International Journal of Otorhinolaryngology and Head and Neck Surgery
*Narang E et al. Int J Otorhinolaryngol Head Neck Surg. 2026 Apr;12(2):185-190*
http://www.ijorl.com
pISSN 2454-5929 | eISSN 2454-5937

DOI: https://dx.doi.org/10.18203/issn.2454-5929.ijohns20260785

**Original Research Article**

# Post COVID assessment of hearing in a tertiary health care centre of India

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**Received:** 28 May 2025
**Revised:** 10 December 2025
**Accepted:** 21 January 2026

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## ABSTRACT

**Background:** We have tried to find out the effects of COVID-19 on the audio vestibular system. We aim to study the type and severity of hearing loss in post COVID patients, if any. We also aim to find out the percentage of patients who have hearing loss following COVID-19 infection. This study also aims to find out the probable site of involvement of the audio vestibular system.
**Methods:** This study was conducted at a tertiary care hospital. 76 health care workers who had tested positive for COVID-19 were taken up for the study. All of them underwent Pure Tone Audiometry (PTA), Impedance Audiometry and Otoacoustic Emission Testing (OAE).
**Results:** Pure Tone Audiometry showed hearing loss in 14(18.4%) patients. It was mild in13 (92.9%), sensorineural in 12(85.7%) and bilateral in 11(78.6%). Impedance Audiometry showed Type A curve in 72 patients. On OAE testing 57 patients were pass and 16 were referred in both ears.
**Conclusions:** The percentage of hearing loss among COVID positive workers was 18.4%. Most of them (85.7%) had sensorineural hearing loss which was mild (92.9%). Hearing loss involved the higher frequencies more on PTA and OAE. OAE was referred in 23% of patients suggestive of cochlear outer hair cell as the possible site of involvement in the affected group. The study is registered under Clinical Trials Registry – India (www.ctri.nic.in) with registration number CTRI/2021/04/033078.

**Keywords:** Audiology, COVID, PTA, Impedance audiometry, OAE

## INTRODUCTION

Coronavirus disease is caused by a new coronavirus SARS-CoV-2. The coronavirus disease (COVID-19) was declared a global pandemic by WHO on 11th March 2020.[1] A wide range of clinical features are reported like fever, cough, malaise, breathing difficulty, loss of smell, taste.[2,3] A variety of central and peripheral nervous system manifestations have also been reported like cerebrovascular disease and impaired vision. However, it is not established whether these are a complication of COVID-19 infection or due to side effects of its medication.[4]

Hearing loss is known to occur in many viral infections such as mumps, measles, and cytomegalovirus.[5] Auditory neuropathy has been linked with Guillain Barre Syndrome (GBS). GBS has a known association with coronavirus.[6] Viruses usually cause sensorineural hearing loss which can be unilateral or bilateral, mild to profound. Viruses are known to cause hearing loss by various mechanisms like direct damage to inner ear structures and organ of Corti (such as in measles) or by host immune-mediated damage.[7,8]

Immense research work has been going on, on this novel coronavirus, but still, a lot needs to be explored. Many

long-term effects on post COVID patients remain unknown. We have tried to find out the effects of the virus on the audio vestibular system. We aim to study the type and severity of hearing loss in post COVID patients if any. We also aim to find out the percentage of patients who have hearing loss following COVID-19 infection. This study also aims to find out the probable site of involvement of the audio vestibular system.

