










Hearing test results of newborns born from the coronavirus disease 2019 (COVID-19) infected mothers: A tertiary center experience in Turkey

Gazi Yıldız¹ , Didar Kurt¹ , Emre Mat¹ , Pınar Yıldız² , Gülfem Başol¹ ,
Elif Cansu Gündoğdu¹ , Betül Kuru¹ , Bahtisen Topcu³  and Ahmet Kale¹ 

¹Obstetrics and Gynecology Department, University of Health Sciences Kartal Dr. Lutfi Kırdar Research and Training Hospital, Istanbul, Turkey

²Obstetrics and Gynecology Department, Adatıp Kurtköy Hospital, Istanbul, Turkey

³Neonatology Department, University of Health Sciences Kartal Dr. Lutfi Kırdar Research and Training Hospital, Istanbul, Turkey

Abstract

Objective: Congenital infections can cause newborn hearing loss. Although vertical transmission of coronavirus disease 2019 (COVID-19) infection is theoretically possible, this has not been proven yet. To our knowledge, there is no previous report on whether COVID-19 infection during pregnancy can cause congenital hearing loss. This paper aimed to find an answer to this question.

Method: This retrospective, single-center study was performed between April 2020 and May 2021 at a tertiary care referral center in Turkey. A total of 422 pregnant women who had coronavirus infection during pregnancy were followed and 203 of them gave birth in our institution. Results of hearing screening tests of 199 newborns were assessed retrospectively.

Results: Of patients included in the study, 23 (11.6%) had the disease in the first trimester, 62 (31.2%) in the second trimester, and 114 (57.3%) in the third trimester. In the first hearing test performed on newborns, unilateral hearing loss was observed in 21 babies (10.5%). Hearing tests of these newborns were found to be normal in the second test performed 15 days later.

Conclusion: Considering the incidence of congenital hearing loss, the absence of hearing loss in our newborn population does not confirm the argument that coronavirus infection does not cause congenital hearing loss. This issue should be evaluated with larger patient series. In addition, it should be kept in mind that hearing loss can occur at later ages as well.

Key words: congenital infections, coronavirus, COVID-19, newborn hearing loss, pregnancy.

Introduction

Congenital hearing loss is an important disease as it can cause a delay in speech and language development and also leads to educational and social problems.^{1,2} Congenital infections, particularly cytomegalovirus (CMV) infection, can cause newborn hearing loss.³

Early diagnosis of this condition is very crucial for these babies because the sooner the diagnosis is made, the earlier treatment begins and the lower the risk of irreversible pathologies. For this reason, hearing screening is included in newborn screening programs in some countries and this screening is also available in our country.

Received: March 25 2021.

Accepted: August 26 2021.

Correspondence: Gazi Yıldız, Obstetrics and Gynecology Department, University of Health Sciences Kartal Dr. Lutfi Kırdar Research and Training Hospital, Istanbul, Turkey. Email: drgaziylidiz@gmail.com

Novel coronavirus emerged in Wuhan, China in December 2019 and rapidly become widespread in the world. The World Health Organization (WHO) declared the coronavirus infection as a global pandemic on March 11, 2020.^{4,5} Coronavirus infected many people in the world globally, and pregnant women were also affected by this virus. Although it is known that pregnancy is not a condition that adversely affects the coronavirus infection course, vertical transmission to the fetus is still the subject of research. Although vertical transmission of Coronavirus disease 2019 (COVID-19) infection is theoretically possible, this has not been proven yet. Possible ways of transmission of infection to the baby are intrauterine vertical transmission, transmission from breast milk, or contact with mother's vaginal secretions, skin, or anus at birth.

This paper aimed to find an answer to the question that if the COVID-19 infection during pregnancy can cause congenital hearing loss.

