

Review Article

Hearing loss and vertigo among COVID-19 patients: a review

Santosh Kumar Swain*

Department of Otorhinolaryngology and Head and Neck Surgery, IMS and SUM Hospital, Siksha "O" Anusandhan University, Kalinga Nagar, Bhubaneswar, Odisha, India

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***Correspondence:**

Dr. Santosh Kumar Swain,

E-mail: santoshvoltaire@yahoo.co.in

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ABSTRACT

The coronavirus disease 2019 (COVID-19) is an acute respiratory disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The clinical presentations of the COVID-9 patients vary from mild respiratory illness to fatal possible outcomes like death. SARS-CoV-2 infection can cause a wide range of extrapulmonary manifestations including sensory and neural complications like olfactory and/or gustatory dysfunction, otologic manifestations and long-term neurological complications. The association between the COVID-19 infection and hearing loss and vertigo make intuitive sense, give neuropathic manifestations of the inner ear resulting in cochleovestibular symptoms. Hearing loss and vertigo are interesting clinical outcomes associated with COVID-19 infections. Hearing loss and vertigo in COVID-19 patients have not received much attention from medical professionals. COVID-19 infection could have deleterious effects on the inner ear despite patients are asymptomatic. Hearing loss and vertigo play an important role for affecting routine activity and result in invisible handicap of the affected person and psychological solitary confinement. In current COVID-19 pandemic, some patients of COVID-19 are presenting with cochleovestibular symptoms such as hearing loss, vertigo and tinnitus. The proper understanding of the pathophysiology behind the hearing loss and vertigo in COVID-19 infections requires further research. This review article discusses the details of this epidemiology, etiopathology, assessment and management of the hearing loss and vertigo among COVID-19 patients.

Keywords: COVID-19, SARS-CoV-2, Vestibulocochlear manifestations, Sensorineural hearing loss, Vertigo

INTRODUCTION

COVID-19 is a highly contagious disease caused by a novel virus called severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).¹ This SARS-CoV-2 virus is a large and encapsulated positive-strand RNA virus.¹ The widespread of transmission and infectivity of the COVID-19 infections lead to an unrestricted health threat to the planet. The common clinical manifestations of the COVID-19 patients are fever, cough, fatigue, sore throat, headache, gastrointestinal symptoms, olfactory and taste dysfunctions.² Although certain viral infections are associated with hearing loss and vertigo, there is still unknown whether COVID-19 infections result in auditory-vestibular dysfunction or not. In the current

pandemic, COVID-19 patients are often presenting with smell and taste disorders, prompting the possibility of the direct neuropathic effect of the SARS-CoV-2.³ Similar to the effects of the viruses on the neural pathways of the taste and smell sensations, post-viral hearing loss or vertigo are known sequelae of the COVID-19 infections that can result in labyrinthitis or vestibular neuritis.⁴ The otological manifestations in COVID-19 infections may be mild or severe to profound, unilateral or bilateral. In COVID-19 patients, the development of hearing loss and vertigo are uncommon and exact etiopathology is difficult to explain in the current pandemic. There are no robust epidemiological studies are lacking for hearing loss and vertigo in COVID-19 patients, indicating that these medical entities are neglected.

Methods of literature search

We performed a literature review of the hearing loss and vertigo among COVID-19 patients from the database of PubMed, Medline, Scopus, and Google scholar search with terms hearing loss, vertigo, COVID-19 infections with cochleovestibular symptoms. We reviewed different current articles published in national and international journals. All the articles were read and analysed, with relevant data being extracted. A flowchart of the selected articles is in Fig.1. This manuscript reviews the details of hearing loss and vertigo among COVID-19 patients with its epidemiology, pathophysiology, clinical presentations, assessment and its management. This review article surely makes a baseline from where further prospective studies can be designed for the hearing loss and vertigo among COVID-19 patients which can help to prevent this morbid clinical entity.

Epidemiology

COVID-19 is an infectious respiratory disease and its clinical manifestations range from asymptomatic or flue like symptoms to severe dyspnea.⁵ The first case of COVID-19 was reported in Wuhan, China in late December 2019 and then spread worldwide.⁶ The world health organization (WHO) declared COVID-19 as a global pandemic on March 11, 2020.⁷ World health organization (WHO) has estimated that approximately 360 million people with disabling hearing loss in the world which proved that more than half of the persons with hearing loss can be prevented by early diagnosis and treatment.¹ COVID-19 infections and its impact on auditory and vestibular system are not reported much in literature and is very little mentioned in the medical literature. The prevalence of cochleovestibular symptoms following COVID-19 infections has been estimated by very few systematic reviews. Previously brainstem involvement by corona virus and caused neuro-auditory dysfunction and hearing loss.⁸ There is another study of effect of COVID-19 infections on the cochlear hair cells and leading to hearing loss even in asymptomatic patients.⁹ A systematic review in December 2020 on auditory-vestibular symptoms of COVID-19 patients showed that tinnitus had an estimated prevalence of 14.8%.¹⁰ Other auditory-vestibular manifestations like hearing loss (7.6%) and vertigo (7.2%).¹⁰

