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Coronavirus Pandemic

Impact of COVID-19 on the treatment outcomes of secretory otitis media

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Abstract

Introduction: The World Health Organization (WHO) officially lifted the global emergency designation for coronavirus disease 2019 (COVID-19) in May 2023. Nonetheless, the long-term repercussions of the pandemic—referred to as 'long COVID'—have persisted. It is also highly likely for the disease to be complicated by secretory otitis media (SOM). This study aimed to determine if there is anything particularly distinctive about SOM associated with long-COVID, and could it affect the therapeutic outcomes of the latter.

Methodology: A total of 102 patients diagnosed with COVID-19-associated SOM between December 2022 and May 2023 were retrospectively analyzed. Pre- and post-treatment pure-tone audiometry thresholds were assessed to evaluate therapeutic efficacy. Follow-up assessments were performed at 1, 3, 6, and 12 months' post treatment, and the findings were compared with those of a control group of 98 patients who had SOM but not COVID-19 infection during the same time frame.

Results: All patients showed normal hearing thresholds post treatment. A comparative analysis using a two-sample t-test revealed no statistically significant difference in the average speech-hearing thresholds between the two groups post-treatment ($t = 0.099$, $p = 0.92$). No recurrence was observed in either group during the year-long follow-up period.

Conclusions: Although COVID-19 is commonly associated with SOM, patients can expect satisfactory recovery of their hearing function with proactive treatment strategies.

Key words: COVID-19; SOM; secretory otitis media; deafness.

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Introduction

The novel coronavirus pneumonia (COVID-19) began to ravage the world in December 2019, inflicting immense suffering and incalculable losses on people worldwide [1]. By December 2022, the term 'novel coronavirus pneumonia' was officially changed to 'novel coronavirus infection' in China. The proportion of patients developing severe pneumonia post infection has been relatively low recently, with the majority presenting as asymptomatic or experiencing symptoms of upper respiratory tract infection [2,3]. Concurrently, with the implementation of the 'Category B, Class B' management policy, the otolaryngology outpatient department began to witness a significant influx of patients with secretory otitis media (SOM) associated with coronavirus infection. Given that this virus is a new pathogen with highly contagious properties, this study aimed to investigate whether the SOM it causes has peculiarities and whether it affects the therapeutic outcomes in the long term. A total of 102 cases of SOM associated with coronavirus infection confirmed by nucleic acid testing and otoendoscopy in the hospital between December 2022 and May 2023 were retrospectively analyzed to summarize and analyze the audiological characteristics, treatment efficacy, and long-term prognosis of SOM occurring with coronavirus. These cases were compared with 98 cases of SOM in the absence of coronavirus encountered during the same period. The patients were followed up for 1-year post treatment, and the findings are reported in the subsequent section.

Methodology

The Otolaryngology Head and Neck Surgery outpatient department at the hospital received 102 patients (61 men and 41 women; 106 ears) with SOM associated with COVID-19 infection from December 2022 to May 2023. SOM occurred in the right, left, and bilateral ears in 52, 46, and 4 patients, respectively. Ages ranged from 8 to 81 years, with an average of 38.2 ± 20.5 years, and a medical history of 1 day to over a week. During the same period, 98 patients (50 men and 48 women; 101 ears) with SOM not associated with COVID-19 were treated. SOM occurred in the right,

left, and bilateral ears of 49, 46, and 3 patients, respectively. Ages ranged from 15 to 53 years, with an average of 30.2 ± 10.4 years, and a medical history of 1 day to over a week was recorded. Each patient underwent thorough medical history inquiry, physical examination, otoendoscopy, tuning fork tests, Eustachian tube function tests, pure-tone audiometry, and acoustic immittance measurements. Before treatment, the air conduction (AC) and bone conduction (BC) pure-tone thresholds at 125, 250, 500, 1000, and 2000 Hz were measured, with 500, 1000, and 2000 Hz considered speech frequencies for calculating the pure-tone average (PTA) and air-bone gap (ABG). Post-treatment, pure-tone audiometry was re-evaluated using a MADSEN 922 audiometer (MADSEN, Copenhagen, Denmark) calibrated to zero according to national standards, and the results were compared with those of pre-treatment assessments to summarize and analyze the effects of the therapy. Both groups were followed up at 1, 3, 6, and 12 months to record recurrence rates.

Statistical analysis was performed using paired t-tests before and after treatment for each individual, with a significance level of $\alpha = 0.05$. Finally, the mean speech thresholds post-treatment for both groups were compared using independent sample t-tests, with a significance level of $\alpha = 0.05$, and all analyses were conducted using SPSS 26.0 software (IBM Corp, Armonk, NY, USA).