## METHODS

76 health care workers from a tertiary healthcare Centre, who had tested positive for COVID-19 (henceforth addressed as 'patients'), in the period between March 2020 and June 2021 were taken up for the study. Only those in the age group 20-50 years were included in the study. Patients with previous ear disease, history of previous hearing loss, any chronic illness were excluded from the study. Patients were asked for any audio vestibular symptoms like hearing loss, tinnitus, and vertigo. They were asked the date of the positive COVID test report, whether tested by RT/PCR or RAT. Any previous history of ear disease or hearing loss was ruled out. Otoscopic examination of the ears was done to rule out any wax or pre-existing middle ear disease. Patients with wax or acute URI were called again after 1 week for audiometry testing. All of them underwent Pure Tone Audiometry, Impedance Audiometry, and Otoacoustic Emission Testing. Pure tone audiometry (PTA) was done using ALPS AD 2100 Audiometer. The diaphragm of the headphone was placed over the opening of the external auditory meatus. Air conduction thresholds were obtained for frequencies ranging from 250 Hz to 8000Hz. Bone conduction thresholds were measured for frequencies ranging from 250 Hz to 4000 Hz. The pure tone average was calculated from hearing thresholds at frequencies of 500Hz, 1 kHz, 2 kHz, and 4 kHz. Impedance audiometry was done using Impedance audiometer MI-34 MAICO to rule out any middle ear disease. The type of tympanogram was noted.

Otoacoustic emissions (OAE) were done using MAICO EROSCAN. The size of this tip was selected after visually inspecting the patient's ear canal size so that a snug fit of the TEOAE probe was achieved. In this study, criteria used for passing a patient on OAE were: Response Spectrum contained 3dB more power than the noise spectrum in three of the frequencies (2.0, 3.0, 4.0, and 5.0 kHz).

Those that did not fulfill this criterion were labeled as 'Referred'. All testing was carried out in a double-walled, sound-treated room within permissible noise limits. Informed consent was taken from all participants. The study was approved by the Institutional Ethical Committee (Protocol no. 90/4820 on 23/04/2021). The study is registered under Clinical Trials Registry – India (CTRI) with registration number CTRI/2021/04/033078.

## RESULTS

A total of 76 patients participated in the study.

Of the total patients, 30 were males (39.5%) and 46 females (60.5%). Age varied from 20 to 50 years. The mean age of the patients was 33.8 years. The most common symptoms were fever (56.6%), loss of taste (47.4%) and smell (43.4%), cough (38.2%), headache (34.2%), nasal congestion (23.7%), malaise (22.4%), chills (17.1%), respiratory distress (6.6%) and rhinorrhea (3.9%) (Figure 1).

