between hearing loss in the right ear and the control group, and 33.3% of diabetic patients had hearing loss in the right ear. There was no meaningful relationship between the auditory hearing of the left ear and the control group.

Discussion

Although the effects of diabetes on many organs of the body are well known, there is still a great deal of ambiguity regarding the amount, type and mechanism of its effect on the auditory system. The results of this study confirm the negative and destructive effects of diabetes on auditory quality of diabetic patients. The association between diabetes and hearing loss was first reported by Jordao and colleagues in 1857 [13]. Many studies, in agreement with our findings, confirmed the undesirable effects of diabetes on hearing. Kurt in a 2002 study of 75 diabetes type 2 and 45 healthy individuals, showed that diabetics had significant hearing loss at all frequencies compared to the control group [14].

Several studies have therefore been undertaken to confirm or reject this connection and to investigate the mechanism of harm creation damage [15-18].

Maia and colleagues in 2005 reviewing the review on 16 studies, which included 14397 people, in addition to the relationship between Diabetes and sensory nervous hearing loss are recognized, about The causes of hearing loss in these patients did not reach a decisive conclusion, but they said they were the cause of hearing loss in diabetic patients Can be caused by angiopathy, neuropathy, genetic effects or a mixture of All of these factors [19].

Olubunmi and colleagues in a review study and meta-analysis in 2013 Investigating the effects of diabetes on auditory function Found that type 2 diabetic patients were at least as low as control group Mild degrees of hearing loss are higher. Average threshold for PTA for all frequencies in diabetic patients compared to control group Higher, but clinically, this threshold was at frequencies between 6000 Up to 8000 was more visible. In these patients, also V wave delays in the ABR, suggesting retro-cochlear conflict. Age and Duration of DM in patients plays an important role in the occurrence of hearing loss related to diabetes [20].

Mitchell and colleagues in 2009 in a prospective study for evaluation of diabetic patients, the patients participating in the study by order is re-examined again after 5 years and then after 10 years. In this study, after 5 years 2334 patients and after 10 years 1953 patients were re-examined and Audiometry for them were done. The results of this study showed that age-related hearing loss were present in 50% of diabetics and 38.2% of non-diabetics. After 5 Years the incidence of hearing loss in diabetics and non-diabetics were 18.7% and 18%. Worsening of hearing loss (> 5 dB) in patients whose newly diagnosed diabetes (69.6%) respectively were more than non-diabetic patients (47.8%). The results showed that Type II diabetes is associated with the prevalence of hearing loss, but There is no relationship to the incidence of hearing loss. More sample size and Prospective evaluations with the 5 years following-up the Patients are the benefits of this study rather than previous studies [21].

Miller and colleagues in a cohort study on 33 diabetic patients with proliferative retinopathy in 1983 found that there was no significant difference in hearing loss between diabetic and non-diabetic patients with conventional audiometric studies. But when more precise tools are used (especially in the area of hearing clarity), there is a clear difference between the two groups. The difference in the results of this study with our findings can be due to the oldness of this study and the methods for evaluating the hearing in it, as well as the number of higher sample size in the control group (209 people). On the other hand, the mean age of patients in this study (43 years) was lower than our study (53.7 years) [22].

On the other hand, contrary to the findings of our study, Gibben and colleagues, in a study of 50 diabetic patients and their comparison with the control group, reported that hearing power and incidence of hearing impairment in diabetic patients did not differ with healthy subjects [23].

In a study by Dalton and colleagues in 1998, a study of 344 patients with type II diabetes found that there was a weak link between type II diabetes and hearing loss, and insulin dependent diabetes only had an effect on the history of pyrexia in the patients. They also stated that due to the cross-sectional nature of the study, understanding the relationship between type II diabetes mellitus and hearing loss is not possible, and a longitudinal study is needed to find out the exact relationship between these two. In this study, the hearing level of patients with diabetes was normal. Perhaps one reason for the discrepancy between this study and other studies is the high age of the participants in the study (65 years in the control group and 69 in the diabetic group), which caused the hearing loss in the control group too high during the aging process and the difference between the two groups has disappeared because in the same study in the age group of 45 to 59 years the incidence of Hearing loss was significantly different with the control group [24].

In our study, there was no significant difference in the incidence of hearing impairment and the mean of left and right hearing loss in two groups of diabetic patients with and without retinopathy. However, in patients with retinopathy The prevalence of impaired and mean hearing loss was higher.

Martin and associates in 2015 in a study of 130 patients between 24 and 73 years old in four poor diabetic groups, good control diabetics, pre-diabetics and healthy subjects as control group showed that diabetics with weaker diabetes had a significantly higher hearing impairment than non-diabetics [25]. Also, hearing loss was observed in 13.9% of patients without retinopathy and 10% of patients with Retinopathy, as in our study, did not show a clear difference in the incidence of this complication based on the presence or absence of retinopathy. The reasons for the discrepancy between the results of this study and our findings in relation to the relationship between diabetes control and the prevalence of hearing loss can be attributed to a larger sample size (130 people) and a different assessment method Because in this study instead of examining the correlation between FBS or HbA1C with hearing loss, patients were divided into four groups for controlling diabetes and compared them with each other.

