

Special Edition
"New Frontiers in Tinnitus,
Hearing Loss and Hyperacusis"

Mini Review

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Tinnitus, Hearing Impairment and Diabetes: A Mini-Review

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ABSTRACT

Introduction: Tinnitus is defined as the perception of sound in the absence of a matching external acoustic stimulus. Diabetes is a metabolic disorder in which the body is unable to metabolize glucose, thus characterized by symptoms such as hyperglycemia and alterations in the protein and fat metabolism. Diabetes has been found to be associated with hearing impairment as well. Tinnitus as a symptom is mostly observed in disorders involving metabolic disturbances and diabetes mellitus

Objective: This paper aims to present the literary findings on the link between tinnitus, hearing impairment and diabetes.

Review: Existing studies support the idea that tinnitus is a symptom associated with a variety of auditory disorders for which the mechanisms are not well understood. Tinnitus has been considered as a side effect of metabolic disorders, medications or high-level of insulin. Diabetes-induced animal studies have shown that such microvascular changes might occur in the inner ear as well which may disrupt the flow of circulation, result in the narrowing of capillaries and lead to the loss of outer hair cells, which are responsible for the amplification of sound entering the cochlea. Existing literary records support the idea that diabetic persons mostly experience cochlear, retrocochlear or combined cochlear-retrocochlear hearing disorders.

Conclusion: Tinnitus is a debilitating condition for which no standardized protocol has been developed to quantify its handicapping effects. Little has been understood of the relationship between diabetes on tinnitus and its relationship with hearing impairment and tinnitus. The comorbidity of the occurrence of hearing loss and tinnitus in diabetes makes this clinical condition even more disabling. A detailed understanding of the occurrence of tinnitus with diabetes will help to plan a better qualitative protocol for the diagnosis, study mechanism levels and provide clinical management of patients suffering from tinnitus, hearing impairment and diabetes.

KEY WORDS: Tinnitus; Hearing impairment; Diabetes.

INTRODUCTION

Tinnitus is defined as the perception of sound in the absence of a matching external acoustic stimulus.¹ Tinnitus is one of the three most significant otoneurological clinical manifestation besides sensorineural hearing impairment and vertigo. About 44 million American adults experience the condition of tinnitus. Of those affected, approximately 1 million consider themselves significantly debilitated as a result.²

In the global scenario, diabetes is ranked as the fourth leading cause of death, in terms of disease. The United Nations estimates the number of people globally affected by diabetes to be 246 million.³ Approximately, 17 million Americans suffer from diabetes.⁴ Diabetes is a metabolic disorder in which the body cannot metabolize glucose characterized by symptoms such as hyperglycemia and alterations in protein and fat metabolism.⁵ Hyperglycemia may arise due to the inability of the pancreas to produce insulin as seen in type 1 diabetes or due to the failure of the body to properly utilize insulin commonly observed in type 2 diabetes. Both of these conditions lead to high glucose levels in the blood.

Glucose functions as a fuel for the normal functioning of the brain. The blood glucose level is recorded as 3.5 to 6.5 mmol/L in humans. In the normal physiology of glucose metabolism, insulin is secreted by the pancreatic beta cells which affects the metabolism and lowers the blood glucose levels.⁶ In persons suffering from diabetes, there occurs an absolute deficiency of insulin.⁶ This may lead to the long term failure of the kidneys, peripheral neuropathy, cognitive degeneration and at times, the complete breakdown of the auditory-vestibular system.⁶ This condition may be associated with microvascular complications affecting the eyes, kidneys, ears, which possibly leads to polyneuropathy of the autonomic and somatic nerve fibres.⁶

Relationship between Diabetes, Hearing Loss and Tinnitus

Diabetes has been closely associated with hearing impairment.⁷ Poor control of glucose metabolism may be observed in both type 1 and type 2 diabetes resulting in high glucose levels in the blood which may result in microangiopathy causing the basement membrane of the capillaries to thicken.⁷ Thickening reduce the space inside the capillaries. Microangiopathy also affects the cochlear vessels of the ear. Studies on diabetes-induced animals have shown that such microvascular changes might occur in the inner ear as well which may disrupt the flow of circulation, result in the narrowing of capillaries, and lead to the loss of outer hair cells, which is responsible for the amplification of the sound entering the cochlea.⁷ This may lead to a complete depletion of nutrients, cell degeneration, and atrophy. Degeneration of nerve cells is observed in both the cochlea and the eighth nerve. The atrophy of outer hair cells in the organs of cortii may also result.⁷

The findings from existing literature supports the idea that persons with diabetes may be more prone towards developing hearing impairment.⁸⁻¹⁰ Neural degeneration and impaired blood flow has been found to affect the central nervous system

(CNS) which may cause sensorineural hearing loss.¹¹ Existing studies support the idea that diabetic persons mostly experience cochlear, retrocochlear or combined cochlear-retrocochlear hearing disorders.

