Relationship between SARS-CoV-2 and hearing loss: A mini-review

Sin Wai Lee, MSc, Kenneth Wei De Chua, AuD, MSc, BSc and Heng-Wai Yuen, MBBS, FAMS (ORL), FRCS

Abstract

The most reported symptoms of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) were initially fever, dry cough, and sore throat. However, as we continue to review the literature, the loss of taste and smell were also added as clinical symptoms of the novel SARS-CoV-2. At present, the effects of SARS-CoV-2 on the auditory system is still not well-understood. This study is a mini-review and aims to find out more about the relationship between SARS-CoV-2 and hearing loss through review of the literature. From our findings, hearing loss is the primary otological symptom of SARS-CoV-2, followed by tinnitus and dizziness. In conclusion, SARS-CoV-2 may have an effect on our auditory system, but due to the small sample sizes in the existing literature, further prospective studies are warranted to determine the relationship between the virus and hearing loss.

Keywords

SARS-CoV-2, SSNHL, tinnitus, COVID-19

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) or COVID-19 was first discovered in China in early 2020. The common symptoms reported were fever, cough, sore throat, headache, muscle ache, diarrhea and dyspnea. As the virus became more widespread and well understood, neurologic manifestations such as loss of taste and smell were also reported and included as symptoms. However, some patients still remain asymptomatic. Amongst the symptoms reported, some patients note a loss of hearing but the relationship between the virus and our auditory system is not well described.

The etiology and pathophysiology of sudden sensorineural hearing loss (SSNHL) is a controversial topic, with the consensus that SSNHL is mostly idiopathic. It is also believed that viral infections or a vascular compromise to the inner ear can cause SSNHL, as there are many viruses that can affect the inner ear structures directly and indirectly. Cohen et al. noted that viruses can cause acquired unilateral or bilateral, sensorineural, mixed or conductive hearing loss through an immune-mediated impairment. The degree and severity of hearing loss varies, depending on the type of viruses. The outcome of the hearing loss also varies as some cases may be partial or completely reversible following the administration of appropriate antiviral drugs and corticosteroid.

SARS-CoV-2 was recently reported to be correlated with hearing loss. However, how SARS-CoV-2 result in hearing loss is not well-understood due to underpowered studies with inconclusive data and differences in methodologies. Nonetheless, a laboratory study revealed that the coronavirus, a neurotropic virus has the ability of infecting the brainstem. This review could suggest if SARS-CoV-2 have a role in the auditory system. Certain viruses such as cytomegalovirus (CMV), Rubella, Herpes simplex virus and Measles are neurotrophic and can cause sensorineural hearing loss either through direct damage to neural cells or through secondary immune-mediated response (inflammation) of the inner ear. SARS-CoV-2, a neurotropic coronavirus may also cause sensorineural hearing loss in a similar manner.

Corresponding Author:
Sin Wai Lee, Department of Otorhinolaryngology-Head and Neck Surgery, Otology Balance and Hearing Implant (OBHI) Service, Changi General Hospital, Medical Centre 2B, 2 Simei St 3, Singapore 529889, Singapore. Email: gordon.lee@cgh.com.sg
| Authors                        | Study design | Total patients | Age (years) | Gender | Symptoms                                      | Unilateral or bilateral hearing loss | Audiological assessment | Audiological results | Number of SARS-CoV-2 positive | Treatments                                                                 |
|-------------------------------|--------------|----------------|-------------|--------|-----------------------------------------------|--------------------------------------|-------------------------------|----------------------|---------------------|---------------------------------------------------------------------------|
| Lamouner et al.,9 Brazil      | CR           | 1              | 67          | 1F     | SSNHL, tinnitus, cough, fever, chills and nausea | Right                                | PTA, tympanometry             | PTA: Moderate to Severe hearing loss | 1                   | Combined (Oral and intratympanic) corticosteroid therapy: prednisolone and dexamethasone |
| Abdel Rhman and Abdel Wahid,12 Egypt | CR           | 1              | 52          | 1M     | SSNHL, tinnitus                              | Left                                 | PTA, tympanometry             | PTA: severe hearing loss from 250 Hz to 8 kHz | 1                   | Intratympanic injection of methylprednisolone                             |
| Edwards et al.,13 UK          | CR           | 1              | 68          | 1F     | SSNHL, tinnitus, fever                       | Bilateral                            | PTA                           | PTA: Severe to profound hearing loss bilaterally | 1                   | Oral prednisolone and intratympanic injection of methylprednisolone       |
| Kilic et al.,14 Turkey        | CS           | 5              | 29 - 54     | 5M     | SSNHL                                        | 3 Left, 2 Right                      | PTA, tympanometry             | PTA: Low to mid frequencies mild to moderate hearing loss | 1                   | Oral hydroxychloroquine                                                   |
| Yaseen et al.,6 Iraq          | Retrospective | 26, 1 lost follow up | 21 - 66    | 6M, 20F| SSNHL, vertigo, Anosmia, dysphonia, and ageusia | 17 Bilateral, 7 Left                 | PTA, tympanometry, TEOAE      | PTA: Mild and moderate hearing loss. TEOAE: Reduced amplitude | 26                  | Oral prednisolone with or without intratympanic injection of dexamethasone |
| Öztürk et al.,8 Turkey        | CS           | 30             | 18 - 45     | 14M, 16F| SSNHL, tinnitus, anosmia, ageusia, dizziness, fever, headache, fatigue and dry cough       | NA: not mentioned clearly in the paper | PTA, tympanometry, TEOAE, DPOAE | PTA: 4 kHz and high frequencies. TEOAE and DPOAE: Lower values at high frequencies | 30                  | 16 treated with favipiravir, 4 hydroxychloroquine, 10 without medication |

