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Original Research Article

Does hearing loss relate to gestational diabetes mellitus?

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ABSTRACT

Background: This study aims to check if gestational diabetes mellitus leads to changes in hearing.
Methods: A prospective hospital based observational study was performed with total 60 subjects in age group of 18-40 years in the Department of Otolaryngology and Head and Neck Surgery and the Department of Obstetrics and Gynaecology, Lady Hardinge Medical College, New Delhi between November 2016 to March 2018. Subjects were divided in two groups. The first group included 30 pregnant women with diagnosed gestational diabetes mellitus and the second group had 30 pregnant women not having gestational diabetes mellitus. Pure-tone audiometry and impedance audiometry was performed twice in all the subjects, first during the antepartum period and second time during the postpartum period.
Results: Significant difference was seen between the average of air conduction threshold values at speech frequencies between the two groups during both antepartum and postpartum period.
Conclusions: The alterations in hearing sensitivity in air conduction between the two groups can be attributed to gestational diabetes mellitus.

Keywords: Gestational diabetes mellitus, Hearing, Pregnancy, Hearing loss

INTRODUCTION

As per WHO estimates 2018, hearing loss is the fourth highest cause of disability globally with 6.1% of the world's population having disabling hearing loss.[1] An intrinsic relationship between diabetes mellitus (DM) and auditory dysfunction has been shown in literature. Retrospective analysis has shown that as many as 50% of patients with DM have some form of auditory dysfunction.[2] The general clinical manifestation is gradual bilateral sensorineural hearing loss (SNHL) akin presbycusis, but early hearing loss and hearing loss at low and medium frequencies has also been reported in the medical literature.[3-7] Recent review of literature reveals that DM is an important factor for sudden unilateral hearing loss too.[7,8] SNHL may thus be considered as a chronic complication of DM.

Gestational diabetes mellitus (GDM) is characterized by carbohydrate intolerance with an onset or first recognition during pregnancy.[9,10] It is the most common medical illness which affects maternal and perinatal mortality and morbidity. The prevalence of diabetes in women of child bearing age has dramatically increased.[11-13] About 1-14% of all pregnancies are complicated by diabetes mellitus and 90% of them have GDM.[9] Gestational diabetes mellitus can cause complications in pregnancy similar to those seen in pre-existing diabetes mellitus.[3,14] From the aforesaid account it would be reasonable to assume that cochlear dysfunction might be an outcome of gestational diabetes as the inner ear is sensitive to altered glucose metabolism in GDM.[14,15] Etiopathogenesis of this hearing loss due to DM is attributed physiologically to neuropathy and angiopathy or a combination of both.[3,14-18] The cochlea may also be a

target organ for the ill effects of altered blood glucose and insulin levels, as it does not store energy.

The impact of GDM on hearing loss has not been adequately explored, in spite of the involvement of the sense of hearing. When a search of the available medical literature was done, only one study could be found on the cited subject which reported a high frequency SNHL in gestational diabetes.[14] In view of marked paucity of data, we did this study to evaluate the effect of GDM on hearing.

METHODS

The study sample comprised 30 pregnant women diagnosed with GDM attending the antenatal clinic in the Department of Obstetrics and Gynaecology, Lady Hardinge Medical College, New Delhi between 28-33 weeks of gestational age and a control group consisting of 30 pregnant women without gestational diabetes mellitus matched for gestational age and BMI. The study was conducted jointly by the Department of Otolaryngology and Head and Neck Surgery and the Department of Obstetrics and Gynaecology, Lady Hardinge Medical College, New Delhi between November 2016 to March 2018.

The inclusion criteria was adhered to, which included: Pregnant women with single live fetus with gestational diabetes mellitus diagnosed on oral glucose tolerance test (OGTT) with least 1 abnormal value and the control group comprised of women without gestational diabetes with single live fetus.

Patients with DM prior to pregnancy, having aural complaints at the time of testing like hearing loss, tinnitus, ear discharge or ear fullness or giving history of ear disease in past, previous history of sensorineural hearing loss, history of ototoxic drug intake and history of previous ear surgery were excluded from the study. Also, all pregnant women underwent a detailed antenatal check-up as per institutional protocol where the women are screened for anaemia, hypertension, thyroid disorders and other pregnancy related diseases. Hypertensive pregnant women and women with thyroid disease were also excluded from the study. Iron and folic acid supplements were started after antenatal examination as per the departmental protocol.

