

The Relationship between Hearing Loss and Proliferative Diabetic Retinopathy: Case Series

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ABSTRACT

Background: This study aims to find the correlation between the presence of hearing loss and its severity in patients with proliferative diabetic retinopathy taking the type of ophthalmic neovascularization as a guide for the severity of retinopathy.

Material: Prospective study included 42 consecutive patients who are known to have proliferative diabetic retinopathy. The average severity of hearing loss was recorded, and its relationship with patients' diabetes mellitus (DM) duration, demographics, and diabetic retinopathy severity was described.

Results: In the group of recruited patients, there were more males (61.9%) than females (38.1%) with mean age of 59.45 years and having average diabetes duration since its discovery was 17.4 years. There were 7 patients with normal hearing (m:3, f:4), 31 affected with bilateral sensorineural hearing loss (SNHL) (m:20, f:11), one with bilateral mixed (having both neurosensory and conductive components) hearing loss (male) and three with different types of hearing loss in both ears (m:2, f:1). None had pure conductive hearing loss except for one patient with right tympanic membrane rupture, and her right ear was excluded. Most ears were having mild and moderate sensorineural hearing loss (32 and 24 respectively) leaving seven ears with severe and one with profound sensorineural hearing loss. There were only four ears with mixed hearing loss with 2 of them having moderate hearing loss. Thirteen of our patients had DM more than 20 years and all of them had at least moderate SNHL component. 25 patients had DM for 11-20 years; 28% of them were normal, 60% had mild and moderate SNHL and 12% were having severe and profound hearing loss. There are 13 patients with DM of more than 20 years and all of them were having at least mild SNHL. There are three patients younger than 40 years two of which were normal and one with mild hearing loss. Nine patients were above the age of 70, third of which were having severe and profound hearing loss and the other two thirds with only mild and moderate hearing loss. There was an increasing number of patients with ages in-between 40 and 70 with moderate and severe SNHL as compared with younger age groups.

Conclusion: A higher number of cases of severe hearing loss were noted in older male patients with longer duration of DM since diagnosis. Most of the hearing loss were mostly sensorineural in nature. Patients with more severe diabetic retinopathy scored comparable hearing loss test results as was compared with less severe diabetic retinopathy cases.

Keywords: Sensorineural hearing loss, Diabetes Mellitus, proliferative diabetic retinopathy.

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Introduction

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Diabetes mellitus (DM) is believed to be a chronic metabolic disorder that constitutes a major public health concern and it is characterized by hyperglycemia and numerous abnormalities in the

metabolism of fat and protein. Its association with a number of microvascular complications has been known for long, most commonly affecting eyes (retinopathy), kidneys (nephropathy) and neurons (neuropathy).⁽¹⁾

A direct relationship between DM and sensorineural hearing loss (SNHL) has been established by an association between maternally inherited type of diabetes mellitus in Wolfram syndrome and congenital severe hearing impairment.⁽²⁾

Some large-scale studies disputed the relationship between diabetes and hearing loss, concluding that diabetic control, duration, and medication types were not associated with hearing loss.^(3,4) However, the relationship between many other types of diabetes and hearing is much more complex. Therefore, it was the focus of many other studies and it was found that there are many factors in diabetes that might affect hearing both on the short and long-term aspects. Changes in systemic insulin concentration can alter the endolymphatic potential by altering the glucose concentration which may alter hearing;⁽⁵⁾ but on the long-term effects, it is widely accepted that type II DM may induce microvascular and neuropathic changes, which could result in complications of the auditory pathway from the cochlea to the cortex.⁽⁶⁻⁸⁾

Even though many reports have evaluated and dissected the relationship between hearing loss and DM in the literature, there is no dedicated study of audiometric data in patients with advanced diabetic microangiopathic complications (proliferative diabetic retinopathy). This study aims to find the correlation between the presence of hearing loss and its severity along with the presence of proliferative diabetic retinopathy taking the type of ophthalmic neovascularization as a guide for the severity of retinopathy.

MATERIAL AND METHODS

This prospective study included 42 consecutive patients who were known to have proliferative diabetic retinopathy and undergoing argon-green laser treatment in the military hospitals of Al-Karak and Tafilah (Prince Ali Bin Al-Hussein military hospital and Prince Zaid Bin Al-Hussein military hospitals respectively) during the period between April and August 2018.

Having the approval of Royal Medical Services' ethical committee, consent forms were signed by patients and each one of them was assigned a case number so that no personal identifiers were used in the data for statistical analysis. Age, gender, type and duration of Diabetes Mellitus, along with type of ophthalmic neovascularization (rubeosis iridis, neovascularization of the disc, and/or neovascularization elsewhere) were recorded.

