

A retrospective study on hearing outcomes of infants of COVID-19 mothers pre-vaccination era



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ABSTRACT

Background: A COVID-19 infection can result in a variety of symptoms. Findings must be carefully reviewed because there is still a dispute over the potential involvement of the audiovestibular system. Moreover, there is debate over the intrauterine transfer of COVID-19 infection from mother to fetus in pregnant people. There are not many investigations on the audiovestibular symptomatology of infants exposed to COVID-19 during pregnancy. **Aims and Objectives:** This study looks at any potential links between the COVID-19 gestational infection and the start of hearing impairment in babies. The verification of hearing's engagement in COVID-19 allows for the planning of the time and methods for children's audiological evaluations. **Materials and Methods:** Newborns had audiological examination and screening for hearing loss. The automatic transient evoked otoacoustic emissions (OAEs) test is used to evaluate newborns for hearing impairments before they are released from the hospital. By employing the COVID-19 case history, otoscopy, acoustic immittance test, transient evoked OAEs test, and mother, pregnancy, and perinatal case histories, an audiological examination is conducted on children under 3 months of age, with 2 weeks, 1 month and 3 months of age follow-up. **Results:** The research comprised 100 children. Of these infants, 90% were part of the neonatal hearing screening initiative. Due to isolation protocols, the remaining 10 neonates did not undergo hearing screening; instead, a direct audiological examination was performed on them. Out of the 90 newborns that were tested, only 11 had a bilateral REFER test result, but the audiological examination revealed a normal hearing threshold. **Conclusion:** There is no data in this study that a mother's COVID-19 infection results in hearing loss in newborn.

Key words: Otoacoustic emission (OAE), Auditory brainstem response (ABR), Transmission evoked otoacoustic emission (TEOAE)

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INTRODUCTION

Severe acute respiratory syndrome-related coronavirus 2 (SARS-CoV-2) initially came out in the city of Wuhan in China at the end of 2019 and then expanded around the world affecting all age groups.¹ It was dubbed coronavirus disease 2019 (COVID-19) and declared a global health emergency of international concern in 2020.² A COVID-19 infection can result in a broad range of symptoms, from a mild infection to a serious case of interstitial pneumonia, and involvement of the nervous system, with the most prevalent symptoms being

anosmia, hyposmia, hypogeusia, and dysgeusia.³ Patients with COVID-19 infection showed signs of hearing loss, tinnitus, and dizziness, which suggests that even the audio-vestibular system may be implicated.

In addition, intrauterine COVID-19 transfer from mother to fetus pregnant women's infection is a contentious topic. As a matter of fact, studies that^{4,5} discover no proof of vertical transmission, whereas some propose. Although improbable, it is plausible that around 3% of newborns born to mothers who tested positive for SARS-CoV-2 are reported to have COVID-19.⁶⁻⁸ In the case of a neonatal infection, the most common symptoms in decreasing order

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of probability are fever, gastrointestinal, and respiratory manifestations.

Breastfeeding is not linked to late COVID-19 infection, but mother-child separation from birth is.⁹

Studies on the audiovestibular system of infants exposed to COVID-19 intrauterine are few. Based on the TEOAE data, Celik et al.,¹⁰ discovered a deficiency in the medial olivocochlear efferent pathway, indicating that cochlear functioning in newborns whose mothers have undergone COVID-19 should be investigated. Testing positive for SARS-CoV-2 protein creatinine ratio during pregnancy is substantially linked to an increased likelihood of abnormal newborn hearing screening findings, as shown by Alan and Alan.^{10,11} The study presented in this paper evaluates the hearing function of newborns of mothers diagnosed with COVID-19 disease detected by nasopharyngeal swab.

Aims and objectives

Verifying the auditory function of infants born to COVID-19-positive women is the goal of this investigation. This study looks into any potential links between newborns' hearing impairment and the COVID-19 gestational infection. To look into potential link between COVID-19 and hearing loss in infants by audiological evaluation.

MATERIALS AND METHODS

Study design

A retrospective study conducted in the department of otorhinolaryngology Institute of Social Obstetrics and Kasturibha Gandhi Government Hospital, Madras Medical College, Chennai. Ethical committee approval obtained from our institute (No. IC-MMC/Approval/03042024). Newborns whose moms with COVID-19 infection underwent audiological assessment and screening for hearing loss. Before being discharged from the hospital, a newborn's hearing was assessed using the automatic transient evoked otoacoustic emissions (OAEs) test.

The infant was evaluated audiometrically at 1 and 3rd months. During the audiological evaluation, the following assessments were performed on each patient.

Maternal age (Figure 1), TORCH complex (toxoplasmosis, others, rubella, cytomegalovirus, and herpes simplex) infections during pregnancy and pathologies, drug use, birth weight, gestational age, gender, type of delivery, Apgar score, breastfeeding type, and risk factors for hearing loss (per JCHI 2019),¹² results are all included in the study.

