Prevalence of hearing loss in COVID-19 patients: post-discharge

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COVID-19 is an acute respiratory disease caused by a novel coronavirus. The first human case of COVID-19 was officially reported in Wuhan city, China in December 2019(Savtale et al., 2021). The clinical symptoms of COVID-19 include fever, dry cough, tiredness, nasal congestion, headache, conjunctivitis, sore throat, diarrhoea, and loss of taste/smell. (World Health Organization, 2020). Besides respiratory involvement, it has been established that COVID-19 can also affect the human body's other vital organs such as the Heart, Kidneys, and brain. The auditory system has also been implicated(Munro et al., 2020; Mustafa, 2020).

Several studies have shown that viral infections can lead to hearing loss. Sensorineural hearing loss is a common sequel of viral infections, however, a viral etiology has been proposed to cause mixed and conductive hearing loss as an inflammatory response to infection. Cytomegalovirus affects the inner ear (Organ of Corti) as well as the vestibular labyrinth, on more specific basis the sensory cells of the utricle and Saccule(Gabrielli et al., 2014).

Trott et al., 2022 in a review of COVID-19 syndrome, listed some of the authors who reported the prevalence rate of symptoms relating to audio-vestibular systems in their Covid-19 population. Hearing loss was reported in 5.2 – 6.4 % of people (Davis et al., 2021), and tinnitus varied widely across three studies 26% (Davis et al., 2021), 14.5% (Orrù et al., 2021), and 6.9% (Gold et al., 2021) and vertigo across two studies (Rass et al., 2021; Orrù et al., 2021) ranging from 6 to 13.3%.

Savtale et al., 2021 in their study of determining the prevalence of ENT symptoms in 180 COVID-19 patients 54.4% of them reported hearing loss which was sudden in onset among this 81.6% of them recovered after treatment and 66.66% reported tinnitus. They also stated that these symptoms can be taken as biomarkers which would help in the early diagnosis of Covid-19 patients.

Although certain studies show that there is a high risk for hearing loss after a pandemic , which is based on the complaints reported by the patients which are not yet clinically established through a detailed audiological evaluation. As COVID-19 is relatively a new phenomenon, but there are no studies based on the effect of COVID-19 on the hearing status of affected individuals, the complaints such as sudden hearing loss, tinnitus, and vertigo seen in patients without major symptoms have strengthened this possibility (Basoz et al., 2022). Considering the lack of published data on hearing loss manifestation in COVID-19-positive patients, Therefore the present study aims to obtain the prevalence of hearing loss in COVID-19 patients after discharge. Which would help in the early identification and early intervention of the problem.

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Objective: The study is intended to find the prevalence of hearing loss in COVID-19 recovered patients after discharge from the hospital.

Method:

The study was a cross-sectional study of COVID-19 patients admitted to R L Jalappa Hospital and Research Center (Sri Devaraj Urs Academy of Higher Education and Research), Kolar, Karnataka, India, between July 2021 to December 2021. This study was approved by the Central Ethical Committee with reference number SDUAHER/KLR/Dept R&I/42/2021-2022. The patients who participated in the study were admitted to the hospital for treatment after Real-time Polymerase (RT-PCR) results revealed positive for COVID-19.

A total of 150 patients who fulfilled the inclusion criteria were considered in the study after being discharged, ages ranging from 18- 60 years. Patients with a history of hearing or hearing-related problems, prolonged exposure to noise at the workplace, middle ear pathology, ototoxic drug usage, and known neurological or psychiatric conditions were excluded from the study. A written informed consent was taken from all the patients who participated in the study.

Tympanometry was performed using Iventis Clarinet Plus middle ear analyzer to rule out the middle ear pathology. A two-channel GSI Audiostar pro diagnostic audiometer was used to find the hearing threshold from 250 Hz to 8000Hz using DD45 Headphones. High-frequency thresholds were estimated from 10 kHz to 16 kHz using a GSI Audiostar pro diagnostic audiometer with DD 450 headphones. Transient evoked otoacoustic emission (TEOAE) was recorded using an Otodynamics ILO-V6 analyzer, presenting a nonlinear click at 80dB peak SPL near the canal level. The data was tabulated and analyzed at the significance level of 0.05. Frequency distribution for descriptive statistics was completed using SPSS version 23.0 software.

