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Sensorineural Deafness in Diabetes Mellitus

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Abstract

Introduction

The complications of diabetes mellitus are classified according to the affected structures in microvascular (diabetic neuropathy, diabetic retinopathy and diabetic nephropathy) and macrovascular (coronary ischemi c disease, cerebrovascular disease). Among the microangiopathic complications, neurosensory hearing loss (NSHL) is a common disorder, especially among elderly patients. Although the first case of NSHL in a diab etic patient was described by Edgar in 1915, so far there have been few large clinical trials to establish a cor relation between the risk of hearing loss and the presence of diabetes. In spite of the fact that NSHL has an insidious onset, cases of sudden onset neurosensory hearing loss have also been reported in diabetic pacie nts, considered an ENT emergency. [2], [3], [4].

Material and Method

We reviewed the literature by searching the MEDLINE database for the most representative articles publish ed so far. The studies that we selected were observational studies that hypothesize a link between diabetes mellitus and risk of neurosensory hearing loss. Those studies included patients with type 2 diabetes, type 1 diabetes and prediabetes.

Conclussions

This article aims to review recent studies of progressive neurosensory hearing loss as well as suddenly insta lled hearing loss among diabetic patients. Although it can be asymptomatic in the beginning, losing or lowe ring sound perception is an extremely important marker of the quality of life of diabetes patients, providing an argument for screening this microvascular disorder often overlooked during clinical examinations.

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1. Introduction

> **On a global scale, diabetes is one of the most common metaboli c disorders, especially in low and middle-income countries [1, 2, 3]. In Romania, the number of patients with diabetes is estimated at ~ 3 million, with an incidence of 11.6% in 2014. [4, 5, 6].The pa thophysiology mechanism of neurosensory hearing loss is not full y understood, the causes having more of a speculative character due to the anatomical complexity of the vestibulocochlear appara tus.**

However, **neuropathic and microvascular changes associated with diabetes mellitus seem to be the ba sis for NSHL**. Another hypothesis of the pathophysiological mechanism is the degeneration of the acoustic nerve. [7] Other changes that lead to hearing loss by labyrinth damage include the thickening of the capillar y walls, constant disruption of nutrient transport and reduction in blood vessel size. [8], [9] Insulin resistanc e and hyperinsulinemia, as metabolic alterations associated with diabetes mellitus, increase the triglyceride production rate.

Numerous studies have described the association between glucose and lipid metabolic disorders in patients with vertigo, highlighting the increased risk for atherosclerosis and myocardial infarction. However, change s in long-term insulin concentrations may accelerate atherosclerosis in patients with diabetes. [9] **Glycemic imbalance, both by hyper or hypoglycemia, can interfere with the proper functioning of the inner ear , causing auditory, vestibular or mixed impairment, as it is known that this structure has a very acti ve metabolism, but does not possess energy storage capacity**. [11], [12], [13] Microscopic examination a lso revealed changes in the acoustic-vestibular nerve due to alteration of the myelin sheath accompanied by perineurium fibrosis, a decrease of the cell population in the cochlea, reduction of the number of nerve fibre s in the spiral lamina. It also is a reduction of the number of lymph nodes in the nucleus superior olives, infe rior colliculus and medial geniculate body, with no direct connection between diabetes and hearing centre s in the temporal lobe. [14]

It is worth mentioning the correlation between the existence of severe neuropathy or diabetic retinopathy a nd hearing impairment. However, there was no direct association between the age and severity of diabetes a nd the degree of hearing loss. [15] On the other hand, some studies show the involvement of central auditor y pathways, as the physiologic structure involved in the progression of hearing loss. [16] Some clinical tria ls have described a decrease in the number of bipolar neurons in Corti’s spiral ganglion. [5]

The hearing is usually installed gradually, bilaterally, initially affecting high frequencies. Genetic syndrome s have described as a been incriminated as a causal factor of hearing the loss in certain individuals, the mec hanism involved is genetic inheritance associated with maternal mitochondrial DNA; it has been shown that the incidence of mitochondrial hearing loss is approximately 0.5-1% of the total cases of hereditary hea ring loss. **Clinical characteristics of patients with maternal diabetes mellitus and hearing loss are: mat ernal diabetes mellitus, diabetes mellitus** (usually insulin-dependant diabetes mellitus but also progressi ve to insulin-dependent – progression due to mitochondrial dysfunction affecting the beta cells of the pancre as), **patients have a low or normal BMI, with an onset of diabetes before age 40 and have neurosensor y hearing loss initially for high frequencies**. [17] There also have been reported more cases of NSHL in p atients with neuropathy, at all wavelengths ranging between 250 Hz and 8000 Hz. [18].

