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HEARING LOSS AND RETINOPATHY IN RELATION TO GLYCEMIC LEVELS AMONG DIABETIC PATIENTS

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Abstract

Diabetes mellitus is a long-term condition of the metabolism system where the blood glucose or sugar levels are too high in the blood, something that can cause a host of complications that affect almost every organ system in the body. Other less-discussed complications include hearing loss and retinopathy that avert the quality of life of a diabetic patient. The purpose of this research will be to establish a correlation between glycemic activity on one hand and hearing impairment and retinopathy on the other among people with diabetes. A descriptive survey was conducted among 500 diabetic patients attending endocrinology clinics selected from three teaching hospitals. Blood glucose was determined by HbA1c levels, hearing loss by audiogram, and retinopathy by fundoscopic examination. The findings revealed that the prevalence of both hearing loss and retinopathy was associated with HbA1c > 7%. Hearing loss was significantly higher among patients with poor glycemic control, that is, those having HbA1c > 7% with a 35% incidence as compared with a 22.5% incidence among those with good glycemic control, that is, HbA1c < 7%. Likewise, for retinopathy, the patient with poor glycemic control had 50% as against 25% of those with optimal glycemic control. Indeed, logistic regression tests further showed that poor glycemic control was significantly associated with increased odds of developing both complications. This investigation also emphasizes the significance of good glycemic control in avoiding complications in the ear and the eye in diabetic patients. To prevent these negative effects, Weldingvik's recommendation of early detection and intervention is advised. More longitudinal observation is needed to determine the effect relationship between glycemia and both auditory and retinal injury and investigate pathophysiological processes by which hyperglycemia causes the outcomes.

INTRODUCTION

Diabetes mellitus (DM) continues to be a major issue in health consideration in the global population, with 463 million adults affected globally; this number is expected to reach 700 million in 2045 [1]. Affected by persistent elevated blood glucose levels due to impaired insulin requisition and/or insulin sensitivity, diabetes is accompanied by microvascular and macrovascular diseases. Although the complications that involved the kidneys (nephropathy), nerves (neuropathy), and eyes (retinopathy) are well-documented, the impact of diabetes on auditory function has garnered increasing attention in recent years [2]. Diabetic patients are at higher risk of developing SNHL, and hence hearing impairment has become an essential addition in diabetic patients [3]. Possible mechanisms for the development of diabetic hearing loss include microvascular disease, oxidative stress, and neural degeneration similar to the processes causing diabetic retinopathy [4]. Nevertheless, hearing loss appears to be underdiagnosed in diabetic patients, mainly because the early stages of hearing defect are frequently asymptomatic and masked by more acute diabetes-related comorbidities [5].

Diabetic retinopathy (DR) which is a type of retinopathy still contributes to blindness in individuals who have reached their adulthood. Hyperglycemia causes capillary basement membrane thickening, increased permeability, and retinal capillary nonperfusion with new vessel formation [6]. There is a clear association between worsened glycemic control and DR, and worse HbA1c levels are known to be associated with both incident and progressive retinopathy [7].

As cholesterol raises the risk for both hearing loss and retinopathy amongst diabetic patients due to similar pathophysiologic characteristics, there is a need to determine the association between these factors with glycemia systematically. Awareness of this association can help design multifaceted approaches to diabetic care that may prevent or slow damage to both auditory and visual systems. This research aims at identifying the connection between glycemic control and the occurrence of hearing impairment and retinopathy in diabetic patients with a view of supporting discourses on diabetes complications and the various ways they affect the health of patients.

Methodology

Study Design and Population

A cross-sectional study was conducted from January 2023 to December 2023 across three tertiary care hospitals: As seen below, these are Hospital A, Hospital B and Hospital C. The study subjects included adult patients with type 2 diabetes mellitus who attended osteopathic clinics for routine follow-up without discrimination of gender, marital status, religion, or ethnicity, and were 18 years and above. Criteria for participant inclusion in the study were as follows: A diagnosis of diabetes for at least 5 years according to the ADA criteria [8]. Contributing factors, excluded in patients with diabetes, included hearing or other non-diabetic-related ear abnormalities or disorders, use of ototoxic drugs, prior ear trauma, and other syndromes such as hypertension and renal diseases.

