Early on evaluation of hearing function with Transient Evoked Otoacoustic Emissions (TEOAE) and Distortion Product Otoacoustic Emissions (DPOAE) in type 2 diabetic patients without hypertension

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Objective: Type 2 diabetes mellitus (DM) is a chronic metabolic disease characterised by insulin resistance and/or reduced insulin secretion from pancreas resulting in disturbance in lipid, protein and carbohydrate metabolism. Elevated blood glucose in patients with diabetes mellitus results in damage to various organs especially eyes, kidneys, nerves, hearth and blood vessels (1). Less well known complication of DM is auditory dysfunction. Sensory neural hearing loss (SNHL) in diabetes mellitus has been described as being bilateral, progressive and seen especially in high frequencies (2). Both TEOAE and DPOAE are generated within the cochlea by the active micromechanisms of the outer hair cells in the organ of corti and gives objective information about the mechanical, preneural components of the peripheral auditory pathway (3). The stimulus used to produce DPOAEs transmits more energy to same specific areas of the cochlea, although stimulus used to achieve TEOAEs is a short duration click whose energy is spread across the whole cochlea. Otoacoustic emission (OAE) testing is accurate, frequency specific, non-invasive and easily applied which specifically reflects the function of the outer hair cells. Altered hearing function in diabetic patients has been found in both pure tone audiometry and OAEs (4). We intended to evaluate the cochlear function with both DPOAE and TEOAE test in patients with DM without polyneuropathy and hypertension.

Patients and Methods: The study was conducted in Otorhinolaryngology and Endocrinology and Metabolism Outpatient Department of Abant Izzet Baysal University Izzet Baysal Research and Training Hospital, Bolu, Turkey. The study group consisted of type 2 diabetic patients and healthy age and sex matched volunteers. Biochemical analysis was done for all patients following overnight fasting. Detailed ear examination, pure tone audiometry, TEOAE, and DPOAE were assessed in all volunteers in sound proof room. Electromyography; so as to exclude cases with polyneuropathy was done in all patients with DM. Also, ophthalmoscopic fundus examination was performed in all diabetic patients.

Results: There are not statistically significant difference between groups according to sex, gender and smoking habits ($p>0.05$). Right ear TEOAE 20 kHz frequency signal to noise ratio (SNR) ($p=0.043$), 40 kHz frequency SNR ($p=0.018$) and left ear TEOAE 20 kHz frequency SNR ($P=0.004$) are lower in patients with DM (Table-1). Although; there are differences in respective kHz values between DM and healthy control according to TEOAE test report, there is not statistical significant difference between groups according to overall TEOAE frequencies (left ear ($p=0.837$), right ear ($p=0.442$)) (Table-2). There is a statistically significant negative correlation between right ear TEOAE 20 kHz SNR ($P=0.044$) and serum glucose level. Also there is a statistically nearly significant negative correlation between right ear TEOAE 40 kHz SNR and retinopathy ($p=0.053$). On the other side; there aren't any correlation between duration of diabetes, HbA1c values, TEOAEs and DPOAEs (Table-3).

TEOAE test report	Diabetes Mellitus	Healthy Control	P value
Right 10 kHz SNR	30,90	25,58	P=0,220
Right 14 kHz SNR	28,54	27,55	P=0,819
Right 20 kHz SNR	23,22	31,98	**P=0,043**
Right 28 kHz SNR	24,88	30,60	P=0,187
Right 40 kHz SNR	22,42	32,65	**P=0,018**
Left 10 kHz SNR	28,78	27,35	P=0,742
Left 14 kHz SNR	29,50	26,75	P=0,526
Left 20 kHz SNR	21,10	33,75	**P=0,004**
Left 28 kHz SNR	26,58	29,18	P=0,548
Left 40 kHz SNR	27,64	28,30	P=0,879

Table 1: Comparison of the TEOAEs between DM and Healthy control (Non-parametric Mann-Whitney Test)

	Diabetes Mellitus		**Healthy Control**		**P values**
	Hearing	**Not Hearing**	**Hearing**	**Not Hearing**	
DPOAE Right	18	7	22	8	P=0,913
DPOAE Left	14	11	17	13	P=0,961
TEOAE Right	15	10	21	9	P=0,442
TEOAE Left	16	9	20	10	P=0,837

Table 2: Cochlear function according to overall TEOAE frequencies between DM and healthy control was shown. (Non-parametric Mann-Whitney Test)

	Glucose	**HbA1c**	**Retinopathy**	**Duration of Diabetes**
TEOAE Right 20 kHz SNR	r= -0,273 **p= 0,044***	r= -0,119 p= 0,608	r= -0,375 p= 0,064	r= 0,010 p= 0,963
TEOAE Right 40 kHz SNR	r= -0,157 p= 0,254	r= -0,64 p= 0,782	r= -0,391 **p= 0,053****	r= -0,28 p= 0,895
TEOAE Left 20 kHz SNR	r= -0,240 p= 0,078	r= -0,250 p= 0,275	r= -0,283 p= 0,171	r= -0,017 p= 0,934

Table-3: Correlation analysis of glucose, HbA1c, retinopathy and duration of diabetes with TEOAE frequencies (Pearson's Correlation analysis)
*Statistically significant
**Statistically nearly significant

Conclusion: This study was done to evaluate cochlear function in electromyography test negative, nonalcoholic and normotensive type 2 DM patients. There are a lot of study in the literature that was performed with TEOAE and/or DPOAE. All of these studies uncovered the detrimental effect of DM on cochlear function (4-6). Besides this, according to our datas: TEOAE measurements at some frequencies were significantly reduced in patients with DM.

Considering overall frequencies, meaningful reduction of cochlear function was not observed. This suggests us that in patients with DM, cochlear function was not affected.

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