Prevalence of hearing loss among Saudi type 2 diabetic patients

Afaf H. Bamanie, MD, PhD, Khaled I. Al-Noury, MD, FRCSC.

ABSTRACT

الأهداف: مقارنة ضعف السمع وأشكال المخططات السمعية في المجموعة المُصابة بداء السكري من النمط الثاني مع مجموعة التحكم التي تم اختيارها من نفس الفئة العمرية في المجتمع السعودي.

الطريقة: أُجريت هذه الدراسة المراقبة في قسم أمراض الأنف والأذن والحنجرة بمستشفى جامعة الملك عبدالعزيز، جدة، المملكة العربية السعودية وذلك خلال الفترة من يناير 2005م إلى ديسمبر 2009م. شملت الدراسة 196 فرداً (تتراوح أعمارهم ما بين 29– 69 عاماً)، وقد تم تقسيمهم إلى مجموعتين وهما: مجموعة داء السكري من النمط الثاني (العدد=109 مريضاً)، ومجموعة التحكم (العدد=87 فرداً). ولقد قمنا باستثناء المرضى الذين لديهم تاريخ سابق للتعرض للضوضاء، وفقد السمع التوصيلي، واستخدام الأدوية السامة، وظهور ضعف السمع سابقاً في العائلة. كما وتمت أيضاً معاينة العوامل التالية: العمر، والجنس، وتاريخ العائلة الطبي، ومدة الإصابة بداء السكري، ونوع العلاج الحالي، ومضاعفات المرض. لقد تم تسجيل صافي توتر السمع باستخدام وحدة قياس الصوت (الديسيبل)، وتحليل البيانات المُعطاة إحصائياً، ومن ثم تم عمل مقارنة بين المجموعتين اللتان تضمنتهما الدراسة.

النتائج: أشارت نتائج الدراسة إلى وجود علاقة قوية بين داء السكري من النمط الثاني وفقدان السمع وخاصة في الترددات السمعية المنخفضة والمتوسطة وذلك بالمقارنة مع مجموعة التحكم، وكان مخطط السمع المُسطح من أكثر أشكال المخططات السمعية شيوعاً. لقد لوحظ أن المرضى الذين يعانون من مضاعفات السكري معرضين أكثر من غيرهم لخطر فقد السمع، ولوحظ أيضاً ارتباط استخدام الأنسولين بزيادة خطر الإصابة بفقد السمع.

خاتمة: أثبتت الدراسة مدى العلاقة القوية بين داء السكري من النمط الثاني وفقد السمع وخصوصاً في الترددات السمعية المنخفضة والمتوسطة. وقد ترتبط العوامل التالية: العمر، واستخدام الأنسولين للتحكم بزيادة سكر الدم، وظهور مضاعفات المرض بزيادة خطر الإصابة بفقد السمع بين مرضى داء السكري من النمط الثاني.

Objectives: To compare hearing impairment and audiometric shapes associated with type 2 diabetes mellitus (T2DM) with an age-matched control group in the Saudi population.

Methods: This is an observational case-control study at a tertiary academic referral center. We recruited 196 individuals (age; 29-69 years) attending the Department of Otolaryngology, King Abdulaziz University Hospital between January 2005 to December 2009, and grouped them into T2DM (n=109) and control (n=87) groups. We excluded patients with a history of noise exposure, conductive hearing loss, ototoxic medications, and a positive family history of hearing impairment. Age, gender, family history, duration of T2DM, current treatment, and presence of diabetic complications were noted. Pure tone hearing (in decibels [dB])was recorded. Data were statistically analyzed against the matched control group.

Results: We identified a strong relationship between T2DM and low and mid frequencies hearing loss than the matched controls. A flat audiogram was the most common audiometric shape observed. Patients with associated diabetic complications were at a higher risk of hearing loss, while hyperglycemic control by insulin was also observed to be a risk factor for hearing loss.

Conclusions: The T2DM is strongly associated with hearing loss especially in the low and mid frequencies. Several factors including age, diabetes control by insulin, and presence of complications, may be risk factors for hearing loss in DM patients.