An informed consent was taken from all the subjects after explaining the purpose of the study and the nature of the investigations involved. Once included in the study, all the patients underwent a detailed history and examination as per predesigned proformas. As per institutional protocol, IADPSG (International Association of Diabetes and Pregnancy Study Groups) recommendations were followed for OGTT and used for diagnosing GDM. The pure tone audiometry (PTA) and impedance audiometry was done twice on all the subjects, first during the antenatal period between 28-32 weeks of gestational age and the second time at 6 weeks post-delivery. The audiometry was performed in a sound-proof room with minimal ambient or background noise using a single examiner for all the cases and controls. PTA was done on Labat Audiolab Audiometer (Labat Srl, Italy). HDA 300 Sennheiser earphones (Sennheiser, Germany) were used for measuring AC threshold values and the BC was tested by RadioEar B-71 Bone transducer (RADIOEAR, USA). Modified Hughson-Westlake method was used for conducting PTA. Impedance audiometry was done using MAICO MI44 impedance audiometer (MAICO diagnostics, Berlin, Germany). We did not include brainstem evoked response audiometry (BERA) in our study even though it is an objective method of assessment because of institutional constraints and non-availability of BERA testing at times.

Out of the 30 pregnant women with GDM and 30 control group subjects, 2 women with GDM and 3 control group subjects were lost to follow-up during the post-partum period. Air conduction (AC) and bone conduction (BC) threshold values were compared between the two groups. The AC threshold values were calculated for the following frequencies: 0.25 kHz, 0.5 kHz, 1 kHz, 2 kHz, 4 kHz and 8 kHz whereas for BC threshold values, frequencies used were 0.25 kHz, 0.5 kHz, 1 kHz, 2 kHz and 4 kHz.

Categorical variables were presented in numbers and percentages and continuous variables were presented as mean±SD and median. Normality of data was tested by Kolmogorov-Smirnov test. If the normality was rejected then non parametric test was used.

Statistical tests were applied as follows-

- Quantitative variables were compared using Independent T test/Mann-Whitney Test (when the data sets were not normally distributed) between the two groups and paired T test/ Wilcoxon signed test within group across follow up.
- Qualitative variables were correlated using Chi-Square test/ Fisher exact test. A $p<0.05$ was considered statistically significant. The data was entered in MS Excel spread sheet and analysis was done using Statistical Package for Social Sciences (SPSS) version 21.0.

RESULTS

There were statistically no significant differences in the baseline characteristics such as age, gestational age at the time of testing, gravida and time-period of follow-up post-delivery between pregnant women with gestational diabetes and non-diabetic pregnant women ruling out any possible confounding effect of these variables. The demographic profile of the test subjects is shown in a tabular form in the table below (Table 1).

Table 1: Demographic profile of study groups.

Variable		Cases (%)	Controls (%)	P value
Age-wise distribution (in years)	≤20	0 (0)	2 (6.45)	0.236
	21-25	16 (42.11)	16 (51.61)	
	26-30	14 (36.84)	9 (29.03)	
	31-35	5 (13.16)	4 (12.9)	
	35-40	3 (7.89)	0 (0)	
Gravida	Primigravida	11 (28.95)	7 (22.58)	0.549
	Multigravida	27 (71.05)	24 (77.42)	
Family history	Positive	12 (31.58)	5 (16.13)	0.138
	Negative	26 (68.42)	26 (83.87)	

Note: Data presented as number of subjects (percentage of the total number of subjects in that group); Family history was taken for the history of diabetes in any of the first-degree relatives.

Table 2: Comparison of hearing threshold values.

