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ASSESSMENT OF HEARING IN NEONATES OF MOTHERS WITH GESTATIONAL DIABETES MELLITUS: A CROSS-SECTIONAL STUDY

Dr. K Sri Mangaladevi* — Post Graduate, Department of ENT, Sri Venkateshwaraa Medical College Hospital and Research Centre, Ariyur, Puducherry 605017 *Corresponding Author

Dr. V Prabu — Professor & Head of the Department, Department of ENT, Sri Venkateshwaraa Medical College Hospital and Research Centre, Ariyur, Puducherry 605017

ABSTRACT **Introduction:** Gestational diabetes mellitus (GDM) is one of the most common metabolic disorders complicating pregnancy and is associated with various adverse maternal and neonatal outcomes. Recent evidence suggests that maternal hyperglycaemia may adversely affect fetal auditory development, increasing the risk of congenital hearing impairment. **Methodology:** A hospital-based cross-sectional study was conducted among 195 neonates born to mothers with gestational diabetes mellitus, pre-gestational diabetes, and non-diabetic mothers. Hearing assessment was performed using Transient Evoked Otoacoustic Emission (TEOAE). Maternal diabetic status was obtained from medical records and correlated with neonatal hearing outcomes. **Results:** Among the 195 neonates, 65 belonged to each study group. Hearing impairment was identified in 15.4% of neonates born to mothers with GDM and 24.6% of neonates born to mothers with pre-gestational diabetes, compared with only 1.5% among neonates of non-diabetic mothers. A statistically significant association was observed between maternal diabetic status and neonatal hearing impairment ($p < 0.001$). **Conclusion:** Maternal diabetes, particularly gestational and pre-gestational diabetes, is associated with an increased risk of hearing impairment in neonates. Early audiological screening among high-risk newborns is essential for timely diagnosis and intervention.

KEYWORDS : Gestational Diabetes Mellitus, Hearing Impairment, Neonates, Otoacoustic Emission, Congenital Hearing Loss

INTRODUCTION

Hearing is one of the most important special senses, enabling communication, language acquisition, cognitive development, and social interaction. Congenital hearing loss (CHL) is among the most common sensory impairments affecting newborns and may significantly impact speech development, educational achievement, and psychosocial well-being if not detected early (1,2). The World Health Organization estimates that over 430 million people worldwide experience disabling hearing loss, including 34 million children, and this burden is expected to increase substantially in the coming decades (3). Early identification of hearing impairment is therefore crucial for timely intervention and improved developmental outcomes.

Gestational diabetes mellitus (GDM) is defined as glucose intolerance first recognized during pregnancy and is one of the most common metabolic disorders complicating gestation (4). The prevalence of GDM has been increasing globally due to rising maternal age, obesity, sedentary lifestyles, and dietary transitions. In India, the burden of GDM is substantial and continues to rise, posing significant risks to both maternal and neonatal health (5). Maternal hyperglycaemia has been associated with adverse fetal outcomes including macrosomia, prematurity, respiratory distress, and metabolic complications.

Recent evidence suggests that maternal diabetes may also influence fetal auditory development. Hyperglycaemia-induced oxidative stress, microvascular alterations, inflammation, and metabolic dysregulation can potentially affect cochlear development and auditory neural pathways (6,7). Several studies have reported a higher prevalence of hearing impairment among neonates born to mothers with gestational and pre-gestational diabetes compared with neonates of non-diabetic mothers (8,9). However, data from the Indian population remain limited. Therefore, the present study was undertaken to assess hearing outcomes among neonates born to mothers with gestational diabetes mellitus and compare them with neonates born to non-diabetic mothers.

METHODOLOGY

Study Design

Hospital-based cross-sectional study.

Study Setting

Department of Otorhinolaryngology, Sri Venkateshwaraa Medical College Hospital and Research Centre, Puducherry.

Study Duration

3 months.

Sample Size

Based on previous literature reporting a hearing impairment prevalence of 39.1% among neonates born to diabetic mothers, the minimum sample size was calculated as 187. A total of 195 neonates were included in the study.

Sampling Method

Convenience sampling.

Inclusion Criteria

- Neonates born to mothers diagnosed with gestational diabetes mellitus.
- Neonates born to mothers with pre-gestational diabetes.
- Healthy neonates born to non-diabetic mothers.

Exclusion Criteria

- Low birth weight neonates.
- Neonates with congenital anomalies.
- Neonates with intrauterine infections.
- Neonates exposed to ototoxic drugs.
- Neonates with low APGAR scores.

Data Collection Procedure

Following Institutional Ethics Committee approval and informed consent, maternal demographic and obstetric information was recorded. Maternal diabetic status was verified using antenatal records.

All neonates underwent detailed otological examination followed by Transient Evoked Otoacoustic Emission (TEOAE) testing in a soundproof environment. The outcomes were recorded as "Pass" or "Refer."

Statistical Analysis

Data were entered using EpiData software and analysed using SPSS version 25. Descriptive statistics, Chi-square test, and ANOVA were employed. A p-value <0.05 was considered statistically significant.

Ethical Clearance

The study received approval from the Institutional Ethics Committee of Sri Venkateshwaraa Medical College Hospital and Research Centre (IEC Ref No: 7/SVMCH/IEC/0820).

RESULTS

A total of 195 neonates participated in the study, comprising 65 neonates each in the GDM, pre-gestational diabetic, and non-diabetic groups.

The mean maternal age was significantly higher among GDM mothers (29.25 ± 3.66 years) and pre-gestational diabetic mothers (29.71 ± 3.84 years) compared with non-diabetic mothers (25.42 ± 4.42 years) ($p<0.001$).