Materials and Methods

This retrospective, single-center study was performed between April 2020 and May 2021 at Kartal Dr. Lütfi Kırdar City Hospital, Istanbul, Turkey, which is a tertiary care referral center with approximately 4000 deliveries per year. Ethics committee approval for this study was obtained prior to the conduct of the study (reference number: 2020/514/187/11, date:14.10.2020). The study was performed according to the standards of the Helsinki Declaration. The information of all pregnant women who were delivered in our hospital with the history of a COVID-19 infection and newborns born from these mothers were collected retrospectively from patients medical files in our hospital databases. COVID-19 infection was diagnosed via COVID-19 reverse transcription-polymerase chain reaction (RT-PCR) test obtained from the nasopharyngeal swab. Written informed consent was taken from the patients who agreed to participate in the study after giving detailed information about the purpose of the study.

Hospital records showed us 422 pregnant women who had coronavirus infection during pregnancy were followed in our obstetrics clinic between April 2020 and May 2021 and 203 of them gave birth in our institution. Demographic characteristics of all the patients, including age, gravida, parity, abortus, smoking status, educational level, occupation, consanguinity, and blood types were recorded. The gestational week when the mother was infected, symptoms, drugs used for

the treatment of COVID-19 infection, gestational week of birth, route of delivery, sex of the baby, Apgar score of newborn, and need for neonatal intensive care unit (NICU) admission also were recorded.

Results of hearing screening tests of 199 newborns were assessed retrospectively. Risk factors for hearing loss at newborn or early childhood period were questioned for every screened newborn. These risk factors are; history of maternal TORCH infection, familial hearing impairment, anomalies of head and neck related with the external ear canal and middle ear, birth weight under 1500 g, birth with lower Apgar scores, hyperbilirubinemia of newborn, bacterial meningitis, usage of ototoxic drug, and prolonged mechanical intubation. Hearing screening of newborns was cared out made in accordance with the standards of the National Newborn Hearing Screening Program in our institution. The group without risk factors was evaluated with transient evoked otoacoustic emissions (TEOAE) using echo screen TOA (Natus Medical Incorporated, San Carlos, CA, USA) apparatus. Pass/fail system was used for this evaluation. Failed ones were reassessed 15 days later once again with the same methodology. Patients with known risk factors and two times failed tests were sent to Auditory Brainstem Response (ABR) protocol. All newborns of our study were accepted as risky and they all went on to undergo ABR test directly. Hearing tests were performed in newborns before their discharge from the hospital. Tests were performed in a silent room which was only used for hearing tests and by a certificated nurse and two audiological technicians on their mothers lap or on a stretcher while they were sleeping deeply. Before newborns were put to sleep, three electrodes were attached to the babies and they were sent to the sleeping room. After babies went into sleep, cables of ABR machine were connected with electrodes. A click sound was given to the external auditory channel with the appropriate probe. If the hearing of the newborn was normal then the normal hearing wave of ABR was seen on machine's screen and pass indicator was turned on. If the newborn cannot pass the test, then the fail indication was seen this time. Newborns with uni or bilaterally failed ears were all examined by an otolaryngologist. Obstructive debris of external ear canal, serous otitis media, and other possible problems were evaluated. After appropriate treatment, second ABR tests were performed. Hearing screening results of newborns were recorded on a form.

All statistical analyses were performed with SPSS v21 (SPSS Inc., Chicago, IL, USA). Descriptive statistical analyses were used. Data are given as mean \pm SD or median (minimum–maximum) for continuous variables with regard to normality of distribution, and as frequency (percentage) for categorical variables. Less than 14th gestational week was accepted as the first trimester, 14–28th week as the second trimester, > 28th week as the third trimester.

Results

Between April 2020 and May 2021, 203 women were delivered in our hospital who had a history of COVID-19 infection during pregnancy. In this retrospective study, we excluded four of these patients (two of them were in utero mort fetalis, one baby had fetal anomaly and one baby prematurely delivered and died postnatally before hearing test was