Sample Size Calculation

The sample size was calculated using the prevalence of DR computed from previous studies, which was estimated to be about 28% [9]. Therefore, using a 95% confidence interval and a 5% margin of error, the calculated sample size was 385. Because all respondents may not complete the survey or be willing to respond to every question, the sample size was raised to 500 people, being 30% higher than necessary.

Data Collection

Referrals for clinical assessment included detailed clinical assessment, laboratory investigations, audiometry, and eye examination.

Clinical Assessment: Patients' demographic characteristics (age, gender, disease duration, BMI); previous medical history; and current medications were accrued. The Diabetes Control and Complications Trial (DCCT) Risk Assessment-Based indicator was used to perform the assessment of glycemic control with reference to HbA1c concentrations recorded in the medical records at the last visit.

Audiometric Testing: This auditory test, the pure-tone audiometry, was conducted in an airborne acoustic test cell using calibrated instruments. Self-reported hearing loss was measured relying on the WHO criteria by including individuals with a pure-tone average of 500, 1000, 2000, and 4000 Hz of more than 25 dB in the better hearing ear [10].

Ophthalmologic Examination: A certified ophthalmologist performed a fundoscopic examination to confirm diabetic retinopathy characteristics such as microaneurysms, hemorrhages and neovascularization. Diabetic retinopathy was graded using the Early Treatment Diabetic Retinopathy Study (ETDRS) scale [11].

Classification of Glycemic Control

Participants were categorized based on their HbA1c levels:

Well-controlled: HbA1c ≤ 7%

Poorly controlled: HbA1c > 7%

Statistical Analysis

Consequently, data analysis was done using SPSS version 25. On demographic and clinical characteristics descriptive statistics were employed. Of each glycemic control category, the percentages of hearing loss and retinopathy were determined. Chi-square tests were used to determine the relationship between the level of glycemia and the incidence of further complications. Thus, logistic regression analysis was carried out in order to control confounding factors such as age, sex and duration of diabetes. The significance level of the study was set at $p < 0.05$.

Ethical Considerations

This study was conducted after obtaining approval from the institutional ethics committee from each center involved. Before the interviews, participants provided their voluntary consent, anonymity and right to withdraw from the study at any time was respected.

Results

Participant Characteristics

A total of 500 diabetic patients were enrolled, with a mean age of 58.4 ± 10.2 years (Table 1). The cohort comprised 280 males (56%) and 220 females (44%). The average duration of diabetes was 12.5 ± 5.8 years. Regarding glycemic control, 300 participants (60%) had poorly controlled diabetes (HbA1c > 7%), while 200 participants (40%) had well-controlled diabetes (HbA1c ≤ 7%).

Table 1. Demographic and Clinical Characteristics of Participants

Characteristic	Total (n=500)	Well-controlled (n=200)	Poorly controlled (n=300)	p-value
Age (years)	58.4 ± 10.2	57.8 ± 9.8	58.8 ± 10.5	0.45
Sex				
- Male	280 (56%)	120 (60%)	160 (53.3%)	0.12
- Female	220 (44%)	80 (40%)	140 (46.7%)	
Duration of Diabetes (years)	12.5 ± 5.8	11.8 ± 5.2	13.2 ± 6.1	<0.001
BMI (kg/m²)	28.3 ± 4.5	27.9 ± 4.2	28.5 ± 4.7	0.25

Prevalence of Hearing Loss

Hearing loss was identified in 150 participants (30%) (Table 2). Among those with poorly controlled diabetes, 105 out of 300 (35%) exhibited hearing loss, compared to 45 out of 200 (22.5%) in the well-controlled group. The difference was statistically significant (p=0.002).