A significantly greater proportion of GDM mothers (69.2%) had a BMI greater than 23 compared to non-diabetic mothers (30.8%) ($p=0.001$). Multiparity was also more common among diabetic mothers.

Birth weight above 2.5 kg was observed in 67.7% of GDM neonates and 78.5% of pre-gestational diabetic neonates compared to only 24.6% among neonates born to non-diabetic mothers (p<0.001).

Similarly, preterm birth (<37 weeks gestation) was more frequent among diabetic mothers.

Table 1. Maternal and Neonatal Characteristics

Variable	GDM (n=65)	Pre-GDM (n=65)	Non-diabetic (n=65)	p-value
Maternal Age (years)	29.25 ± 3.66	29.71 ± 3.84	25.42 ± 4.42	<0.001
BMI >23	69.2%	53.8%	30.8%	0.001
Multiparity	66.2%	52.3%	38.5%	0.006
Birth Weight >2.5 kg	67.7%	78.5%	24.6%	<0.001
Gestational Age <37 weeks	80%	56.9%	47.7%	0.001

The fasting blood sugar and OGTT values were significantly elevated among diabetic mothers compared with the non-diabetic group.

Table 2. Maternal Glycaemic Profile

Variable	GDM	Pre-GDM	Non-diabetic	p-value
FBS (mg/dL)	101.54 ± 18.44	121.67 ± 8.85	75.15 ± 10.14	<0.001
OGTT (mg/dL)	165.54 ± 20.54	177.24 ± 10.54	101.55 ± 18.43	<0.001

Regarding hearing assessment, OAE screening revealed hearing impairment among 15.4% of neonates born to mothers with GDM and 24.6% of neonates born to mothers with pre-gestational diabetes. In contrast, only 1.5% of neonates born to non-diabetic mothers demonstrated hearing impairment.

Table 3. OAE Screening Outcomes

OAE Result	GDM	Pre-GDM	Non-diabetic	p-value
Pass	84.6%	75.4%	98.5%	0.001
Refer	15.4%	24.6%	1.5%	

DISCUSSION

Gestational diabetes mellitus is an increasingly prevalent obstetric condition worldwide and contributes significantly to maternal and neonatal morbidity. In the present study, mothers with gestational diabetes and pre-gestational diabetes were significantly older than non-diabetic mothers. Similar findings were reported by Li et al., who identified advanced maternal age as an independent risk factor for the development of GDM through a large systematic review and meta-analysis (10).

The present study also demonstrated significantly higher body mass index (BMI) among diabetic mothers compared with non-diabetic mothers. Maternal obesity has been consistently identified as a major contributor to insulin resistance and gestational diabetes. Rahnemaei et al. and Zhang et al. reported that elevated pre-pregnancy and gestational BMI significantly increase the risk of developing GDM (11,12). Likewise, multiparity was more common among diabetic mothers in our study, which is in agreement with previous studies that reported increased parity as an important risk factor associated with gestational diabetes (13,14).

Neonates born to diabetic mothers in the present study demonstrated significantly higher birth weights compared with those born to non-diabetic mothers. This observation is consistent with the findings of Yang et al., who reported a strong association between maternal hyperglycaemia and fetal macrosomia (15). Elevated maternal glucose levels result in increased transplacental glucose transfer, stimulating fetal insulin secretion and promoting excessive fetal growth (16).

The most important finding of our study was the significantly higher prevalence of hearing impairment among neonates born to mothers with gestational and pre-gestational diabetes. Approximately 15.4% of neonates born to mothers with GDM and 24.6% of neonates born to mothers with pre-gestational diabetes failed OAE screening, compared with only 1.5% among neonates of non-diabetic mothers. Similar observations were reported by Li et al., who demonstrated a significantly increased prevalence of hearing impairment among neonates born to mothers with GDM (17). Padmadasan et al. also observed higher rates of hearing impairment among neonates of diabetic mothers, while Sharma et al. reported a significantly increased risk of abnormal neonatal hearing screening outcomes in infants born to mothers with gestational diabetes (8,18).

The exact mechanism underlying hearing impairment among neonates of diabetic mothers remains incompletely understood. However, several biological pathways have been proposed. Diabetes mellitus is known to cause microvascular damage affecting multiple organs, including the cochlea and auditory pathways (6). Hyperglycaemia-induced oxidative stress and chronic inflammation may result in cochlear hair cell injury and impaired auditory function (19). Furthermore, insulin resistance and endothelial dysfunction may compromise blood flow to the inner ear, affecting cochlear metabolism and auditory signal transmission (20). Neuropathic changes involving the auditory nerve have also been suggested as contributing factors in diabetes-related hearing impairment (21).

The higher prevalence of hearing impairment observed among neonates of pre-gestational diabetic mothers compared with those born to mothers with GDM may be attributable to longer duration and greater severity of maternal metabolic abnormalities. Chronic fetal exposure to hyperglycaemia may adversely influence auditory system development throughout gestation, resulting in a greater risk of congenital hearing impairment.

The findings of the present study emphasize the importance of universal newborn hearing screening, particularly among infants born to diabetic mothers. Early identification and intervention can significantly improve speech, language, cognitive, and social outcomes. Therefore, routine audiological evaluation should be strongly recommended for neonates born to mothers with gestational and pre-gestational diabetes.

CONCLUSION

The present study demonstrates a significant association between maternal diabetes and neonatal hearing impairment. Neonates born to mothers with gestational diabetes mellitus and pre-gestational diabetes showed a substantially higher prevalence of abnormal OAE findings compared to neonates born to non-diabetic mothers. These findings support the inclusion of maternal diabetes as an important risk factor for congenital hearing impairment. Early audiological screening and appropriate follow-up among high-risk neonates can facilitate prompt diagnosis and intervention, thereby improving long-term developmental outcomes.

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