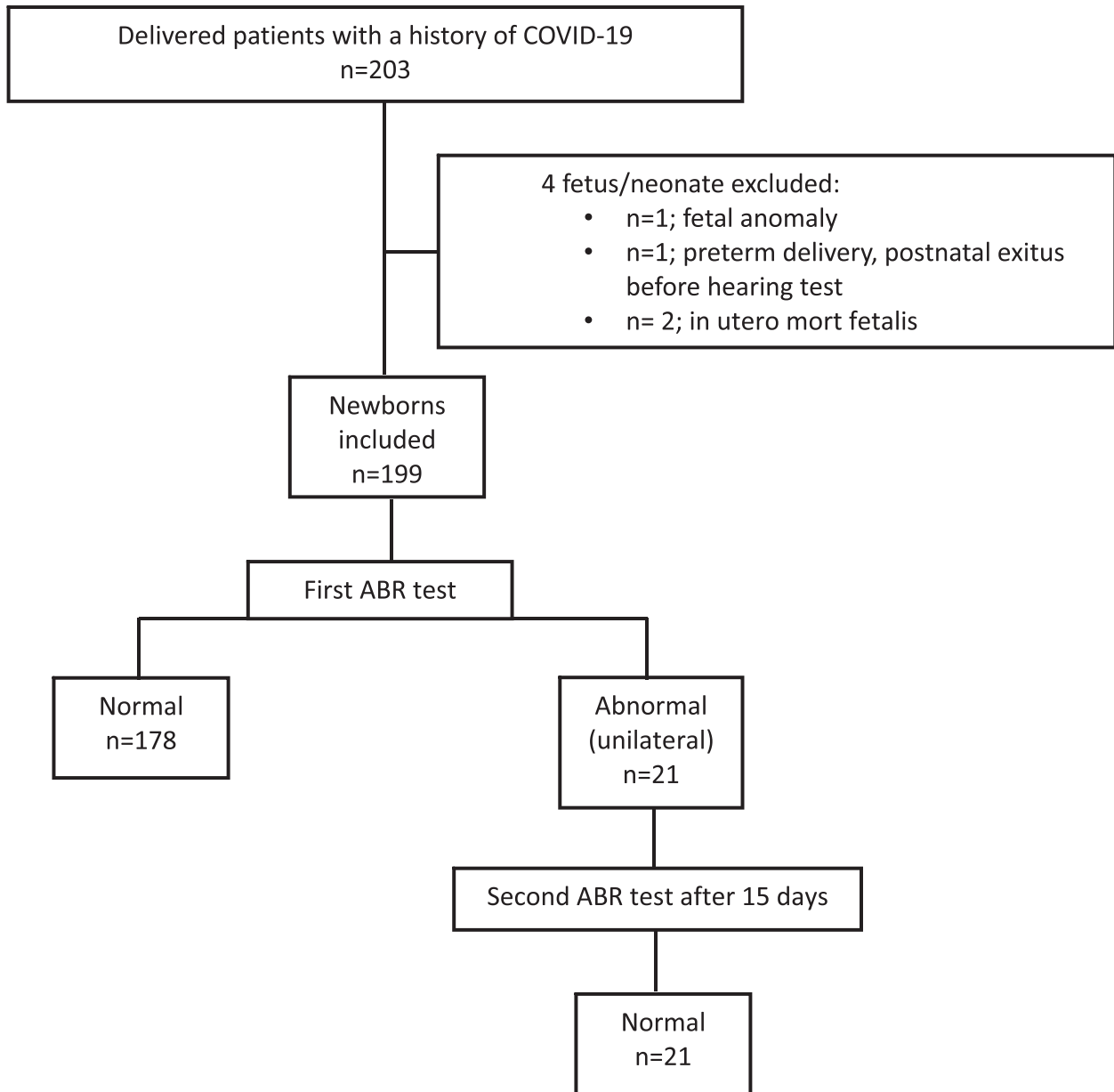


FIGURE 1 Flowchart of the study and auditory brainstem response (ABR) test results of newborns

