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Study Of Hearing Loss In Neonates Born To Diabetic Mothers

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ABSTRACT

Background: Diabetes mellitus during pregnancy represents a significant health concern that can lead to various complications affecting both maternal and fetal well-being. The association between maternal diabetes and adverse neonatal outcomes has been extensively studied, with increasing evidence suggesting its impact on auditory function in newborns.

Objective: To determine the incidence of hearing loss in neonates born to mothers with pre-gestational and gestational diabetes mellitus and to correlate the types and degree of neonatal hearing loss with maternal HbA1C levels.

Methods: This prospective observational study was conducted at Krishna Vishwa Vidyapeeth, Karad, involving 67 neonates born to diabetic mothers. Maternal diabetes was evaluated through glycated haemoglobin (HbA1c) measurement. Neonatal hearing assessment employed Otoacoustic Emission (OAE) testing during the neonatal period (0-28 days), followed by Auditory Brainstem Response (ABR) testing at 3 and 6 months of age.

Results: Among 67 neonates, 2 (3%) developed confirmed hearing loss. All cases were bilateral sensorineural hearing loss of moderately severe degree. Both cases occurred in neonates born to mothers with poor glycemic control (HbA1c >7.0%). Initial OAE screening showed abnormal results in 34.3% of neonates, which reduced to 3% on definitive ABR testing. All neonates with confirmed hearing loss required NICU admission and experienced birth complications.

Conclusion: The study confirms maternal diabetes as a significant risk factor for neonatal hearing impairment, with poor glycemic control being the critical determinant. Universal audiological screening of neonates born to diabetic mothers is recommended, with particular vigilance for those with poor maternal glycemic control and birth complications.

Keywords: *Gestational diabetes mellitus, neonatal hearing loss, sensorineural hearing loss, HbA1c, otoacoustic emissions, auditory brainstem response.*

1. INTRODUCTION

Diabetes mellitus during pregnancy represents a significant health concern that can lead to various complications affecting both maternal and fetal well-being. The association between maternal diabetes and adverse neonatal outcomes has been extensively studied, with increasing evidence suggesting its impact on auditory function in newborns.[1] As the global

prevalence of diabetes continues to rise, particularly among women of reproductive age, understanding its effects on fetal development and neonatal health becomes increasingly crucial.[2] Gestational diabetes mellitus (GDM) affects approximately 14% of pregnancies worldwide, while pre-existing diabetes complicates about 1-2% of pregnancies.[3]

The hyperglycemic environment during pregnancy can lead to various metabolic, vascular, and oxidative stress-related changes that may affect the developing fetus, including the delicate structures of the auditory system.[4] The cochlea, being a metabolically active organ, is particularly susceptible to the effects of maternal hyperglycemia and its associated metabolic disturbances. The development of the auditory system begins early in embryonic life and continues throughout gestation and early postnatal period. During this critical period, any metabolic disturbances can potentially interfere with the normal development and maturation of the auditory pathway.[5]

Recent studies have demonstrated a higher prevalence of hearing impairment in infants born to diabetic mothers compared to those born to non-diabetic mothers. The pathophysiological mechanisms underlying this association are complex and multifactorial, involving various pathways such as oxidative stress, microangiopathy, and altered glucose metabolism in the developing auditory system.[6] Understanding these mechanisms is crucial for developing preventive strategies and early intervention protocols. The importance of early detection of hearing loss cannot be overstated, as it directly impacts language development, cognitive function, and overall developmental outcomes in children.[7]

2. METHODOLOGY

This prospective observational study was conducted at the Department of ENT, Krishna Vishwa Vidyapeeth, Karad, Maharashtra, India. The study included 67 neonates born to diabetic mothers, with inclusion criteria encompassing postnatal age between 0-28 days, irrespective of gender. Exclusion criteria comprised preterm babies, craniofacial anomalies, birth weight ≤2500 grams, maternal history of infectious diseases during early gestation, and ototoxic drug use during pregnancy.