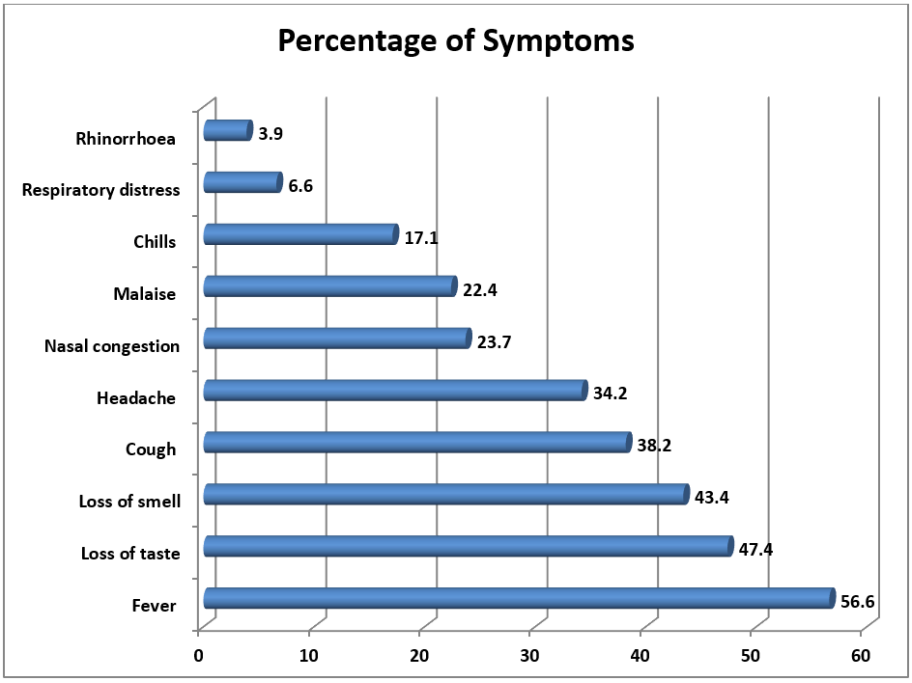


**Figure 1: Common symptoms amongst patients.**

**Table 1: Pure tone audiometry results of those 14 patients with hearing loss.**

| | Right ear threshold(dB) | Left ear threshold(dB) | Type of hearing loss | Degree of hearing loss | Laterality |
|---|---|---|---|---|---|
| **1** | 30 | 30 | SNHL | Mild | Bilateral |
| **2** | 31.25 | 28.75 | SNHL | Mild | Bilateral |
| **3** | 65 | 38.75 | SNHL | Right moderately severe and left mild | Bilateral |
| **4** | 26.25 | 23.75 | SNHL | Mild | Unilateral |
| **5** | 37.5 | 36.25 | SNHL | Mild | Bilateral |
| **6** | 38.75 | 28.75 | CHL | Mild | Bilateral |
| **7** | 27.5 | 27.5 | CHL | Mild | Bilateral |
| **8** | 23.3 | 31.2 | SNHL | Mild | Unilateral |
| **9** | 37.5 | 36.25 | SNHL | Mild | Bilateral |
| **10** | 28.75 | 26.25 | SNHL | Mild | Bilateral |
| **11** | 30 | 33.75 | SNHL | Mild | Bilateral |
| **12** | 33.75 | 27.5 | SNHL | Mild | Bilateral |
| **13** | 23.75 | 27.5 | SNHL | Mild | Unilateral |
| **14** | 33.75 | 35 | SNHL | Mild | Bilateral |

**Table 2: Impedance audiometry results of all patients.**

| | Right ear | Left ear |
|---|---|---|
| **Type A** | 72 | 73 |
| **Type B** | 2 | 2 |
| **Type C** | 2 | 1 |

**Table 3: Result of all patients tested on OAE.**

| | Right ear | Left ear |
|---|---|---|
| **OAE pass** | 60 | 57 |
| **OAE refer** | 16 | 19 |

**Table 4: Overall results of PTA, impedance audiometry and OAE of all 14 patients with hearing loss.**

| | Ear tested | Pure tone audiometry | Impedance audiometry | Oae |
|---|---|---|---|---|
| **1** | Right ear | 30dB SNHL | A type | Refer |
| | Left ear | 30dB SNHL | A type | Refer |
| **2** | Right ear | 31.25 dB SNHL | A type | Refer |
| | Left ear | 28.75dB SNHL | A type | Refer |
| **3** | Right ear | 65 dB SNHL | A type | Refer |
| | Left ear | 38.75 dB SNHL | A type | Refer |
| **4** | Right ear | 26.25 dB SNHL | A type | Pass |
| | Left ear | 23.75 dB SNHL | A type | Pass |
| **5** | Right ear | 37.5 dB SNHL | A type | Refer |
| | Left ear | 36.25 dB SNHL | A type | Refer |
| **6** | Right ear | 38.75 dB CHL | C type | Refer |
| | Left ear | 28.75 dB CHL | B type | Refer |
| **7** | Right ear | 27.5 dB CHL | C type | Refer |
| | Left ear | 27.5 dB CHL | C type | Refer |
| **8** | Right ear | 23.3 dB SNHL | A type | Pass |
| | Left ear | 31.2 dB SNHL | A type | Refer |
| **9** | Right ear | 37.5 dB SNHL | B type | Refer |
| | Left ear | 36.25 dB SNHL | A type | Refer |
| **10** | Right ear | 28.75 dB SNHL | A type | Refer |
| | Left ear | 26.25 dB SNHL | A type | Refer |

Continued.

| | Ear tested | Pure tone audiometry | Impedance audiometry | Oae |
|---|---|---|---|---|
| 11 | Right ear | 30 dB SNHL | A type | Refer |
| | Left ear | 33.75 dB SNHL | A type | Refer |
| 12 | Right ear | 33.75 dB SNHL | A type | Refer |
| | Left ear | 27.5 dB SNHL | A type | Refer |
| 13 | Right ear | 23.75 dB SNHL | A type | Pass |
| | Left ear | 27.5 dB SNHL | A type | Pass |
| 14 | Right ear | 33.75 dB SNHL | A type | Refer |
| | Left ear | 35 dB SNHL | A type | Refer |

In our study group, on taking history only one patient complained of hearing loss in the right ear, with onset one month after being COVID positive. No other patient in this group complained of any audio vestibular symptom like tinnitus, vertigo, or hearing loss. None of the patients tested were hospitalized for COVID. All the patients, on otoscopic examination, had normal intact tympanic membranes.