Saudi Med J 2011; Vol. 32 (3): 271-274

From the Department of Otolaryngology, Head & Neck Surgery, King Abdulaziz University, Jeddah, Kingdom of Saudi Arabia.

Received 9th October 2010. Accepted 25th January 2011.

Address correspondence and reprint request to: Dr. Khaled I. Al-Noury, Department of Otolaryngology, Head & Neck Surgery, King Abdulaziz University, PO Box 35135, Jeddah 21488, Kingdom of Saudi Arabia. Tel. +966 (2) 6408351. Fax. +966 (2) 6408281. E-mail: Kalnoury@kau.edu.sa

Diabetes is a complex multisystem disease characterized by its renal, visual, and neuropathological complications.[1] Most experimental and clinical evidence suggest that these complications are a consequence of metabolic derangement, mainly hyperglycemia.[1] The incidence of diabetes mellitus (DM), especially type 2 DM (T2DM), has increased over the past decade. The incidence of associated hearing impairment has been reported between 45 and 51%, although this depends on the method used to identify hearing impairment.[2,3] However, diabetic patients have a higher prevalence of hearing impairment, and do not achieve the same reduction in hearing over time as individuals without diabetes.[2,4] In this study, we examined the prevalence of hearing impairment and audiogram shapes in Saudi T2DM patients, and compared the findings with those of matched non-diabetic controls.

Methods. The ethical approval for this observational case-control study was obtained from the hospital's ethical committee. A questionnaire and a consent form were completed by all patients. We excluded patients with a history of noise exposure, ototoxic medications, conductive hearing loss, and a positive family history of hearing impairment. We recruited 196 individuals (age; 29-69 years) attending the Department of Otolaryngology, King Abdulaziz University Hospital, Jeddah, Kingdom of Saudi Arabia between January 2005 to December 2009, and grouped them into T2DM (n=109) and control (n=87) groups. Type 2 diabetes was defined as physician-diagnosed diabetes based on glycosylated hemoglobin (HbA1c) or a fasting blood glucose >7.0 mmol/L. Age, gender, family history, duration of T2DM, current treatment, and presence of diabetic complications were recorded. A pure-tone hearing (in decibels [dB]) audiogram, serum cholesterol, and triglycerides were also recorded. In this study, we assessed 2 parameters: hearing loss in the best ear with the minimum hearing loss threshold across the entire frequency range, and hearing loss in the worst ear with the maximum average threshold value for the entire frequency range. Any hearing impairment was defined as average pure-tone audiometry threshold of the worse ear >25 dB. Pure tone audiogram shapes were determined by calculating the differences in the average hearing thresholds between the different frequency regions represented by low (250-500 Hertz [Hz]), mid (1000-2000 Hz), and high (4000-8000 Hz) frequencies.

Data analysis was carried out using the Statistical Package for Social Sciences version 9 for Windows (SPSS Inc, Chicago, IL, USA). $P<0.05$ was considered statistically significant.