Diabetes may also affect people who can hear normally. The reasons attributed to the same can be 1) the presence of neurophines. One neurophine is equivalent to the nerve growth factor (NGF) essential for the development, survival and maintenance of the peripheral and CNS. A decrease in the NGF plays a significant role in causing diabetic neuropathy.¹² The persons with diabetes may retain their normal sense of hearing until the NGF is present in an inadequate amount or diabetic neuropathy has occurred. In the clinical case of diabetic neuropathy, the reduction in the level of the NGF may lead to hearing impairment. Studies support the understanding that electrical signals travel slowly from the cochlea along the auditory nerve and the brainstem more often in diabetic relative to the non-diabetic patients.

Tinnitus as a symptom is mostly observed in disorders involving metabolic disturbances and diabetes mellitus.¹² Tinnitus has been considered as a side effect of metabolic disorders, medications or high-level of insulin.¹³ The metabolism of the inner ear depends on the oxygen and glucose supply from the blood circulation. Alterations in the glucose metabolism can thereby disturb the function of the brain cells and the inner ear; which may lead to reduced processing of complex sounds as speech and contributes as a cause of occurrence of tinnitus with hearing impairment. Tinnitus may have various debilitating effects on the sufferer.

The list of literary findings in association with diabetes, hearing loss, and tinnitus have been represented in the following Tables.

Diabetes and Hearing loss	Findings
Chamyal ¹⁴	Vestibulo-Cochlear functions were observed in diabetic patients, with mild to moderate hearing impairment, showing bilateral symmetrical high frequency loss, cochlear in nature which was more prevalent in aged patients with a family history of diabetes.
Donald et al ¹⁵	Persons with diabetes showed longer interpeak latencies in the ABR.
Jha, Agarwal and Singh ¹⁶	Patients with diabetes mellitus showed an increased hearing threshold in higher frequencies.
Alborch et al ¹⁷	Amplitudes of DPOAE's and TEOAE's were reduced in diabetic patients relative to people who hear normally.
De Espana et al ¹⁸ , Miller et al ¹⁹	Higher risks of hearing impairment was observed in patients with severe neuropathy or retinopathy.
Dasgupta et al ²⁰	Sensorineural hearing impairment was mostly observed in diabetes mellitus patients.
Taylor and Irwin ²¹	Patients with diabetes showed the symptoms of low frequency hearing loss.
Austin DF et al ²²	Diabetes has been associated with an increased risk of hearing loss.
Malucelli et al ²³	The prevalence of hearing loss was observed in diabetes mellitus type 1 patients and the use of high frequency audiometry was recommended for testing of these patients.
Martin DK et al ²⁴	The severity of diabetes in relation to hearing impairment was studied. Diabetes has been found to be a leading cause for vascular and neurological malfunction which impairs the auditory functions. Diabetes leads to devastating complications of vascular and neurological malfunction and appears to impair auditory functions.

Diabetes and Tinnitus	Findings
Meyerhoff and Shrewsbury ²⁵	In their screening survey, it was found that diabetic patients were mostly affected by tinnitus of hypoglycemia and hyperglycemia.
Akkuzu et al ²⁶	The clinical incidence of tinnitus was confirmed in diabetes mellitus patients.
Maia and Campos ²⁷	The study indicated that diabetes mellitus patients showed symptoms of dizziness, tinnitus and hearing impairment. The loss of hearing was considered as sensorineural in nature.
Kraft ²⁸	Humming in the ear was the common symptom in persons affected by both tinnitus and diabetes.
Swain SK et al ²⁹	In their study conducted on the Indian population of 240 diabetic patients, it was found that 29% of the affected patients suffered from tinnitus along with the other associated problems like vertigo, etc.
Figueiredo et al ³⁰	Hypertension was positively linked with the presence of tinnitus. The prevalence of hypertension was more predominant in patients having tinnitus (44.4%) than without tinnitus (31.4%).

CONCLUSION

Diabetes has a devastating effect from the periphery (cochlea) to the CNS, leading to neuropathy of the auditory nerve which may cause tinnitus. Tinnitus is a symptom associated with various auditory disorders for which the mechanisms are not well understood. Little has been established from the relationship between diabetes on tinnitus and its relationship with hearing impairment and tinnitus. Tinnitus is a disabling condition for which no standardized protocol has been developed to quantify its handicapping effects. The co-morbidity of the occurrence of hearing loss and tinnitus in diabetes makes this condition even more debilitating. A detailed understanding of the occurrence of tinnitus with diabetes is directed towards establishing a better qualitative protocol for the diagnosis and clinical management of patients suffering from tinnitus, hearing impairment, and diabetes. This will further help to understand the specific roles of the neural codes involved, at the level of mechanism, to record the related abnormalities, and provide for the timely diagnosis of this condition.

CONFLICTS OF INTEREST

The author declares that there are no conflicts of interest.

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