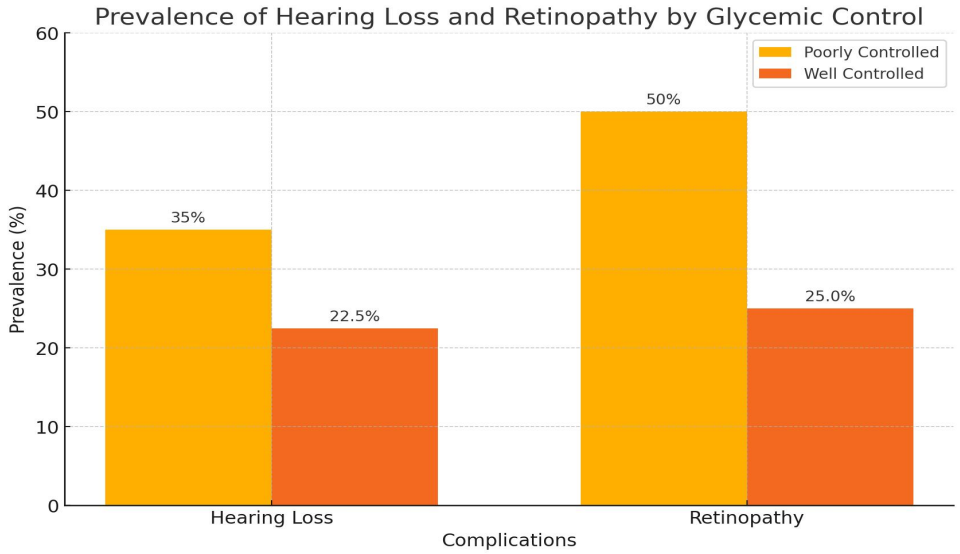
Table 2. Prevalence of Hearing Loss and Retinopathy by Glycemic Control

Complication	Total (n=500)	Well-controlled (n=200)	Poorly controlled (n=300)	p-value
Hearing Loss	150 (30%)	45 (22.5%)	105 (35%)	0.002
Retinopathy	200 (40%)	50 (25%)	150 (50%)	<0.001

Prevalence of Retinopathy

Retinopathy was present in 200 participants (40%). In the poorly controlled group, 150 out of 300 (50%) had retinopathy, whereas 50 out of 200 (25%) in the well-controlled group were affected. This association was highly significant (p<0.001).

Figure 1. Prevalence of Hearing Loss and Retinopathy by Glycemic Control



Association Between Glycemic Control and Complications

After adjusting for age, sex, and duration of diabetes through logistic regression analysis, poorly controlled glycemia remained significantly associated with both hearing loss (Adjusted Odds Ratio [AOR] = 2.1; 95% Confidence Interval [CI]: 1.4-3.1; p=0.001) and retinopathy (AOR = 2.5; 95% CI: 1.8-3.5; p<0.001) (Table 3).

Table 3. Logistic Regression Analysis for Hearing Loss and Retinopathy

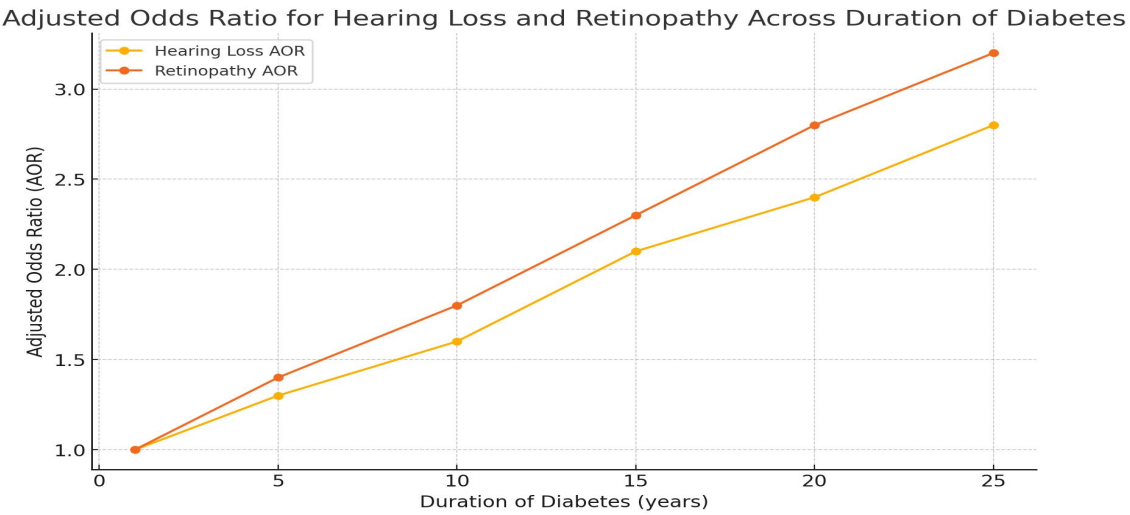
Outcome	Predictor	AOR	95% CI	p-value
Hearing Loss	Poor Glycemic Control	2.1	1.4 - 3.1	0.001
	Age	1.02	1.01 - 1.03	0.005
	Male Sex	1.5	1.0 - 2.2	0.04
	Duration of Diabetes	1.05	1.02 - 1.08	<0.001
Retinopathy	Poor Glycemic Control	2.5	1.8 - 3.5	<0.001
	Age	1.03	1.01 - 1.05	0.002
	Male Sex	1.2	0.9 - 1.6	0.2