SARS-CoV-2 case history concerning gestational age of infection, symptomatology, use of drugs, result of the

nasopharyngeal swabs, otoscopy; transient evoked OAEs test; auditory brainstem response (ABR) test.

Duration of study: January 2020–December 2020-1 year Inclusion criteria

Those parents willing for follow-up and give consent for an audiological evaluation of infants.

Exclusion criteria

Those parents not giving consent for examination and follow-up and babies with poor Apgar score, preterm babies, and weight <2000 g.

Our hospital uses the automatic transient evoked otoacoustic emissions (A-TEOAEs) test as part of their newborn hearing screening process before being discharged from the hospital. A sterile probe was inserted into the ear to record reactions to stimuli. The test results for each ear was immediately recorded by the gadget as either PASS or REFER. About the 30/35 dB HL hearing threshold was a PASS response. Those who had B/L REFER were given acoustic immittance and ABR test to identify hearing threshold. A threshold ≤ 30 dB HL was considered to be normal hearing. Neonates are recorded when they are asleep. In ABR, three electrodes are positioned on the mastoid of both ear, and the upper forehead, the electrode impedance was checked and clicks were employed as the stimulus. There were 2048 fr sweeps with a stimulation rate of 11/s. A 3000 Hz low-pass and a 100 Hz high-pass filter were used and results interpreted.

RESULTS

Demographic and clinical characteristics

The mean maternal age at the time of birth was 27 years (range 21–35 years). During pregnancy, TORCH complex was evaluated in 94 mothers (94%), (Table 1) 42 mothers showed various diseases during pregnancy: Gestational 10 diabetes in cases; hypothyroidism in eight cases; hypertension in 15 mothers, anemia in 7 mothers, All of them took medication during pregnancy for comorbidities. In particular, 10 mothers had non-steroidal anti-inflammatory drugs and (20) antibiotics, there were 10 cases of enoxaparin, and Figure 2 shows the maternal COVID-19 symptoms. About 54% of the subjects did not show symptomatology and the infection diagnosis was based on at least one positive nasopharyngeal swab. In the cases of symptomatic infection, the most frequent symptoms were ageusia, anosmia, and fever followed by cough and pneumonia. The mothers were treated only if they had specific symptoms with symptomatic drugs. In general, 46 mothers took medication for the infection. The primary medications used, in combination or alone,

| Table 1: Overall details of babies | |
|------------------------------------|----------------------------|
| Birth weight (g) | Average range: 2000–3800 g |
| Gender | |
| Male | 42 |
| Female | 58 |
| Torch infection screening | |
| Total: 100% | Done for: 94% |
| Apgar score | |
| 4–6 | 10 |
| 7–10 | 90 |
| Type of delivery | |
| Vaginal delivery | 48 |
| LSCS | 52 |
| Comorbidity in pregnancy | |
| Anemia | 7 |
| Hypertension | 15 |
| Diabetes | 10 |
| Hypothyroidism | 8 |
| Breast-feeding given Yes/No | |
| Yes | 98 |
| No | 2 |
| Risk factors for hearing loss | |
| Consanguinity | 20 |
| Family H/O hearing loss | 7 |

were: antibiotics (20), non-steroidal anti-inflammatory drugs (10), and heparin (10). All neonates were subjected to nasopharyngeal swab at birth. Only two children had one positive swab in the absence of COVID-19 symptomatology.

Newborn hearing screening outcomes

Twenty-seven newborns showed risk factors for neonatal hearing loss (risk factors defined in agreement with the Joint Committee on Infant Hearing 2019¹²). These risk factors were seven hearing loss in family history, and 20 consanguinity of the parents. About 90% (n=90) of the children were subjected to a newborn hearing screening program using the A-TEOAE test before hospital discharge. The remaining 10 newborns were not subjected to hearing screening for isolation measures but underwent the audiological evaluation later. Only 11 of 100 screened neonates showed a bilateral REFER test result Table 2.

The neonate with bilateral REFER result at hearing screening showed bilateral B curve in tympanometry and on further follow-up normal audiological evaluation with a normal bilateral ABR thresholds (bilateral 30 dB HL) obtained.

