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Is There an Association Between Sudden Sensorineural Hearing Loss and Coronavirus Disease 2019? A Comparison Between the Pre-pandemic and Pandemic Periods in Portugal

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ABSTRACT

Background: Sudden sensorineural hearing loss (SSNHL) is a frequent pathology that has already been associated with vascular phenomena, immune causes, and viral infections. Various reports have suggested that coronavirus disease 2019 (COVID-19) infected patients are prone to develop SSNHL, but evidence so far is inconsistent. In this study, we aim to compare the incidence of SSNHL in the pre-pandemic and pandemic periods in order to clarify the impact of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection and/or immunization in the epidemiology of SSNHL.

Methods: We retrospectively selected all the patients who were admitted in the emergency department of Centro Hospitalar do Tâmega e Sousa with SSNHL's diagnosis. The pre-pandemic period was defined from January 2, 2018, to March 1, 2020, and the pandemic period from March 2, 2020, to May 2, 2022. The incidence was calculated as the number of confirmed cases of SSNHL per total number of audiological evaluations performed in the emergency department in each period.

Results: The incidence of SSNHL was 8.1% in the pre-pandemic period, compared to 11.1% in the pandemic period. However, no significant difference was observed between the 2 periods ($P > .05$). One patient presented with SSNHL within 5 days after testing positive for SARS-CoV-2. Of the confirmed cases in the pandemic period, 52.4% were already vaccinated for COVID-19 at the time of occurrence.

Conclusion: Based on our results, we cannot affirm that the incidence of SSNHL has significantly increased since the beginning of the pandemic in Portugal. However, we must consider the limitations inherent to lockdown period in their interpretation.

Keywords: Sudden sensorineural hearing loss, COVID-19, vaccination, incidence

Introduction

Sudden sensorineural hearing loss (SSNHL) is a frequently encountered condition in the field of otolaryngology, with an estimated incidence ranging from 5 to 20 cases/100 000 patient-year.[1] Despite some heterogeneity regarding diagnostic criteria, the most accepted definition is characterized by a sensorineural hearing loss of at least 30 dB over 3 or more consecutive frequencies that occurs within a 72-hour period.[2] Moreover, patients frequently report associated tinnitus, vertigo, dizziness, or ear pain.[2] In most cases, the disease is restricted to 1 ear. Bilateral cases are rare and, when they occur, causes such as genetic disorders, sarcoidosis, or neoplasms must be considered.[3] Regardless, all patients with presumptive SSNHL should undergo a magnetic resonance imaging or auditory brainstem response to exclude retrocochlear pathology, according to the American Academy of Otolaryngology Head and

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Neck Surgery.[3] A conventional computed tomography (CT) scan lacks the level of image resolution to accurately evaluate the internal auditory canal and thus is not routinely recommended in the initial assessment.[3]

It is known that around 10%-15% of SSNHL cases have an underlying identifiable cause.[4] For this reason, SSNHL is usually classified as an idiopathic multifactorial pathology.[1] Several factors have been postulated as potential contributors for this disease, such as vascular phenomena, immune causes, or viral infections.

Viral-induced hearing loss has been extensively described in the literature and differs greatly according to the type of virus.[5] In most cases, the hearing loss following a viral infection is sensorineural, but conductive and mixed hearing loss have also been reported.[6] The mechanism by which viruses induce hearing loss may include direct damage to the cochlear nerves and/or structures or host immune-mediated damage.[7] Moreover, some viruses may induce coagulopathy leading to cochlear ischemia and subsequent hearing loss.[5]

The first confirmed case of coronavirus disease 2019 (COVID- 19) in Portugal happened on the March 2, 2020. This condition, caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has a broad spectrum of severity and is usually characterized by fever, dyspnea, headache, muscle pain, diarrhea, and sore throat. Severe acute respiratory syndrome coronavirus 2 has recognized neurotrophic and neuroinvasive characteristics[5] and has already been linked to cranial neuropathies such as anosmia and facial nerve palsy.[8] Furthermore, COVID-19 patients frequently present with thrombotic events due to coagulopathic phenomenons.[7]