Case selection criteria

Patients diagnosed with SOM associated with COVID-19 infection confirmed by nucleic acid testing and otoendoscopy presenting with symptoms such as aural fullness, hearing loss, otalgia, and tinnitus; with pure-tone audiometry indicating conductive hearing loss and tympanometry revealing a type B or C tympanogram were included. Patients with SOM who tested negative for coronavirus were excluded from the study.

The exclusion criteria were (1) perforated tympanic membranes, (2) surgical treatment, (3) abnormal neoplasms in the nasopharyngeal region identified through nasal endoscopy, (4) concomitant systemic diseases or other significant organ diseases, (5) communication barriers, (6) comorbid psychiatric disorders, (7) pregnancy or lactation, and (8) incomplete clinical data.

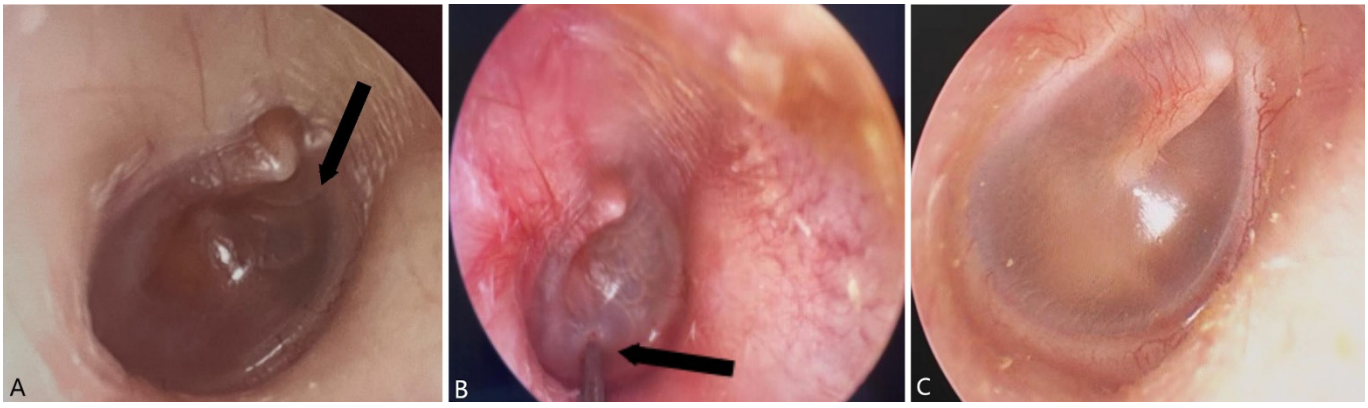
Treatment

All patients initially underwent a 14-day course of conservative medical treatment, and myringotomy was performed in cases where treatment was ineffective. The specific treatment protocol was as follows. The COVID-19-positive group included 92 patients who were cured within 14 days using the following medical treatments.

- Budesonide nasal spray: 64 μg per nostril, twice daily.
- Carbocisteine oral solution: 10 mL, three times daily.
- Amoxicillin capsules: 0.75 g, three times daily.

The remaining 10 patients who did not respond to the medical treatment within 14 days, underwent myringotomy (Figure 1). After routine disinfection of the external auditory canal and topical anesthesia, a size 5 long needle attached to a syringe was used to puncture the anteroinferior quadrant of the tympanic membrane. 5 mg sodium phosphate dexamethasone was injected into the middle ear cavity following complete aspiration of the effusion, and a 1-week follow-up appointment was scheduled to confirm recovery. In the COVID-19-negative group, 90 patients were cured within 14 days

Figure 1. Patients underwent myringotomy.



A: After conservative treatment, fluid was still visible in the middle ear cavity, with the fluid level indicated by the black arrow; **B:** After aspirating the middle ear effusion, sodium phosphate dexamethasone was injected into the middle ear cavity; **C:** Tympanic membrane post recovery.

of medical treatment, while 8 patients who did not respond underwent myringotomy.

Results

Pure tone audiometry

A retrospective analysis was conducted on 102 patients with SOM associated with COVID-19 who were treated and followed up in the outpatient department (Table 1). Post-treatment audiometric assessments revealed significant improvements in hearing. The mean pre-treatment air conduction (AC) PTA at the speech frequencies was 40.1 ± 10.4 dB HL, which improved to 20.9 ± 4.2 dB HL after treatment (t = 6.384, $p < 0.01$). The average ABG decreased from 24.8 ± 13.5 dB HL to 8.1 ± 7.6 dB HL (t = 6.508, $p < 0.01$). Figures 2 and 3 illustrate the comparative changes in AC thresholds at various frequencies before and after treatment in the two groups of patients.