DISCUSSION

According to recent research, COVID-19 infection raises the possibility of developing ear issues. Some of the mechanisms linked to changes in hearing and balance include inflammatory processes with excessive formation

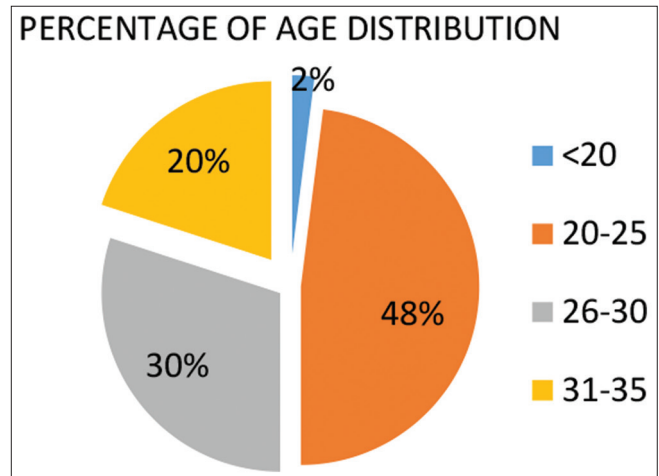


Figure 1: Age distribution of mothers

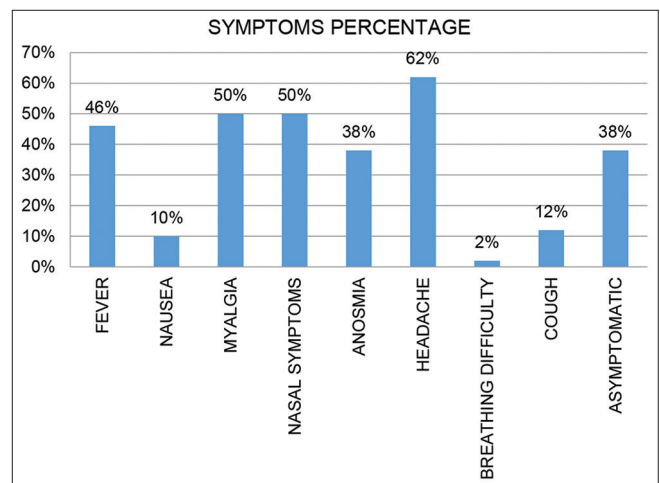


Figure 2: Maternal covid-19 symptoms

of reactive oxygen species, ototoxicity from antiviral therapies, and hematogenous changes with hemoglobin attachment and erythrocyte penetration.¹³ The literature is split on the likelihood of COVID-19 spreading vertically; yet, some investigations report angiotensin-converting enzyme 2 (ACE2) expression and the presence of viruses in the placenta.¹⁴ Furthermore, in comparison to adults, children have a decreased frequency of COVID-19 infection and less severe clinical signs; yet, infections in infants are still conceivable.¹⁵

This publication reports on research that assessed the auditory function of infants born to moms who tested positive for COVID-19. Only infant 11 (11%) showed bilateral REFER findings during newborn hearing screening evaluation (before hospital discharge). The information presented here is consistent with the Joint Committee on Infant Hearing’s (2019)¹² recommendations, which provide a reference level of <4% for infants who do not pass the initial screening stage.

Table 2: Results of infants

| COVID status of infants | No. babies with OAE-PASS | No. babies with OAE-REFER | Audiological follow-up |
|-------------------------|--------------------------|---------------------------|------------------------|
| Negative | 81 | 9 | Done within 2 weeks |
| Positive | 8 | 2 | After 2 weeks |

OAE: Otoacoustic emission

Conversely, Alan and Alan's study¹¹ revealed that, in comparison to the control group, infants delivered to women infected with COVID-19 had higher REFER findings. The automated ABR test was used for newborn hearing screening in the Alan and Alan research, whereas the ATOAE test was used in the study reported in this publication. These methods assess two distinct facets of the transmission of hearing. In instance, cochlear nerve transmission is assessed by ABR, whereas otoacoustic emission assesses the functioning of the outer hair cells. According to recent literature reviews, COVID-19 infection can impact the peripheral nervous system, namely, the cranial nerves and nuclei of the brainstem^{16,17} by direct invasion through downregulation of ACE2 and over-reaction of ReninAngiotensin-pathway, or secondly, by systemic immune response.¹⁷

In this study, OAE done at 2 weeks 1 month, and 3 months.

Within 2 weeks after delivery, this test was conducted. In contrast, there was no difference between the groups on the ABR test, which was conducted 4 weeks and 12 weeks after delivery.¹¹ The study reported in this paper found that the median age at which an audiological assessment was performed was around 3 months of age. In the sample examined in this article, the COVID-19 infection is in the third trimester. Since three of the instances occurred in the third trimester and one in the first, there was no relationship found between the three newborns with altered OAE and the trimester of infection. The investigation reported in this publication is restricted by the small sample size of women who were infected with COVID-19 throughout the first and second trimester. More research on the long-term effects of infection in the first and second trimesters is required for pregnant women.

Limitations of the study

Information about mothers infected in 1st and 2nd trimester not included in the study. Information about infants of mothers affected by covid-19 not included in the study.

CONCLUSION

Only 11 out of the hundred newborns tested in this study had B/L REFER in OAE and on further follow-up, normal ABR was obtained. Maternal COVID-19 infection resulting

hearing loss in newborn is not established in this study population. Information on early maternal COVID-19 infection in the first and second trimester is needed to establish a link between COVID-19 and hearing loss in infants.

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