Result:

A total of 150 patients participated in the study after meeting the inclusion criteria. The mean age of the patients was 44.29 ± 12.69 years (age range:18-60 years), 56.7% of the patients were males and 43.3% were females. The most frequent complaints that were reported by patients during admission were Fever (78.9%), Fatigue (65.3%), and Shortness of breath (57.6%). Among the patients selected, 54.7 % of them were admitted to the ICU ward to receive immediate care, and 36.7% were provided with ventilators for supporting normal breathing.

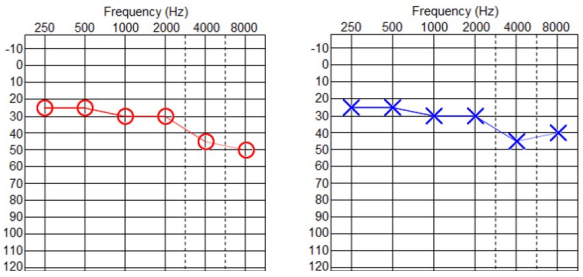
Pure tone Audiometry

All the patients were subjected to Puretone audiometry testing to find theihearing threshold. Of these 45(30%) patients were identified with sensorineural hearing loss with a mean threshold of 33.96 ± 14.03 in the right ear and 34.38 ± 15.61 in the left ear, ranging from mild to moderate in degree. The average threshold across the frequencies of both ears is shown in figure 1. Among these 95.55% were found to have a mild degree of hearing loss and 4.44% had moderate hearing loss. 86.66% of patients were diagnosed with bilateral hearing loss and 13.33% had unilateral hearing loss (Table 1).

Table 1 The results of pure tone audiometry (n=45)

	Configuration of hearing loss			
No. of patients	Bilateral 39(86.66%)		Unilateral 6(13.33%)	
	Male	Female	Male	Female
	24(53.33 %)	15(33.33 %)	3(6.66 %)	3(6.66 %)

Figure 1:



a. b.

The average threshold (n=45) of the right ear (a) and left ear (b) across the frequencies.

High-frequency audiometry

High-frequency audiometry (HFA) was performed on all patients out of which 36.66% of them either had affected or absent responses for the test. 6.66% had an affected and 2.00% had no response to the threshold in high-frequency audiometry with the normal threshold in conventional pure-tone audiometry. The HFA results of 45 patients who had hearing loss in given in Table 2.

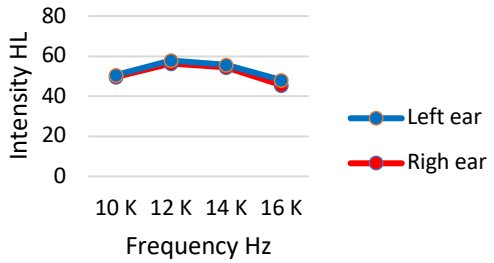
Table 2 High-frequency audiometry results (n=45)

No. of patients	Patients with affected HFT 42(93.33%)		Patients with absent HFT 15(33.33%)	
	U/L	B/L	U/L	B/L
	10(22.22 %)	32(76.19 %)	10(22.22 %)	5(11.11 %)

Note: HFT-High frequency threshold

The mean average threshold of high-frequency audiometry in 45 patients who had a hearing loss is depicted in Figure 2.

Figure 2:



The mean average threshold of high-frequency audiometry (n=45)

Otoacoustic emission

OAE was carried out to check the integrity of the outer hair cells (OHC) of the cochlea. Of which 41.33% were identified as having OHC dysfunction, in that 54.83% were male, and 45.16% were female. Similarly, 54.83% were having bilateral and 45.16% were having unilateral OHC dysfunction (Table 3). OAE outcome in the patients who were diagnosed as having hearing loss are given in Table 4. The mean signal-to-noise ratio of 45 patients is shown Figure 3.

Table 3: Results of TEOAE (n=62)

	Bilateral OHC Dysfunction 34(54.83%)		Unilateral OHC Dysfunction 28(45.16%)	
No. of patients	Male	Female	Male	Female
	22(35.48%)	12(19.35%)	12(19.35%)	16(25.80%)

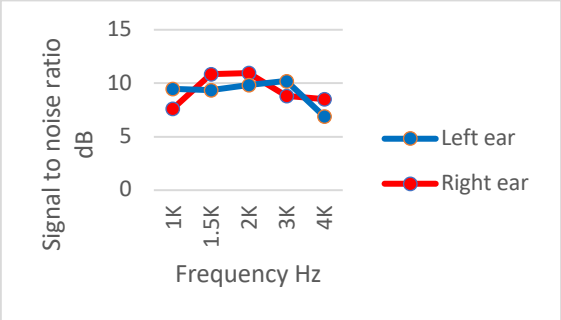
Note: TEOAE - Transient evoked otoacoustic emission, OHC – outer hair cells

