Sudden Sensorineural Hearing Loss among COVID-19 Patients-Our Experiences at an Indian Teaching Hospital

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ABSTRACT

Objective: To study the sudden sensorineural hearing loss (SSNHL) in patients with COVID-19 infections.

Methods: This is a retrospective descriptive study. There were 16 COVID-19 patients participated in this study those presented with sudden sensorineural hearing loss (SSNHL). The study was done between March 2020 to August 2020. All these patients were diagnosed with SARS-CoV-2 infection with help of the reverse transcription polymerase chain reaction (RT-PCR) testing.

Results: Out of 652 COVID-19 patients, 16 (2.45%) patients diagnosed with SSNHL. Out of 16 patients with SSNHL, 11 (68.75%) were male and 5 (31.25%) were female with male to female ratio of 2.2:1. The age ranges of the participants were 38 to 72 years with a mean age of 48.42 years. There were 14 (87.50%) patients were presented with unilateral and 2 (12.50%) were presented with bilateral SSNHL. There were left sided SSNHL in 9 patients (56.25%) and right side SSNHL in 5 patients (31.25%).

Conclusion: There should be continuous monitoring of the SSNHL. Tracing COVID-19 infection is needed to ensure a detailed understanding of this inner ear pathogenesis.

Keywords: COVID-19 patients; SARS-CoV-2; sudden sensorineural hearing loss (Siriraj Med J 2021; 73: 77-83)

INTRODUCTION

Hearing loss has a vital role in speech and communication and can cause an invisible handicap of the affected person and psychological solitary confinement. The World health organization (WHO) has documented that around 360 million people with disabling hearing loss in the world which proved that more than half of the persons with a hearing handicap can be prevented by early diagnosis and treatment.[1] The association between the COVID-19 infection and sudden sensorineural hearing loss makes intuitive sense, given the neuropathic manifestations of the inner ear and auditory nerve. Although certain viral infections cause hearing loss, there is still unknown whether COVID-19 infection leads to auditory dysfunction or not. COVID-19 infection is highly contagious and seen in the respiratory system due to the novel virus SARS-CoV-2 (Fig 1).[2] There are several causes for hearing loss in clinical practice. Viral etiology is often ignored during assessing hearing loss. Viral infections like cytomegalovirus (CMV) cause congenitally acquired hearing loss and many other

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Received 9 September 2020 Revised 2 November 2020 Accepted 3 November 2020

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http://dx.doi.org/10.33192/Smj.2021.11

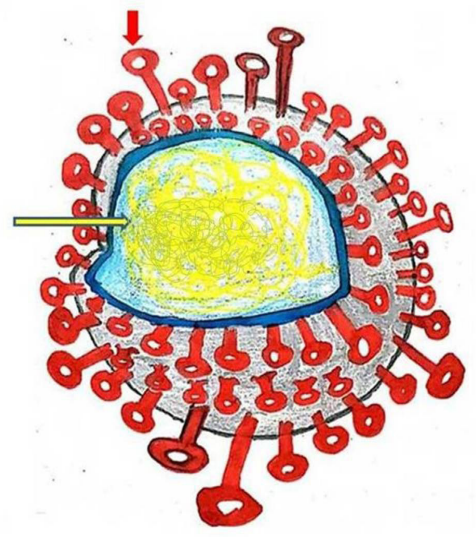

Fig 1. Structure of the COVID-19 virus (Red arrow is spike protein over lipid membrane, yellow arrow indicates RNA).

viruses are also associated with congenital or acquired hearing loss.[3] Typically viruses cause sensorineural hearing loss. The viral etiology is often proposed for the etiology of otosclerosis.[4] HIV infection can cause conductive hearing loss through fungal and bacterial infections which are frequent after immunosuppression by the virus. The hearing loss by viral etiology can be mild or severe to profound, unilateral or bilateral. In COVID-19 infections, the development of the SSNHL is rare and the exact etiopathology is difficult to explain in this current pandemic. Here this study is relating to the impact or incidence of the novel corona virus infection on the auditory system with the manifestation of SSNHL.

