

Hearing loss and type 2 diabetes: is there a link?

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Abstract

Recent meta-analysis has confirmed an association between hearing loss and diabetes. The cause remains uncertain and open to academic debate.

This five-year retrospective study examined the outcomes of patients referred for audiological investigations from a large primary care diabetes clinic. Audiological assessment included pure-tone audiometry, and the presence of neuropathy was identified by foot examination and risk stratification.

Referral rates of patients with diabetes were nearly twice those seen in the non-diabetic population (7.5% [107/1428] vs 4% [499/12422]). Hearing loss was identified in 77 patients. The majority (84.1%) had high-frequency sensorineural hearing loss. Loss of protective sensation on the 10g monofilament test (OR 3.2, CI 1.6–6.5) and vibration sense (OR 2.6, CI 1.2–5.6) was significantly higher in the hearing loss group when compared with a group with type 2 diabetes and normal hearing (n=219). The hearing loss group had almost twice the rate of at-risk feet (37.7% vs 20.1%); (OR 2.4, CI 1.4–4.2). Pre-existing cardiovascular disease was the only pre-morbid condition that was associated with hearing loss (OR 1.8, 95% CI 1.1–3.2). There were no differences in HbA_{1c} and lipids.

This is the first study from primary care to show that hearing loss is prevalent and has a strong association with peripheral neuropathy.

There are no effective strategies yet identified that can prevent or reverse diabetes-related hearing loss. Clinicians should recognise the association between diabetes and hearing loss, and engage in preventative health education and hearing conservation strategies. Copyright © 2014 John Wiley & Sons.

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Key words

type 2 diabetes; hearing loss; neuropathy; primary care

Introduction

Clinicians involved in the care of patients with diabetes will be very familiar with the neuropathic complications of diabetes. Conversely, many diabetes specialists will be unaware that the auditory system may also be affected by the same pathogenic mechanisms of non-enzymatic glycation, activation of the polyol pathway and generation of reactive oxygen species resulting from hyperglycaemia.¹ However, the precise nature of impaired hearing in diabetes is poorly understood and other explanations include diabetes-related microvascular disease on the cochlea.² As the microcirculation of the cochlea is embedded within the temporal bone it cannot be examined, so the only available anatomical evidence is from post-mortem studies. In adults with diabetes, these have shown pathology that includes loss of hair cells,³ thicker vessel walls of the stria vascularis and of the basilar membrane,⁴ sclerosis of the internal auditory artery, demyelination of the cochlear nerve and atrophy of the spiral ganglion.^{5,6}

Presbycusis (age-related hearing loss) is the most common communication disorder and the third highest self-reported disability.⁷ The failure to appreciate that hearing loss can affect the diabetic population means that it is largely unrecognised by diabetes services. The explanation for this may in part lie in the fact that, although there have been a number of articles published in otorhinolaryngology specialty journals on this subject, there have only been two articles in major diabetes journals over the past five years.^{8,9}

Early epidemiological evidence provided conflicting views as to whether there was a relationship between hearing loss and diabetes.^{1,10,11} Only one of these studies showed any convincing association.¹ Most other studies were small cross-sectional studies, using limited hearing measures and a single glycated haemoglobin (HbA_{1c}) value as an inadequate measure to evaluate an association with hearing loss that usually progresses over a number of years.¹² A recent meta-analysis of 13 such studies (number of patients

with hearing impairment included in the studies ranged from 34–1536) showed that, in subjects with diabetes, hearing impairment was 2.1 times more prevalent.⁸ There had been much debate as to whether age and age-related hearing loss were confounders and, as a result, some individual studies were unable to show an association with diabetes. However, in the meta-analysis, the observed significant relationship between hearing impairment and diabetes was preserved, with stratified analysis showing a stronger association in studies of younger participants, and the odds ratio remained significant in studies restricted to participants having a mean age of over 60 years.

We present the first clinical research paper to report the association between diabetes and hearing loss in a UK population.

Study aims

The aims of our study were: to determine the extent of hearing impairment within a primary care type 2 diabetes population; and to look for any relation between hearing loss and peripheral neuropathy, and associations with metabolic and macro/microvascular complications.

Methods

A five-year retrospective study up to August 2013 was undertaken to examine the outcomes of those patients from a large primary care clinic who were referred for audiological assessment due to self-reported hearing loss. Audiological assessment comprised history, otoscopy, tympanometry and pure-tone audiometry (PTA). PTA used threshold levels at 250, 500, 1000, 2000, 4000 and 8000 Hz to determine hearing function and to categorise the level of hearing loss.

Foot examination was undertaken during the diabetes annual review by two health care workers trained to perform foot screening. This included an assessment of sensory neuropathy with 10 g monofilament and 128 Hz tuning fork vibration testing, and foot pulses were examined. These findings determined a risk classification as recommended by NICE.¹³ Low risk had normal sensation and

palpable pulses; increased risk had either neuropathy or absent pulses; high risk had neuropathy or absent pulses plus deformity or previous ulcer; and the highest category was ulcerated foot within the preceding 12 months.