2. Methods and studies

We analysed 26 clinical trials and reviews, the relationship between these two conditions remaining unclea r, some studies suggesting that diabetes can cause a loss of neurosensory hearing, while others are failing to find an association.

3. Discussion

The study by Srinivas *et al*., [19] in India, a country with the second largest population of diabetic patients, demonstrates a significant association between the presence of neurosensory hearing loss and poor control of type 2 diabetes, predominantly in elderly patients. **The authors analyzed 50 patients aged between 31 and 65 with different socio-economic backgrounds, following HbA1c levels, pre- and post-meal glyce mic values, duration of diabetes; then all of these patients were evaluated by tuning-fork test and a udiometry, and those with hearing loss were classified according to the type of impairment in conduct ing hearing loss, neurosensory hearing (perception), and mixed hearing loss**. 66% of the tested patients were diagnosed with NSHL (33 patients), of whom 27 were mildly hearing impaired, and 6 had a moderate hearing loss.

It was observed that NSHL prevalence is increased among the 46-65-year-old group (78.12%), especially in the case of disease duration of more than ten years. The study did not reveal statistically significant differ ences between the two sexes. The limitation of this study, mentioned by the authors, is due to the lack of dif ferentiation between hearing loss occurring with age and that produced by biochemical mechanisms that o ccur in diabetes mellitus. A study in Brazil [20] evaluated 901 Brazilian adults, Adult Health (ELSA-Brasil) who performed audiometry tests as part of the initial assessment. There were no significant differences be tween patients with and without diabetes after adjustment for age, sex and the presence of hypertension. Results for audiometry testing at 250-8000 Hz, SRT (Speech Recognition Threshold) and SDS(Speech Disc rimination Test) were significantly more severe in the diabetic group than in the control group.Uchida *et al* ., [21] argued that the association between diabetes and neurosensory hearing loss could not be made, becau se of the multiple variables that may interfere with this association, including exposure to noise and presbyc usis, suggesting that age contributed most to lower hearing thresholds of those with diabetes.

> **Their conclusions do not support those of other studies, showing a more severe effect of diabetes on hearing in younger age groups .The pilot study by Misra *et al*., [22] proposed to identify the ana tomical cochlear or retrocochlear area affected predominantly in patients with diabetes and neurosensory hearing loss.**

The randomised study included 42 patients with diabetes, excluding patients with chronic exposure to noise, those with a history of chronic otitis media, tympanic perforation, adherence or fluid in the middle ear as well as the patients with diabetes and systemic complications. The glycemic control mark er used was glycosylated haemoglobin (Hb1AC). There was a slight decrease in hearing, even in patients di agnosed with diabetes for a short time. The hearing loss described in these patients was mild, asymptomatic , bilateral and symmetrical, being solely neurosensory, the lesion site being predominantly cochlear. There was also an increased incidence of hearing the loss in the age group of 30-50 years, a finding unconfirmed in other studies.

Concerning patients over the age of 50, there has been a decrease in the incidence of hearing loss, probably due to the lower participation in this study, but also due to increased morbidity and mortality caused by both natural causes and complications of diabetes. 61.22% of patients did not have a history of nutritional restriction or antidiabetic treatment, reflecting an increase in the incidence of complications, including irrev ersible hearing loss. In this study, the maximum number of patients 33 (78.57%) had a hearing loss of only 6-8 kHz, affecting both ears following Cullen and Cinnamond studies [23], who found that hearing the loss in people with diabetes was more pronounced in higher frequencies at a bilateral level.

All four patients with hearing loss in the range of 500Hz-1kHz (main speech frequencies) showed a modera te degree of loss of hearing with a cochlear site of the lesion.Nagaoka *et al*., [24] examined the relationship between diabetes mellitus, hypertension and dyslipidaemia in patients with a sudden hearing loss between 2000 and 2007. **There were selected 35 persons divided into two groups: the associated disease group a nd the group without an associated disease**. Associated disease group comprised patients with sudden idi opathic hearing loss and systemic arterial hypertension, diabetes and dyslipidemias, alone or in combinati on.

The group without associated disease included patients with sudden NS idiopathic hearing loss without the conditions mentioned above. Sudden idiopathic hearing loss of NS in the presence of systemic arterial hype rtension, diabetes and dyslipidemias in the seniors was associated with a higher prevalence of cerebral micr oangiopathy (as evidenced by MRI) and a slower hearing recovery. The second study, conducted by Weng *et al*., [2] is a retrospective analysis using the data of 67 patients admitted to the Taiwan National Universit y Hospital in 1984-2003, all of whom are diabetic and have suddenly installed deafness, defined as a unilate ral hearing loss (30 dB) in at least three adjacent audiometric frequencies.