Table 4: Results of TEOAE in patients with hearing loss (n=45)

	Bilateral OHC Dysfunction 16(35.55%)		Unilateral OHC Dysfunction 11(24.44%)	
No. of patients	Male	Female	Male	Female
	8(17.77%)	8(17.77%)	7(15.55%)	4(8.88%)

Note: TEOAE - Transient evoked otoacoustic emission, OHC – outer hair cells

Figure 3:



The mean signal-to-noise ratio of Otoacoustic emission (n=45)

Discussion:

The novel severe acute respiratory syndrome coronavirus 2 is the cause of the global respiratory pandemic known as Coronavirus-2019 (COVID-19) (SARS-CoV-2) (World Health Organisation WHO, 2019). Which is rapidly spreading and affecting the livelihood of many. It has been established that COVID-19 majorly affects the respiratory system of human beings leading to acute respiratory distress syndrome (ARDS) (Vallamkondu et al., 2020). Hearing loss can be a significant cause of morbidity and can easily be missed in the intensive care setting. Being aware and screening for hearing following COVID-19 enables an early course of treatment, which offers the best chance of restoring hearing (Koumpa et al., 2020).

In the current study, 45 patients (30%) had hearing loss ranging from mild to moderate degrees based on Puretone audiometry. Davis et al., 2021 in their study reported a prevalence of 4.2-6.5% for hearing loss which is lower than the present study. In a study by Savtale et al., 2021, 54.4% of patients reported hearing loss, which was higher than the present findings. This discrepancy in the prevalence of hearing loss can be related to the differences in methods and standards used to diagnose hearing loss. In our study, an average of 500Hz, 1kHz, 2kHz, and 4kHz was conducted to diagnose hearing loss, and an average of above 25 dB was considered as having a reduced hearing senstivity. Pure tone audiometry test results revealed a loss of 30dB at 1kHz and 2kHz and significant hearing loss in high frequencies (4kHz-8kHz), similar findings were obtained in a study done by Mustafa, 2020 in asymptomatic COVID-19 patients.

Extended high-frequency audiometry was done, the average of all the patients showed significant hearing loss between 10kHz – 16kHz considering the normative values given by Wang et al., 2021 across the age groups as reference. It was noted that 37.7% in the right ear and 35.5% in the left ear, 62.22% in the right ear, and 53.3% in the left ear response at 14 and 16kHz was absent in patients who had hearing loss in conventional audiometry. The effect of absent responses at high frequencies can be observed with the better average obtained.

Basoz et al., 2022 in his study found a eminent significant difference in the amplitude of OAE at 4kHz and showed the effect of Covid-19 on the peripheral hearing system. In our study, we found that 60% of the patients who were diagnosed as having hearing loss had OHC dysfunction. But, the average OAE amplitudes in patients who had hearing loss were well above 6db in all the frequencies as per the passing criteria of the Joint Commission of Infant hearing 2007(Busa et al., 2007). In view of the fact of the high amplitude in certain patients and the average values that are considered. Despite having absent OAE across the frequency ranging from 24.44% - 55.55% in the right ear and 11.11% - 53.33% in the left ear. There was a significant reduction in the OAE amplitude at 4kHz when compared to other frequencies as seen in Bosaz's study, similar findings were obtained in a study done by Mustafa, 2020 in asymptomatic COVID-19 patients.

It is essential to consider hearing evaluation in patients who previously had a viral infections it's not just to identify the hearing loss but to provide immediate and appropriate management to improve hearing ability and quality of life after the recovery from the viral infection.

Conclusion:

It can be concluded that the prevalence of hearing loss is high among the COVID-19 patients in our study. This suggests that COVID-19 patients have a greater chance of developing hearing loss during or post-recovery from COVID-19 infection. We would recommend regular hearing evolution of all the patients admitted with COVID-19 with Conventional and Extended High-frequency Audiometry, Immittance audiometry, and Otoacoustic emission as a test battery. To not overlook on need for early diagnosis of hearing loss and prompt treatment or rehabilitation. For a better understanding of pathogenies, a long-term study with follow-up needs to be carried out.

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