VOLUME - 11, ISSUE - 11, NOVEMBER - 2022 • PRINT ISSN No. 2277 - 8160 • DOI : 10.36106/gjra

Original Research Paper

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A PROSPECTIVE STUDY TO DETERMINE ASSOCIATION OF GESTATIONAL DIABETES MELLITUS WITH MATERNAL HEARING IN PRIMIGRAVIDA

Dr. Pooja Swami	Senior Resident, MS ENT, Department of ENT, SMS Medical College and Hospital, Jaipur, India.
Dr. Sachin Goel	Senior Resident, MS ENT, DNB ENT, Department of ENT, ABVIMS & Dr RML Hospital, New Delhi, India.
Dr. Kanwar Sen	Principal Consultant, MS ENT, Department of ENT, ABVIMS & Dr RML Hospital, New Delhi, India.
Dr. Gaurang Singhal*	Senior Resident, MS ENT, DNB ENT, Department of ENT, ABVIMS & Dr RML Hospital, New Delhi, India. *Corresponding Author

ABSTRACT **Introduction:** It is well established that diabetes mellitus impairs the hearing threshold levels. However, there is insufficient literature describing the effect of gestational diabetes mellitus on hearing threshold levels and its reversibility. **Method:** A prospective cross sectional study was conducted between 2019 to 2021 in which 33 primigravida patients with gestational diabetes mellitus in the case group and 33 primigravida patients without gestational diabetes mellitus in third trimester were included in the control group, matched for gestational age and body mass index. A medical history was taken for each participant, and otological inspections and high-frequency audiometry tests were performed. **Results:** There was statistically significant difference between the hearing thresholds of the case and control group especially above 8kHz with cases showing poor thresholds as compared to controls. However, the hearing improves in the postnatal period. **Conclusion:** Gestational diabetes mellitus causes significant reversible hearing loss mainly at high frequencies and more research should be done on large sample size with long follow up in post natal period to confirm the findings.

KEYWORDS : Gestational Diabetes Mellitus, High frequency hearing loss, Pure Tone audiometry

INTRODUCTION

Hearing loss is one of the most prevalent symptoms of sensory deficit in humans today. It is the second leading cause of 'Years lived with Disability (YLD)' all over the world. According to WHO estimates, 6 percent of Indians suffer from hearing loss.[1] As per a statistical profile on disabled persons issued in 2016 by the Government of India based on the 2011 Census, 19 % of the disabled persons in India are having a disability in hearing, next only to disability in movement.[2]

Diabetes mellitus (DM) is a common metabolic condition manifesting as an impairment of functions of various body systems.[3] According to a retrospective study, up to 50% of DM patients exhibit some degree of auditory dysfunction.[4] Gestational diabetes mellitus(GDM) is a disorder in which women who have never had diabetes mellitus develop glucose intolerance of varying degree during pregnancy. India is the second most populous country globally and rates of GDM are estimated to be 10-14% of total pregnancies.[5] According to the Diabetes in Pregnancy Study Group India (DIPSI), Indian women are 11 times more likely than other women to develop glucose intolerance during pregnancy.[6]

In GDM, exposure of the cochlea to hyperglycemia and hyperinsulinemia along with an imbalance in oxidant/antioxidant equilibrium may lead to hearing impairment by disruption of the endocochlear potential. Since, the stria vascularis is known to use intense metabolic activity, its functioning depends on adequate energy supply and slight disturbance in its metabolism can affect the endocochlear potential generated by it.[7]

To our knowledge only few studies have been conducted which reported a high-frequency SNHL in GDM.[3] So we have tried to evaluate the impact of GDM on hearing levels in primigravida and its reversibility post natally.

MATERIAL METHODS

The current prospective cross sectional study was conducted at ABVIMS and Dr. RML Hospital, Delhi from 2019 to 2021. We included 33 primigravida patients with GDM in the case group and 33 primigravida patients without GDM in third trimester were included in the control group, matched for gestational age and body mass index. Patients having past history of middle ear disease, ear surgery, hearing impairment, Diabetes Mellitus, ototoxic drug intake and systemic corticosteroid intake were excluded from the study.