Several reports in the literature have suggested that COVID-19 infected patients are prone to develop SSNHL. However, the evidence so far is highly inconsistent and mainly based on single case-reports which limits the potential to obtain reliable conclusions.[2]

There was also concern in the otolaryngology community regarding the potential impact of SARS-CoV-2 vaccines inoculation on the incidence of the disease. Sudden sensorineural hearing loss has already been described as a rare lateral effect following immunization with other widely administered vaccines, such as rabies, hepatitis B, measles, or H1N1.[9] Formeister et al[10] stated that the incidence of SSNHL occurring after COVID-19 vaccination is comparable to, or possibly even lower, than that of the general population. However, methodological limitations and potential biases demand cautious interpretation of these recent results.[11]

This study aims to compare the incidence of SSNHL in Centro Hospitalar do Tâmega e Sousa in the pre-pandemic and pandemic period and to describe the main differences regarding clinical presentation between these 2 time frames. We hope to bring some clarity regarding the potential impact of SARS-CoV-2 infection and/or immunization in the epidemiology of SSNHL and its management.

MAIN POINTS

- *Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has recognized neurotrophic and neuroinvasive characteristics and has already been linked to cranial neuropathies such as anosmia and facial nerve palsy.*
- *Although the absolute number of cases of sudden sensorineural hearing loss (SSNHL) was higher during the pandemic period, there were no significant differences in the incidence of SSNHL between the 2 compared periods in our sample.*
- *The limitations imposed by the pandemic contingency plan and reticence to seek public hospitals may have led to an underestimation of the number of cases of SSNHL during the pandemic period.*
- *In the future, large-dimension studies are necessary to clarify the true impact of coronavirus disease 2019 infection on hearing function and optimize patient management.*

Material and Methods

This is a retrospective cohort study that aims to compare the incidence of SSNHL in the pre-pandemic and pandemic period. The pre-pandemic period was defined between January 2, 2018, and March 1, 2020, whereas the pandemic period started on March 2, 2020, and finished on May 2, 2022. Each study interval has a duration of 26 months.

We selected all the patients that were admitted to the emergency department of Centro Hospitalar do Tâmega e Sousa with the diagnosis of SSNHL in the period between January 2, 2018, and May 2, 2022. Each episode was retrospectively reviewed individually regarding the required criteria to be classified as SSNHL: (1) hearing loss that is sensorineural in nature; (2) hearing loss of at least 30 dB in at least 3 consecutive frequencies; (3) occurrence in a 72-hour period. Patients with concomitant signs of vestibular impairment in the acute phase of the disease were also included in this study.

All the patients with a previous history of audio-vestibular disorders that could justify a SSNHL, such as Ménière's disease or with any known cause for the presented hearing impairment (acoustic trauma, ototoxic drugs, etc.), were excluded from the study. Cases that did not fully meet the criteria mentioned above were not considered.

We calculated the incidence in the pre-pandemic and in the pandemic period as the number of confirmed cases of SSNHL per the total number of audiological evaluations performed in the emergency department in the corresponding period of time. The chi-square test was performed to compare the incidence in the pre-pandemic and pandemic period. A *P*-value <.05 was considered significant.

For each confirmed case in the pandemic period, we also assembled information regarding the presence of recognized symptoms of COVID-19 infection and the result of screening tests for SARS-CoV-2 infection when available. We also took information regarding the immunization status of each patient.

The present study was approved by the ethics committee of Centro Hospitalar do Tâmega e Sousa (PROC. No. 50/December 22, 2023).