TABLE 1 Characteristics of the COVID-19 infected mothers and their babies

	Mean (SD)	Minimum–maximum	Number (percentage)
Maternal age (years)	29.84 (4.9)	18–42	
Maternal comorbidities			
Asthma and GDM			1 (0.5)
Asthma and FMF			1 (0.5)
Brain tumor			1 (0.5)
Epilepsy			1 (0.5)
Hypothyroidism			5 (2.5)
Thyroidcancer			1 (0.5)
GDM			5 (2.5)
Asthma			2 (1)
IHC			2 (1)
Gestational week of an infection	28.19 (10.4)	6–41	
Trimester of the infection			
First			23 (11.6)
Second			62 (31.2)
Third			114 (57.3)
Delivery week	38.6 (1.8)	28–42	
Route of delivery			
Normal vaginal			91 (45.7)
Cesarean			108 (54.3)
Newborn weight (g)	3320.1 (433.3)	1170–4600	
Newborn sex			
Female			95 (47.7)
Male			104 (52.3)
Need of NICU follow up			13 (6.5)
Length of stay at NICU (day)	10.4 (13.1)	2–45	
Positive COVID-19 RT-PCR test of a newborn			1 (0.5)

Abbreviations: FMF, Familial Mediterranean fever; GDM, gestational diabetes mellitus; IHC, intrahepatic cholestasis of pregnancy; NICU, newborn intensive care unit.

performed) and we analyzed 199 mothers and their babies data (Figure 1).

The mean age of mothers were 29.84 ± 4.9 years and the mean week of COVID-19 infection diagnosis was 28.19 ± 10.4 (Table 1). Of patients included in the study, 23 (11.6%) had the disease in the first trimester, 62 (31.2%) in the second trimester, and 114 (57.3%) in the third trimester. During COVID-19 infection, 76 patients (38.2%) were followed up in an outpatient setting, 122 (61.3%) patients were followed up in the hospital's inpatient service and one patient (0.5%) was followed up in the adult intensive care unit. One-hundred eighty of the mothers (90.4%) had no comorbid illness. The patient who was followed in the adult intensive care unit did not have any comorbidity. The mean week of delivery was 38.6 ± 1.8 and the mean birth weight was 3320.1 ± 433.3 gr. In 45.7% of the patients, the delivery was performed by normal spontaneous route, and in 54.3% by cesarean section. And 52.3% of the babies born were male and 47.7% female. Fifteen deliveries were premature birth and seven of

these newborns were followed up in the neonatal intensive care unit.

In the first hearing test performed on newborns, unilateral hearing loss was observed in 21 babies (10.5%). Eleven babies had hearing loss in the right ear (52.4%) and 10 in the left ear (47.6%). One (4.7%) of the patients whose first hearing test result was abnormal were the babies who had the disease in the first trimester, 10 (47.6%) had the disease in the second trimester and 10 (47.6%) had the disease in the third trimester. Hearing tests of these newborns were found to be normal in the second test performed 15 days later.

Discussion

Congenital hearing loss is an important health problem of babies. Coronavirus infected so many people in the world globally, and pregnant women were also affected by this virus. It is still unknown that if

COVID-19 infection during pregnancy can transmit to the fetus. In this study, we aimed to find an answer of the question that if COVID-19 infection during pregnancy can cause congenital hearing loss.

It is unknown if coronavirus infection can be vertically transmitted to the fetus. In one systematic review, vertical transmission was investigated among 310 infected women's newborns via nasal swab or IgM positivity in cord blood and no positivity was shown.⁶ In the systematic review by Yang and Liu newborns of 83 COVID-19 positive mothers were included, and vertical transmission was investigated by coronavirus RT-PCR examination made from amniotic fluid, cord blood, placenta samples, neonatal nasopharyngeal swab, and IgM or IgG levels of neonatal blood. Only nasopharyngeal swab was positive in three babies, and virus-specific antibody levels were high in other six neonates' serum sample.⁷ Egloff et al. Stated in their literature review that among 179 COVID-19 positive mothers who were infected close to birth, vertical transmission was suspected in eight neonates (all cord blood and amniotic fluid RT-PCR results were negative but nasopharyngeal swabs [five neonates] or blood IgM levels [three neonates] were positive in some neonates).⁸ In one systematic review, 161 studies and 3985 pregnant women with coronavirus infection were included, and there stated that totally 163 amniotic fluid, placenta, and/or cord blood samples were analyzed for coronavirus and 10 were positive, and also 61 newborns were positive for COVID-19 infection.⁹ In our study group, one neonate's COVID-19 RT-PCR test taken from the nasopharyngeal swab was positive after birth. This newborn's mother was infected close to birth, and the hearing test of this baby was also normal. With the limited number of cases in the literature, none of these findings precisely proves intrauterine vertical transmission, and further studies need to be performed. Also, it is still unknown if infection during the first or second trimester can cause congenital infection.^{8,10}