Ninety-eight patients with SOM not associated with COVID-19, who were treated and followed up in the outpatient department, showed significant improvements in their audiometric assessments post-treatment. The mean pre-treatment AC PTA at speech frequencies was 38.9 ± 8.9 dB HL, which improved to 20.1 ± 4.5 dB HL after treatment (t = 10.165, $p < 0.01$). The ABG decreased from 22.9 ± 10.8 dB HL to 10.1 ± 3.8 dB HL (t = 8.116, $p < 0.01$).

A comparative analysis of the mean speech-hearing thresholds between the two groups after treatment using an independent sample t-test revealed no statistically significant differences (t = 0.099, $p = 0.92$). These findings indicate no discernible difference in hearing levels between the two groups following treatment.

Table 1. Comparison of clinical characteristics.

Clinical Characteristics	COVID-19 (+) group (n = 102)	COVID-19 (-) group (n = 98)	*p* value
Gender			0.27
Male	61	50	
Female	41	48	
Age (years)	38.2 ± 20.5	30.2 ± 10.4	0.12
Affected ear			0.61
Left	46	46	
Right	52	49	
Bilateral	4	3	

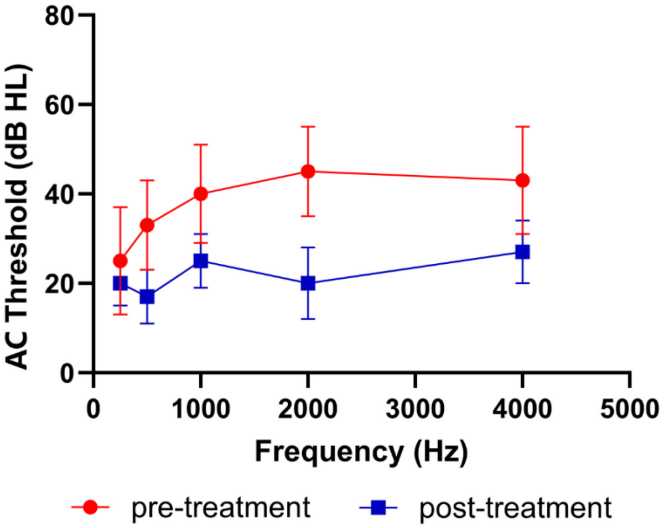
Acoustic conductance test

After treatment, of the 106 ears with SOM associated with COVID-19 infection, 83 had a type 'A' tympanogram, 9 had a type 'As' tympanogram, 11 had a type 'Ad' tympanogram, and 3 had a type 'B' tympanogram.

Of the 101 ears with SOM not associated with COVID-19 infection, 80 had a type 'A' tympanogram, 13 had a type 'As' tympanogram, 7 had a type 'Ad' tympanogram, and 1 had a type 'B' tympanogram.

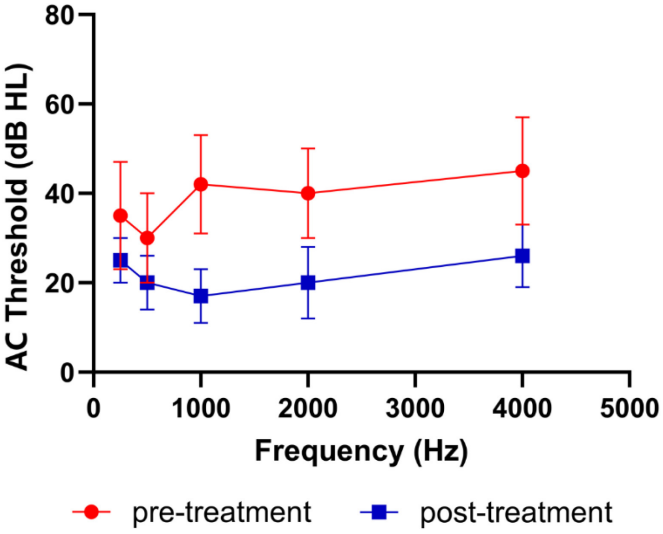
A comparison of post-treatment tympanogram patterns between the two groups showed no statistically significant differences (c2 = 3.2790, $p = 0.395$). Therefore, there was no conclusive difference in tympanogram type between the two groups. Both groups were followed up at 1, 3, 6, and 12 months, with no recurrence in either group.

Figure 2. Hearing changes in the COVID-19 positive group.



Changes in air conduction (AC) thresholds at various frequencies before and after treatment in 102 patients (106 ears) in the COVID-19 positive group.

Figure 3. Hearing changes in the COVID-19 negative group.



Changes in air conduction (AC) thresholds at various frequencies before and after treatment in 98 patients (101 ears) in the COVID-19 negative group.