			Right ear			Left ear		
			Cases	Controls		Cases	Controls	
			Mean±SD (dB)	Mean±SD (dB)	P value	Mean±SD (dB)	Mean±SD (dB)	P value
AC	Antepartum	250 Hz	19.74±11.39	11.45±10.66	0.003	19.6±12.54	15.64±13.65	0.214
		500 Hz	21.58±8.78	12.74±9.11	0.0001	22.24±10.64	16.93±10.93	0.046
		1 kHz	21.71±9.32	14.68±7.52	0.001	21.05±10.28	18.07±8.63	0.202
		2 kHz	22.9±18.51	16.77±8.12	0.092	20.92±10.32	19.52±8.88	0.552
		4 kHz	24.34±18.82	16.77±11.07	0.052	21.97±13.02	22.1±13.83	0.97
		Pure tone average	22.63±12.81	15.24±7.93	0.002	21.55±10.22	19.15±9.06	0.085
	Postpartum (6 weeks)	250 Hz	15.2±9.3	9.38±8.38	0.026	13±7.91	12.29±10.83	0.794
		500 Hz	16±6.77	11.25±6.47	0.016	16.2±7.11	14.38±7.98	0.47
		1 kHz	16.2±6.96	10.62±5.38	0.003	15±9.01	15.62±8.25	0.926
		2 kHz	15.6±9.28	16.46±8.01	0.731	15.6±9.28	16.46±8.01	0.731
		4 kHz	17±7.91	14.58±6.41	0.247	17.2±9.8	17.29±8.34	0.972
		Pure tone average	16.5±6.68	12.45±4.34	0.006	16±7.6	15.94±6.4	0.586
BC	Antepartum	250 Hz	8.42±7.63	8.23±6.53	0.911	8.42±7.63	8.55±6.22	0.941
		500 Hz	13.95±7.98	12.74±6.03	0.49	13.68±7.23	13.06±6.15	0.706
		1 kHz	13.29±9.1	13.06±5.43	0.904	12.9±7.13	13.55±5.8	0.682
		2 kHz	17.5±11.67	15.16±5.84	0.6	16.45±7.53	15.48±6.37	0.676
		4 kHz	15.92±12.88	14.84±7.01	0.676	15.53±10.51	15.48±8.1	0.985
		Pure tone average	15.16±9.86	13.95±4.44	0.795	14.64±7.25	14.4±4.77	0.62
	Postpartum (6 weeks)	250 Hz	6.2±5.82	6.46±6.51	0.884	6.4±5.11	6.88±5.86	0.763
		500 Hz	10.2±5.49	9.79±4.77	0.783	10.2±5.49	9.79±5	0.787
		1 kHz	10±5.59	10.42±5.3	0.79	10±5.59	10.62±5.38	0.692
		2 kHz	12.8±7.51	12.08±4.64	0.691	12.8±7.51	12.29±4.66	0.778
		4 kHz	13.8±8.2	11.25±5.16	0.325	13.2±8.65	11.46±5.41	0.598
		Pure tone average	11.7±5.18	10.88±3.27	0.644	11.55±5.39	11.04±3.47	0.748

Note- AC: Air conduction, BC: Bone conduction, SD: Standard deviation, Pure tone average is the average of hearing threshold values at 0.5, 1, 2 and 4 kHz.

The AC and BC threshold values for both cases and controls at speech frequencies, that are 0.5 kHz, 1 kHz, 2 kHz and 4 kHz, with the average of these four were compared and is shown in the tables below (Table 2). It was observed that there are statistically significant differences in the AC threshold values between the cases and the controls, mainly in the right ear only, which was seen both during the antepartum testing and post-delivery testing. The above observation points towards a possible effect of GDM on hearing.

Table 3: Average of AC and BC threshold values at 0.5, 1, 2 and 4 kHz (antepartum vs. postpartum).

		Antepartum	Postpartum	P value
Cases (women with GDM)	Average AC (0.5, 1, 2 and 4 kHz)- right ear (dB)	22.63±12.81	16.5±6.68	0.002
	Average AC (0.5, 1, 2 and 4 kHz)- left ear (dB)	21.55±10.22	16±7.6	0.011
	Average BC (0.5, 1, 2 and 4 kHz)- right ear (dB)	15.16±9.86	11.7±5.18	0.001
	Average BC (0.5, 1, 2 and 4 kHz)- left ear (dB)	14.64±7.25	11.55±5.39	0.474

AC: Air Conduction, BC: Bone Conduction, GDM: Gestational diabetes mellitus.

An intra-group analysis was also done within the case group (pregnant women with GDM). The antepartum hearing threshold values were compared with the postpartum values and the changes seen were statistically significant ($p<0.05$). It was observed that the hearing threshold values improved post-delivery. The findings are presented in a tabular form (Table 3).