Contrary to our study, Bamanie and associates reported that factors such as age, diabetes insulin control, and the presence of other complications of diabetes may be a risk factor for hearing loss in type II diabetic patients [25].

It is often difficult to attribute hearing loss to diabetes alone, as other vascular diseases are common in these patients, and there are Combined variables such as presbycusis in these patients.

Duck and colleagues studied the interaction of high blood pressure in IDDM patients with hearing loss. They observed that high blood pressure and diabetes had a synergistic effect in reducing neurosensoral hearing loss in high frequencies. Microvascular effects of hypertension are similar to those of people with diabetes, which makes this data acceptable. This concept is important because the prevalence of hypertension in diabetic patients varies from 10% to 80% according to various reports. Accordingly, due to the similarity of the blood flow to the ears and eyes of the capillaries, patients with diabetes with retinopathy should have a more severe hearing loss [26].

Jorgensen and associates Have considered hearing loss in patients with diabetes mellitus with proliferative retinopathy twice as common [27].

Also, the results of our study on the comparison of the relative frequency of sensory neural hearing loss and the reduction of hearing loss in diabetic patients in terms of HgbA1c status showed that there was no significant correlation between HGBA1C and sensory neural hearing loss.

While in the 2013 study by Farooq and associates Among 110 patients, 87 patients (79%) had SNHL and there was a strong correlation between the severity of SNHL with higher FBS and HbA1c levels. This study also focused on performing audiometric tests for all diabetic patients in order to identify the sensory neural hearing loss. The differences observed in this study can be due to the low average age of patients in this study (45 years), long follow-up of patients (3 months), and the relationship between hearing loss severity and control of blood sugar rather than the prevalence of hearing loss [28].

Lerman and associates Also reported that there was a higher incidence of subclinical hearing loss in diabetic patients who did not have good blood glucose control (Higher HbA1c). The mean age in this study (42 years) was lower than our study. In this study, as with our study, the prevalence of hearing loss in the right ear was higher, but there was no particular reason for the difference between the two ears [29].

Vivek and associates in a study of 100 diabetic patients under 60 years of age (50 patients with diabetes and 50 uncontrolled diabetes), Found that 74% of the patients had sensory neural hearing loss. In this study, age and sex had no significant effect on sensory neural hearing loss. In this study, people with uncontrolled diabetes had mild to moderate hearing loss in both ears at high frequencies (compared to those with diabetes control). Thus, the researchers concluded that poor blood glucose control in diabetics would increase the risk of hearing loss in these patients [30].

In a 2003 study by Kakrlapudi and associates 8562 patients with sensory neural hearing loss and 66035 healthy subjects with regard to the effect of diabetes on sensory neural hearing loss were studied. The prevalence of hearing loss in patients with diabetes was 13% and in healthy subjects was 10%. Hearing loss was more severe in patients with concomitant nephropathy, and the incidence of sensory hearing loss increased in patients with poorer diabetes control [15].

As we can see, most of the previous studies, contrary to our findings, have shown that inappropriate control of diabetes promotes faster hearing impairment due to diabetes. Our study findings may be due to a relatively small sample size. Diabetes seems to be the same as the mechanism that causes the involvement of the vessels and nerves of other organs It also causes cochlear neural and vascular involvement and progressive sensory neural hearing loss. However, to justify the relationship between diabetes and hearing loss, some researchers have developed the angiopathic and some others neurological origins.

Orts and associates in a study of hearing impairment in diabetic patients, have been diagnosed with impaired function in external ear follicles [31]. Meanwhile, in the study of Nageris and associates the involvement of ear cell damage in the pathogenesis of hearing impairment in diabetic patients has been rejected [32].

Pathological changes that cause diabetes in the vessels and nerves of the inner ear can lead to a reduction in sensory neural hearing loss. These changes include sclerosis of internal ear artery, thickening of steria arteries, spiral ganglion atrophy and eight-nerve demyelination in the ears of patients whom been autopsied [33].

The metabolic effects of diabetes on the nerves are a major damage caused by increased blood sugar to the nerve tissue. One of the major consequences of increasing glucose is the production of non-enzymatic glucose. As the process progresses, advanced glucosasion is stored in many cellular structures and tissues, including type IV collagen. This collagen is found in important areas of the peripheral hearing system including vascular, spiral ligament and myelinated hearing nerve, so from this track could have an impact on the auditory system and disrupt it [15].

In general, hearing impairment in diabetic patients appears to be due to neuropathy or microangiopathy that can reduce hearing ailments.

Conclusion

According to the results of this study, it is suggested that hearing examinations should be made on the agenda of diabetic patients. A basic audiometry and the audiogram to be taken in the course of diabetes routinely. Also, to prevent harmful effects of hearing loss on a person's lifestyle, with the help of hearing aids, it can be helpful to prevent the disability of these patients.

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