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.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 celecoxib 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 tadalfil 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...
Unusual association of diseases/symptoms

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

<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>
</tr>
<tr>
<td>White cell count</td>
<td>7.1</td>
<td>9.9</td>
<td>8.8</td>
</tr>
<tr>
<td>C-reactive protein</td>
<td>346</td>
<td>32</td>
<td>34</td>
</tr>
<tr>
<td>D-dimer</td>
<td>16470</td>
<td>1230</td>
<td>260</td>
</tr>
<tr>
<td>Ferritin</td>
<td>5347</td>
<td>1275</td>
<td>1673</td>
</tr>
<tr>
<td>Lactate dehydrogenase</td>
<td>945</td>
<td>295</td>
<td>237</td>
</tr>
<tr>
<td>Troponin</td>
<td>7</td>
<td>51</td>
<td>8</td>
</tr>
<tr>
<td>Interleukin 6</td>
<td>6.45</td>
<td>4.51</td>
<td></td>
</tr>
<tr>
<td>Interleukin 10</td>
<td>3.01</td>
<td>2.16</td>
<td></td>
</tr>
<tr>
<td>Pro-calcitonin</td>
<td></td>
<td></td>
<td>0.58</td>
</tr>
</tbody>
</table>

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 admin-
istration 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 improve-
ment in his hearing seen on pure tone audiograms.

OUTCOME AND FOLLOW-UP
No clear aetiology for the SSNHL was found, but it was postu-
lated 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 System-
atic Reviews and Meta-Analyses (PRISMA) guidelines. This
resulted in three case reports and two case-control studies which
were fully reviewed.

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. The first case mentioning sensorineural
hearing loss in a SARS-CoV-2 positive patient was by Sriwiji-
talai and Wiwanitkit in April 2020, and only four papers
related to sensorineural hearing loss have been published since.
Another two cases were described where new onset sensori-
neural hearing loss in SARS-CoV-2 positive patients with no
previous otological problems was seen and no other causality
found. Degen et al 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 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, Kılıç et al performed a polymerase chain reaction
(PCR) test on five patients with SSNHL. 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 sensi-
tivity 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. It is
thus possible that an even higher proportion of the patients with
sensorineural hearing loss seen by Kılıç 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 thresh-
olds and TEOAE amplitudes. This indicates a potential relation-
ship 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. SARS-CoV-2 is believed to bind to the ACE-2
receptor which is present on alveolar epithelial cells and endo-
thelial 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. Furthermore, SARS-CoV-2 causes an inflam-
matory response and an increase in cytokines such as tumour
necrosis factor-α, interleukin 1 and interleukin 6. Both a direct
entry into the cochlea and inflammation leading to cell stress
mechanisms that have been implicated in persistent senson-
neural 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 wide-
spread 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 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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