The patients can be divided into three categories depending upon the time of audiometry test after being tested as COVID positive. 60 patients when tested had COVID more than 6 months back, 13 had in the past 3 to 6 months while 3 had COVID within past 3 months.

Pure Tone Audiometry showed hearing loss in 14(18.4%) patients. 13(92.9%) had mild, 1 moderately severe and none had severe hearing loss. 2(14.3%) had conductive, 12(85.7%) had sensorineural hearing loss. 3(21.4%) had unilateral hearing loss and 11(78.6%) had bilateral. The PTA results of patients with hearing loss are summarized in Table 1. Impedance Audiometry results are shown in Table 2. On OAE testing 57 patients were passing and 16 were referred in both ears. 3 patients had OAE pass in the right ear and referred in the left ear (Table 3).

The results of hearing loss on Pure Tone Audiometry, Otoacoustic Emissions, and Impedance Audiometry have been compiled in Table 4.

## DISCUSSION

The rate/percentage of hearing loss among COVID positive workers was 18.4% (14 patients). It has been calculated from the number of patients having a hearing loss on PTA. 85.7% of them had sensorineural hearing loss. The hearing loss was mild in most of them (92.9%). Most of them had bilateral involvement (78.6%). Few other studies have also reported similar findings. Almuforrij and Munro did a systematic review on COVID -19 and audiovestibular symptoms. They found the prevalence of hearing loss to be 7.6%.[9] Dharmarajan S et al reported a case series of 100 patients which is a high number among the publications to date. They noticed sensorineural hearing loss in 53 COVID patients.[10] This high rate (18.4%) implies that hearing loss can be a part of the clinical spectrum of COVID-19. However, it is difficult to ascertain whether this hearing loss is due to a virus or due to medications taken for treatment of COVID like hydroxychloroquine. In our study, OAE was referred in 23% of COVID positive health care workers. Otoscopic examination and Impedance Audiometry were normal in most of them which suggest normal middle ear function. Amongst those 14 patients with hearing loss, 10 had a referred OAE with a type A Impedance curve. This is suggestive of cochlear outer hair cells as the possible site of involvement in the affected group. Mustafa et al did a case-control study on 20 patients (asymptomatic SARS-CoV-2 vs. control) and found that the asymptomatic SARS-CoV-2 group had significantly poorer hearing thresholds at 4-8 kHz and lower amplitude transient evoked otoacoustic emissions. High-frequency hearing loss and referred OAE have also been reported by Dharmarajan S et al.[10,11] We also compiled our result and found that hearing loss involved the higher frequencies more on PTA and OAE. The average of pure tone thresholds of all 14 patients with hearing loss, at each frequency, has been calculated. The results are shown in Table 5.

**Table 5: Average of pure tone thresholds at each frequency.**

| Frequency tested | Ear laterality | Average of all 14 patients with hearing loss | Ear laterality | Average of all 14 patients with hearing loss |
|---|---|---|---|---|
| **250 HZ** | Right | 26.8 dB | Left | 25.4 dB |
| **500 HZ** | Right | 28.9 dB | Left | 27.1 dB |
| **1000HZ** | Right | 28.6 dB | Left | 25.4 dB |
| **2000 HZ** | Right | 33.2 dB | Left | 26.4 dB |
| **4000 HZ** | Right | 40 dB | Left | 35.4 dB |
| **8000 HZ** | Right | 44.3 dB | Left | 36.1 dB |

**Table 6: Number of patients OAE pass at each frequency.**

| Frequency tested | Ear laterality | Number of patients OAE pass | Ear laterality | Number of patients OAE pass |
|---|---|---|---|---|
| **2 HZ** | Right | 67 | Left | 65 |
| **3 HZ** | Right | 61 | Left | 61 |
| **4 HZ** | Right | 58 | Left | 56 |
| **5 HZ** | Right | 48 | Left | 48 |

On OAE, the response at each frequency was summated for all patients. The results are shown in Table 6.

