Hearing in Young Diabetic Patients

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Abstract

Among patients who have sensorineural hearing loss of unknown etiology, diabetes is one of the diseases to be routinely investigated. The purpose of this study was to examine the uncertain relationship between sensorineural hearing loss and diabetes. The authors prospectively studied the pure tone audiometry in 60 diabetic patients, aged less than 40 years and in 60 randomly selected age and sex matched non-diabetic control subjects. The average hearing threshold of the diabetic patients showed a significant elevation than the control subjects although this average threshold in the young diabetic group was still within normal limits. Finally, no consistent association between the average hearing threshold and factors; such as duration of disease, controllable status of diabetes, presence of family history of diabetes or presence of any complication was found to be significant among young diabetic patients.

Key word : Diabetes, Hearing Threshold

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Among patients with sensorineural hearing loss of unknown etiology, investigation for diabetes is routinely done by most otolaryngologists. Evidence is needed to show whether the relationship between diabetes and hearing loss really exists since this has been a subject of controversy for decades. To this day, reports in the literature contain evidence both supporting[1-5] the correlation of the existence of

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hearing loss in diabetics and those which showed no correlation[6-9]. The manifestation type of sensorineural hearing loss in diabetes was described as progressive and ipsilateral with gradual onset predominantly affecting the higher frequencies[5,6]. The mechanism of hearing impairment in diabetic patients is not clear but is postulated to involve microvascular component. Neuronal microvascular compromise can result in a degeneration and finally deficit of the auditory nerve. Recent studies suggested that the pathogenic lesion in diabetic hearing impairment probably affected both the inner ear cochlea (peripheral) and retrocochlea (central auditory pathways)[2,13].

MATERIAL AND METHOD

Study design

Most previous studies on hearing loss and diabetes in the literature have generally included all age groups which may not exclude hearing loss which occurs in the aged such as presbycusis. This study was designed to investigate the auditory status in young adult diabetic patients, to find any abnormal hearing compared to control subjects in a Thai population. Several potential relevant factors were also studied for any correlation to the auditory status in diabetic patients.

Selection of subjects

A prospective study involving 60 young adult diabetics (aged less than 40 years) consulted to Otolaryngology Clinic from the Diabetic Clinic, at Ramathibodi Hospital, was carried out from January to December 1999. They were questioned about their diabetic history and otological symptoms. Specific questions on diabetic duration and clinical details of diabetes were studied. Specific otolaryngological examination was performed. A standard pure tone audiogram was obtained from each ear, from 250 to 8,000 Hz for air conduction, and from 500 to 4,000 Hz for bone conduction in a sound-proof room with appropriate masking where indicated. Pure tone air audiogram was used to evaluate the hearing threshold. Subjects with conductive hearing loss were excluded.

The inclusion criteria for the diabetic study group (DSG) were as follows:

1. Diabetic patients aged less than 40 years.
2. Otological examination showed normal external ear canal and tympanic membrane.

Exclusion criteria were:

1. Subjects with a past history of ear disease, noise exposure, ototoxic drug usage, severe head injury or familial history of hearing loss.
2. Subjects with conductive hearing loss.

Fifty- eight diabetic patients satisfied these criteria and were included in the study. Patients' clinical manifestations and medical records were studied as potentially relevant variables, these included:

1. Duration of diabetes whether it was less than 5 years, or 5 years and more.
2. Fasting blood sample of HbA_{1c} value showed disease control status. An acceptable control was defined by an average HbA_{1c} of less than 8 mg per cent and the value of 8 mg per cent or more was classified as an unacceptable control.
3. Any positive family history of diabetes.
4. Presence of complications such as neuropathy, retinopathy or nephropathy.

Control population

Data for the control subjects was randomly taken from files of normal healthy subjects where age and sex matched.

Satistical analysis

1. Comparison of the hearing threshold at each of the average pure tone frequency between DSG and control subjects. Results of each ear are presented as mean ± SD.
2. Determining the influence of relevant variables on the hearing threshold at each frequency by measuring the difference in average hearing threshold between the DSG and control subjects.