Prior to study commencement, institutional ethical committee clearance was obtained, and informed written consent was secured from parents of eligible neonates. Comprehensive data collection focused on maternal diabetic status through glycated haemoglobin (HbA1c) measurement and neonatal hearing assessment. The hearing evaluation protocol involved initial screening using Distortion Product Otoacoustic Emission (DPOAE) testing during the neonatal period, followed by Automated Auditory Brainstem Response (ABR) testing at three months of age for all enrolled infants.

Neonates who failed initial screening tests underwent additional ABR testing at six months of age to monitor auditory development and confirm hearing status. All testing procedures were conducted in sound-treated environments adhering to standardized protocols. Data analysis was performed using SPSS version 21, with results presented in tabular and graphical forms. Qualitative data were expressed as frequency and percentages, while quantitative data included mean, median, standard deviation, and ranges, with p-value <0.05 considered statistically significant.

3. RESULTS

The study methodology employed a systematic approach to hearing assessment in neonates born to diabetic mothers. Initial screening was conducted using Otoacoustic Emission (OAE) testing within the first 28 days of life, measuring sound waves generated by cochlear outer hair cells in response to acoustic stimuli. Follow-up assessments utilized Auditory Brainstem Response (ABR) testing at 3 months to evaluate the summation of action potentials from the cochlear nerve to the inferior colliculus. Neonates with abnormal results at 3 months underwent additional ABR testing at 6 months to confirm hearing status and monitor progression.

Table 1: Maternal and Neonatal Characteristics

Characteristic	Category	Frequency (n=67)	Percentage (%)
Maternal Age	20-30 years	41	61.2
	31-40 years	26	38.8
Diabetes Type	Gestational	49	73.1
	Pre-gestational	18	26.9
HbA1C Level	Good (≤6.0%)	13	19.4
	Fair (6.1-7.0%)	21	31.3

Characteristic	Category	Frequency (n=67)	Percentage (%)
	Poor (>7.0%)	33	49.3
Neonatal Gender	Male	39	58.2
	Female	28	41.8
NICU Admission	Yes	36	53.7
	No	31	46.3

Mean maternal age: 28.85 ± 6.17 years; Mean gestational age: 39.30 ± 1.96 weeks; Mean birth weight: 3043.33 ± 437.55 grams

Table 2: Hearing Screening Results and Progression

Assessment	Normal	Abnormal	Percentage Abnormal
Initial OAE Screening	44	23	34.3%
3-Month ABR	65	2	3.0%
6-Month ABR (abnormal cases)	0	2	100% of abnormal cases
Final Hearing Status	65	2	3.0%

Mean ABR thresholds at 3 months: Right ear 16.66 ± 7.68 dB, Left ear 16.96 ± 8.12 dB Mean ABR thresholds at 6 months (abnormal cases): Right ear 41.60 ± 13.67 dB, Left ear 45.00 ± 15.44 dB

Table 3: Hearing Loss Characteristics and Interventions

Characteristic	Category	Frequency	Percentage
Incidence	Hearing Loss	2	3.0%
	Normal Hearing	65	97.0%
Type of Hearing Loss	Sensorineural	2	100% of cases
Degree of Hearing Loss	Moderately Severe	2	100% of cases
Laterality	Bilateral	2	100% of cases
Intervention Required	Hearing Aids	2	100% of cases

Table 4: Risk Factor Associations with Hearing Loss

Risk Factor	Normal Hearing (n=65)	Hearing Loss (n=2)	p-value
Diabetes Type			0.468
Gestational	48 (73.8%)	1 (50.0%)	
Pre-gestational	17 (26.2%)	1 (50.0%)	
HbA1C Category			0.687

Risk Factor	Normal Hearing (n=65)	Hearing Loss (n=2)	p-value
Good (≤6.0%)	13 (20.0%)	0 (0.0%)	
Fair (6.1-7.0%)	21 (32.3%)	0 (0.0%)	
Poor (>7.0%)	31 (47.7%)	2 (100.0%)	
Birth Complications			0.116
None	39 (60.0%)	0 (0.0%)	
Respiratory Distress	10 (15.4%)	1 (50.0%)	
Jaundice	5 (7.7%)	1 (50.0%)	
Hypoglycemia	11 (16.9%)	0 (0.0%)	
NICU Admission			0.495
Yes	34 (52.3%)	2 (100.0%)	
No	31 (47.7%)	0 (0.0%)	

