**EDITORIAL**

**Hear the Ear: Gear up, Diabetes Care**

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**INTRODUCTION**

Diabetes is a multifaceted and multisystemic disease. A broad spectrum of pathophysiological abnormalities interacts to create an equally complex array of clinical presentations. Experts have crafted taxonomic structures to understand the nosography of diabetic complications. Acute and chronic, metabolic and mitogenic, vascular-metabolic and visceral-metabolic, macrovascular and microvascular—these are some of the adjectives we use to list complications of diabetes in meaningful buckets. Taxonomy, however, is not foolproof. Even when we classify living entities as plants or animals, as vertebrates or invertebrates, and vertebrates as male or female, we acknowledge that there may be exceptions. This is true for diabetes as well. Not all cases of diabetes can be typed clearly, and not all complications can be classified uniformly.

One complication that defies a simple label is sensorineural hearing loss (SNHL). Hearing loss is known to occur more frequently in persons living with diabetes. As per available clinical data, the prevalence of hearing loss in people with long-duration of uncontrolled hyperglycemia in India can be as high as 85%. Another study from the United States has specifically depicted the weighted prevalence of low-frequency hearing loss (defined as the average threshold at 500, 1,000, and 2,000 Hz), and high-frequency hearing loss (average threshold at 5,000, 6,000, and 8,000 Hz) to be 34.6% and 65.5%, respectively. The high prevalence is attributed to multiple risk factors and etiopathological mechanisms that explain the association between hearing loss and diabetes. The detrimental downstream effects of untreated hearing loss, such as dementia, are also well-reported. Yet, this crucial clinical entity is neither listed in the classic vascular complications of diabetes nor has been adequately addressed in novel concepts such as visceral-metabolic optimization of diabetes. The problem has also not been adequately prioritized as a significant risk in the World Health Organization Global Report on diabetes.

Multiple similarities, connections, and associations exist between diabetes and hearing loss (Table 1). Paradoxically, this complexity may preclude awareness and understanding of the importance of hearing loss in diabetes. Abraham et al., from Ludhiana, Punjab, India, address this gap by sharing data on the prevalence and clinical associations of hearing loss in type 2 diabetes. In their well-designed study of 200 adult participants living with type 2 diabetes, they assessed the status of distal peripheral sensory-motor neuropathy (DSPN) using the Michigan diabetic neuropathy score and hearing loss with pure tone audiometry. The study defined hearing loss as pure tone average >15-decibel hearing level (dBHL) in the worse ear. Clinically significant hearing loss (CSHL) was defined as pure tone average >25 dBHL in the worse ear. Pure tone average was defined as the average of 500, 1,000, and 2,000 Hz. The World Health defines hearing loss as a hearing threshold >20 dB in the better hearing ear. Hearing threshold refers to the minimum sound intensity that an ear can detect as an average of values at 500, 1,000, 2,000, and 4,000 Hz in the better ear.

In this study, the prevalence of hearing loss was 81%, including 28.5% with CSHL. Further the authors reported that hearing loss was more frequent in persons with moderate/severe neuropathy (87.6%) and mild neuropathy (80.9%), compared to those without neuropathy (66.7%); hearing loss and hearing threshold correlated directly with the severity of neuropathy, and also with a degree of uncontrolled hyperglycemia, or glycated hemoglobin (HbA1c). Hearing loss was also more common in elder men and was significantly associated with reduced estimated glomerular filtration rate on univariate analysis. Hearing impairment was more in higher frequencies (2000, 4000, and 8000 Hz), and the correlation of hearing loss with neuropathy was also stronger in these frequencies.

The relationship between neuropathy and hearing impairment suggests that evaluation of auditory acuity must be included as a part of the screening and monitoring of neuropathy in diabetes. One may screen for hearing loss with simple validated tools such as the single question screening tool and Hearing Handicap Inventory for the Elderly–Screening version. Clinical tests like the whispered voice, finger rub, and tuning fork tests may also be used. Handheld audiometers are easy to use and interpret and can be utilized at different levels of diabetes care settings, including primary healthcare centers.