Patients (38 men and 29 women) had an average age of 60.1+/-11.9 years, mean age of diabetes 7.5+/-7.7 y ears and low glycemic control, showing a HbA1c of 9.9+-2.9 %. In regard to the evolution at follow-up, pat ients were divided into 2 groups: favorable development, characterized by increased hearing with a minim um of 30 dB or up to the same level as the contralateral ear (34.3%) of patients, or unfavorable evolution , t hese patients having an improvement in auditory perception below 30

Db (65.7%). The analysis could not establish a correlation between age of diabetes, therapeutic regimen, fasting blood glucose values, HbA1c values, the presence of dyslipidemia or hypertension and impact on auditory perception. However, the relationship between postprandial glycemic values and the level of contralateral ear damage has been demonstrated, suggesting that postprandial glycemia outside the target may be an indicator of the risk of cochlear injury. Malucelli *et al*., [17] describe a statistical difference in hearing thresholds between patients with type 1 diabetes and nondiabetics. In this study, the severity of the neurosensory hearing loss was not correlated with the age or severity of diabetes. Sixty subjects were enrolled in case-control groups.

Otoscopy examined subjects of both groups, conventional audiometry with frequencies ranging from 250-8000Hz, bone conduction audiometry from 500-4000Hz, followed by SRT and SDT tests and high-frequency audiometry ranging from 9000- 16000Hz, the latter being an essential resource for early detection of hearing the loss in the cochlear duct. Audiological examination showed statistically significant differences in diabetic subjects compared to non-diabetic subjects at frequencies of 250, 500, 10000, 11200, 12500, 14000 and 16000Hz.

4. Conclusions

Diabetes mellitus is on a global scale, one of the most common metabolic disorders, particularly in low and middle-income countries. In Romania, the number of diabetes patients is estimated at ~ 3 million, with an incidence of 11.6% in 2014. The complications of diabetes mellitus are classified according to the affected structures in microvascular (diabetic neuropathy, diabetic retinopathy and diabetic nephropathy) and macrovascular (coronary ischemic disease, cerebrovascular disease). Among the microangiopathic complications, neurosensory hearing loss (HNS) is a common disorder, especially among elderly patients.

> **The pathophysiological mechanism of neurosensory hearing loss is a complex one, including neuropathic and microangiopathic changes resulting in acoustic nerve degeneration, thickening of the capillary walls, consequent disturbance of nutrient transport, and reduction in blood vessel size.Srinivas *et al*., [19] observed an increased prevalence of HNS among the 46-65- year-old patient group, especially in the case of a more continued evolution of diabetes (over ten years), with no statistically significant difference between the two sexes.**

Regarding the sudden loss of NS hearing in the presence of hypertension, diabetes and dyslipidemia in the e lderly, there was a higher prevalence of cerebral microangiopathy (MRI) with poor prognosis in the rate of hearing recovery [24], while Weng *et al*., [2] could not establish a correlation between age of diabetes, thera peutic regimen, fasting blood glucose levels, HbA1c values, presence of dyslipidemia or hypertension and i mpact on auditory perception. However, the relationship between postprandial glycemic values and contra lateral ear damage was highlighted, suggesting that postprandial glucose beyond target may be an indicator of the risk of cochlear damage.

> **At the same time, audiological examination revealed statistically significant differences in subjects with type 1 diabetes compared to non-diabetic subjects at frequencies of 250, 500, 10000, 11200, 12500, 14000 and 16000 Hz [17], another study showing similar r esults, with more cases of NSHL at 250-8000 Hz audiometry, S RT and SDS among diabetic patients than in the control group [20], [25], [26]. The studies presented in this review failed to e stablish a clear connection between neurosensory hearing loss a nd diabetes mellitus. Although several cases of hearing the loss in diabetic patients have been reported in case-control studies sh owing the characteristics above – progressive, bilateral, symme trical, high-frequency impairment, it is difficult to differentiate NS deafness from presbycusis.**

We believe that larger scale studies are required, studies that should exclude more causes of NSHL, such as genetic factors (congenital deafness), as well as chemical or physical factors – ototoxic medication use, ex posure to noise.In conclusion, the diabetic patient should benefit from the interdisciplinary collaboration be tween diabetes and the ENT specialists, primarily for the early screening of hearing loss through audiome tric testing, but also for the management of progressive or suddenly installed hearing loss, taking into acc ount the specific features of this metabolic disorder.

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