Two comparisons were undertaken. All patients aged over 40 years and referred for hearing assessment were identified. Patients with self-reported hearing loss and diabetes ($n=107$) were compared to the general population to establish the difference in referral rate.

A second group of patients with type 2 diabetes, aged over 40 years and self-reported normal hearing ($n=219$), were identified from a survey that included direct questioning to identify the presence of normal hearing or hearing loss. This group was compared to those patients with diabetes and hearing loss to analyse differences in peripheral neuropathy and stratified foot risk, vascular disease, hypertension, chronic kidney disease, micro/macrobalbuminuria, retinopathy, glycaemic control and lipids that may account for risks in developing hearing loss within a population with diabetes.

Results

From a large general practice with a diabetes register of 1428, 107 (7.5%) reported hearing problems and were referred for audiological investigations. This is nearly twice the rate seen in the non-diabetic population (499/12 422, 4%). There was no significant difference in mean age between the two groups (diabetes group 75.3 years [SD ± 10.6 , range 41.3–96.7] vs 73.6 years [SD ± 13.6 , range 40.1–101.8; $p=0.2$]).

Eighty-two patients aged over 40 years with type 2 diabetes attended and underwent an audiological assessment using pure-tone audiometry. Hearing loss was identified in 77 patients.

The majority (84.1%) had high-frequency sensorineural hearing loss, eight had mixed/conductive hearing loss and five assessments were normal. Degree of hearing loss (dB HL) was mild (20–40) in 11 (14.3%), moderate (41–70) in 48 (62.3%), severe (71–95) in 15 (19.5%), and profound (>95) in three (3.9%).

Duration of hearing impairment was over six months and gradual in onset in nearly all cases (72, 93.5%). Most (85.7%) had moderate to profound hearing loss at the time of referral.

There were no differences in HbA_{1c} and lipids between patients with diabetes and hearing loss, and patients with diabetes and self-reported normal hearing. Pre-existing cardiovascular disease was the only pre-morbid condition that was significantly higher in the group with hearing loss (OR 1.8, 95% CI 1.1–3.2). (Table 1.)

Patients with self-reported normal hearing had a significantly higher BMI (Table 1).

Loss of protective sensation on the 10 g monofilament test (OR 3.2, CI 1.6–6.5) and vibration sense (OR 2.6, CI 1.2–5.6) was significantly higher in the hearing loss group. This resulted in the hearing loss group having nearly twice the rate of at-risk feet (37.7% vs 20.1%); (OR 2.4, CI 1.4–4.2). (Table 1.) One in each group had foot ulceration.

Discussion

This is the first study from primary care to show that hearing loss is prevalent among a primary care population with type 2 diabetes. The higher rate of self-reported hearing impairment compared to the normal population (1.9-fold) is consistent with other studies.⁸ Most patients afflicted with hearing problems do not report their difficulties for some considerable time and not until there is substantial hearing loss. It is a poignant reminder to diabetes clinicians that involvement of the vestibulocochlear system can be added to the litany of neuropathic complications in diabetes. Recent meta-analysis has shown that hearing impairment is associated with diabetes.^{8,14} The incidence of hearing loss can range between 44% and 69.7%.¹⁴

Severity of hearing loss has been related in a small number of reports with duration of diabetes⁹ and poor glycaemic control,⁸ and microvascular complications such as diabetic nephropathy¹ and retinopathy in women (irrespective of diabetes status).¹⁵ Only one other study has shown an association with peripheral

Variable	Hearing loss in type 2 diabetes (n=77)		Self-reported normal hearing in diabetes (n=219)		P-value
	No.	%	No.	%	
Gender: male	46	59.7	134	61.2	NS
	Mean	SD	Mean	SD	
Age (years)	71.9	8.9	69.5	10.2	NS
HbA _{1c} (mmol/mol)	54.5	14.3	57.4	13.7	NS
Total cholesterol (mmol/L)	4.07	1.2	3.9	1.03	NS
HDL (mmol/L)	1.38	0.43	1.3	0.3	NS
Triglyceride (mmol/L)	1.77	1.0	1.85	1.0	NS
BMI (kg/m ²)	30.2	6.1	32.5	6.7	<0.01
	No.	%	No.	%	
Retinopathy	20	26.0	54	24.7	NS
Micro/macroalbuminuria	23	29.9	52	23.7	NS
Hypertension	54	70.1	163	74.4	NS
Cardiovascular disease	31	40.3	59	26.9	<0.05
Chronic kidney disease stages 3–5	24	31.2	59	26.9	NS
Peripheral arterial disease	6	7.8	11	5.0	NS
Foot examination:					
Increased/high risk and ulcer	29	37.7	44	20.1	<0.005
Monofilament test – abnormal	18	23.4	19	8.7	<0.005
Vibration sense – absent	13	16.9	16	7.3	<0.05

Table 1. Characteristics of patients aged over 40 years with type 2 diabetes: pure-tone audiometry defined hearing loss compared to self-reported normal hearing

neuropathy and low/mid-frequency hearing impairment.¹⁶ The clinic in this study adhered to guideline-driven intensive titration with modern multiple antidiabetic therapies. This policy may have eliminated any differences in glycaemic control between the two groups that may have been more apparent in older studies, possibly biased by variances in treatment policy.