Only one patient in our study complained of hearing loss. In the rest hearing loss was detected on Audiometry. The reason could be the mild degree of hearing loss (92.9%).

Since the start of COVID, many other studies have mentioned hearing loss.

Fidan et al reported a patient with unilateral mild-to-moderate conductive hearing loss due to acute otitis media.[12] Rhman and Wahid reported a single case of sudden onset unilateral sensorineural hearing loss and tinnitus in a COVID positive patient. There was no associated vertigo, ear discharge, or ear pain. It improved with intratympanic steroids.[13] Sriwijitalaia and Wiwanitkitb also reported a case of sensorineural hearing loss in Thailand. She underwent standard respiratory care. However, there was no change in hearing loss.[14] Sun et al reported a patient with bilateral sensorineural hearing loss but it is not known whether this was a pre-existing symptom.[15] Chantal et al reported a 60-year-old case of COVID 19 infection under ICU care who complained of hearing loss and tinnitus. His audiological evaluation showed no response on the right side and profound sensorineural hearing loss on the left side. Magnetic Resonance Imaging of the brain showed pronounced contrast enhancement in the right cochlea, decreased fluid signal in the basal turn of the cochlea. The case was managed by a CI in the right ear and intratympanic triamcinolone in the left ear.[16] Koumpa et al reported a case of sudden sensorineural hearing loss which improved partially with intratympanic steroids.[17] Tinnitus and vertigo have been reported in some studies.[12,15,18-20] Other ear symptoms reported were otalgia, otitis externa, and otitis media.[12,16,19]

All the above studies point towards CI after COVID infection. Intratympanic steroids have been used successfully by many authors.

There are certain limitations to the study. Previous unsuspected hearing loss cannot be ruled out. The relation of time duration between COVID infection and onset of hearing loss is not known.

The relation between COVID-19 and the audio vestibular system is not well established yet. It is very early to predict the kind of association between COVID 19 and hearing loss. The nature of hearing loss whether temporary or permanent, static or progressive has to be ascertained. But definitely, COVID associated hearing loss is an emerging area of concern during the pandemic and there is a need for detailed studies and research work for a better understanding of this entity. We also intend to follow up with these patients and look for any changing trends. Also, our sample size is small to draw any definitive conclusion.

## CONCLUSION

The percentage of hearing loss among COVID positive workers was 18.4%. Most of them (85.7%) had sensorineural hearing loss which was mild (92.9%). Hearing loss involved the higher frequencies more on PTA and OAE. OAE was referred in 23% of patients suggestive of cochlear outer hair cell as the possible site of involvement in the affected group. Different modalities of treatment have been used in the form of oral steroids, intratympanic steroids, and CI. This study discusses the effect of COVID infection on hearing. The treatment of patients who have been discovered with hearing loss has to be planned out as there are no recommendations yet. Early detection of hearing loss is important so that timely intervention can be given. The treatment protocol for post COVID hearing loss has to be chalked out.

*Funding: No funding sources*
*Conflict of interest: None declared*
*Ethical approval: The study was approved by the Institutional Ethical Committee (Protocol no. 90/4820 on 23/04/2021). The study is registered under Clinical Trials Registry – India (CTRI) with registration number CTRI/2021/04/033078.*

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**Cite this article as:** Narang E, Tyagi S, Tyagi H, Jain N, Roy S, Singh J, et al. Post COVID assessment of hearing in a tertiary health care centre of India. Int J Otorhinolaryngol Head Neck Surg 2026;12:185-90.