MATERIALS AND METHODS

This retrospective study was conducted at a tertiary care teaching hospital. The study was done during the period between March 2020 to August 2020. This study was approved by the Institutional ethical committee (IEC) with reference number IEC/IMS/SOA/21/12.3.2020. The COVID-19 patients with sudden sensorineural hearing loss (SSNHL) were participated in this study. The patient details were collected from the patient files of the hospital. Informed consent was obtained from the patients those participated in this study. The audiological symptoms were searched from 652 COVID-19 patients at COVID-19 hospital. The eligible candidates were presented with SSNHL. SSNHL was defined as a hearing loss of more than 30 decibel at three consecutive frequencies at least over a period of less than 3 days.[5] Audiological assessments were done by tuning fork test, pure tone audiometry and tympanometry. All the COVID-19 patients those complained of sudden hearing loss were evaluated by otolaryngologists. Those patients discharged from the COVID hospital with a history of SSNHL and confirmed with investigations were also included in this study. All the patients those participated in this study were tested positive reverse transcription polymerase chain reaction (RT-PCR) for SARS-CoV-2 before admission to the COVID hospital. COVID-19 patients with a previous history of hearing loss and any association such as a history of the ototoxic drugs, noise exposure, age related hearing loss, measles, mumps, rubella, meningitis, syphilis, hypertension, thyroid diseases, diabetes mellitus and kidney diseases were excluded from this study. COVID-19 patients with a history of oral hydroxychloroquine taken previously were excluded from this study. Proper history taking and otological examinations including tuning fork tests were done in all the participants before audiological testing. All the participating patients were underwent pure tone audiometry testing, tympanometry and Otoacoustic emissions (OAE) which were done by an audiologist in a soundproof room. The pure tone audiometry was performed with all safety protocols for the COVID-19 pandemic. Pure tone audiometry findings were done with frequency at 250, 500, 100, 2000, 4000 and 8000Hz using Telephonics TDH39 earphones. The audiometric assessment was conducted in a sound treated room, using GSI 61 clinical audiometer. The average value for the hearing threshold at 500Hz, 1000Hz and 2000Hz was calculated. The pure tone average greater than 25 decibels was considered as hearing loss. Tympanometry was carried out with help of the amplaid 775 middle ear analyzer to rule out middle ear pathology. Before performing the pure tone audiometry, tuning fork tests were done by using 256,512 and 1024 Hz tuning forks. Transient evoked otoacoustic emissions (TEOAEs) were recorded in all participating patients with help of the Madsen Capella Analyzer. The stimuli in TEOAEs were a nonlinear click of about 80 dB peak SPL in the ear canal. The spectrum analyzer was stimulated as 4ms after the presentation of the stimuli for avoiding the ringing of the input stimuli and the temporal window was set at 20ms. Magnetic resonance imaging (MRI) of the brain was done in all the cases with SSNHL to find out the status of the inner ear. In this study, all the data were recorded and analyzed by using Statistical Package for Social Science (SPSS) software, v20.

RESULTS

In this study, 652 COVID-19 patients were evaluated to find out hearing loss. Out of 652 patients, 16 (2.45%) patients were diagnosed with SSNHL. These 16 patients underwent an audiological assessment at the otolaryngology

department. All the sixteen patients presented with SSNHL after confirmation with pure tone audiometry. There were 11 (68.75%) were male and 5 (31.25%) were females with male to female ratio of 2.2:1. The age ranges of the participating patients were 38 years to 72 years of age with a mean age of the study patients was 48.42 years. There were 7 patients (43.75%) in the age range of 38 to 50 years and 9 patients (56.25%) in the age range of 51 to 72 years (Table 1). All of these patients were positive with RT-PCR for SARS-CoV-2. There were 9 patients (46.42%) with SSNHL in the left ear, 5 patients (31.25%) with SSNHL in the right ear and 2 patients (12.50%) had bilateral sudden SSNHL. All these patients were presented with symptoms of sudden hearing loss and heaviness in the affected ear. Out of 16 patients, 5 (31.25%) presented with tinnitus and 3 (18.75%) presented with vertigo (Table 1). In this study, 13 patients (81.25%) presented with SSNHL along with respiratory symptoms such fever, cough, throat pain, rhinorrhea, loss of smell, dysgeusia and hearing loss whereas 3 patients(18.75%) were presented with only hearing loss and heaviness in the ear during stay at the COVID hospital. There were no respiratory symptoms among 3 patients (Table 1). Tuning fork tests were performed in all cases. In tuning fork test with 512 Hz tuning fork, the Weber test showed lateralization towards the right side with patients with left sided hearing loss and towards the left side in case of right sided hearing loss. The tympanometry test revealed a type-A tympanogram in 13 patients (81.25%), indicating normal middle ear whereas the type-C tympanogram was found in 3 patients (18.75%) which indicates eustachian tube dysfunction. In this study, 14 (87.50%) showed unilateral SSNHL and 2 (12.50%) showed bilateral SSNHL. In this study, 11 patients (68.75%) showed high frequency hearing loss in pure tone audiometry whereas the rest 5 (31.25%) showed low frequency hearing loss. Out of the 16 patients, 15 (93.75%) showed reduced amplitude of the TEOAEs (Table 2). In 10 patients (62.50%) with SSNHL, MRI with contrast showed enhancement of the cochlea on the affected side (Fig 2). All the diagnosed cases of SSNHL were treated with oral prednisolone 1mg/kg/day in the tapering dose for 3 weeks. Along with oral prednisolone, oral vitamin-B with folic acid complex and with proton pump inhibitor was taken by patients daily. As all these patients were at the COVID hospital and isolation in the home, proper evaluation and follow up were not done properly. The hearing status of the patients was obtained by a telephonic conversation with the patient. There was the recovery of the hearing in 9 patients (56.25%) after appropriate and prompt treatment. The recovery of hearing loss to normal was confirmed by pure tone audiometry.