Discussion

The etiological factors of SOM have not been clearly identified in clinical practice. SOM is believed to be associated with Eustachian tube dysfunction and infections [4–11]. Individuals infected with the novel coronavirus since December 2022 have predominantly exhibited symptoms of upper respiratory tract infections [2,3], such as mild-to-moderate fever, nasal congestion, rhinorrhea, dry throat, and sore throat. The nasal mucosa becomes congested and swollen after a viral infection, leading to nasal congestion. Viscous secretions further exacerbate the congestion and block posterior nasal apertures. At this point, air from the external ear cannot reach the middle ear through the Eustachian tube. Because the air in the middle ear is gradually absorbed, a relatively negative pressure environment develops, leading to transudation in the middle ear and slow accumulation of effusion. Additionally, owing to the discomfort caused by nasal symptoms such as congestion and rhinorrhea, patients frequently blow their noses forcefully. Under this pressure, the virus can invade the middle ear through the Eustachian tube, proliferating within the epithelial cells of the middle ear mucosa, destroying the lysosomal membrane, and causing cellular autolysis.

Concurrently, the virus can interrupt the intracellular substance and energy metabolism, reducing ciliary transport and ultimately leading to SOM development [12,13].

Considerable debate exists domestically and internationally regarding the treatment of SOM. Current recommendations advocate conservative treatment, such as regular medication and physical therapy, as the first choice. This study employed the same conventional therapeutic methods used for ordinary SOM to ascertain whether the novel coronavirus has any specific impact on the treatment and long-term prognosis of associated SOM. Budesonide nasal spray was used to improve nasal ventilation and restore the pressure balance between the middle ear and the external environment. Oral amoxicillin capsules were used to control potential bacterial infections. A carbocisteine oral solution was used to reduce the viscosity of the effusion in the tympanic cavity, increase its clearance rate, and reverse the metaplasia of the tympanic mucosa [14]. If conservative treatment was ineffective, further surgical interventions, as well as emerging endoscopic and Eustachian tube treatments [15], could be implemented. These approaches reduce surgical trauma and significantly improve safety and accuracy.

As a newly discovered virus, the novel coronavirus is more contagious and pathogenic than common respiratory viruses, and its disease course is longer. However, in this study, 102 patients with COVID-19 exhibited conductive hearing loss characteristics typically observed in SOM upon audiological examination, with AC thresholds in the speech frequency range falling within 40 dB and ABGs within 30 dB [16]. The mean AC PTA improved from 40.1 ± 10.4 dB HL to 20.9 ± 4.2 dB HL ($t = 6.384$, $p < 0.01$) after active conservative treatment, supplemented by necessary myringotomy and aspiration; and the average ABG decreased from 24.8 ± 13.5 dB HL to 8.1 ± 7.6 dB HL ($t = 6.508$, $p < 0.01$), achieving satisfactory therapeutic outcomes. The mean AC thresholds of speech frequency after treatment were compared between the COVID-19-positive and COVID-19-negative groups, with no statistically significant difference, indicating that there was no discernible difference in hearing levels between the two groups after treatment. Follow-up was continued for 1, 3, and 6 months, and 1-year post-treatment, with no recurrence in either group.

The focus of this study was to clarify the impact of the novel coronavirus on the treatment and long-term prognosis of SOM associated with it, using the same conventional treatment methods as for ordinary SOM, including drug treatment and myringotomy. Therefore, further testing and analysis of middle ear effusions were not conducted, which is a limitation of the present study. Other limitations were the relatively small sample size and follow-up time, which was statistically counted up to only 1 year.

Coronavirus infection, identified as a unique global event, is highly contagious and has been found to be easily complicated by SOM. It can manifest as symptoms such as tinnitus, aural fullness, and hearing loss, which can affect patients' quality of life and even increase their psychological burden. As the virus continues to spread and mutate, it is anticipated to continue to infect humans [17]. However, with prompt and appropriate treatment, the function of the Eustachian tube can be restored or improved, a pressure balance between the middle ear and the outside can be achieved, and the effusion in the middle ear can be cleared. This can restore patients' hearing function and improve their quality of life without adversely affecting the long-term prognosis of SOM. Considering that SOM is a long-term and chronic condition, further follow-up observations and statistical analyses with larger sample sizes are needed to verify the conclusions.

Conclusions

The novel coronavirus continues to spread and mutate, and it will continue to coexist with us in the long term. Very good results in restoring patients' hearing and improving their quality of life can be achieved with active treatment. However, this does not affect the long-term prognosis of SOM, and there is no need for panic.

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Compliance with ethical standards

Formal consent is not required for this type of study.

Authors contributions

XM: conceptualization, funding acquisition, writing—review and editing; TZ: data curation; QW: methodology, JD: resources; JZ: writing—original draft; WZ: writing—original draft. All authors have read and agreed to the published version of the manuscript.

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Conflict of interest

No conflict of interest is declared.

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