The Cinderella status of hearing loss, as a chronic vascular complication, of diabetes, may also be due to the perception that there are no specific treatments or interventions for it; this is not true. Reasonable glycemic control itself may prevent or retard the impairment of hearing. In persons with type 2 diabetes, for every 10% increase in HbA1c, a 32% increase in impaired speech perception and a 19% increase in high-frequency hearing loss have been noted. This means that glycemic control per se has an otoprotective effect. Metformin has been shown to decrease the probability of sudden SNHL in type 2 diabetes as well.

Aspirin, a drug frequently used to reduce the risk of atherosclerotic cardiovascular disease, is known to be ototoxic. It reduces cochlear emissions, damages the spiral ganglion neurons, and negatively impacts the central processing of hearing. Therefore, it should be used only when the indication is backed by evidence. Certain antibiotics, such as aminoglycosides, and anticancer drugs like cisplatin and carboplatin, can also impair hearing. These should be used cautiously in persons with, or at high-risk of, hearing loss. Excessive noise exposure is the leading cause of hearing loss, and this should be a focus of primordial and primary preventative strategies. Avoidance of substance abuse, especially tobacco, should also be highlighted.

Hearing loss is connected with other microvascular morbidities such as nephropathy and retinopathy. Considering this, it makes sense to explore the effect of glucagon-like peptide receptor agonists (GLP1RA), sodium-glucose cotransporter-2 inhibitors (SGLT2i), and linagliptin on auditory acuity. These drugs have a renoprotective impact and may be otoprotective as well. Another renoprotective drug, finerenone, reduces inflammation and fibrosis in the kidney through its mineralocorticoid receptor.

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Epidemiology
- Both diabetes and hearing loss are equally common.
- The prevalence of both syndromes is increasing worldwide.
- Both have more than one type of presentation.
- Both conditions have well-described pre-disease states.
- A significant proportion of persons living with these diseases are unaware of their diagnosis.

Risk factors
- Both may have a genetic origin.
- Both increase with age.
- Lifestyle is a major determinant of both—excessive noise contributes to hearing loss, and physical inactivity to diabetes.
- Dietary choices influence both glucose control and auditory health.
- Both can be iatrogenic—they can be precipitated by the use of drugs.

Etiopathogenesis
- The inner ear is one of the most densely vascularized structures in the body and is susceptible to vascular injury, which is common in diabetes.
- Microangiopathy, that is, microvascular dysfunction or endothelial dysfunction, can lead to hearing loss,
- The inner ear’s stria vascularis is a high-energy consumer with a high mitochondrial density and is susceptible to abnormalities in oxidative phosphorylation.
- Dysfunctional mitochondria, and the associated generation of reactive oxygen species, are essential pathophysiologic abnormalities in diabetes and hearing loss.
- Poor glycemic control is directly associated with hearing loss.

Management and prevention
- Lifestyle and dietary modification are important aspects of managing both conditions
- Early screening and diagnosis, as well as the regular follow-up, are mandated in both.
- Metformin has been shown to reduce the risk of hearing loss.
- GLP1RA, SGLT2i, and finerenone, which are nephroprotective, may be otoprotective as well.
- Imeglimin, through its mitochondrial-based mechanism of action, may improve auditory health as well as help manage glucose in type 2 diabetes.

Pragmatic proposals
- All persons with hearing loss, especially high pregnancy hearing loss, should be screened for diabetes.
- All persons with diabetes should be screened for hearing loss.
- Screening for hearing loss should be done along with screening for neuropathy, and/or retinopathy.
- Screening may be done earlier, or repeated more frequently, in persons with risk factors for, or established ear disease.
- Good glycemic control, along with the facilitation of a healthy lifestyle, and aids to enhance hearing, should be offered to all persons living with CSHL.

Table 1: Diabetes and hearing loss—similarities, synapses, and solutions

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References