NORTHWESTERN MEDICAL JOURNAL

Northwestern Med J. 2025;5(1):46-50
DOI: 10.54307/NWMJ.2025.78

RESEARCH ARTICLE

Evaluation of hearing screening results of newborns born to SARS-CoV-2 positive pregnant women

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Cite as: Akça Ü, Sanrı E, Akça G. Evaluation of hearing screening results of newborns born to SARS-CoV-2 positive pregnant women. Northwestern Med J. 2025;5(1):46-50.

ABSTRACT

Aim: It is a scientific fact that certain viral infections during pregnancy cause hearing loss in newborns. The aim of this study was to investigate whether such infections are the cause of congenital hearing loss. This study was based on an examination of the hearing screening of newborns born to pregnant women affected by the current pandemic caused by the SARS-CoV-2 virus, which is responsible for the disease designated Coronavirus Disease 2019 (COVID-19).

Materials and Methods: In this retrospective case-control study, demographic data and ABR hearing test results of a total of 81 newborns were compared with those of 101 healthy controls. The newborns were born to mothers who tested positive for SARS-CoV-2 polymerase chain reaction (PCR) during pregnancy between March and September 2022. The mothers of the healthy controls had no problems during pregnancy.

Results: The prevalence of SARS-CoV-2 PCR positivity during pregnancy was 3.5%. A higher cesarean delivery rate was observed in the group with positive SARS-CoV-2 infection (p=0.028). The failure rate of the initial screening test was higher in both groups (22/81 vs. 25/101; p=0.712). However, a subsequent analysis revealed that there was no statistically significant difference between the results of the secondary follow-up screening (p=0.926).

Conclusion: The study data suggest that there is no indication that maternal SARS-CoV-2 infection during pregnancy results in neonatal hearing loss.

Keywords: COVID-19, hearing loss, pregnancy, newborn

INTRODUCTION

The novel strain of the virus is called SARS-CoV-2. It causes a severe illness called acute respiratory distress syndrome (1). According to the World Health Organization (WHO), more than 660 million cases of the disease have been reported worldwide as of January 2023, and more than 6.7 million deaths related to the disease have been reported. This virus, which primarily affects the respiratory system, causes damage to other organs and systems. There have also

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Received: 13.01.2024 **Accepted:** 08.11.2024 **Published:** 31.01.2025

been numerous cases of anosmia and hearing loss thought to be associated with the disease (2).

Congenital hearing loss is one of the most common birth defects. It leads to a significant delay in the child's social and language development (3). Congenital viruses such as the TORCH group viruses and Zika virus may result in fetal involvement. Direct damage to the hair cells in the inner ear and organ of Corti by these viruses may result in hearing loss in the infant (4,5). Vertical transmission of these viruses from mother to fetus has been proven. Nevertheless, the transmission route of SARS-CoV-2 remains a subject of scientific debate. The detection of angiotensin converting enzyme 2 receptor in the placenta and the presence of SARS-CoV-2 Ig M antibodies in the infant have been suggested as evidence of vertical transmission (6). Hearing screening has long been used in many countries to diagnose hearing loss at an early stage, to predict the potential outcome of treatment, and to anticipate the effects of any resulting impairment. The most commonly utilized methodologies are transient evoked otoacoustic emission (TEOAE) and automatic auditory brainstem response (AABR) tests (7). The objective of this investigation was to assess the outcomes of hearing assessments in neonates born to mothers who tested positive for SARS-CoV-2 and to determine whether these infants exhibit indications of hearing impairment.

MATERIALS AND METHODS

The present study is a retrospective analysis of newborns delivered at Samsun University Children's Hospital between March 2022 and September 2022. The necessary approval was obtained from the Scientific Research Ethics Committee of Samsun Training and Research Hospital on February 16, 2022, under the decision number 2022/3/4. The study included infants born to mothers who tested positive for SARS-CoV-2 during pregnancy and who gave birth between the specified dates. The study excluded infants with a history of asphyxia, hereditary sensorineural hearing loss in the family, TORCH infection, brain and facial anomalies, ototoxic drug use, jaundice requiring blood transfusion, and patients with a history of APGAR 1 (i.e., a minute score between 0 and 6). A control group was formed among newborns born to mothers with the same conditions and negative SARS-CoV-2 PCR test results. Gender, mode of delivery, and ABR results were categorized as non-continuous variables, whereas birth weight, maternal age, paternal age, and gestational age were categorized as continuous variables.