DISCUSSION

COVID-19 is an infection of the respiratory tract caused by a novel virus called severe acute respiratory syndrome corona virus 2 (SARS-CoV-2).[2] Corona viruses causing COVID-19 are encapsulated or enveloped positive strand RNA virus which can be classified into four genera such as alpha, beta, delta and gamma. Out of these four types, alpha and beta are known to infect human beings.[6] The first case of COVID-19 infection was reported in Wuhan, China in late December 2019 which now covered all over the world.[7] By 27th February 2020, more than 82,000 COVID-19 positive cases with death more than 2800 have been reported of which approximately 95% the positive cases and 97% of deaths were in China.[8] By March 26th, 2020, there were 462,684 patients with COVID-19 infections reported in 199 countries.[9] By the 16th August 2020, over 1.8 million new cases of COVID-19 and 39000 new death were reported by WHO and this gives the cumulative total to 21.2 million confirmed cases of COVID-19 including 761000 deaths.[10] The novel SARS-CoV-2 virus is transmitted from one person to

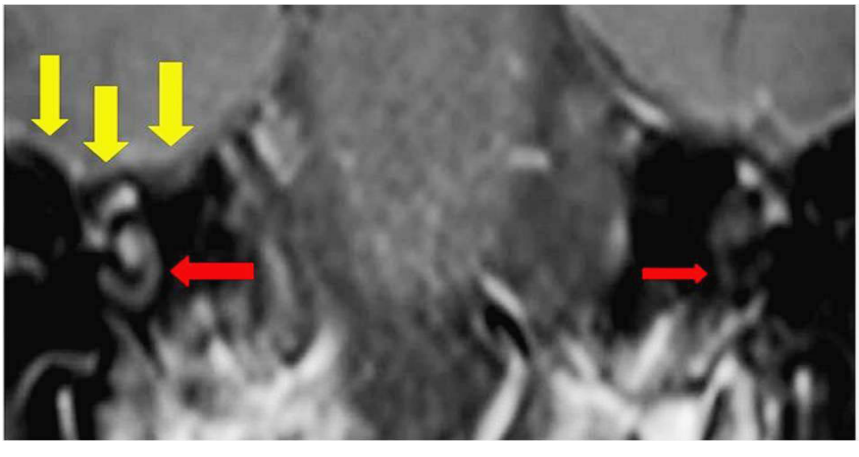

Fig 2. MRI with coronal view in T1 post-contrast sequence showing increased contrast enhancement of the right side cochlea (thick red arrow) and the left side cochlea (thin red arrow) showing normal enhancement. Meninges at the base of the temporal lobe at the right side showing linear enhancement (yellow arrows).

TABLE 1. Outcomes of RAI therapy at the 6 to 9-month follow-up.

Characteristics	n=16	Percentage (%)
Gender		
Male	11	68.75
Female	5	31.25
Age group		
38-50	7	43.75
51-72	9	56.25
Sudden sensorineural hearing loss (SSNHL)	16	100
SSNHL in right ear	5	31.25
SSNHL in left ear	9	56.25
SSNHL in both ear	2	12.5
Tinnitus	5	31.25
Vertigo	3	18.75
Sudden hearing loss with respiratory infections (Fever, cough, throat pain, throat pain, cough, rhinorrhea, loss of smell and dysgeusia)	13	81.25
No respiratory symptoms but with hearing loss and heaviness in the ear	3	18.75

TABLE 2. Audiological profile of the COVID-19 patients.