For the oral glucose tolerance test, the IADPSG (International Association of Diabetes and Pregnancy Study Groups) recommendations were followed as per the 28 institution's protocol. 75gm glucose was given orally and blood samples were taken just before the administration of glucose, at 1 hour and 2 hours after administration. The normal values being < 92mg/dL, <180mg/dl and <153mg/dl at fasting, 1 hour and 2 hour respectively. One or more abnormal values were required for diagnosis of Gestational Diabetes Mellitus. Seven sample blood sugar profile was done after the diagnosis was made i.e. fasting, post-breakfast, pre-lunch, post-lunch, pre-dinner, post-dinner and at 2 AM. The blood sugar profile was done once every 2 weeks. The values of fasting blood sugar were considered to be deranged if >95mg/dL and post-prandial blood sugar deranged if 2-hour blood sugar levels >120mg/dL. Diabetic diet was immediately following the diagnosis of GDM was made. Appropriate treatment was also started if the blood glucose levels were found to be deranged at any time during the pregnancy.

The study was approved by the Institutional Research Ethics Committee. Patients gave informed consent before undergoing the following procedures.

After conducting necessary otorhinological assessment, patients were then subjected to audiometric evaluation. Pure tone audiometry was done on MADSEN Asteria audiometer. Earphones- Sennheiser HDA 300 earphones (figure 1) and Telephonics TDH 39 (figure 2) were used for measuring air conduction threshold values while bone conduction was done using Radio Ear B-71(figure 3).

Figure 1: HDA 300 Sennheiser Supra-aural Earphones For Air Conduction Testing

Figure 2: Telephonics TDH 39 Earphone For Air Conduction Testing

Figure 3: Radio Ear B-71 for bone conduction testing

Modified Hughson-Westlake procedure was used for pure tone audiometry. For air conduction, the first frequency tested was 1kHz and then higher frequencies were tested in ascending order (2kHz, 4kHz, 8kHz,10kHz, 12kHz, 14kHz, 16kHz and 18kHz), 1kHz was retested and then lower frequencies were tested in descending order (500 Hz, 250 Hz and 125 Hz). However, for bone conduction, testing was done from 500 Hz to 4kHz as large discrepancies are seen in bone conduction testing above 8Khz due to excess air radiated sound from the bone vibrator.[8] Results were recorded on an audiogram. Follow up pure tone audiometry was done at 6 weeks in postnatal period.

The data was compiled and analyzed using MS Excel ® office365, GraphPad prism 8.4.2, and SPSS version 25. Descriptive statistics were presented in the form of proportions/percentages for categorical variables and continuous variables were presented as mean ± SD and median. Chi-Square test/Fisher exact test was used for comparision of proportions (categorical variables). Continuous variables were analyzed using the Mann-Whitney test/ student T-test (independent group / unpaired data) and Wilcoxon sign rank test / paired T-test (for paired data) based on normality of data. A p-value of<0.05 was considered statistically significant.

RESULTS

In the present study, case cohort comprised of 33 primigravida patients with GDM similarly control population comprised of 33 primigravida patients without GDM. Audiometry examination was done in third trimester in both case and control groups with mean gestational age of 36.58 ± 0.79 weeks and 36.24 ± 0.9 weeks respectively. In case group mean age was 27.58 ± 4.52 while in control group mean age was 25.15 ± 2.62.

The mean value of air conduction thresholds and bone conduction thresholds at various frequencies in both ears are shown in Table 1,2 and Figure 4. Air conduction thresholds showed mild to moderate hearing loss at frequencies at and above 10 kHz however no hearing loss was seen in air and bone conduction below 10 kHz. Mean hearing threshold at 10 kHz, 12kHz, 14kHz, 16kHz and 18kHz were 27.12 ± 11.11, 34.55 ± 17.61, 47.12 ± 16.35, 48.48 ± 16.61 and 33.03 ± 11.25 in right ear and 27.88 ± 12.25, 34.24 ± 15.62, 46.06 ± 15.40, 46.52 ± 15.69 and 31.97 ± 10.38 in left ear respectively. The difference between the mean hearing thresholds at all frequencies was found to be statistically significant for both the ears (pvalue <0.0001).