Statistical data was performed with student *t*-test for comparison between the two groups, a p-value less than 0.05 is considered significant.

RESULTS

Audiologic findings

Three patients had symptomatic hearing difficulty, and all showed mild loss from audiogram. The averages of pure tone threshold at 250, 500, 1,000, 2,000, 4,000, 8,000 Hz of DSG and control subjects are demonstrated in Table 1. This average hearing threshold at each frequency was not greater than 25 decibels and was considered as normal hearing, however, it was interesting to find that each average threshold was significantly more elevated than the control subjects especially at low and high

Table 1. The averages of hearing threshold from each frequency in diabetic study group (DSG) and control subjects.

Frequencies Hz	Right ear			Left ear		
	DSG	Control subjects	p-values	DSG	Control subjects	p-value
250	23.88 ± 10.84	14.42 ± 5.6	<0.001	23.10 ± 9.73	13.17 ± 6.31	<0.001
500	21.47 ± 8.93	14.48 ± 8.95	<0.001	20.0 ± 6.07	11.83 ± 6.83	<0.001
1,000	20.0 ± 11.58	13.0 ± 9.7	<0.001	17.76 ± 7.27	11.58 ± 7.73	<0.001
2,000	17.33 ± 12.82	12.92 ± 11.69	=0.002	16.03 ± 9.63	11.25 ± 7.62	=0.003
4,000	19.48 ± 14.77	11.25 ± 7.34	<0.001	19.57 ± 13.32	11.58 ± 7.78	<0.001
8,000	21.55 ± 18.95	12.83 ± 8.15	=0.001	21.47 ± 17.01	13.1 ± 9.42	<0.001

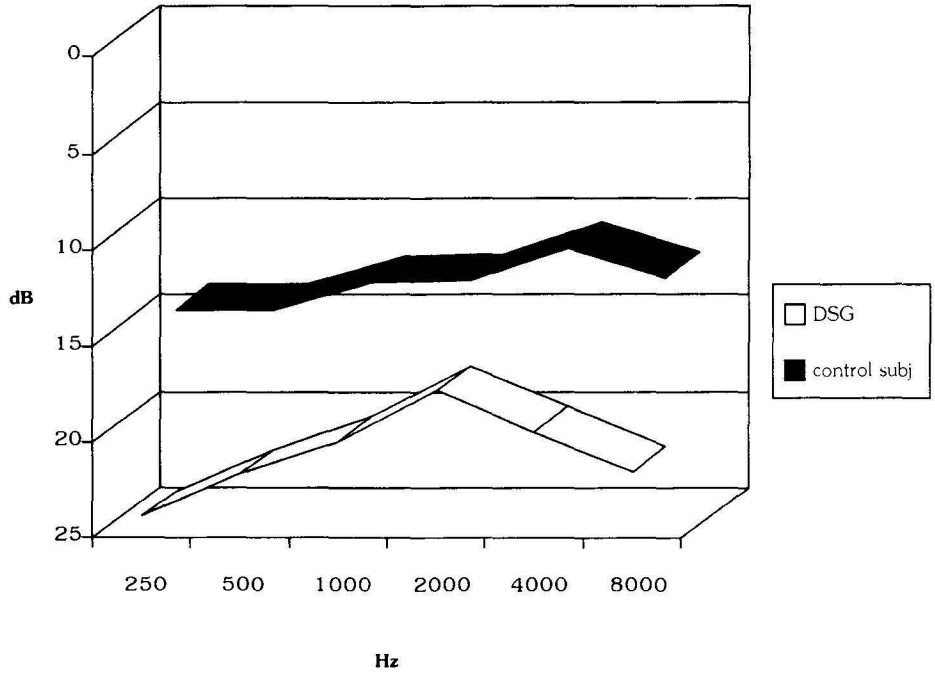

Fig. 1. Averages of hearing threshold in the diabetic study group (DSG) and control subjects in the right ear.

frequencies than at mid frequency ($p<0.05$). (Table 1, Fig. 1 and 2)

Clinical findings

Of 58 patients in the DSG, there were 26 males, mean age 30.58 years (range 18-39 years), and 32 females, mean age 28.03 years (range 17-39 years). The control subjects consisted of 30 males, mean age 28.67 years (range 17-39 years) and 30 females, mean age 27.43 years (range 18-35 years).