Results. We compared 52 males (47.7%) and 57 females (52.3%) with T2DM to 46 non-diabetic males (52.9%) and 41 females (47.1%). The clinical characteristics of both groups are shown in **Figures 1, 2 & 3**. The mean age of T2DM subjects was 47.9 and for the control group was 45.7 years. The mean duration of DM was 10.52 years. There was no significant difference for the gender within each group according to the binomial test. There was also no significant difference in mean age between the diabetic and control groups by using the t test for independent samples. The chi-square test indicated no significant difference in gender between both groups. There was no significant difference in the minimum age, at which hearing loss started in the diabetic group (30 years in females and 33 in males), and in the control group (30 years in both males and females). For the hearing loss in the worst ear, 76 patients in the DM group were found to have hearing impairment with a mean age of 50.82 years, while 34 individuals in the control group were identified with hearing impairment with a mean age of 51.91 years. In general, the prevalence of hearing impairment in the diabetic group was significantly higher than in the control group (p=0.005). There was no significant difference between genders in both groups. With regard to the ear with the best hearing, hearing loss was observed in 57 DM patients, and this was significantly higher (p=0.005) than that observed in the control group (**Table 1**). The prevalence of hearing loss with reference to the worst or best hearing ear in different frequency regions was significantly different between the diabetic and control groups in the mid and high frequency regions. However, it was only significantly different in female diabetic patients (p=0.005) in the low frequency region compared with control (p=0.009). The average threshold level for the best and worst hearing in diabetic patients was higher than that in the controls. Flat audiograms formed the highest proportion of audiometric shapes observed in the diabetic and control groups. They were observed in 73 (67%) of the best hearing ears and 62 (56.9%) of the worst hearing ears in the diabetic group. In the control group, flat audiograms were observed in 69 (79.3%) of the best hearing ears and 64 (73.6%) of the worst hearing ears. Eighty-two subjects in the diabetic and 40 in the control groups had a family history of DM. The chi-square test showed that the diabetic group had a significantly larger number of subjects with a family history of DM than the control group (p=0.005) (**Table 2**). Finally, we investigated the relationship between hearing loss in the best and worst ears in both groups with DM duration and patient age by using linear regression analysis. We observed a significant relationship between hearing loss and age

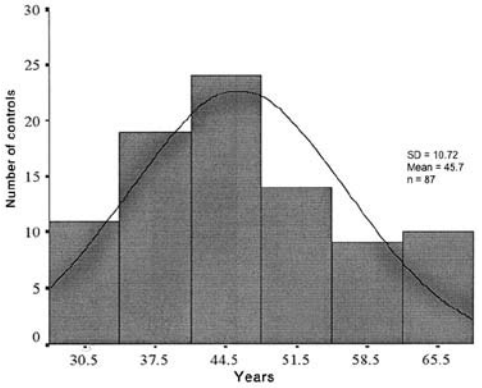

Figure 1 - Age distribution analysis of the control group.

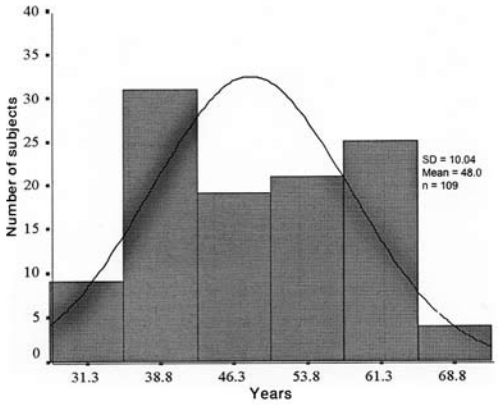

Figure 2 - Age distribution analysis of the type 2 diabetes mellitus group. SD - standard deviation

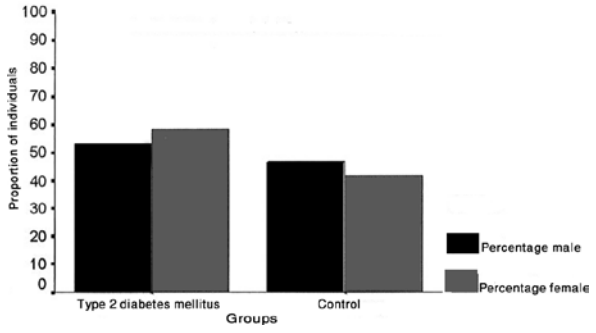

Figure 3 - Gender distribution analysis in the type 2 diabetes mellitus and control groups.

Table 2 - Family history of diabetes in the diabetic and control groups.

Groups	Family history of DM	No family history of DM
Diabetic	82 (75.3)	27 (24.7)
Control	40 (46.0)	47 (54.0)
P-value	c^2 = 20.23, degrees of freedom = 1, p=0.005	

Table 3 - Diabetes mellitus (DM) complications in the study group (n= 87).