The statistical analysis was conducted using the SPSS 25.0 (Statistical Package for the Social Sciences, Version 25.0, Chicago, USA) statistical program. In order to facilitate the comprehension of the data, continuous variables are expressed as the mean ± standard deviation. Categorical variables are presented as percentages. The independent samples t-test was used to compare data between patients and healthy subjects. A chi-squared test (x^2) was used to facilitate comparison of data presented as percentages. Pearson's correlation coefficient was used for correlation analysis. A p-value less than 0.05 was considered statistically significant for all data.

Compliance with ethical standards

Approval was obtained from the ethics committee before the study began. The study was conducted in accordance with the principles established in the Declaration of Helsinki, and each participant provided written informed consent prior to involvement which included a detailed description of the study.

RESULTS

A total of 2,532 births occurred during the study period, and 88 pregnant women (3.5%) tested positive for SARS-CoV-2 by PCR. Eight newborns from seven pregnancies were excluded from the study because they met the established exclusion criteria. Of the eight newborns excluded from the study, four met the criteria for exposure to ototoxic drugs for more than five days, two met the criteria for multiple pregnancies resulting from twin births, and two met the criteria for being born with a birth weight of less than 1,500 grams. The study sample comprised 81 newborns, while the control group consisted of 101 newborns. No significant differences were observed between the two groups with regard to maternal age, paternal age, birth weight, gestational week, and sex (p=0.783, p=0.781, p=0.791, p=0.871, p=0.655, respectively). A

comparison of the case and control groups revealed a statistically significant difference in the rate of cesarean delivery, with a higher prevalence in the case group (p = 0.028). Demographic characteristics are presented in Table 1.

Otoscopic examination of the patients who underwent ABR testing revealed no statistically significant differences between the two groups in either the right or left ear. In the case group, 15 newborns (18.5%) exhibited bilateral referral, 5 newborns (6.2%) demonstrated right unilateral referral, and 2 newborns (2.5%) exhibited left unilateral referral. In the control group, the ABR test results were as follows: 17 newborns (16.8%) exhibited bilateral referral, 4 newborns (3.9%) exhibited a right unilateral referral, and 4 newborns (3.9%) exhibited a left unilateral referral. In the two groups, the bilateral pass result in the initial test was calculated as 59 newborns (72.8%) and 90 newborns (89.1%), respectively. A comparison of the ABR test results between the two groups did not show a statistically significant difference, as indicated by the p-value (p=0.712).

Patients who received a referral result in the initial screening underwent a repeat ABR test two weeks later. In the case group, one newborn (4.5%) exhibited a bilateral referral , while 21 newborns (95.5%) demonstrated a bilateral transition. In the control group, one newborn (4.0%) exhibited a bilateral reference result, while 24 newborns (96.0%) demonstrated a bilateral reference result. There was a statistically insignificant difference between the two groups (p=0.926). The results of the newborn hearing screening test for both groups are presented in Table 2.

DISCUSSION

Congenital hearing loss can be attributed to a number of environmental factors, including infection, the use of ototoxic drugs, premature birth, and asphyxia. Additionally, developmental and genetic causes may also contribute to this condition. Hearing loss resulting from infection can be congenital or acquired, temporary or permanent, and may manifest as sensorineural or conductive hearing loss (8). The underlying mechanisms have been identified as striae,

Table 1. A comparative analysis of the demographic and clinical characteristics of the two groups

		Maternal SARS-CoV-2 (+) group	Control group	p value*
Mother's age (min.-max.)		27.16±4.67 (19-39)	26.97±4.56 (18-41)	0.783
Father Age (min.-max.)		30.32±5.62 (19-40)	30.08±5.56 (18-39)	0.781
The infant's birth weight (in grams).		3236.66±449.74	3219.20±432.61	0.791
Birth week (min.-max.)		38.55±1.25 (37-41)	38.52±1.27 (37-41)	0.871
Gender	Female	42 (51.9%)	49 (48.5%)	0.655
	Male	39 (48.1%)	52 (51.5%)	
Mode of delivery	Vaginal delivery	24 (29.6%)	46(45.5%)	**0.028**
	Cesarean section	57 (70.4%)	55 (54.4)	