The course of the COVID-19 infection during pregnancy is not worse than for the normal population, but pregnant women with additional comorbidities may be more at risk for serious illnesses.^{11,12} Our seven patients had additional comorbid diseases, and all of these patients were hospitalized but none of them needed intensive care unit admission. One patient who needed ICU admission for 15 days did not have any illness and her delivery was preterm at 31st week.

COVID-19 infection can also cause some perinatal complications, Dashraath et al. stated in their review 2% of miscarriage, 10% of intrauterine growth restriction (IUGR), and 39% of preterm birth rates.¹⁰ In our population eight deliveries (11.6%) were preterm, a total of four infants were followed up in the neonatal intensive care unit and three of them were preterm babies.

Environmental or genetic factors can cause congenital hearing loss and some of the environmental risk factors are infections, ototoxicity, prematurity, and asphyxia.¹³ Viral infections acquired during pregnancy can be vertically transmitted to the fetus and can cause congenital infections.¹⁴ Hearing loss due to viral infections can be congenital or acquired, permanent or reversible, sensorineural, or conductive.¹⁵ Many different mechanisms play part in hearing loss; direct damage to stria vascularis, organ of Corti or neurons, indirectly decreasing the immunity and causing secondary infections, damage caused by the host immune response to viral antigens, and unknown mechanisms.¹⁵ Viral agents which are known to be related with congenital hearing loss are toxoplasma gondii, rubella virus, herpes simplex virus, human immunodeficiency virus (HIV), *Treponema pallidum*, lymphocytic choriomeningitis virus, and CMV.^{1,13,15,16} Congenital CMV infection is the most common cause of acquired hearing loss in newborns in developed countries (20%–30% of congenital sensorineural hearing loss is caused by CMV infection),^{13,17} also overall hearing loss incidence in congenital CMV infection is 12.6% (18). This hearing loss can be detected in the newborn period, as well as in infancy or in later childhood^{13,17}; hence, some authors suggested that infected children should be screened periodically.^{15,18} Also, Leal et al. reported that babies aged between 0 and 10 months diagnosed with congenital Zikavirus infection with microcephaly have sensorineural hearing loss at the rate of 5.8%. However, in this article, the authors reported that it is necessary to decide on the prevalence of hearing loss by performing a hearing test on babies of all mothers, including those who are infected with Zikavirus and have no symptoms.¹⁹ Recently, Celik et al. investigated the effect of coronavirus infection during pregnancy on cochlear functions of newborns and concluded insufficiency of medial cochlear efferent system functions.²⁰ The inclusion of congenital hearing loss screening in neonatal screening programs has enabled early diagnosis and rapid management of these patients, and also some antiviral treatments can

reverse or stop the progression of this hearing loss.¹⁵ Sometimes, vaccines can reduce the incidence of congenital hearing loss by preventing infection. According to the above-mentioned information, we aimed to find an answer to the question whether coronavirus infection can cause congenital hearing loss, and it was established that all of the newborns included in our study have normal hearing screening tests.

Considering the incidence of congenital hearing loss, the absence of hearing loss in our newborn population does not confirm the argument that coronavirus infection does not cause congenital hearing loss. This issue should be evaluated with larger patient series. In addition, it should be kept in mind that hearing loss can occur at later ages as well.

Conflict of Interest

The authors declare that they have no conflict of interest.

Data Availability Statement

Research data are not shared.