Parameters	Number of the patients (n=16)	Percentage (%)
Pure tone audiometry		
Unilateral SNHL	14	87.50
Bilateral SNHL	2	12.50
Tympanogram		
Type A	13	81.25
Type C	3	18.75
TEOAE		
Reduced amplitude	15	93.75

another by respiratory droplets or contact with an infected person. The symptoms of the COVID-19 infection may appear after 2 to 14 days following the exposure (based on the incubation period of COVID-19 virus). The clinical presentations of the COVID-19 patients are fever, cough, fatigue, gastrointestinal symptoms, sore throat, headache, olfactory and taste dysfunctions.[11] In this study, 13 patients (81.25%) presented with SSNHL with respiratory symptoms such as fever, cough, throat pain, cough, rhinorrhea, loss of smell and dysgeusia whereas 3 patients (18.75%) were presented with only hearing loss and heaviness in the ear without any respiratory symptoms. The elderly patients and the persons with co-morbid conditions or immunocompromised conditions are prone to serious outcomes such as acute respiratory syndrome (ARDS) and cytokine storm.[11] The neurological manifestations associated with SARS-CoV-2 infections are nonspecific symptoms such as loss of smell, loss of taste, dizziness, ataxia and peripheral nerve involvement. The etiopathology for SSNHL includes neuritis of the cochlear nerve by the virus, inflammation of the cochlea by viral infection and the perilymphatic tissues. The evidence of sensorineural hearing loss (SNHL) was also documented with infections of certain viruses such as herpes simplex virus, measles virus, hepatitis virus, rubella virus, mumps virus, human immunodeficiency virus (HIV), Lassa virus and enteroviruses.[12] Incidence of SNHL is 12 to 19% cases in rubella infections, up to 33% in infections with herpes simplex virus, 0.1 to 3.4% in measles, 0.005 to 4% in mumps,6 to 23% (asymptomatic patients) to 22- 65% (symptomatic patients in cytomegalovirus infections and 27.5 to 33.5% in HIV infections.[13] Certain viruses like rubella and cytomegalovirus infections cause congenital SNHL which are not documented in case of COVID-19 infections. There are three mechanisms associated with the incidence of SSNHL in viral infections such as: (1) neuritis caused by viral infection of auditory nerves or cochlea; (2) viral involvement of the perilymphatic tissues; (3) Stress response occurred by cross reactions of the antigens of the inner ear.[14] Study on the animal was showing viral infections causing hearing loss through directly affecting labyrinth or indirectly through cerebrospinal fluid.[15,16] If any patients develop the SSNHL and seek consultations at the outpatient department of Otorhinolaryngology, they should require RT-PCR testing to rule out SARS-CoV-2 infection. There are several reports regarding the neurological involvement by the SARS-CoV-2 infection but not much report with SSNHL. One study reported with non-specific neurological symptoms ataxia, dizziness, olfactory or gustatory dysfunctions and neuralgia due to peripheral nerve involvement by SARS-CoV-2.[17] This study tried to find out the specific SSNHL among the COVID-19 patients. The better way to study the etiology is autopsy which seems to provide definite evidence towards a better understanding of the nerve involvement by the virus. In past SARS-CoV and Middle East respiratory syndrome corona virus (MERS-CoV) outbreak, cerebrospinal fluid studies revealed the presence of the nucleic acid and neural involvement in an autopsy study.[18,19] Autopsy studies of the patients with SARS-CoV-2 had shown the hyperemic and edematous brain tissue along with degeneration of the nerves.[20]

The SARS-CoV-2 enters the airways and invade the cell by penetrating the angiotensin-converting enzyme 2 (ACE2) receptors at the lungs. Once the cytosolic pH decreases, the binding of the ACE 2 to the virus will be easier.[21] As the cytosolic pH decreases with the increase of age, the virus can lead to easy and heavy infections in elderly persons.[21] The SARS-CoV-2 can attach to the hemoglobin and penetrate the red blood cell/erythrocyte.[22] Then this virus can be transported with erythrocyte or vascular endothelium and affect all the tissues with ACE2. There are abundant ACE2 at the brain and medulla oblongata.[23] The auditory center is situated at the temporal lobe of the brain where ACE2 is present. Over expression of ACE2 in the brain except at the medulla oblongata has a positive effect like anti-oxidant and anti-inflammatory and regulator of the blood pressure.[23] But, if the cytosolic pH is less, raised ACE2 leads to an increase in the viral load.[21] So, the SARS-CoV-2 infection may progress to more severity. The virus release excess cytokines at the auditory center of the brain and its surroundings. So, it can cause permanent damage to the auditory center of the brain by raising oxidative damage. If there is excessive activation of the virus at the auditory center, can cause it hypoxic and lead to damage. The virus has also nature to cause an increase in thrombosis risk. SARS-Cov-2 can infect the veins which drain the auditory center so can make a clot of these vessels. This clot blocks the blood vessels and affects the hearing center, leading to ischemic damage. Because of the impaired vascularity and susceptibility for thrombosis in elderly age people, hearing problems may happen by this above mechanism. There may be associated with inner ear symptoms like tinnitus and vertigo may be found. In this study, 5 patients (31.25%) presented with tinnitus and 3 patients (18.75%) presented with vertigo.