Patients who were diagnosed with retinal venous occlusive disorders, substance abuse, or known to have any major psychiatric illness were excluded from the study.

Patients were then sent for ENT assessment where history was taken to ascertain symptomatology (decreased hearing, tinnitus, inability to discriminate partially or fully) and to rule out other causes of hearing loss like noise-induced hearing loss, ototoxic medications, head trauma or ear surgery. They were clinically examined by the specialist, and pure tone audiometry was done according to protocols using audiometer model Madsen Zodiac 901 by well-trained audiologists. The average of

hearing loss for each ear is calculated by summing the hearing thresholds at the frequencies of 500 Hz, 1000 Hz, 2000 Hz, and 4000 Hz then dividing the result by four.

Tympanometry was ordered in patients who were found to have conductive or mixed hearing loss element, or in case of abnormal tympanic membrane on clinical examination.

RESULTS

In the 42 patients assigned with hearing loss, there were 26 males and 16 females with ages averaging at 59.45 years (Min = 20 years and Max = 80 years). Mean DM duration since its discovery was 17 years and 5 months (Min = 6 years and Max = 29 years) with only one patient labeled as type I DM.

Subjects were assigned hearing loss severity according to the classification system used for hearing loss level mostly used by hearing care professionals. (9), (**Table I**) In this study, patients with hearing losses averages of 56 to 69 dB (moderate to severe) were considered as moderate hearing loss.

Table I: Classification system used for hearing loss

The degree of hearing loss	Hearing loss average in dB
normal	Up to 25
mild	26 -40
moderate	41- 55
Moderate to severe	56 -69
severe	70 -90
profound	> 91

As depicted in (**Table II**), there were 31 patients affected with bilateral sensorineural hearing loss, one patient with bilateral mixed hearing loss, seven without any hearing loss, and three with differing hearing loss types among both ears. Of the later group, two have SN in one ear and mixed hearing loss in the other ear, whereas the third patient has one normal ear and the other ear was excluded from the study due to tympanic membrane perforation. None of the included patients in the study had pure conductive hearing loss in both ears.

Table II: Presence and type of deafness in the study group

	Normal	Sensorineural	Mixed	Conductive	Other
Patients (42)	7 16.67%	31 73.81%	1 2.38%	0 0%	3 (different for both ears) 7.14%
0Ears (84)	15	64	4	0	1 (Excluded)

The hearing loss severity distribution among its different types in our patients' ears was depicted in (**Figure 1**). Taking into consideration that the hearing loss severity in the mixed type was labeled according to the neurosensory component; most ears were having mild and moderate sensorineural hearing loss (32 and 24 respectively) leaving seven ears with severe and one with profound SNHL. There were only four ears with mixed hearing loss, one was mild HL, one was severe HL, and two of them were having moderate HL.

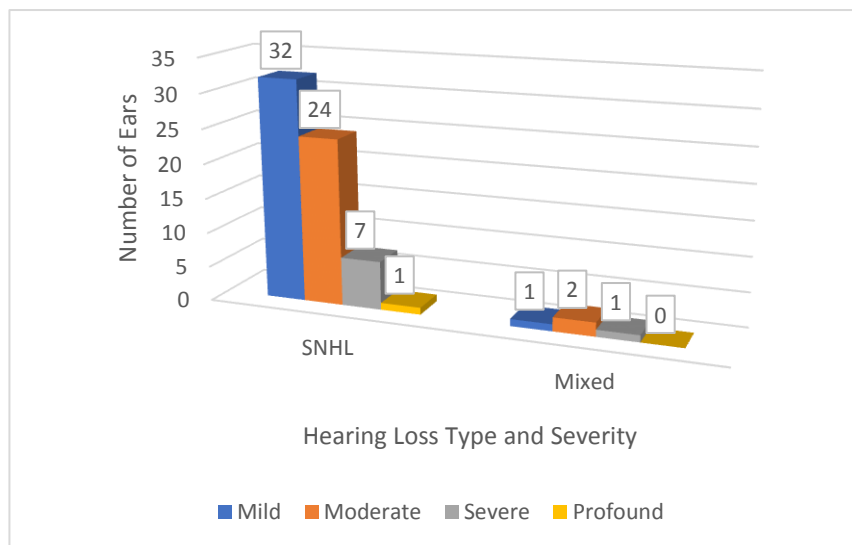


Figure 1: Type and Severity of Hearing Loss in Tested Separate Ears

We have grouped the patients, taking the most severe sensorineural hearing loss component of either ear, and showed the distribution of that hearing loss along their diabetic retinopathy neovascularization location in (**Figure 2**). Nine of the patient's had rubeosis in either or both eyes, three with neovascularization on the disc (NVD) while the rest of the patient had only neovascularization elsewhere (NVE). Of notice, fourteen of the NVE only patients had moderate SNHL followed by nine with mild SNHL, three with severe and profound hearing loss and four without SN hearing loss whereas rubeotic patients were two with mild SNHL, three with moderate SNHL, and three with normal hearing testing.

