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Commentary

Auditory system and COVID-19

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Abstract

The COVID-19 pandemic that emerged in 2020 may affect the peripheral and central auditory system. According to studies in the literature, symptoms affecting the vestibulocochlear system such as sudden hearing loss, tinnitus, and vestibular neuritis are seen in individuals with COVID -19. While viral pathogens directly affect the structures that supply blood and nutrition to the inner ear, such as the stria vascularis, they can indirectly cause hearing disorders by damaging the immune system. Depending on the affected anatomical region, different symptoms can be observed in individuals. For this reason, post-disease audiological evaluations should be made for individuals with COVID-19. Annual follow-up of these individuals should be added to clinical procedures so that long-acting effects are not overlooked.

Keywords: COVID-19, Hearing system, Efferent system

Abbreviations: CMV: Cytomegalovirus; OAE: Otoacoustic Emission Test; DPOAE: Distortion Prouduct Otoacoustic Emission; TEOAE: Transient Otoacoustic Emission; ABR: Auditory Brainstem Response

Introduction

On January 30, 2020, the World Health Organization (WHO) declared the epidemic caused by SARS-CoV-2 (COVID-19) a public health situation of international importance [1,2].

Typical signs and symptoms which based on validated PCR and usually developing 5-6 days (range 1-14 days) after infection include fever, dry cough, fatigue, sputum production, shortness of breath, sore throat, headache, dizziness, myalgia or arthralgia, chills, nausea or vomiting, nasal congestion, diarrhea, hemoptysis, and conjunctival obstruction [3,4]. Neurological symptoms such as stroke, epileptic seizure and encephalitis which affect the central and peripheral nervous system and skeletal muscles have also been observed in patients [5]. It is known that viral pathogens such as measles, mumps, herpes simplex virus etc., especially cytomegalovirus (CMV), cause auditory effects directly by affecting inner ear structures such as stria vascularis, organ of corti, Reissner's membrane, and indirectly by damaging the immune system [6]. In temporal bone studies examining the pathophysiology of viral diseases, it has been shown histopathologically that viruses pass through the stria vascularis and endolymph, cause hydrops of the cochlear canal and saccule, can be cultured from the perilymph fluid, and cause viral antigen production in spiral ganglion cells in the organ of Corti [7-9].

Studies have shown that also COVID-19, a viral disease, causes auditory and vestibular complaints such as hearing loss, tinnitus and dizziness [10]. Some reports have published that COVID-19 can also cause cranial neuropathies such as anosmia and facial nerve palsy. This neurotropic condition was thought to be associated with sudden sensorineural hearing loss in patients with COVID-19 [11,12]. The findings obtained in the study of Fidan *et al.* in which they investigated sudden sensorineural hearing loss in individuals with COVID-19, strengthened the relationship between acute mononeuropathies and COVID-19. They explained the hearing loss in patients with COVID-19 by the spread of the virus in the temporal region, causing excessive cytokine release, which in turn causes oxidative destruction [13].

Audiological Findings in COVID-19

When the studies in the literature are examined, the presence of sensorineural hearing loss, which decreases towards high frequencies is observed in patients with COVID-19 [14-17]. Hearing loss that decreases towards low frequencies has also been observed rarely [18,19]. In addition, there are studies in which conductive and mixed hearing loss associated with development of middle ear infection is observed [20,21]. In the case study of Chirakkal *et al.* in a 35-year-old person with tinnitus in the left ear who had COVID-19, no OAE was obtained at low frequencies. In the study of Almufraji *et al.* and in the study of Öztürk *et al.* in which 30 people aged 18-45 who had COVID-19 were included, a decrease in OAE amplitude was observed at high frequencies [17,19,21]. In our study conducted on 23 people aged between 20 and 40 who had COVID-19, we obtained significant decreases in low frequencies (250 Hz and 500 Hz) in addition to the decrease between 4 kHz and 12.5 kHz in the audiometric evaluation of these individuals. OAE results, we only obtained a decrease in amplitude at 4 kHz in TEOAE findings [22]. Ozturk *et al.* observed a significant decrease in DPOAE responses of 4 kHz and above, but no significant difference was found in our study. This is explained by the fact that TEOAE is more sensitive to cochlear sensitivity than DPOAE. These findings support the intracochlear involvement associated COVID-19, and the higher frequency involvement is explained by the higher intrinsic sensitivity of the basal region of the cochlea [23].