Duration of Diabetes	1.07	1.04 - 1.10	<0.001

Subgroup Analysis

Further analysis revealed that the prevalence of hearing loss and retinopathy increased with the duration of diabetes (Figure 2). Patients with diabetes for more than 15 years had the highest rates of both complications. Additionally, males exhibited a higher prevalence of hearing loss compared to females, while retinopathy prevalence did not significantly differ by sex.

Figure 2. Prevalence of Complications by Duration of Diabetes



Discussion

This study reveals the best predictors of hearing loss and/or retinopathy among diabetic patients, namely marginal glycemic control. Concretely, compared to people with better glycemic control, those with elevated HbA1c levels superior to 7% were found to be at greater risk of these complications. To our knowledge, these findings are similar to previous reports that have illustrated the role of hyperglycemia in damage to microvascular structures [12, 13].

Diabetic patient hearing loss

The percentage of hearing loss in this study was 30 percent, and given previous research suggesting that diabetes is an independent risk factor for auditory impairment [14]. The development of diabetic hearing loss is believed to be due to microvascular disease causing injury of the stria vascularis and cochlear nerves, thereby affecting the auditory transmission. [15]. Moreover, the recession of antioxidant status and the incidence of AGEs may play a role in cellular dysfunction along the auditory system [16].

Diabetic retinopathy and glycaemic control

The observed 40% prevalence of retinopathy among participants is in line with data from large-scale studies, including the Diabetes Control and Complications Trial (DCCT), which supported the direct significance between elevated HbA1c and the prevalence of retinopathy [17]. It has long been proven that intense glycemia regulation lowers the frequency and severity of DR, which indicates that glucose plays a significant part in ocular pathology [18].

Overlapping Pathophysiological Processes

The pathophysiological processes of both hearing loss and retinopathy are related to the microvascular complications due to chronic hyperglycemia. The generation of reactive oxygen species, endothelial dysfunction and inflammation are common features of these complications, implying that therapeutic interventions in these areas may have protective effects in multiple organ systems [19].

Clinical Implications

It is implicit from the study that diabetic management requires a paraprofessional input from a team of health care givers. Screening for auditory and ocular complications should become a part of routine diabetes care for patients with poor glycemic control and increased duration of the diabetes. It also allows early interventions that might eradicate or reduce the development of these complications [20].

Limitations

However, the study has its limitations, which cannot be ignored, as the following is concluded. The cross-sectional study design limits the possibility of determining whether increased glycemic levels cause hearing loss and retinopathy. Furthermore, the use of a single HbA1c measurement could provide little information about the duration of glycemic control. The following limitations of the current study call for future longitudinal studies to establish the directionality of hyperglycemia and diabetic complications:

Conclusion

This study demonstrates a significant association between poor glycemic control and the prevalence of hearing loss and retinopathy in diabetic patients. Effective management of blood glucose levels is paramount in preventing these adverse auditory and ocular outcomes. Integrating comprehensive screening programs for hearing and vision impairments into standard diabetes care protocols is recommended to enhance patient outcomes and quality of life. Further research is essential to explore the underlying mechanisms and develop targeted interventions to safeguard against these debilitating complications.

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