DISCUSSION

Hearing loss is a major health problem affecting the quality of life and performance at workplace. Most important causes of hearing loss are presbycusis, followed by noise exposure, ototoxic drugs, and viral infections.[19]

Not enough evidence is available to define diabetes mellitus as a cause of hearing loss, let alone gestational diabetes mellitus. Studies have been done in recent past that showed a positive correlation between diabetes and hearing loss and then, there are other studies that refute this claim.[3] It was believed earlier, that hearing loss in diabetes can be explained on the basis of neuropathy, angiopathy or a combination of both. However, angiopathy appears to be the main contributor to hearing loss which is also supported by histopathological findings of microvascular lesions of the inner ear, such as thickness of basal membrane of stria vascularis capillaries, endothelial proliferation and accumulation of glucoproteins.[3]

The National Diabetes Data Group (NDDG) conducted a research which is the basis of "Classification of Glucose Disorders based on Etiology" by WHO.[20] Based on this, diabetes mellitus and other states of glucose intolerance are classified into 3 subclasses: type 1 DM, type 2 DM and secondary diabetes associated with another identifiable condition or syndrome.[14,20]

Gestational diabetes frequently precedes type 2 DM which has been shown in two large meta-analyses on the risk of development of type 2 DM following history of gestational diabetes mellitus and as per these 2 meta-analyses, there is a risk ratio of 7.43 and a cumulative incidence rate of up to 70%.[14]

There is a limited data to indicate if gestational diabetes has the same effect on hearing as type 2 DM. To our knowledge, only one such study has been done by Selcuk et al from Turkey, published in 2014 in which they found no significant differences in average pure tone air-bone hearing thresholds between gestational diabetic and non-diabetic pregnant female group.[14] The proposed pathophysiological mechanism of vasculopathy with or without neuropathy as a reason for auditory complications seen in patients with long standing diabetes might hold true for GDM also, but there is a paucity of research available on this topic in the medical literature.

Previous studies done to see the effect of diabetes mellitus on hearing had mostly shown a positive correlation between DM and hearing loss. Akinpelu et al in a study published in 2014 found that type 2 diabetic patients had a higher incidence of hearing loss when compared with controls which was clinically more relevant at 6000 and 8000 Hz.[18] While most studies showed a positive correlation between DM and hearing loss, a study by Harner with a sample size of 200 diabetics found no increased frequency of hearing loss or other otological problems, thus coming to the conclusion that there was no association between DM and hearing loss.[21] Horikawa et al in his meta-analysis of cross sectional studies using Medline services [1950-2011] and Embase services [1974-2011] concluded that hearing impairment in diabetic patients compared with non-diabetic patients was consistent regardless of age.[22] To see a correlation between GDM and hearing loss, Selcuk et al in their study found a high frequency hearing loss in patients with GDM but otherwise no significant differences were seen when average pure tone air-bone conduction thresholds were compared between pregnant women with GDM and without GDM.[14] In our study, the average of BC threshold values at speech frequencies showed no significant difference ($p>0.05$) between the two groups (pregnant women with GDM vs. pregnant women without GDM). The above observations are in line with the study done by Selcuk et al who also observed no significant difference between the air-bone hearing thresholds between gestational diabetic and non-diabetic group ($p>0.05$). A positive correlation has been seen between diabetes and hearing loss in case of type 2 DM but not in the case of GDM and it can be explained on the basis of long standing nature of the disease in case of former.

However, when AC thresholds at different frequencies were compared, we found a significant variation between hearing threshold values of pregnant women with GDM and pregnant women without GDM.

We also did an intra-group comparison (within the group of pregnant women with GDM). We observed that the AC hearing threshold values and BC hearing threshold values for the left ear only showed an improvement post-delivery, with the change being statistically significant. The change could be due fluctuations in the blood glucose level but post-delivery the blood sugar levels begin to normalize, which is where GDM differs from type 2 DM. It may lead to improvement in the hearing of the female. The inner ear being metabolically active requires high glucose levels because of high energy utilization and because of that, it is vulnerable to metabolic and circulatory stress as well as to the fluctuation in blood glucose levels.

Gestational diabetes mellitus, may lead to hearing loss similar to that seen in diabetes mellitus. However, a detailed evaluation of hearing loss in GDM requires more studies on this subject with a larger study population and additional research concentrating more on the pathophysiological mechanisms.

CONCLUSION

Gestational diabetes mellitus may lead to hearing impairment similar to what is seen in type II diabetes mellitus as suggested by significant changes seen when the AC hearing threshold values were compared with controls. However, a larger sample size and more similar studies are required to study the cause and effect.

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