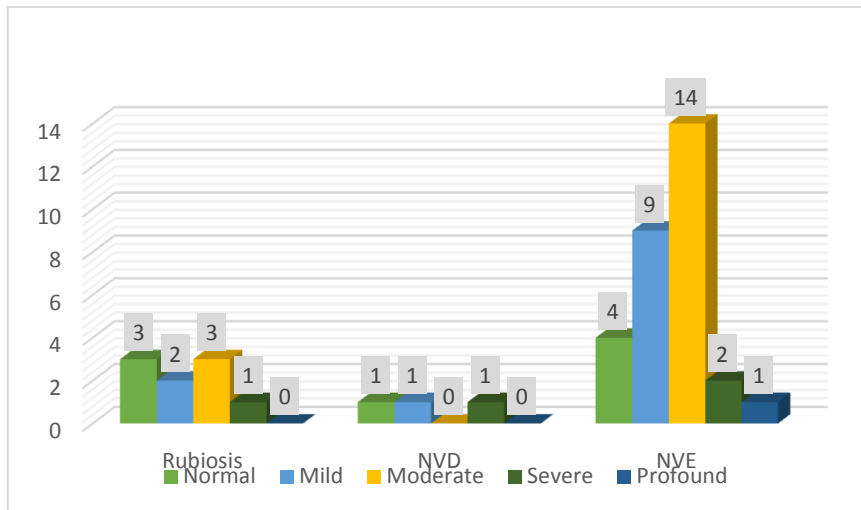


Figure 2: Severity of Diabetic Retinopathy Along With Severity of Hearing Loss in Patients

Patients' duration of DM were grouped into three groups: less than ten years, more than 20 years and in-between (11-20 years). As shown in (**Table III**), thirteen of our patients had DM for more than 20 years, and all of them had at least mild SNHL component. 25 patients had DM for 11-20 years, and 28% of them were normal, and 60% had mild and moderate SNHL. Patients with an average DM duration of fewer than ten years were four; one patient had normal hearing testing and three with moderate hearing loss at most.

Table III: Distribution of hearing loss severity along with DM duration

DM Duration (Years)	Number of Patients	Normal	Mild Hearing Loss	Moderate Hearing Loss	Severe & Profound Hearing Loss
Less than 10	4	1	2	1	0
11-20	25	7	6	9	3
More than 20	13	0	4	7	2

Distribution of age groups and resultant hearing loss exams were put in (**Table IV**). There are three patients younger than 40 years two of which were normal and one with mild hearing loss. Nine patients were above the age of 70, one third of them were having severe and profound hearing loss and the other two thirds with only mild and moderate hearing loss. Patients between 40 and 70 years were put into three 10-years groups showing that none of the patients aged 41-50 years had moderate or severe hearing loss whereas this jumps to 60% in patients of age groups 51-60 (none of which has severe SNHL) and to 45% in patient's age group 61-70 years of age.

Age Group (Years)	Number of Patients	Normal	Mild Hearing Loss	Moderate Hearing Loss	Severe & Profound Hearing Loss
Less than 40	3	2	1	0	0

41 – 50	5	1	4	0	0
51 – 60	10	2	2	6	0
61 – 70	15	3	3	7	2
More than 70	9	0	2	4	3

Table IV: Patient age groups and their hearing tests results

(*Figure 3*) depicts gender and the distribution of severity of hearing loss (if found). In the group, 38% of males had no or mild hearing loss compared to 56% of females in the study group. Gender had little impact on the percentage of patients having severe or profound hearing loss which is 12% of males and 13% of females. Males had more moderate hearing loss than females.