DM complications	n (%)
Neuropathy	62 (71.3)
Hyperlipidemia	42 (48.2)
Cataract	20 (22.9)
Hypertension	24 (27.6)
Retinopathy	19 (21.8)
Heart disease	15 (17.2)
Renal disease	11 (12.6)
Diabetic foot	4 (4.6)

Table 4 - Number of patients according to their current treatment and their mean hearing thresholds in dB hearing loss.

Current treatment	n (%)	Mean ± SD of dB HL
Diet	6 (5.5)	12.08 ± 3.41
Oral hypoglycemic agents	97 (89.0)	15.14 ± 5.46
Insulin*	6 (5.5)	31.25 ± 12.27

SD - standard deviation, dB - decibels, HL - hearing level, *p=0.003

(p=0.001). Eighty-seven (79.8%) patients were found to have the following complications, such as neuropathy, hyperlipidemia, cataract, hypertension, retinopathy, heart disease, renal disease, and diabetic foot (**Table 3**). The chi-square test showed a significant relationship between complications and the average hearing level in the best and worst hearing ears (c^2=7.69, degrees of freedom[df] = 1, p=0.006), this was due to 66 (86.8%) diabetic patients had hearing loss with complications, while only 10 (13.2%) patients had hearing loss without complications. There was a significant increase in the mean hearing threshold of patients who were receiving insulin treatment compared to those on a diet and/or oral hypoglycemic agents to control their diabetes (p=0.003) (**Table 4**).

Table 1 - Clinical features and prevalence of hearing impaired patients in the diabetic and control groups.

Groups	Worst ear			Best ear		
	n	Male	Female	n	Male	Female
	n (%)					
Diabetic	76 (69.7)	37 (48.7)	39 (51.3)	57 (52.3)	31 (54.4)	26 (45.6)
Control	34 (39.1)	24 (70.6)	10 (29.4)	22 (25.3)	16 (72.7)	6 (27.3)
P-value	0.005			0.005		

Discussion. Diabetes mellitus and other metabolic disorders have been associated with sensorineural hearing loss, however, this has been a matter of debate since Jordao[5] first reported it in 1857. It remains controversial whether the relationship between DM and hearing loss is a causal one. Some studies reported a significant correlation,[2,4] while others did not.[6] The pathophysiology underlying diabetes-associated hearing loss is unclear, thus allowing for speculation. A leading hypothesis is the effect of diabetes-related microvascular disease on the cochlea.[7] Temporal bone studies have demonstrated pathology in the stria vascularis and in hair cells during postmortem studies of the inner ear in diabetic adults.[8,9] There is also controversy regarding the relationship between hearing impairment and age, gender, disease duration, diabetic control, and the severity of diabetes.[2,10,11]

The current study showed that Saudi type 2 diabetic patients had a significantly poorer hearing threshold than the control group, which is in agreement with several studies.[2,4] We observed that the threshold shift was significant in the low and mid frequencies in the diabetic group, which is also consistent with previous studies.[12] However, other studies have reported that hearing loss was more significant in high frequencies.[13] All audiograms for the better and worse hearing ears were described manually by looking into the differences between average values of low and mid, low and high, and mid and high frequency in each audiogram in the study and control group. Different authors have reported different audiogram shapes, such as flat and high frequency gently sloping, steeply sloping, and low ascending types. The flat type is the most frequently observed audiogram shape in DM patients.[12] In our tested population, both genders were affected equally. These results differ from other reports indicating that males were more affected than females.[11] In the present study, we found that diabetic control and low complications rate had a significant relationship with the degree of hearing loss, which is consistent with other reports.[14]

A selection bias might have occurred, and this could be one of the limitations of our study. High frequency range audiometry testing should be considered for proper assessment level of impaired hearing in diabetic subjects.

