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.

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.1 It is a relatively common pathology seen in otolaryngology, with a worldwide incidence of 5–160 cases per 100 000 people annually.2 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.3 Viruses causing hearing loss have been described, mainly including the herpes species and cytomegalovirus, but these are uncommonly seen as the cause of SSNHL.4

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.5 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 colecaciferol 20 000 units twice weekly, doxazosin 4 mg once daily, fluticasone 125 μg 1–2 puffs/day, 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 tadafal 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 he was normotensive and heart sounds and lung fields were normal. He had no focal neurology. His left ear was patent and had intact tympanic membranes. On examination his ear canals were patent and his left ear was inflamed with intact tympanic membranes.

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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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.6–10

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 by Kilic et al.11 The first case mentioning sensorineural hearing loss and could be occurring in the case of the SARS-CoV-2 positive patient was by Sriwiji-talai and Wiwanitkit in April 2020,10 and only four papers 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.13 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.14 Furthermore, SARS-CoV-2 causes an inflammatory response and an increase in cytokines such as tumour necrosis factor-α, interleukin 1 and interleukin 6.3 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

<table>
<thead>
<tr>
<th>Investigation</th>
<th>On admission</th>
<th>Step down to ward</th>
<th>At discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haemoglobin</td>
<td>140</td>
<td>80</td>
<td>96</td>
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<tr>
<td>White cell count</td>
<td>7.1</td>
<td>9.9</td>
<td>8.8</td>
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<tr>
<td>C-reactive protein</td>
<td>346</td>
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<tr>
<td>D-dimer</td>
<td>16470</td>
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<tr>
<td>Ferritin</td>
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<tr>
<td>Lactate dehydrogenase</td>
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<td>295</td>
<td>237</td>
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<tr>
<td>Tropinin</td>
<td>7</td>
<td>51</td>
<td>8</td>
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<tr>
<td>Pro-calcitonin</td>
<td></td>
<td></td>
<td>0.58</td>
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</tbody>
</table>

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 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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