Table 1: Mean Air Conduction Thresholds In Pregnant Females With And Without GDM

Frequency (kHz)	Case (n=33) Mean loss (dB)		Control (n=33) Mean loss (dB)		p value	
	Right ear	Left ear	Right ear	Left ear	Right ear	Left ear
0.25	10.00 ± 3.75	10.45 ± 4.40	6.82 ± 2.44	6.52 ± 2.33	<0.0001	<0.0001
0.5	13.18 ± 5.28	12.84 ± 5.61	9.85 ± 4.24	9.70 ± 3.74	<0.0001	<0.0001
1	17.58 ± 5.74	17.66 ± 6.65	12.88 ± 4.68	13.48 ± 4.05	<0.0001	<0.0001
2	22.27 ± 7.08	24.42 ± 6.36	15.76 ± 5.47	16.21 ± 5.45	<0.0001	<0.0001
4	24.70 ± 6.12	26.82 ± 6.71	16.36 ± 4.89	17.12 ± 5.16	<0.0001	<0.0001
8	21.97 ± 5.58	22.58 ± 7.19	7.42 ± 3.34	7.12 ± 3.31	<0.0001	<0.0001
10	27.12 ± 11.11	27.88 ± 12.25	8.94 ± 4.10	8.64 ± 3.81	<0.0001	<0.0001
12	34.55 ± 17.61	34.24 ± 15.62	10.45 ± 4.02	10.00 ± 4.33	<0.0001	<0.0001
14	47.12 ± 16.35	46.06 ± 15.40	12.73 ± 4.69	12.42 ± 4.35	<0.0001	<0.0001
16	48.48 ± 16.61	46.52 ± 15.69	16.06 ± 5.12	15.30 ± 4.99	<0.0001	<0.0001
18	33.03 ± 11.25	31.97 ± 10.38	10.05 ± 1.97	10.30 ± 3.29	<0.0001	<0.0001

Table 2: Mean Bone Conduction Thresholds In Pregnant Females With And Without GDM

Frequency (kHz)	Case (n=33) Mean loss (dB)		Control (n=33) Mean loss (dB)		p value	
	Right ear	Left ear	Right ear	Left ear	Right ear	Left ear
0.25	8.03 ± 3.24	6.96 ± 2.73	6.81 ± 2.40	6.52 ± 2.29	0.08	0.48

0.5	10.60 ± 4.39	9.54 ± 3.55	9.69 ± 4.07	9.54 ± 3.34	0.38	1.00
1	13.48 ± 4.34	13.33 ± 5.02	12.72 ± 4.28	13.33 ± 4.02	0.73	1.00
2	15.15 ± 4.68	16.82 ± 5.47	15.15 ± 4.52	15.45 ± 4.32	1.00	0.26
4	16.51 ± 4.17	16.51 ± 5.70	15.75 ± 3.91	16.06 ± 3.84	0.44	0.70

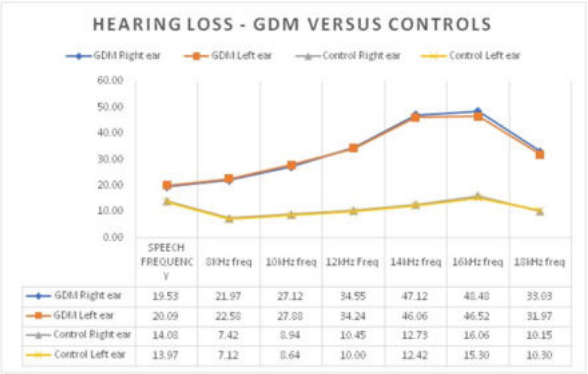

Figure 4: Depicting comparison between hearing thresholds at speech and high frequencies in both right and left ears among cases and controls

In follow up period all patients with GDM had normal blood glucose levels with improved glucose tolerance. Pure tone audiometry thresholds at 6 weeks in patients with GDM in postnatal period revealed improvement in mean hearing thresholds both in speech frequencies as well as high frequencies and the difference was statistically significant (p value <0.05) as shown in Table 3 and Figure 5. However the mean hearing threshold lies below 25dB in some frequencies implying that the reversal was not complete.