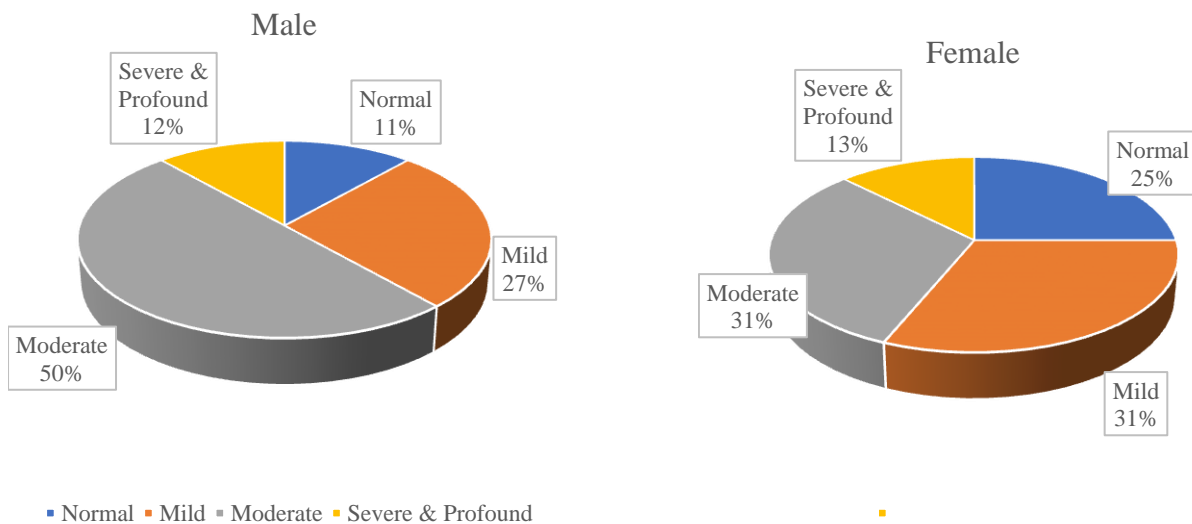


Figure 3: Hearing loss severity percentage distribution among genders.

DISCUSSION

Diabetes mellitus is a major public health concern, the prevalence of which is high in Jordan and is increasing.⁽¹⁰⁾ It is associated with microvascular and neuropathic complications affecting the retina, kidney, peripheral arteries, and peripheral nerves.

Sensorineural hearing impairment could plausibly be a result from injury to the vasculature or the neural system of the inner ear caused by the pathologic changes that accompany diabetes. Evidence of such pathology, including internal auditory artery sclerosis, stria vascularis capillaries thickening, spiral ganglion atrophy, and eighth cranial nerve demyelination, has been described

among autopsied patients with diabetes^(11,12) or microangiopathic involvement of the endolymphatic sac and/or basilar membrane vessels.⁽¹³⁾

Otolaryngology literature review shows a consensus that diabetes and SNHL relationship is a complex one as the study of which has been limited to many small studies⁽¹⁴⁻¹⁷⁾ or occupational noise-exposed samples.⁽¹⁸⁾ Epidemiological evidence from one population-based cohort study suggested a weak association⁽¹⁹⁾ whereas a few authors, Harner⁽²⁰⁾ and Shargorodsky⁽⁴⁾ as examples, have denied the relationship between the two.

There was no definite conclusion regarding DM duration and its control methods in relation to hearing loss. Celiket al.⁽²¹⁾ showed that DM duration effect was noticed on the hearing threshold especially after the first decade of the disease and the affected frequencies were the mid and high ones. Axelsson et al.⁽¹⁴⁾ showed that diabetic patients on oral medications had worse hearing abilities than those treated with insulin, despite the fact that the latter group had DM for an average of ten or more years. Swain et al.⁽²²⁾ had results in the same direction that hearing loss, tinnitus, and vertigo were better controlled by intake of insulin than oral antihyperglycemic agents and diet regulation. On the other hand, Bainbridge et al.⁽³⁾ showed that diabetic control, duration, and medication types used to treat it were not associated with hearing impairment.

Even after correction for senile deafness, Axelsson and Fagerberg⁽²³⁾ showed that the incidence of pure tone hearing loss increases with age in patients with diabetes. Cullen and Cinnamon⁽²⁴⁾ found that male gender had much more impact on hearing loss in patients with diabetes especially at lower frequencies.

Other factors that might affect hearing loss in people with diabetes are hypertension and nephropathy. Duck et al.⁽²⁵⁾ support the hypothesis that diabetic end-organ damage of the cochlea is augmented in the setting of hypertension and has a synergistic effect on high-frequency SNHL. The microvascular effects of hypertension are like those of diabetes, making these data plausible. Ooley et al.⁽²⁶⁾ showed that after controlling for diabetic management, as measured by HbA1C and creatinine, level of diabetic retinopathy was significantly associated with hearing loss severity in both ears.

Our study was prospective and descriptive one dedicated to audiometric tests for diabetic patients with advanced microangiopathic changes in the eye, i.e. proliferative diabetic retinopathy, to highlight the presence and the type and severity of hearing loss while noting the type of neovascularization as a measure of ocular ischemic advancement, age, gender, duration of diabetes.

CONCLUSION

In this study group of patients with proliferative diabetic retinopathy, a higher number of cases of severe hearing loss were noted in older male patients with longer duration of DM since diagnosis. Most of the hearing loss was sensorineural in nature. Patients with more severe diabetic retinopathy scored comparable hearing loss test results with less severe diabetic retinopathy cases.

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