Results

We obtained a total of 44 cases of SSNHL in our sample: 18 in the pre-pandemic period and 26 in the pandemic period. A total of 9 patients were excluded from the study, 4 from the pre-pandemic period, and 5 from the pandemic period. Six of these patients did not fulfill the established criteria to be classified as SSNHL, 2 patients had a previous history of Ménière's disease, and the last one presented hearing loss subsequent to otological trauma. Hence, we obtained a total of 14 confirmed cases in the pre-pandemic period and 21 confirmed cases in the pandemic period (Figure 1).

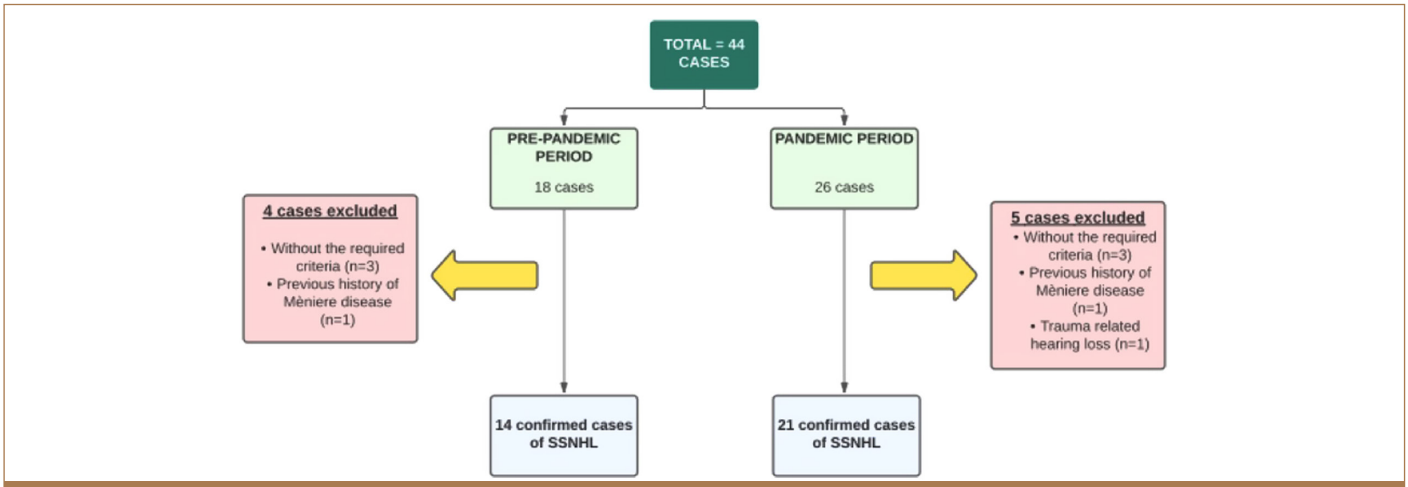

Figure 1. Exclusion criteria and selection of patients with Confirmed Sudden Sensorineural Hearing Loss.

The mean age of patients with confirmed SSNHL was 58.57 years in the pre-pandemic period and 58.00 years in the pandemic period. In both instances, the majority of patients were male. The demographic characteristics are summarized in Table 1.

All cases presented with unilateral symptoms. The pure-tone average (PTA) of the affected ear was recorded upon admission and following treatment for each case. The mean values obtained for each period are presented in Table 2. Mean PTA at presentation was 75.86 dB ± 19.05 during the pre-pandemic period and 76.76 dB ± 23.08 during the pandemic. Following treatment, the mean PTA was 61.29 dB ± 16.55 in the former group and 52.11 dB ± 32.08 in the latter. Two patients lost follow-up during the pandemic, thus preventing the assessment of post-treatment PTA in these specific cases. There were no significant differences in the hearing test results between groups ($P = .90030$ at admission and $P = .26563$ after treatment; Student's *t* test).

The number of audiological evaluations performed in the emergency department was 173 in the pre-pandemic period and 190 in the pandemic period. The incidence of SSNHL was 8.1% in the pre-pandemic period versus 11.1% in the pandemic period. No significant difference was found between the 2 periods ($P = .33992$; chi-square test).