Etiopathology

The mechanism of hearing loss and vertigo by viral infections varies significantly and ranges from direct damage to inner structures.¹¹ Viruses are also known to cause neurological manifestations like anosmia, facial nerve weakness, and sudden sensorineural hearing loss.¹² Whether SARS-CoV-2 can invade the neural pathways of hearing and balance is not confirmed, but initial observations implicate the possibility. In addition to direct cytotoxic effect of the virus, inflammatory response, cytokine storm and cerebrovascular events,

particularly in the posterior circulation and ototoxic drugs such as azithromycin, hydroxychloroquine being used extensively during current pandemic as therapeutic drugs may also contribute for hearing loss or balance disorders associated with COVID-19 infections.¹³ Similar to the effects of the viruses on the neural pathways of the olfactory tract, post-viral hearing loss or vertigo are known sequelae of the viruses which result in vestibular neuritis or labyrinthitis.¹⁴ Although SARS-CoV-2 can invade the neural pathways, the exact mechanism for involvement of the hearing and balance not exactly known, however the initial observations implicate the possibility for etiopathology of cochleovestibular damage. A recent study in asymptomatic COVID-19 patients revealed increased high-frequency pure-tone thresholds while transient evoked otoacoustic emissions were significantly decreased, all in the absence of otologic symptoms.¹⁵ The SARS-CoV-2 neurotropism may inflict a wide range of neuropathic effects, potentially including effects on neural tracts governing hearing and balance.

There is three mechanisms as associated with SNHL in viral infections such as: neuritis caused by a viral infection in the cochlea or auditory nerve; viral infection of the peri-lymphatic tissue; stress response seen by cross-reactions of the antigens of the labyrinth.¹⁶ A study on animals was revealing viral infections causing otological manifestations through direct involvement of labyrinth or indirectly via the cerebrospinal fluid.¹⁷ There is evidence of sensorineural hearing loss (SNHL) with infections of certain viruses such as measles virus, herpes simplex virus, rubella virus, hepatitis virus, mumps virus, human immunodeficiency virus (HIV), lassa virus, and enteroviruses.¹⁸ The incidence SNHL in rubella infection is 12 to 19%, upto 33% in herpes simplex virus, 0.1 to 3.4% in measles, 0.005% to 4% in mumps, 6 to 23% (asymptomatic patients) to 22 to 65% (symptomatic patients) in cytomegalovirus infection and 27.5% to 33.5% in HIV infections.¹⁹ These viral involvements of inner ear suggest that auditory and vestibular involvement may occur by SARS-CoV-2.

Hearing loss and vertigo

The clinical manifestations of the COVID-19 infection may appear after 2 to 14 days following exposure of the SARS-CoV-2 infection.²⁰ The elderly patients and individuals with co-morbid conditions or immunocompromised conditions are prone to serious outcomes like acute respiratory distress syndrome (ARDS) and cytokine storm.²¹ Three things can happen in COVID-19 infections such as respiratory distress, some patients improve after treatment, and rest recovers with no medical treatment.²² In some cases of COVID-19 infections, the patient presents with otological manifestations.²³ Clinicians particularly otolaryngologists have an important role as health care providers for seeing the patients with vestibulocochlear manifestations in COVID-19 manifestations. The otolaryngological

manifestations have a higher risk of spread to others because of frequent touching sites of the hand to nose and mouth. The otorhinolaryngological manifestations include hyposmias, dysgeusia, nasal congestions, nasopharyngeal congestions, dizziness, hearing loss, and tinnitus.²³

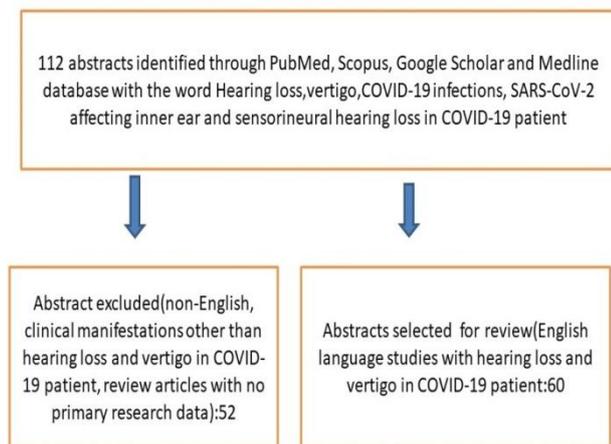


Figure 1: Flow chart showing method of literature search.

