

## Case report

## Sudden irreversible hearing loss post COVID-19

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**SUMMARY**

Sudden onset sensorineural hearing loss (SSNHL) is frequently seen by otolaryngologists. The exact pathophysiology of the disease is still unknown, with the most likely causative factor being following a viral infection. Immediate steroids are the best treatment to improve prognosis. Despite a plethora of papers in the literature describing SSNHL, there are only a few reported cases of hearing loss following COVID-19, none of which have been reported in the UK. This paper presents the first UK case of SSNHL following COVID-19. Physical examination and imaging excluded any other cause of hearing loss. A literature review showed that four other cases have been previously described. Hearing loss can be a significant cause of morbidity and can easily be missed in the intensive care setting. Being aware and screening for SSNHL following COVID-19 enables an early course of steroids, which offers the best chance of recovering hearing.

**BACKGROUND**

Sudden onset sensorineural hearing loss (SSNHL) is defined as a hearing loss of at least 30 dB in at least three consecutive frequencies that has developed within 3 days.<sup>1</sup> It is a relatively common pathology seen in otolaryngology, with a worldwide incidence of 5–160 cases per 100 000 people annually.<sup>2</sup> In most cases the aetiology of the hearing loss is not confirmed, and it is attributed to different pathologies including viral related, immune mediated, cellular stress response and vascular occlusion.<sup>3</sup> Viruses causing hearing loss have been described, mainly including the herpes species and cytomegalovirus, but these are uncommonly seen as the cause of SSNHL.<sup>4</sup>

The novel SARS-CoV-2 leading to COVID-19 has affected over 0.5 million people and caused a plethora of documented symptoms. The virus mainly affects the upper respiratory system causing symptoms of fever and cough, leading to pneumonia and multi-organ failure. A large proportion of the cases seen are asymptomatic (20–86% of reported cases) or have mild unreported symptoms.<sup>5</sup> Neuronal inflammation related to COVID-19 has been reported previously in the context of anosmia, but the relationship between COVID-19 and sensorineural hearing loss has not been thoroughly explored to date.

**CASE PRESENTATION**

A 45-year-old patient with asthma presented to our otolaryngology department following a week of hearing loss while in hospital for the treatment

of COVID-19. He was admitted to hospital on day 10 of COVID-19 symptoms and subsequently required intubation and transfer to the intensive care unit (ITU) due to high work of breathing. He was intubated for 30 days and his admission was further complicated by bilateral pulmonary emboli, ventilator-associated pneumonia, pulmonary hypertension and anaemia. He received remdesivir, intravenous steroids and plasma exchange to treat his COVID-19 infection and clinically improved. A week after extubation and transfer out of ITU he noticed left-sided tinnitus and sudden onset hearing loss. He had no previous history of hearing loss or ear pathology.

His past medical history before admission included asthma, but he was otherwise fit and well. His medications during his admission were colchicine 20 000 units twice weekly, doxazosin 4 mg once daily, fluticasone 125 µg 1–2 puffs/day, fluticasone propionate 50 µg nasal spray, folic acid 5 mg once daily, lansoprazole 30 mg once daily, loratadine 10 mg once daily, ramipril 5 mg once daily, rivaroxaban 20 mg once daily, salbutamol inhaler as needed and tadalafil 10 mg as needed. He was also receiving teicoplanin and ciprofloxacin during his admission, which were completed 2 days before the time of onset of hearing loss, but no ototoxic medications were administered.

On examination his ear canals were patent and non-inflamed with intact tympanic membranes. Bedside testing suggested left-sided sensorineural hearing loss with a negative Rinne's test on that side and a Weber's test lateralising to the opposite side. He had no further focal neurology. He was managed with 7 days of 60 mg oral prednisolone. He subsequently had a pure tone audiogram confirming the diagnosis with 2, 3, 4 and 6 kHz frequencies being the most affected and elevated hearing thresholds of 65, 75, 75 and 85 dB, respectively. He subsequently underwent a series of intratympanic steroid injections.

Following intratympanic steroid administration, his pure tone audiogram showed partial improvement with thresholds of 55, 60, 60, 80 dB at 2, 3, 4 and 6 kHz frequencies, respectively.

**INVESTIGATIONS**

At the onset of his hearing loss his white cell count was within normal range with a slightly elevated C-reactive protein linked to his COVID-19. Full autoimmune screen including rheumatoid factor, antinuclear antibody, antineutrophil cytoplasmic antibody, centromere antibody, smooth muscle antibody and anti-cardiolipin antibody was negative. Angiotensin converting enzyme, immunoglobulins



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## Unusual association of diseases/symptoms

**Table 1** Blood results on admission, on the ward and at discharge

Investigation	On admission	Step down to ward	At discharge
Haemoglobin	140	80	96
White cell count	7.1	9.9	8.8
C-reactive protein	346	32	34
D-dimer	16 470	1230	260
Ferritin	5347	1275	1673
Lactate dehydrogenase	945	295	237
Troponin	7	51	8
Interleukin 6	6.45	4.51	
Interleukin 10	3.01	2.16	
Pro-calcitonin		0.58	

and complement C3 and C4 were within normal range. A viral screen for influenza and HIV was negative.

Inflammatory markers on admission, in hospital and at discharge are shown in [table 1](#).

An MRI scan of the internal auditory meatus excluded further causes of the unilateral hearing loss.