Tuning fork tests, pure tone audiometry, tympanometry and Otoacoustic emissions (OAE) were done to evaluate the SSNHL in our study patients with COVID-19 infection. The type and degree of hearing loss were assessed by

the tuning fork test and pure tone audiometry. In this study majority of the cases of SSNHL (68.75%) show high frequency hearing loss in pure tone audiometry. In this study, 87.50% patients showed unilateral SSNHL and 12.50% cases showed bilateral SSNHL. In this study, 11(68.75%) showed high frequency hearing loss in pure tone audiometry. Tympanometry was done to assess the middle ear pathology. In this study, 13 patients (81.25%) showed type-A tympanogram and 3 patients (18.75%) showed type-C tympanogram. Type-A tympanogram indicates normal middle ear whereas type-C indicates eustachian tube dysfunction. The airway infections in COVID-19 patients specifically infections or inflammations at the nasopharynx cause Eustachian dysfunction and responsible for type-C tympanogram. Otoacoustic emissions represent a form of energy produced from the outer hair cells of the cochlea. Otoacoustic emissions can be spontaneous (SOAEs), evoked by transient stimuli like clicks or tone bursts (TEOAEs). TEOAEs are not invasive and can be easily performed. For performing TEOAEs, the time is short, low cost and high sensitivity.[24] In this study, 15 patients (93.75%) showed reduced amplitude in TEOAE which indicates subtle deterioration of the outer hair cell functions of the cochlea. The magnetic resonance imaging (MRI) with the contrast of the brain and inner ear may show the inflammatory changes at the cochlea and auditory center. Even cochlear ossification may be found because of the inflammation. In this study, 62.50% of patients showed signs of inflammation at the cochlea in MRI. Thorough investigations should be done to find out the exact etiology of the SSNHL and using other treatment options in COVID-19 positive patients can prevent such undesirable complications.

It is challenging for a clinician to identify the etiology as COVID-19 infections for SSNHL and start appropriate treatment to get maximum clinical recovery with minimal side effects and complications. Corticosteroid is an important first line drug for the treatment of the SSNHL.[25] In this study, all the diagnosed cases of SSNHL were treated with oral prednisolone in the tapering dose and vitamin-B with folic acid complex and with proton pump inhibitor daily. However, the use of the corticosteroids in the SARS-CoV-2 infections as in other viral infections, can lead to increased severity of the infection and cause delayed clearance of the viral infections.[26] In this study 9 patients (56.25%) showed complete resolution of hearing loss/normal hearing and became normal with treatment by corticosteroids. In non-COVID patients, the rate of recovery from SSNHL after treatment in the first week of disease onset, within 2 weeks and beyond 3 months is 87%,52% and <10% respectively.[27,28]

CONCLUSION

Patients with COVID-19 infections have a chance of hearing loss specifically sudden sensorineural hearing loss. In our study, the incidence of SSNHL among COVID-19 patients was 2.45%, where the majority of them were associated with respiratory symptoms. The exact role of the pathogenesis of the SSNHL in COVID-19 infections is not well defined. We would like to recommend routine screening of all the COVID-19 positive cases with pure tone audiometry, tympanometry and otoacoustic emission for early diagnosis of the SSNHL and prompt treatment or rehabilitation. In our study, 56.25% patients with SSNHL recovered with prompt and appropriate treatment. Awareness regarding SSNHL in COVID-19 patients is often crucial in the current pandemic. Early identification of the COVID-19 patients with isolation and early initiation of the targeted treatment for the patients helps to reduce the incidence of the SNHL. A high level of vigilance and assessment of the sudden sensorineural hearing loss in COVID-19 patients require urgent treatment for the revival of hearing. The sudden SNHL may be the only symptom in COVID-19 patients. Awareness of this presentation in COVID-19 patients is often crucial in this current pandemic. Isolation ad early treatment for COVID-19 patients may give a good outcome. This study surely brings awareness among the clinicians and researchers to look for SARS-CoV-2 infections in patients with SSNHL.

Study limitation

This study has a relatively small sample size due to the rarity of the clinical outcome (sudden sensorineural hearing loss) in COVID-19 infections which may limit the outcome of the above interpretation. Although the sample size is small, the result of this study is an important message for the public health point of view to isolate the SSNHL with COVID-19 patients. However, the development of the SSNHL in COVID-19 patients in this study will surely encourage further research.

Conflict of interest: NIL

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