* Kruskal-Wallis H test, Pearson-χ2 cross-tab

Table 2. The results of the newborn hearing screening test for both groups

		Maternal SARS-CoV-2 (+) group (n)	Control group (n)	p value*
ABR	pass	59/81	76/101	0.712
	refer	22/81	25/101	
ABR refer	pass	21/22	24/25	0.926
	refer	1/22	1/25	

* Kruskal-Wallis H test, Pearson-χ2 cross-tab

vasculitis, direct damage to the cochlear organ or neuron, or the addition of more severe infections secondary to immune damage (7,8). In addition to TORCH group infections, Zika virus and HIV have been reported to affect the nerves on the cochlea and cause sensorineural hearing loss in newborns (4).

Three hypotheses have been proposed in studies to explain how hearing loss develops in newborns infected with SARS-CoV2 during pregnancy. The first hypothesis is that maternal infection with SARS-CoV2 would lead to infection of the fetus in utero (9). The second hypothesis is that SARS-CoV2 infection primarily causes placental dysfunction, leading to destruction of placental villi and intrauterine hypoxia (10,11). The last hypothesis is that of vertical placental transmission. It is the assumption that the physiological and immunological protection due to inflammation of the placenta is removed and the inflammation is directly transmitted to the newborn (12).

Despite the existence of studies indicating that SARS-CoV-2 virus may be associated with adverse pregnancy outcomes such as abortion, prematurity, and intrauterine growth restriction, there is currently no evidence of vertical transmission of the virus (13-15). These complications are believed to be due to the systemic effects of the virus on the mother. It has been argued that a significant cytokine storm, especially in severe infections, causes neuronal defects in the fetus due to the proinflammatory period in the first and third trimesters. While vertical transmission has not been proven, the toxic effect of increased TNF-alpha levels in the placenta on the fetus has been emphasized in studies (16,17).

The results of the limited number of studies conducted on this topic are mixed. In a study conducted in 2022, the amplitudes of transient evoked otoacoustic emissions (TEOAE) were found to be reduced in asymptomatic patients with confirmed SARS-CoV-2 infection compared to a control group. Additionally, the study demonstrated the deleterious effects of SARS-CoV-2 on hair cells in the cochlea (18). Kilic et al. (17) reported five patients who developed sudden unilateral sensorineural hearing loss. Conversely, Veeranna et al. (19) observed comparable TEOAE results between the two groups and noted a significant prolongation of the intertopic intervals, suggesting that while impairment of cochlear function is unlikely, ABR function may be potentially affected. Celik et al. demonstrated that infants born to mothers with intrauterine SARS-CoV-2 infection may have a disorder of the medial olivary efferent system (20). In a recent study, Alan et al. proposed that disease during pregnancy may increase the risk of hearing loss in newborns (21). Their findings indicated a higher prevalence of SARS-CoV-2 positivity in the first ABR compared to the control group. In contrast, the four most recent studies indicated no association between SARS-CoV-2 infection and hearing loss in newborns (21-25). Our findings did not show statistical significance in the prevalence of hearing loss between the two groups in the cohort.

CONCLUSION

The results of the current hearing screening indicate that there is no evidence of congenital hearing loss in newborns born to SARS-CoV-2 PCR-positive pregnant women. However, since hearing loss may develop later in life, it is recommended to plan studies with long-term follow-up and more comprehensive technical analyses.

Ethical approval

This study has been approved by the Ethics Committee of Samsun Training and Research Hospital (approval date 16/02/2022, number 2022/3/4). Written informed consent was obtained from the participants.

Author contribution

Surgical and Medical Practices: ÜA Concept: GA; Data Collection or Processing: ES; Analysis or Interpretation: ÜA; Literature Search: GA, EA; Writing: ÜA. All authors reviewed the results and approved the final version of the article.

Source of funding

The authors declare the study received no funding.

Conflict of interest

The authors declare that there is no conflict of interest.

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