References

1. Korver AM, Smith RJ, Van Camp G, et al. Congenital hearing loss. *Nat Rev Dis Primers*. 2017;**3**(1):1–17.
2. Lieu JE, Kenna M, Anne S, et al. Hearing loss in children: a review. *JAMA*. 2020;**324**(21):2195–205.
3. Nicloux M, Peterman L, Parodi M, et al. Outcome and management of newborns with congenital cytomegalovirus infection. *Arch Pediatr*. 2020;**27**(3):160–5.
4. Cucinotta D, Vanelli M. WHO declares COVID-19 a pandemic. *Acta Bio Medica: Atenei Parmensis*. 2020;**91**(1):157.
5. Dey M, Singh S, Tiwari R, Nair V, Arora D, Tiwari S. Pregnancy outcome in first 50 SARS-CoV-2 positive patients at our center. *Gynecol Obstet Reprod Med*. 2021;**27**(1):11–6.
6. Huntley BJF, Huntley ES, Di Mascio D, et al. Rates of maternal and perinatal mortality and vertical transmission in pregnancies complicated by severe acute respiratory syndrome coronavirus 2 (SARS-co-V-2) infection: a systematic review. *Obstet Gynecol*. 2020;**136**(2):303–12.
7. Yang Z, Liu Y. Vertical transmission of severe acute respiratory syndrome coronavirus 2: a systematic review. *Am J Perinatol*. 2020;**37**(10):1055.
8. Eglouff C, Vauloup-Fellous C, Picone O, et al. Evidence and possible mechanisms of rare maternal-fetal transmission of SARS-CoV-2. *J Clin Virol*. 2020;**128**:104447.
9. Rodrigues C, Baía I, Domingues R, et al. Pregnancy and breastfeeding during COVID-19 pandemic: a systematic review of published pregnancy cases. *Front Public Health*. 2020;**8**:806.
10. Dashraath P, Wong JLJ, Lim MXK, et al. Coronavirus disease 2019 (COVID-19) pandemic and pregnancy. *Am J Obstet Gynecol*. 2020;**222**(6):521–31.
11. Pettrosso E, Giles M, Cole S, et al. COVID-19 and pregnancy: a review of clinical characteristics, obstetric outcomes and vertical transmission. *Aust NZJ Obstet Gynaecol*. 2020;**60**(5):640–59.
12. Salem D, Katranji F, Bakdash T. COVID-19 infection in pregnant women: review of maternal and fetal outcomes. *Int J Gynaecol Obstet*. 2020;**21**:291–8.
13. Smith RJH, Bale JR, White KR, et al. Sensorineural hearing loss in children. *Lancet*. 2005;**365**(9462):879–90.
14. Palma S, Roversi MF, Bettini M, et al. Hearing loss in children with congenital cytomegalovirus infection: an 11-year retrospective study based on laboratory database of a tertiary paediatric hospital. *Acta Otorhinolaryngol Ital*. 2019;**39**(1):40.
15. Cohen BE, Durstenfeld A, Roehm PC. Viral causes of hearing loss: a review for hearing health professionals. *Trends Hear*. 2014;**18**:2331216514541361.
16. Gurlek B, Colak S. Antenatal toxoplasma gondii, rubella and cytomegalovirus infection screening among pregnant women attending tertiary university hospital. *Gynecol Obstet Reprod Med*. 2019;**25**(2):74–80.
17. Barbi M, Binda S, Caroppo S, et al. Neonatal screening for congenital cytomegalovirus infection and hearing loss. *J Clin Virol*. 2006;**35**(2):206–9.
18. Goderis J, De Leenheer E, Smets K, et al. Hearing loss and congenital CMV infection: a systematic review. *Pediatr*. 2014;**134**(5):972–82.
19. LealMC MLF, Ferreira TS, et al. Hearing loss in infants with microcephaly and evidence of congenital Zika virus infection—Brazil. *Morb Mortal Wkly Rep*. 2016;**65**(34):917–9.
20. Celik T, Simsek A, Koca CF, Aydin S, Yasar S. Evaluation of cochlear functions in infants exposed to SARS-CoV-2 intrauterine. *Am J Otolaryngol*. 2021;**42**(4):102982.