Abbreviations: CR- case report; CS – cross-sectional; M- male; F- female; DPOAE – distortion product otoacoustic emission; kHz – kilohertz; PTA – pure tone audiometry; TEOAE – transient-evoked otoacoustic emission; SSNHL – sudden sensorineural hearing loss.
The literature was reviewed using search engines like Springer, Cochrane, Google Scholar, Pubmed with keywords such as “SARS-CoV-2 hearing loss”, “Covid-19 hearing loss”, “Covid-19 hearing loss audiological assessment”, “symptoms of SARS-CoV-2”, “symptoms of Covid-19”, “viruses neurologic”.

A previous study showed that the nasopharyngeal swab for reverse transcription-polymerase chain reaction (RT-PCR) had a high sensitivity of up to 100% in detecting SARS-CoV-2. Thus, we believe that the nasopharyngeal swab RT-PCR testing is the most accurate method to confirm if someone has been infected with SARS-CoV-2. Sudden sensorineural hearing loss (SSNHL) is defined as at least 30 decibels (dB) across three consecutive frequencies within 72-hours.

Six relevant articles, of which three case reports, two cross-sectional studies and one retrospective study on SARS-CoV-2 and hearing loss were reviewed based on the clinical manifestations including hearing loss, the audiological assessment, and the positive result of PCR test as inclusion criteria.

In the summary Table 1, we can see that the hearing loss is the primary otological symptom of SARS-CoV-2. A positive 67-year-old female patient was reported suffering from SSNHL and tinnitus in her right ear. Similarly, in another case study, a positive 52-year-old male patient was reported suffering from SSNHL and tinnitus in his left ear. Edwards et al. reported bilateral SSNHL and tinnitus in a SARS-CoV-2 positive 68-year-old lady. Kilic et al. observed mild to moderate SSNHL in the left ear of three patients, and a mild to moderate SSNHL in the right ear of the other two. In a retrospective study by Yaseen et al., they observed bilateral SSNHL in 17 patients and unilateral SSNHL in eight patients. In addition, tinnitus and reduced amplitude of transient-evoked otoacoustic emissions (TEOAE) were reported in all 25 SARS-CoV-2 positive patients. Öztürk et al. reported high-frequency SSNHL, tinnitus and reduced amplitudes of TEOAE and distortion product otoacoustic emissions (DPOAE) in 30 patients. In the absence of hearing loss, abnormal findings in the otoacoustic emissions directly correlate with loss of outer hair cell functions and are suggestive of damage to hearing fine structures.

Typically, viruses can cause sensorineural hearing loss. The mechanism of the viral-induced hearing loss involves affecting the peripheral and central nervous system through inflammation of the auditory nerve, cochlea and the brainstem. The patients in our findings (Table 1) did not have any pre-existing or known history of otologic dysfunction and/or hearing difficulties before SARS-CoV-2 infection. Our review (Table 1) showed that the patients experienced hearing loss unilaterally and bilaterally.

Furthermore, a couple of studies reported patients having high frequencies hearing loss, and reduced amplitudes of TEOAE and DPOAE unilaterally and bilaterally. These findings suggest that SARS-CoV-2 in part disrupts/damages the outer auditory hair cells and may result in eventual SSNHL.

Similarly, Dharmarajan et al. noted 100 positive symptomatic and asymptomatic patients with high frequencies hearing loss and reduced TEOAE amplitudes. In another comparative study, high frequencies hearing loss and reduced amplitudes of TEOAE were found in 20 asymptomatic patients, but not in the control group.

This indicates that SARS-CoV-2 may have effects on the outer hair cells of the cochlea, eventually resulting in SSNHL. Nonetheless, the mechanism of SARS-CoV-2 on hair cells is currently not well elucidated. In a previous study of six SARS-CoV-2 positive patients, high expression of angiotensin-converting enzyme 2 (ACE2), a primary viral receptor required for SARS-CoV-2 entry was found in the middle ear and nasal epithelial cells, suggesting an infection and inflammatory response from the cells and tissues in the ear. This may potentially be a cause of hearing loss as the middle and inner ear share the same space.