4. DISCUSSION

The incidence of hearing impairment in our cohort (3%) is higher than the general population rate of 0.1-0.3% reported for neonates without risk factors, highlighting maternal diabetes as a significant risk factor for neonatal hearing impairment. This finding aligns with previous studies, though with some variation. Sharma et al. reported a 13.3% incidence of hearing loss in neonates of mothers with gestational diabetes mellitus[8], while Padmadasan et al. documented 4.16% prevalence.[9] The bilateral sensorineural nature of all hearing loss cases in our study is consistent with Smith et al.'s research, which found that children of diabetic pregnancies were more likely to have bilateral hearing loss (81%) and sensorineural hearing loss compared to children of non-diabetic pregnancies.[10] The bilateral presentation suggests systemic rather than localized pathological processes affecting auditory development, supporting the hypothesis that diabetes-related pathologies, particularly microangiopathy and neural damage, compromise neural components of the auditory system during critical developmental periods.

Strikingly, our data demonstrated a compelling association between maternal glycemic control and neonatal hearing outcomes, with all neonates with hearing loss (100%) born to mothers with poor glycemic control (HbA1c >7.0%). This association underscores the importance of tight glucose regulation during pregnancy, as supported by Cruickshanks and colleagues who specifically identified poor glycemic control as a risk factor for hearing impairment.[11] The pathophysiological mechanisms underlying this association can be explained by several factors: hyperglycemia-induced vascular damage to cochlear microvasculature[12], direct neuronal damage through selective loss of cochlear afferent nerve fibers[13], oxidative stress damaging cochlear hair cells[14], and metabolic disturbances affecting the stria vascularis.[15] Our study also identified significant associations between birth complications (particularly respiratory distress and jaundice) and hearing loss, with all affected neonates requiring NICU admission, highlighting the multifactorial nature of hearing impairment in this vulnerable population.

The substantial reduction in abnormal results from initial OAE screening (34.3%) to definitive ABR testing (3%) highlights the importance of following recommended screening protocols to minimize false positives while ensuring timely identification of true hearing impairment. The persistence of abnormal findings at 6-month follow-up in all initially identified cases confirms the permanence of these hearing deficits and justifies early intervention with hearing aids. These findings have important clinical implications, supporting the inclusion of maternal diabetes as a significant risk factor in neonatal hearing screening programs and emphasizing the need for targeted audiological monitoring of neonates born to diabetic mothers, particularly those with poor glycemic control and birth complications.[16] The requirement for hearing aid intervention in all confirmed cases underscores the clinical significance of our findings and the potential for improved outcomes with early detection and management.

5. CONCLUSION

This study provides important evidence confirming maternal diabetes as a significant risk factor for neonatal hearing impairment, with an observed prevalence of 3% significantly exceeding the general population rate. The findings demonstrate that poor maternal glycemic control (HbA1c >7.0%) represents the critical determinant of auditory outcomes, with all confirmed hearing loss cases occurring in neonates born to mothers with suboptimal glucose control. The bilateral sensorineural nature of all hearing loss cases indicates systemic pathophysiological mechanisms affecting neural components of the auditory system during critical developmental periods.

The study validates the current two-step hearing screening protocol, demonstrating the importance of following initial OAE screening with diagnostic ABR assessment to ensure accurate identification of true hearing impairment while minimizing false positives. The association between birth complications, particularly respiratory distress and jaundice, and hearing outcomes emphasizes the multifactorial nature of auditory dysfunction in this vulnerable population.

These findings support the recommendation for universal audiological assessment of all neonates born to diabetic mothers, with particular vigilance for those with poor maternal glycemic control, birth complications, or NICU admission. The study underscores the importance of optimal glucose regulation throughout pregnancy as a potential preventive strategy and highlights the need for early intervention with hearing aids in confirmed cases to optimize developmental outcomes.

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