In the literature, there are cases and clinical studies in which tinnitus due to social isolation and stress was observed in the pandemic [17,19,24]. Ozturk *et al.* reported that 33% of the patients had tinnitus in their study. Daher *et al.* also reported a case study of a 42-year-old male patient who did not have auditory complaints such as hearing loss or tinnitus in the past, and who applied to the clinic with bilateral tinnitus after COVID-19. It was thought that the bilateral tinnitus observed in the patient may be related to the psychosocial effect of the pandemic and the weakness in suppressing electrophysiological inputs [24]. In our study conducted in 2022 the decrease in suppression of TEOAE at high frequencies (4 kHz) in the patient group supports this interpretation [22]. Emekci *et al.* also observed a decrease in the suppression of DPOAE in the patient group at all frequencies in their study with 26 adults [25].

Auditory Impact of COVID-19 on Infants

Although there are widespread studies in the literature on the effect of COVID-19 on the adult auditory system, there are also studies conducted in the pediatric group [26-28].

Pregnancy is a process that causes partial suppression of the immune system and predisposes women to viral infections. Even the seasonal flu increases pregnant morbidity, especially in the winter. Therefore, COVID-19 can cause serious health problems in pregnant women [26]. Goulioumis *et al.* evaluated the hearing screening of 111 newborns exposed to SARS-CoV-2 in the intrauterine period with the ABR and TEOAE test. As a result of the study, all newborns passed ABR and TEOAE, and COVID-19 in pregnancy was not found to be a risk factor for hearing loss [27]. Likewise, Mostafa *et al.*, in their study in which they examined hearing screening of 939 newborns exposed to SARS-CoV-2 in the intrauterine period, they observed that there was no increase in the risk of hearing loss in these babies [28]. Contrary to these studies, Çelik *et al.*, in which they examined TEOAE responses in infants exposed to intrauterine SARS-CoV-2, they obtained reduced amplitudes at 3000 and 4000 Hz in the patient group compared to the control group. In addition, a decrease in OAE efferent suppression was obtained in these infants compared to the control group, especially at high frequencies [29]. Similar results from our study of suppressed OAE in the adult group support that the effect of COVID-19 on the efferent system can be observed at high frequencies, regardless of age. It should be considered that the reason for the differences in the literature may be related to the fact that the emission test may produce variable results depending on the probe placement and internal/external noise. In addition, it should be kept in mind that these studies were carried out in infants exposed to SARS-CoV-2 in the intrauterine period and were not evaluated in infants with a direct diagnosis of COVID-19.

Studies have shown that SARSCoV-2-induced neuroinflammatory mechanisms cause auditory/vestibular dysfunction due to brainstem dysfunction [30,31]. It has also been reported that the infection causes ear fullness and otalgia complaints by blocking the eustachian tube in the pediatric group [32]. Although there are not enough studies in the literature evaluating COVID-19 effects separately in adult and pediatric groups, it is thought that auditory effects may be greater in the pediatric group, which has not yet fully completed its auditory maturation.

Conclusion

In the auditory system, COVID-19 causes oxidative destruction in the temporal region, cranial neuropathy, cochlear degenerations in structures such as hair cells/stria vascularis, and may show symptoms such as hearing loss, impaired speech understanding in noise, and tinnitus. In order to reveal these effects, audiometric evaluation, otoacoustic emission test, auditory brainstem responses and peripheral and central auditory system evaluations should be added to clinical procedures according to complaints in individuals who have COVID-19 history. We also believe that future studies on individuals with COVID-19 will be important in revealing the potential long-term effects of COVID-19. We think that questioning the COVID-19 history of individuals referred to Audiology clinics will be important in terms of clinicians' approach to patients.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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Author Contributions Statement

Commentary design: MBB, NTE. Literature collection: MBB, NTE. Literature analysis: MBB, NTE. Drafting of the manuscript: MBB, NTE; and approval of the final version: MBB, NTE.

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