This study has shown a strong association with peripheral neuropathy and hearing loss in type 2

diabetes and suggests the possibility that both complications may be caused by the same pathological mechanisms. There was no association with other diabetes-related microvascular complications including retinopathy, micro/macroalbuminuria and chronic kidney disease.

Hypertension, cardiovascular disease and CVD risk are associated with hearing loss in the general population.¹⁷ These conditions are more prevalent in the diabetes population and may be a reason for the

increase in hearing loss in diabetes. Our study confirmed the hearing loss group had a higher rate of pre-existing combined coronary and cerebrovascular disease. Targeting this particular subgroup of patients and those with peripheral neuropathy with hearing loss screening tests may be an option in identifying those at greatest risk.

Hearing impairment has been shown to be associated with increased BMI in populations under 45 years of age.¹⁸ This study showed the converse was true in a diabetes population aged over 40. Those with hearing loss had a significantly lower BMI which may have been the consequence of associated ill health due to cardiovascular disease and peripheral neuropathy.

Outcomes for the type and severity of hearing loss in the first comparator group of patients without diabetes are not available to analyse and so identify potential reasons to explain differences in referral rates. Patients with diabetes have more frequent contact with primary care clinicians and have a greater opportunity to report hearing difficulties. Attendance rates of all the groups are not reported in this study but may have influenced referral patterns. A further limitation to this observational study was that patients with diabetes in the second comparator group who self-reported normal hearing did not undergo audiological assessment to verify this. The inclusion of patients with hearing loss in the normal hearing group, however, strengthens the observed differences in this study.

There have been no reports showing that improvements in metabolic control can return normal auditory function. It would be hoped that intensive glycaemic control with antidiabetic medication could protect against hearing loss, and further research may be able to prove this.^{2,8,9}

While waiting for effective remedies, clinicians should engage in preventative health education and employ hearing conservation strategies,^{2,9} particularly in relation to precautions with health and safety aspects of work-related noise exposure. Employers should have a hearing conservation programme. This

Key points

- Due to widespread professional lack of awareness of the association of hearing loss with diabetes, it remains largely unrecognised. The presence of hearing loss is an additional barrier to effective communication to promote patient education and self-management
- The association with peripheral neuropathy identified in this study suggests that the vestibulocochlear nerve may be a further structure that can have neuropathic complications attributable to diabetes. However, there are no clinical studies at present to show that the current clinical management of other types of neuropathy has any effect on preventing or reversing hearing loss
- Clinicians should consider routinely assessing patients for hearing loss and referring those for a formal assessment where a concern has been identified. It is also the responsibility of clinicians to promote hearing conservation strategies and raise awareness, especially among younger patients with diabetes

will include rigorous noise control measures in the workplace, limiting exposure, providing quiet areas, and the provision of ear defenders and sound walls. Occupational health physicians may need to consider that employees with diabetes require more frequent audiological assessments. Noise at work regulations now also apply to bar staff and other employees in the entertainment industry.¹⁹ Patients with diabetes should be made aware of the need to protect their hearing during the use of earplugs and headsets when listening to music on personal MP3 players. Reducing the exposure to ototoxic medications may be beneficial.

Observational studies ultimately cannot prove causality; the association of hearing loss with diabetes will remain debatable until prospective studies are undertaken that can examine the dose–response relationship between the severity and duration of diabetes and the risk of hearing loss.

This study has highlighted the important association of diabetes and hearing loss, and more widespread dissemination of this will improve the awareness in professionals engaged in diabetes care. Recognising the association of hearing loss with

diabetes leads to earlier detection and referral for audiological assessment.⁹ The provision of hearing aids will maintain the hearing capabilities of patients.

The American Diabetes Association report, ‘Standards of medical care in diabetes – 2014’,²⁰ recommends that hearing impairment be assessed and addressed as one of the common comorbid conditions that may complicate the management of diabetes. As patients with diabetes are at a greater risk of developing hearing loss, audiological tests to monitor auditory function should be introduced into comprehensive packages of care provided by diabetes services.²¹ Further research and evidence-based outcomes may support the introduction of indicators, within the diabetes domain of the Quality and Outcomes Framework, to identify hearing difficulties in the diabetes population.

Declaration of interests

There are no conflicts of interest declared.

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