Table 1. Demographic Characteristics of Patients with Confirmed Sudden Sensorineural Hearing Loss

Pre-pandemic Period	
Mean age ± SD	58.57 ± 8.48
Sex	
Male, n (%)	10 (71.43)
Female, n (%)	4 (28.57)
Total	14
Pandemic Period	
Mean age ± SD	58.00 ± 13.43
Sex	
Male, n (%)	14 (66.67)
Female, n (%)	7 (33.33)
Total	21
TOTAL	35

SD, standard deviation.

The most common associated symptom in both periods was by far tinnitus (64.3% and 61.9% in the pre-pandemic and pandemic period, respectively). Vertigo was reported in 14.3% of confirmed cases of SSNHL in the pandemic period but was not reported previously. Other less commonly reported symptoms include dizziness (21.4% and 19.0% in the pre-pandemic and pandemic period, respectively) and paresthesias (7.1% and 4.8% in the pre-pandemic and pandemic period, respectively). A magnetic resonance imaging was performed in 85.7% of confirmed cases in the pre-pandemic period versus 61.9% in the pandemic period. Retrocochlear pathology proved to be present in only 2 patients with SSNHL and both occurred in the pandemic period.

Each confirmed case of SSNHL in the pandemic period was actively reviewed regarding the presence of recognized symptoms of COVID-19, the result of respective screening test, when available, and the immunization status. Only 1 patient was actively tested for COVID-19 with a real-time polymerase reaction at the time of onset of the hearing loss, with a negative result. One subject developed SSNHL 5 days after testing positive for SARS-CoV-2 but came to the emergency

Table 2. Clinical Characteristics of the Patients with Confirmed Sudden Sensorineural Hearing Loss

Clinical Characteristics	
Pre-pandemic Period	
Side of deafness	
Right, n (%)	4 (28.57)
Left, n (%)	10 (71.43)
Pure-tone average in the affected ear: mean ± SD (dB)	
Pre-treatment	75.86 ±19.05
Post treatment	61.29 ± 16.55
Pandemic Period	
Side of deafness	
Right, n (%)	15 (71.43)
Left, n (%)	6 (28.57)
Pure-tone average in the affected ear: mean ± SD (dB)	
Pre-treatment	76.76 ± 23.08
Post treatment	52.11 ± 32.08

dB, decibel; SD, standard deviation.

department only 2 weeks after symptom onset. Moreover, another patient was diagnosed with SSNHL 3 months after COVID-19 infection. For the remaining cases, we did not find any mention of associated symptoms that could raise the suspicion of underlying SARS-CoV-2 infection.

It is also worth mentioning that 52.4% of the confirmed cases were already vaccinated for COVID-19 at the time of occurrence. On average, patients experienced SSNHL 54.82 days following immunization. Among those previously vaccinated, 9.1% received a single inoculation before SSNHL onset, 63.6% had undergone 2 prior vaccinations, and 27.3% had been exposed to 3 vaccine doses. One of the patients presented with SSNHL only 1 day after receiving the second dose of the vaccine, while another developed symptoms within 20 days after his first inoculation. The remaining vaccinated patients did not seem to have a significant temporal association with COVID-19 vaccination, defined as an onset within 21 days after vaccination.[12]

Discussion

This study aimed to compare the incidence of SSNHL in the pre-pandemic and pandemic periods, based on the hypothesis that SARS-CoV-2 infection could be the potential cause behind an unexpected rise in the affluence of SSNHL cases in our daily clinical practice. Despite the absolute number of SSNHL cases being considerably higher during the pandemic period, there are no significant differences in the incidence of SSNHL between the 2 confronted periods. This might be due to the fact that during the COVID-19 lockdown period, presential activity was limited to urgent cases and patients were reluctant to visit public healthcare systems considering the risk of being infected by SARS-CoV-2. Therefore, we believe that the actual number of SSNHL cases during the COVID-19 pandemic might, in fact, exceed our findings.