We are unable to explain at this point, why some patients acquired unilateral or bilateral sudden hearing loss due to the scarcity of studies and poor evidence presently. The laterality of hearing loss could be due to age and complications from other medical health history described by Edwards et al., although as a consequence of ageing, we believe to expect greater incidence of bilateral hearing loss than unilateral.

In conclusion, hearing loss affects the individual’s communication and quality of life. Patients with SARS-CoV-2 can be symptomatic or asymptomatic, and may develop SSNHL unilaterally and bilaterally. Most commonly reported symptoms from positive patients are of the respiratory system, and hearing loss is not well-recognized in the clinical spectrum of SARS-CoV-2 symptoms.

Due to limited studies of SARS-CoV-2 on the auditory system, SSNHL could be treated as a non-specific symptom of SARS-CoV-2 and this may lead to a delay in treatment. As effective treatment for SSNHL has a narrow therapeutic window, further studies to determine whether SARS-CoV-2 is correlated with hearing loss are warranted. Nonetheless, the current literature review highlights the possible relationship between SARS-CoV-2 and hearing loss and may serve as a reference for future work. A simplified process of managing the patients suffering from SARS-CoV-2 and hearing loss is depicted in Figure 1. This may benefit clinicians who can intervene.

---

**Figure 1.** Simplified workflow for managing patients positive for SARS-CoV-2 with suspected hearing loss.

---
early and manage patients with SARS-CoV-2-induced hearing loss as we know that treatment is time-sensitive to salvage the patient’s hearing.

Acknowledgements

The authors sincerely thank all members from the Department of Otorhinolaryngology-Head and Neck Surgery.

Author contributions

SW Lee was involved in literature review and writing manuscript. KWD Chua reviewed and edited the manuscript. KWD Chua and HW Yuen reviewed and approved the draft of the manuscript. All authors reviewed and approved the final version of the manuscript.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Availability of data and materials

Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

ORCID iDs

Sin Wai Lee  https://orcid.org/0000-0001-8260-7532
Kenneth Wei De Chua  https://orcid.org/0000-0002-2677-1183

References

1. Huang C, Wang Y, Li X, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet 2020; 395(10223): 497–506.
2. Vaira LA, Salzano G, Deiana G, et al. Anosmia and Ageusia: common findings in COVID-19 patients. Laryngoscope 2020; 130(7): 1787.
3. Mao L, Jin H, Wang M, et al. Neurologic manifestations of hospitalized patients with Coronavirus Disease 2019 in Wuhan, China. JAMA Neurol 2020; 77(6): 683–690.
4. Dharmarajan S, Bharathi MB, Sivapuram K, et al. Hearing loss-a camouflaged manifestation of COVID 19 infection. Indian J Otolaryngol Head Neck Surg 2021; 73(4): 1–5.
5. Mustafa MWM. Audiological profile of asymptomatic Covid-19 PCR-positive cases. Am J Otolaryngol 2020; 41(3): 102483.
6. Yaseen NK, Al-Ani RM and Ali Rashid R. COVID-19-related sudden sensorineural hearing loss. Qatar Med J 2021; 2021(3): 58.
7. Cohen BE, Durstenfeld A and Roehm PC. Viral causes of hearing loss: a review for hearing health professionals. Trends Hear 2014; 18: 2331216514541361.
8. Öztürk B, Kavrak H and Aykul A. Audiological findings in individuals diagnosed with COVID-19. Am J Otolaryngol 2022; 43(3): 103428.
9. Lamounier P, Franco Gonçalves V, Ramos HVL, et al. A 67-Year-Old woman with sudden hearing loss associated with SARS-CoV-2 INFECTION. Am J Case Rep 2020; 21: e927519.
10. Wege H, Watanabe R and ter Meulen V. Relapsing subacute demyelinating encephalomyelitis in rats during the course of coronavirus JHM infection. J Neuroimmunol 1984; 6(5): 325–336.
11. Tsujimoto Yoshie, Terada Junko, Kimura Moto, et al. Diagnostic accuracy of nasopharyngeal swab, nasal swab and saliva swab samples for the detection of SARS-CoV-2 using RT-PCR. Infect Dis (Lond) 2021; 53(8): 581–589.
12. Abdel Rhman S and Abdel Wahid A. COVID -19 and sudden sensorineural hearing loss, a case report. Otolaryngol Case Rep 2020; 16: 100198.
13. Edwards M, Muzaffar J, Naik P, et al. Catastrophic bilateral sudden sensorineural hearing loss following COVID-19. BMJ Case Rep 2021; 14(6): e243157.
14. Kilic O, Kalcaglu MT, Cag Y, et al. Could sudden sensorineural hearing loss be the sole manifestation of COVID-19? An investigation into SARS-COV-2 in the etiology of sudden sensorineural hearing loss. Int J Infect Dis 2020; 97: 208–211.
15. Kurabi A, Pak K, DeConde AS, et al. Immunohistochemical and qPCR Detection of SARS-CoV-2 in the human middle ear versus the nasal cavity: case series. Head Neck Pathol 2022; 16: 607–611.