### TREATMENT

The main treatment for the patient's symptoms was the administration of steroids. He successfully completed a course of 60 mg oral steroids for 7 days which resulted in partial subjective improvement in his hearing. He subsequently had three rescue intratympanic injections of 0.5 mL methylprednisolone sodium succinate (125 mg/mL) which resulted in no further improvement in his hearing seen on pure tone audiograms.

### OUTCOME AND FOLLOW-UP

No clear aetiology for the SSNHL was found, but it was postulated that this could be related to COVID-19.

### DISCUSSION

Sensorineural hearing loss is a subject of ongoing research in the field of otolaryngology with questions focused on the optimal route of steroid administration for treatment. However, SSNHL in the context of COVID-19 has not been widely recognised to date. A systematic literature review was performed using the EMBASE and PubMed databases from 1950 to July 2020. The key words used were the following: 'hearing loss', 'COVID-19', 'coronavirus', 'sensorineural hearing loss'. The literature was reviewed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. This resulted in three case reports and two case-control studies which were fully reviewed.<sup>6-10</sup>

Despite the considerable literature on COVID-19 and the various symptoms associated with the virus, there is a lack of discussion on the relationship between COVID-19 and hearing. Hearing loss and tinnitus are symptoms that have been seen in patients with both COVID-19 and influenza virus but have not been highlighted.<sup>11</sup> The first case mentioning sensorineural hearing loss in a SARS-CoV-2 positive patient was by Sriwijitalai and Wiwanitkit in April 2020,<sup>10</sup> and only four papers related to sensorineural hearing loss have been published since. Another two cases were described where new onset sensorineural hearing loss in SARS-CoV-2 positive patients with no previous otological problems was seen and no other causality found.<sup>7,8</sup> Degen *et al*<sup>7</sup> reported a previously well 60-year-old man with severe COVID-19 requiring ITU stay who developed

right-sided deafness and left sensorineural hearing loss and received intratympanic steroids and a cochlear implant. Rhman *et al*<sup>8</sup> reported an otherwise asymptomatic patient who presented to the clinic with sensorineural hearing loss and a SARS-CoV-2 positive swab and received intratympanic steroids which resulted in some improvement. Similarly, in the case presented here, the patient was previously well with no other attributable cause for his SSNHL. In this case the patient felt the most benefit from oral steroids and had no further benefit from the intratympanic steroid injections. Furthermore, it must be noted that the patient mentioned the difficulty acknowledging the hearing loss in the busy ITU environment and his realisation afterwards.

To investigate the presence of SARS-CoV-2 in patients presenting to the otolaryngology clinic with sensorineural hearing loss, Kilic *et al* performed a polymerase chain reaction (PCR) test on five patients with SSNHL.<sup>6</sup> One of the five patients was found to be SARS-CoV-2 positive and had no other new symptoms apart from SSNHL. It must be noted that the sensitivity of SARS-CoV-2 PCR testing varies greatly between tests. A recent review of the subject quoted sensitivity ranging from 32% to 98% depending on the site and quality of the sample, stage of disease and viral multiplication and clearance.<sup>12</sup> It is thus possible that an even higher proportion of the patients with sensorineural hearing loss seen by Kilic *et al* had been previously infected by SARS-CoV-2.

Lastly, Mustafa measured the transient evoked otoacoustic emissions (TEOAE) of 20 patients with no COVID-19-related symptoms who were SARS-CoV-2 positive and 20 control patients, and found that the SARS-CoV-2 positive patients had significantly worse high frequency pure tone audiometry thresholds and TEOAE amplitudes.<sup>9</sup> This indicates a potential relationship between COVID-19 and cochlear damage.

Despite the low numbers of studies, it is significant to consider the possibility of a relationship between COVID-19 and SSNHL. Histopathological studies of patients with SSNHL have shown loss of hair cells and supporting cells of the organ of Corti without inflammatory cell infiltrate, suggesting that the pathology of idiopathic SSNHL may be related to cellular stress pathways.<sup>13</sup> SARS-CoV-2 is believed to bind to the ACE-2 receptor which is present on alveolar epithelial cells and endothelial cells. It was recently also seen to be expressed in epithelial cells of the middle ear, as well as the stria vascularis and spiral ganglion in mice.<sup>14</sup> Furthermore, SARS-CoV-2 causes an inflammatory response and an increase in cytokines such as tumour necrosis factor- $\alpha$ , interleukin 1 and interleukin 6.<sup>5</sup> Both a direct entry into the cochlea and inflammation leading to cell stress are mechanisms that have been implicated in persistent sensorineural hearing loss and could be occurring in the case of the SARS-CoV-2 infection.

This is the first reported case of sensorineural hearing loss following COVID-19 infection in the UK. Given the widespread presence of the virus in the population and the significant

### Learning points

- ▶ Sudden onset sensorineural hearing loss (SSNHL) can appear following COVID-19
- ▶ As with idiopathic SSNHL, more research needs to be done to evaluate the benefit of steroid administration
- ▶ Screening for hearing loss is suggested in the hospital environments to avoid missing the treatment window and decreasing hearing loss-associated morbidity

morbidity of hearing loss, it is important to investigate this further. This is especially true given the need to promptly identify and treat the hearing loss<sup>15</sup> and the current difficulty in accessing medical services. We suggest that patients are asked about hearing loss in the ITU environments when applicable, and any patient reporting acute hearing loss should be referred to otolaryngology on an emergency basis.

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