Mustafa et al[6] reported that asymptomatic COVID-19 positive patients had significantly worse results in high frequency pure-tone thresholds and transient evoked otoacoustic emissions than non-infected subjects, proving that SARS-CoV-2 might have a detrimental impact on cochlear hair cell functions. Moreover, Fidan et al[8] detected an increased incidence of SSNHL during COVID-19 pandemic compared to the same interval of the previous year. Another study conducted by Parrino et al[13] analyzed the impact of the COVID-19 on the incidence of total acute audio-vestibular disorders, which includes SSNHL, combined acute cochlear and vestibular disorders, and pure vestibular impairments. There were no significant differences between the pandemic period and previous years when analyzing acute audio-vestibular disorders as a whole, but the incidence of SSNHL plus combined acute cochlear-vestibular involvement was significantly higher during the COVID-19 lockdown period.[13] However, there are also some contradictory findings in the literature. A study conducted in Israel concluded that there was a significant decrease in SSNHL's incidence during the pandemic,[14] whether Hafrén et al[15] suggested that there were no changes in the incidence of SSNHL when comparing the pandemic period with previous years. Regardless of these findings, we cannot ignore the severe limitations inherent to the lockdown periods and their impact on the daily function of healthcare systems, which could have affected these last results.

Most patients included in our sample referred associated tinnitus, which is congruent with the available scientific evidence.[2,16] Vertigo is a recognized poor prognostic factor in patients with idiopathic SSNHL[16] and was reported essentially in the pandemic period. One study even reported that mean pre-treatment PTA was 10 dB worse during the pandemic compared to previous years; however, these differences were not statistically relevant.[13] In our sample, there were no significant differences between both periods regarding PTA at admission and following treatment. Whether COVID-19-related SSNHL is associated with a more severe presentation of the disease remains yet to be determined.

In our study sample, magnetic resonance imaging was performed in 85.7% of confirmed cases in the pre-pandemic period, but only in 61.9% of patients during the pandemic. In this last period, 3 patients had a clear clinical contraindication and others refused imaging, but the remaining cases had no clear objection to perform a magnetic resonance evaluation. This difference might reflect the pressure hospitals were subjected to during this phase and the decreased presential outpatient visits, with significant losses in follow-up.

Patients admitted to our institution with SSNHL were not routinely tested for COVID-19. In fact, only 1 patient from our sample was tested for the presence of SARS-CoV-2 at the time of onset of the hearing loss. Thus, we cannot reassure that some of the confirmed cases from our sample did not have an underlying asymptomatic infection. Based on the current evidence, several authors have come to suggest that all patients presenting with SSNHL should be submitted to a nasopharyngeal swab polymerase chain reaction test to exclude infection by SARS-CoV-2.[13,16,17] In our sample, we found 2 confirmed cases of COVID-19-related SSNHL: one developed SSNHL 5 days after testing positive for SARS-CoV-2, while the other presented with hearing loss 3 months after being infected. A systematic review conducted by Meng et al,[2] analyzing 23 patients with COVID-19 related SSNHL, concluded that the time span between the confirmation of COVID-19 infection and beginning of the hearing loss varied between a few days to 2 months.[2] Therefore, although the first patient had a more explicit temporal cause–effect relationship, we cannot ignore a potential correlation between SARS-CoV-2 and development of SSNHL 3 months after.