Symptomatic difficulty in hearing was present in three patients, bilateral in two and progressive in all three patients. The remaining 55 patients did not have any symptoms of hearing loss. Tinnitus was present in two patients who had difficulty in hearing but vertigo, ear fullness or pressure sensation in the ear was not present.

The duration of diabetes in the DSG varied from 1 month to 20 years, 51.72 per cent of the patients had a disease duration of more than 5 years.

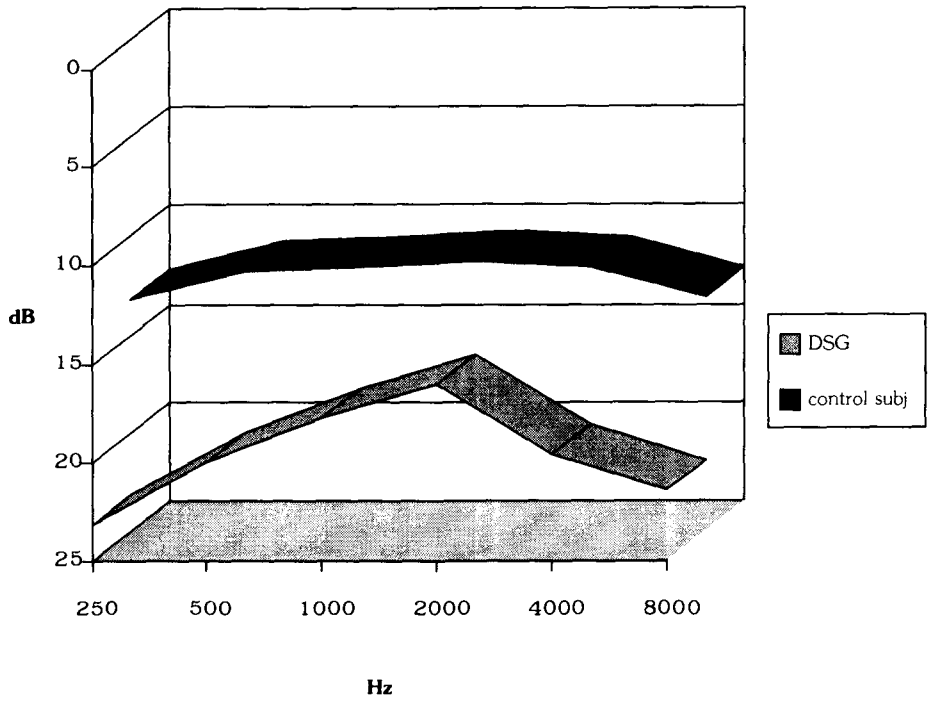

Fig. 2. Averages of hearing threshold in the diabetic study group (DSG) and control subjects in the left ear.

Table 2. The p-values of the correlation between clinical variables and means of hearing threshold from each frequency in the right and left ears.

Factors	250 Hz		500 Hz		1,000 Hz		2,000 Hz		4,000 Hz		8,000 Hz	
	R	L	R	L	R	L	R	L	R	L	R	L
Duration	0.05	0.74	0.06	0.197	0.65	0.33	0.89	0.32	0.90	0.84	0.79	0.38
Disease-controlled status	0.93	0.88	0.58	0.49	0.21	0.30	0.29	0.15	0.64	0.58	0.83	0.96
Presence of family history	0.88	0.66	0.50	0.52	0.24	0.34	0.17	0.39	0.44	0.21	0.45	0.96
Presence of complication	0.54	0.79	0.69	0.70	0.34	0.94	0.33	0.80	0.69	0.44	0.59	0.24

The average HbA_{1C} blood test as an objective indicator of disease-control status was obtained and found to be less than 8 mg per cent in 36.5 per cent of the cases. This was classified as an acceptable control group. Positive family history was found in 44.8 per cent of the patients and only 5.17 per cent have clinical symptoms of diabetic neuropathy.