In conclusion, hearing loss can start at 30 years of age in the general population. In general, the prevalence of hearing impairment was significantly higher in the diabetic group than in the control group. Flat audiograms formed the highest proportion of shapes observed in the diabetic and control groups. There was a significant relationship between patient age and hearing loss, while the duration of diabetes had no significant effect on hearing loss. Patients with associated diabetic complications are at a higher risk of hearing loss, while hyperglycemic control by insulin was observed to be another risk factor for hearing loss. Counseling diabetic patients to control diabetes would help to eliminate some of the causes of hearing loss. Future studies discussing pattern, and prevalence of hearing loss in all types of DM is recommended to exert some effort in eliminating all, or part of the potential weakness of our studies.

Acknowledgment. *The authors gratefully acknowledge Prof. F. Dahlawi, King Abdulaziz University, Jeddah for his valuable guidance in the statistical analysis, and special thanks to the physicians in the General and Diabetes Clinics for their cooperation in referring patients. We would like to thank all the patients who made this study possible.*

References

1. Liu Z, Fu C, Wang W, Xu B. Prevalence of chronic complications of type 2 diabetes mellitus in outpatients - a cross-sectional hospital based survey in urban China. ***Health Qual Life Outcomes*** 2010; 8: 62.
2. Mozaffari M, Tajik A, Ariaei N, Ali-Ehyaii F, Behnam H. Diabetes mellitus and sensorineural hearing loss among non-elderly people. ***East Mediterr Health J*** 2010; 16: 947-952.
3. Mitchell P, Gopinath B, McMahon CM, Rochtchina E, Wang JJ, Boyages SC, et al. Relationship of type 2 diabetes to the prevalence, incidence and progression of age-related hearing loss. ***Diabet Med*** 2009; 26: 483-488.
4. ChengYJ, Gregg EW, Saaddine JB, Imperatore G, Zhang X, Albright AL. Three decade change in the prevalence of hearing impairment and its association with diabetes in the United States. ***Prev Med*** 2009; 49: 360-364.
5. Jordao AMD. Consideration sur un cas du diabete. ***Union Medicale du Paris*** 1857; 11:446. French.
6. Maia CA, Campos CA. Diabetes mellitus as etiological factor of hearing loss. ***Braz J Otorhinolaryngol*** 2005; 71: 208-214.
7. Lisowska G, Namyslowski G, Morawski K, Strojek K. Cochlear dysfunction and diabetic microangiopathy. ***Scand Audiol Suppl*** 2001; 52: 199-203.
8. Fukushima H, Cureoglu S, Schachern PA, Kusunoki T, Oktay MF, Fukushima N, et al. Cochlear changes in patients with type 1 diabetes mellitus. ***Otolaryngol Head Neck Surg*** 2005; 133: 100-106.
9. Fukushima H, Cureoglu S, Schachern PA, Paparella MM, Harada T, Oktay MF. Effects of type 2 diabetes mellitus on cochlear structure in humans. ***Arch Otolaryngol Head Neck Surg*** 2006; 132: 934-938.
10. Kasemsuwan L, Sriwanyong S, Krittiyawong S, Sunetrworakul J, Jiamsuchon K. Hearing in young diabetic patients. ***J Med Assoc Thai*** 2001; 84: 1389-1394.
11. Pudar G, Vlaski L, Filipovic D, Tanackov I. Correlation of hearing function findings in patients suffering from diabetes mellitus type 1 in regard to age and gender. ***Med Pregl*** 2009; 62: 395-401. English, Serbian.
12. Bainbridge KE, Hoffman HJ, Cowie CC. Diabetes and hearing impairment in the United States: audiometric evidence from the National Health and Nutrition Examination Survey, 1999 to 2004. ***Ann Intern Med*** 2008; 149: 1-10.
13. Ren J, Zhao P, Chen L, Xu A, Brown SN, Xiao X. Hearing loss in middle-aged subjects with type 2 diabetes mellitus. ***Arch Med Res*** 2009; 40: 18-23.
14. El-Tabal ES, Mackenzie I, Surenthiran SS, Abouaesha F, Boulton AJM. The relationship of hearing loss to age, duration, degree of control, and complications in diabetic patients. ***Audiological Medicine*** 2003; 1: 242-246.