The eustachian tube is usually blocked by infections in the nasal cavity and nasopharynx.²⁴ The eustachian tube dysfunction often manifests as a blockage sensation in the ear and also otalgia. It may result in severe otalgia, fever, conductive hearing loss (CHL) and even tinnitus.²⁵ This type of aural manifestation results in hearing loss because of eustachian tube dysfunctions resulting in otitis media with effusion.²⁶ A study on asymptomatic patients with confirmed COVID-19 infections showed increased high-frequency pure tone thresholds while transient evoked with significantly decreased in otoacoustic emissions.²⁷ Coronaviruses have neurotropic and neuro-invasive properties.²⁸ However, no report was found on inner ear or vestibulocochlear involvement during SARS-CoV or middle eastern respiratory syndrome (MERS) outbreak. Neurological manifestations of the central nervous system, peripheral nervous system, and skeletal muscles have been documented in hospitalized patients with COVID-19 patients.²⁹ The majority of neurological manifestations are found early in the illness and neurological symptoms are only symptoms found to be caused by COVID-19 infection which encompasses encephalitis, meningitis, demyelination, and Guillain-Barre syndrome.²⁹ So, SARS-CoV-2 neurotropism may make it possible to cause a wide spectrum of neuropathic effects, potentially affects neural networks governing hearing and balance.³⁰ In addition to the direct involvement of virus, inflammatory response, cytokine storm and cerebrovascular events, particularly in posterior circulation and ototoxic medications like hydroxychloroquine and azithromycin being used extensively during the early part of the pandemic as therapeutic agents may also be responsible for

sensorineural hearing loss or balance disorders associated with COVID-19 infections.^{31,32}

Hearing and vestibular organs are closely associated both anatomically and physiologically.³³ They have similar mechanoreceptors which detect sound, body movement, and head orientation in space.³⁴ It is assumed that hearing impairment is associated with labyrinthine dysfunction and may be responsible for postural instability.³⁵ Many times patients are presenting with otologic or neurologic problems and showing with sensorineural hearing loss and true vertigo in COVID-19 patients. If any patients develop inner ear manifestations like SNHL or vertigo, need consultations at the outpatient department of otolaryngology, they should need RT-PCR testing to rule out SARS-CoV-2 infection. There are several reports found regarding the neurological manifestations in COVID-19 infections but not much report with SNHL and vertigo. One study reported non-specific neurological symptoms like ataxia, olfactory or gustatory dysfunctions, and neuralgia because of peripheral nerve involvement by COVID-19 infections.³⁶ Similar to other viral infections, SARS-CoV-2 infection may present with vestibular neuritis, also called as vestibular neuro-labyrinthitis or acute peripheral vestibulopathy.³⁷ Vestibular neuritis is usually a benign self-limited condition which presents with vertigo, nausea, vomiting and sometimes impairment in gait.³⁸ It is often a viral or post-viral inflammatory disorder affecting the vestibular part of the eighth cranial nerve.³⁹ The clinical presentations of these patients include acute vestibular imbalance. COVID-19 infection may present with benign paroxysmal positional vertigo (BPPV). BPPV is thought to be occurred due to free-moving otolith fragments dislodged from the utricular maculae. This debris may float freely inside the endolymphatic system, so it can move to any semicircular canals (canalolithiasis). In typical canalolithiasis variant of BPPV, the free-floating particles inside the lumen of the semicircular canal induce an aberrant signal from the canals, making the illusion of motion, which results in vertigo along with nystagmus. Once otolithic particles move down the most dependent position of the affected canal, the nystagmus and vertigo cease and so the duration of vertigo is brief.⁴⁰

Assessment of hearing loss and vertigo in COVID-19 patients

Proper history taking, otological and neuro-otological examinations including tuning fork tests are required before audiological investigation. Detail audiological assessments are required which include tuning fork test, pure tone audiometry, and tympanometry.⁴¹ Pure tone audiometry testing and tympanometry by an audiologist in a soundproof room are helpful to rule out any hearing loss. In current pandemic, pure tone audiometry and tympanometry should be performed with all safety measures for the COVID-19. Tympanometry is done to assess the middle ear pathology and eustachian tub. Type-A tympanogram indicate normal middle ear. Type-