Table 3: Comparison Of Hearing Threshold In Patients With GDM In Antenatal Period And 6 Wk Postnatal Period

Frequency	Hearing threshold right ear antenatal	Hearing threshold left ear antenatal	Hearing threshold right ear postnatal	Hearing threshold left ear postnatal	p value (Right ear)	p value (Left ear)
Speech frequency	19.53	20.09	16.91	16.88	<0.0001	<0.0001
8 kHz	21.97	22.58	12.27	13.03	<0.0001	<0.0001
10 kHz	27.12	27.88	19.70	22.88	<0.0001	<0.0001
12 kHz	34.55	34.24	29.85	29.55	<0.0001	<0.0001
14kHz	47.12	46.06	42.42	38.48	<0.0001	<0.0001
16kHz	48.48	46.52	37.73	35.30	<0.0001	<0.0001
18kHz	33.03	31.97	24.85	28.03	<0.0001	<0.0001

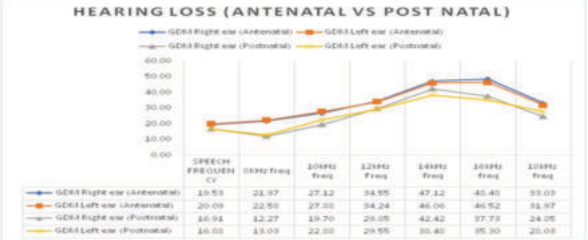

Figure 5: Depicting comparison between hearing thresholds at speech and high frequencies in both right and left ears in prenatal and post natal period (after 6 weeks) among cases

DISCUSSION

Large numbers of studies are available to define diabetes mellitus as a cause of hearing loss. Studies have been conducted recently that shows a strong link between diabetes and hearing loss. Hearing loss in diabetes was previously thought to be caused by neuropathy, angiopathy, or a combination of the two. According to latest studies, angiopathy (microangiopathy) appears to be the main cause of hearing loss. Histopathological findings of inner ear microvascular diseases, such as the thickness of the basal membrane of stria vascularis capillaries, endothelial growth, and glycoprotein accumulation, support this theory.[9,10]

The inner ear is very quick to respond to changes in its metabolism. It does not store energy so an altered level of glucose and insulin may affect its homeostasis and leads to auditory and vestibular dysfunction. Diabetes mellitus has a higher incidence of bilateral SNHL, which affects mainly the higher frequencies.

The National Diabetes Data Group (NDDG) conducted research which forms the basis of the classification of glucose disorders based on etiology, given by WHO. 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.[11]

However, we found only two studies which compared GDM with hearing loss. In the study conducted by Selcuck et al in Turkey in 2014 reported mild to moderate SNHL at 12, 14 and 16kHz in both the ears according to WHO classification. However, the significant difference between the bone conduction thresholds between control group and GDM group was seen at 10 and 14kHz in right ear while the difference was significant at four frequencies for left ears (8, 10, 12 and 14 kHz) in GDM group as compared to control group.[3] Similarly, in the study conducted by Kwatra et al in 2019 in India also found no significant difference in bone conduction thresholds between 250-4000Hz where as they found significant difference in air conduction thresholds between pregnant women with GDM and pregnant women without GDM in the above mentioned speech frequencies.[13] While in the current study, significant difference was present in mean air conduction threshold between pregnant women with GDM and pregnant women without GDM in both lower and higher frequencies in both the ears (250Hz to 18kHz). However, the hearing threshold lies in the normal range at lower frequencies in both cases and controls as compared to the higher frequencies, where the mean air conduction threshold lies in mild or moderate hearing loss category according to WHO classification.[12]

Whereas, the difference was not significant in case of bone conduction threshold at 250-4000Hz. The result of the current study are in concurrence with the previous study conducted by Selcuck et al[3] as both the studied shows mild to moderate hearing loss in patients with GDM at the higher frequencies. Similarly, the difference between the mean air conduction thresholds was also significant as seen by the previous study conducted by Kwatra et al.[13]

In the current study we observed that the hearing thresholds improved in patients with GDM 6 weeks post natally who did not developed overt diabetes mellitus. However the improvement was not complete and further research is required in the matter. Similar to our result Kwatra et al[13] also reported improvement in the hearing threshold in the post natal period.

CONCLUSION

The hearing thresholds lie in the normal range at lower frequencies in patients with GDM while GDM causes mild to moderate hearing loss in higher frequencies in patients which was found to be statistically significant. Hence it can be conveniently concluded that similar to diabetes mellitus, GDM also affects the hearing thresholds. However, larger study population and longer term follow up is required to validate the above findings and to monitor the hearing thresholds of neonates born to patients with GDM.

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