From the study, none of these potentially relevant factors was found to be significantly related to the hearing threshold in the young diabetic group ($p>0.05$). (Table 2)

DISCUSSION

The true existence of hearing impairment in diabetic patient remains controversial. This has been described in a number of clinical studies using statistical analysis[3-5,7,8]. Most previous studies examined hearing impairment in all age groups or

diabetic patient aged less than 60 years in whom presbycusis can interfere with the results. Some were small studies which had limited ability to detect any association but some were larger studies[6,8,10] which also failed to find an overall association between diabetes and hearing loss. This study, which included diabetic patients aged less than 40 years, found no hearing impairment in the DSG, however, the average hearing threshold from each frequency showed a higher threshold level than the control subjects especially at low and high frequencies which was statistically significant ($p < 0.05$). Cullen et al[5] and Axellson et al[6] previously reported and described hearing impairment in diabetes as a progressive, ipsilateral and affecting more at the higher frequencies.

The potential clinical factors which can influence the hearing threshold in the DSG were studied and neither showed significant correlation. Axellson et al[6] found only age not duration of the disease to be associated with hearing impairment. They said the older the patient was, the more likely he will have hearing loss. No correlation between the duration of disease and the average hearing threshold at each frequency was found from this study. In review of the literature, both positive[9,11,12] and negative[1,4-6] relationships between the duration of disease and hearing loss have been reported. For disease control status, Kurien et al noted that poorly controlled diabetes had a worse hearing threshold than those who were well controlled[4]. From this study, an average HbA_{1C} was used as an indicator and was not found to be associated with the hearing threshold. Vascular lesions have been theorized to be an important causative factor for neuronal degeneration of the auditory nerve as has occurred in other organs such as retinopathy or nephropathy [2,13,15,16]. Data from earlier studies suggested hearing loss was associated with the presence of diabetic complications such as retinopathy and nephropathy[1,11,17]. Jorgensen and Buch found hearing loss twice as common in those with severe proliferative retinopathy[1], although Tay et al found no such relationship[11]. However, from this study no significant association between complication and hearing threshold was found.

We concluded that the average hearing threshold in diabetic patients aged less than 40 in this study was within normal limits (0-25 decibels), however a significant elevation of threshold was noted compared to control subjects. This may be taken as a warning sign of future hearing impairment in the diabetic group.

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REFERENCES

1. Jorgensen MB, Buch NH. Studies on inner-ear function and cranial nerves in diabetes. Acta Otolaryngol (Stockh) 1961; 55: 350-64.
2. Friedmann SA. Hearing and diabetic neuropathy. Arch Intern Med 1975; 135: 573-6.
3. Taylor IG, Irwin J. Some audiological aspects of diabetes mellitus. J Laryngol Otol 1978; 92: 99-113.
4. Kurien M, Thomas K, Bhano TS. Hearing thresholds in patients with diabetes. J Laryngol Otol 1989; 103: 164-8.
5. Cullen JR, Cinnamon MJ. Hearing loss in diabetes. J Laryngol Otol 1993; 107: 179-82.
6. Axellson A, Fagerburg SE. Audiotory function in diabetes. Acta Otolaryngol 1968; 66: 49-64.
7. Gibbin KP, Davis CG. A hearing survey in diabetes mellitus. Clin Otolaryngol 1981; 6: 345-50.
8. Axellson A, Sigroth K, Vertes D. Hearing in diabetics. Acta Otolaryngol 1978; 356 (Suppl): 3-23.
9. Sieger A, White NH, Skinner MW, et al. Auditory function in children with diabetes. Ann Otol Rhino Laryngol 1983; 92: 237-41.
10. Harner SG. Hearing in adult-onset diabetes mellitus. Otolaryngol Head Neck Surg 1982; 89: 322-7.
11. Tay HL, Ray N, Ohri R, et al. Diabetes mellitus and hearing loss. Clin Otolaryngol 1995; 20: 130-4.
12. Borsuk J, Lisiecha H, Majcherska B. The audiometric curve in diabetes mellitus. Polish Arch of Med Warsaw 1956; 26: 1159-66.
13. Leo MASD, Nardo WD, Cercone S, et al. Cochlear dysfunction in IDDM patients with subclinical peripheral neuropathy. Diabetes Care 1997; 20:

824-8.
14. Costa OA. Inner ear pathology in experimental diabetes. Laryngoscope 1967; 77: 68-75.
15. Martini A, Comacchio F, Molinari G, et al. Auditory brainstem evoked responses as a function of stimulus repetition in diabetes mellitus. Adv Audiol 1985; 3: 133-41.
16. Makashima K, Tanaka K. Pathological change of the inner ear and central auditory pathways in diabetes. Ann Otol Rhinol Laryngol 1971; 80: 218-88.
17. Celik O, Yalcin S, Celebi H, Ozturk A. Hearing loss in insulin-dependent diabetes Mellitus. Auris Nasus Larynx 1996; 23: 127-32.

ระดับการได้ยินในผู้ป่วยโรคเบาหวานที่อายุยังน้อย

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จนถึงปัจจุบัน ในทางคลินิกยังไม่สามารถบอกได้อย่างแน่ชัดว่าผู้ป่วยที่เป็นเบาหวานจะมีโอกาสเสี่ยงต่อการสูญเสียการได้ยิน หรือผู้ป่วยที่มีการได้ยินเสื่อมเป็นผลมาจากโรคเบาหวาน แต่ในทางปฏิบัติเมื่อผู้ป่วยมีเส้นประสาทหูเสื่อมโดยไม่ทราบสาเหตุ โรคเบาหวานเป็นโรคหนึ่งที่มักต้องคำนึงถึง

การศึกษานี้เป็นการศึกษาระดับการได้ยินในผู้ป่วยโรคเบาหวานที่อายุน้อยกว่า 40 ปี ทั้งนี้เพื่อตัดปัญหาเรื่องการได้ยินเสื่อมในผู้ป่วยสูงอายุออกและเปรียบเทียบกับกลุ่มคนปกติ โดยตรวจการได้ยินด้วยเครื่องตรวจการได้ยิน (audiometer) จากการศึกษาพบว่าระดับการได้ยินเฉลี่ยในผู้ป่วยเบาหวานที่อายุน้อยกว่า 40 ปี ยังอยู่ในระดับของเกณฑ์ที่ปกติคือ 0-25 เดซิเบล แม้ว่ามีเปรียบเทียบกับระดับการได้ยินเฉลี่ยในกลุ่มคนปกติจะพบว่าผู้ป่วยเบาหวานที่อายุน้อยกว่า 40 ปี มีระดับการได้ยินเฉลี่ยที่สูงกว่ากลุ่มคนปกติอย่างมีนัยสำคัญทางสถิติ

เมื่อศึกษาปัจจัยต่าง ๆ ทางคลินิก ที่อาจมีส่วนเกี่ยวข้องกับระดับการได้ยิน ได้แก่ ระยะเวลาที่เป็นความสามารถในการควบคุมโรค มีประวัติครอบครัวเป็นเบาหวาน หรือมีปัญหาแทรกซ้อน ต่างก็ไม่พบว่ามีผลต่อระดับการได้ยินในผู้ป่วยเบาหวานที่อายุน้อยกว่า 40 ปี

คำสำคัญ : โรคเบาหวาน, ระดับการได้ยิน

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