One patient presented with SSNHL 5 days after testing positive for COVID-19, but only came to the emergency department 2 weeks after the onset of symptoms, delaying treatment strategies. This finding is consistent with the study conducted by Fidan et al,[8] where the interim between the onset of symptoms and medical observation was significantly longer in the pandemic than in the previous year. This gap might be responsible for decreasing the recovery rate of these patients.[8] The determination of COVID-19-related SSNHL is of paramount importance since it might alter treatment strategies. Systemic corticosteroids are considered the standard of treatment in patients with SSNHL[3]; however, conflicting evidence exists regarding its use in patients who test positive for SARS-CoV-2. The World Health Organization considers that the use of corticosteroids in COVID-19-positive patients may delay viral RNA clearance and increase disease's severity.[17] Nonetheless, some authors consider that the administration of low-dose corticosteroids in severe cases might even be beneficial and reduce mortality rate in ventilated patients.[18] Therefore, intra-tympanic administration of dexamethasone might be a suitable alternative in this subset of patients, considering that the systemic absorption is minimal reducing side effects.[18]

In our study, about half of the patients were already vaccinated for COVID-19 at the time of occurrence, preventing any reliable

conclusions regarding the weight of vaccination in SSNHL's incidence. One patient presented with SSNHL 1 day after receiving the second dose of the vaccine, while other developed symptoms within 20 days after his first inoculation. Several case reports have emerged documenting the occurrence of SSNHL in the days following COVID-19 vaccination. A study conducted by Jeong et al[19] described 3 cases of SSNHL that occurred within 3 days after inoculation, whereas Tsetsos et al[20] reported a case of SSNHL 2 days after the administration of the second dose of the Oxford–AstraZeneca COVID-19 vaccine. Nonetheless, single case reports lack the statistical power necessary to extrapolate valid conclusions, that can only be obtained by large-dimension studies and systematic reviews. A population-based cohort study suggested that the Pfizer–BioNTech COVID-19 vaccine seemed to be associated with a minor increased risk of SSNHL;[21] however, Formesteir et al[12] failed to identify any significant population-level correlation between COVID-19 vaccination and SSNHL.[12]

The present study has several limitations that could lead to an underestimation of the actual incidence of SSNHL during the pandemic. First, this is a retrospective study with a limited sample size, which can explain the lack of statistically significant differences between groups. Second, as mentioned previously, the limitations imposed by the pandemic contingency plan may have led to an underestimation of the number of cases of SSNHL during this period, since patients were reticent to come to large-dimension healthcare centers, decreasing the number of visits to emergency departments. This topic is plain when we analyze the delay to seek medical attention or even the losses in follow-up during this period. Finally, we only included the patients that were admitted to the emergency department with an SSNHL diagnose, but we did not consider inpatient care settings. For this reason, we must not ignore the possibility of existing patients that were hospitalized for other reasons, for example, COVID-19, and that developed SSNHL in the course of the disease. Nevertheless, it is highly unlikely that this fact would substantially influence our results since the great majority of patients with SSNHL are managed in an outpatient setting and do not require hospitalization.

Despite the absence of significant differences between groups, the incidence of SSNHL was higher during the pandemic than in previous years. This contrast might be even more accentuated if we consider the clear limitations inherent to the lockdown periods that could have led to an underestimation of our findings. This study attempted to bring some clarity regarding the impact of the COVID-19 pandemic on SSNHL's incidence. Coronavirus disease 2019-related SSNHL is increasingly recognized as a novel entity in the scientific community that demands a targeted approach. In the future, large-dimension studies are imperative to clarify the true impact of this viral infection on hearing function and optimize patient management.

Ethics Committee Approval: *The present study (protocol number: 50/22-12-2023) was approved by the Ethics Health Committee of Centro Hospitalar do Tâmega e Sousa on December 22, 2023.*

Informed Consent: *N/A.*

Peer-review: *Externally peer-reviewed.*

Author Contributions: *Concept – A.C., T.B., F.M., C.M., N.L.; Design – A.C., T.B., N.L.; Supervision – T.B., N.L.; Resources – ; Materials – A.C.; Data Collection and/or Processing – A.C.; Analysis and/or Interpretation – A.C., C.M.; Literature Search – A.C.; Writing –A.C., T.B.; Critical Review – T.B., F.M., C.M., N.L.*

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