C indicate esutachian tube dysfunction and Type-B indicates fluids in middle ear. The detailed evaluation of vertigo is evaluated by the proper history taking and different clinical tests for balance. Those patients discharged from the COVID hospital with a history of hearing loss and vertigo and confirmed with investigations of RT-PCR test must be thoroughly assessed. COVID-19 patients with a history of hearing loss, vertigo, and any association such as the history of ototoxic drugs, age-related hearing loss, measles, meningitis, syphilis, hypertension, thyroid disease, noise exposure, diabetes mellitus, and kidney diseases should be considered. Otoacoustic emissions (OAE) represent a form of energy generated from the outer hair cells of the cochlea. OAE can be spontaneous (SOAEs), evoked by transient stimuli like clicks or tone bursts (TEOAEs). TEOAEs are not invasive test and can be easily performed. This test needs lesser time, lesser cost and higher sensitivity.⁴² (D) TEOAE may show reduced amplitude which indicate subtle deterioration of the outer hair cell functions of the cochlea. The magnetic resonance imaging (MRI) with contrast of the brain and labyrinth may reveal inflammatory changes at the cochlea and auditory centre. Cochlea may show ossifications may be seen because of the inflammation. MRI detect the signs of the inflammation in the meninges and the cochlea in COVID-19 patients with SNHL. The primary goal of the MRI in case of sudden SNHL is to exclude pathology at the cerebellopontine angle, brain lesions and cochlear lesions or labyrinthitis. Clinicians should suggest through investigations to find out the exact etiopathology of the sensorineural hearing. So, different treatment options in COVID-19 positive patients which can prevent such undesirable complications. All the inflammatory markers such as erythrocyte sedimentation rate (ESR), C-reactive protein (CRP) and ferritin are useful investigations in COVID-19 patients with cochleovestibular symptoms. The coagulation parameters like d-dimer, fibrinogen and platelet count are useful investigation in these patients.

Computed tomography (CT) scan of the lungs is an important tool for early diagnosis and assessment of the COVID-19 infection. The most classical presentations in the CT scan of the chest include ground-glass opacities, patches, cord-like nodular appearance in the lungs. There is pleural thickening in some cases of the COVID-19 patients. The CT findings of the lungs often appear earlier than clinical presentations of the COVID-19 patients and these clinical findings hanged dynamically as the disease progress. So, a CT scan of the lungs plays a vital role to reveal disease progression and severity of the COVID-19 infection.^{30,31} However, the incidence of hearing loss and vertigo in COVID-19 patients are not usually associated with the infectivity of the patients about RT-PCR and CT scan of the chest. In current confirmed COVID-19 patients, the epidemiological correlations and biopathological mechanisms need urgent studies for examining the association of new-onset of otological symptoms during the present COVID-19 pandemic.

Management

The effective treatment for the COVID-19 infections is currently under the urgent investigation. Presently there is no evidence of the randomized clinical trials regarding the specific treatment which improves the patient outcome in COVID-19 infection.⁴³ It is always challenging for clinician to identify the aetiology as COVID-19 infections for cochleovestibular symptoms and start appropriate treatment to get maximum clinical recovery with minimal side effects and complications. Corticosteroid is an important first line treatment for SNHL.⁴⁴ Oral prednisolone in the tapering dose and vitamin-B with folic acid complex are helpful in SNHL in COVID-19 patients. However, the use of the corticosteroids in the SARS-CoV-2 infections as in other viral infections, can lead to increased severity of infection and cause delayed clearance of the viral infections.⁴⁵ One study showed 56.25% of COVID-19 patients showed complete resolution of hearing loss and became normal with treatment by corticosteroids.³⁰ In case non-COVID-19 patients, the rate of recovery from SNHL after treatment with corticosteroid in the first week of disease onset, within 2 weeks and beyond 3 months is 87%, 52% and <10% respectively.^{46,47} Irrespective of the etiology, the potential treatment of vestibular neuritis requires symptomatic medication and vestibular rehabilitation. Corticosteroids can be used in case of severe cases.⁴⁸ In case patients are refractory to the traditional management of cochleovestibular symptoms of COVID-19 infections, patient must be treated with intravenous steroids along with supportive care.⁴⁹

CONCLUSION

The outbreak of COVID-19 infection leads to an acute respiratory illness by SARS-CoV-2. Global attention is now on the infected patients. Although a large group of patients often presenting with respiratory or flu-like symptoms, the otological manifestations such as hearing loss and vertigo sometimes unnoticed. The exact mechanisms of the vestibulocochlear damage in COVID-19 infection still require further research. Although the otological symptom such as hearing loss and vertigo are not common like cough and fever in COVID-19 infections but these symptoms have high impact on patients hearing loss, balance disorder and communication problem which make life measurable. If any COVID-19 patient presented with hearing loss and vertigo, immediately require audiological, vestibular and radiological tests along with prompt treatment. The clinicians should give close attention to any otological symptoms such as hearing loss, vertigo, and tinnitus along with symptoms of the respiratory airway. Early identification of hearing loss and vertigo need prompt treatment to avoid important morbid situations of the COVID-19 patients.

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