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Clinical and audiological aspects of individuals with sudden deafness post-COVID-19 in Manaus, Amazonas

Aspectos clínicos e audiológicos de indivíduos com surdez súbita pós-COVID-19 em Manaus, Amazonas

Aspectos clínicos y audiológicos de personas con sordera súbita post-COVID-19 en Manaus, Amazonas

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ABSTRACT

Objective: To describe the clinical and audiological aspects of four patients, who experienced episodes of tinnitus and unilateral deafness and sought medical attention during the COVID-19 pandemic in Manaus-AM. **Methods:** The audiological evaluation consisted of Pure Tone Audiometry, Logoaudiometry, Acoustic Immittance Measurements, Evoked Otoacoustic Emissions, and Brainstem Auditory Evoked Potentials. **Results:** The patients, 02 men, 01 woman and 01 child, aged range of 05 to 76 years, revealed in the audiological assessment, profound and moderate sensorineural hearing loss and one patient reported improvement in hearing after the treatment with corticoid. **Conclusion:** We present the clinical and audiological aspects of four patients with post-COVID-19 SSHL during the first pandemic in Manaus, with involvement ranging from profound to moderate and whose loss mechanisms are not known.

Keywords: Hearing, Audiometry, Sudden hearing loss, COVID-19, Brazil.

RESUMO

Objetivo: Descrever os aspectos clínicos e audiológicos de quatro pacientes que vivenciaram episódios de zumbido e surdez unilateral e procuraram atendimento médico durante a pandemia de COVID-19 em Manaus-AM. **Métodos:** A avaliação audiológica constou de Audiometria Tonal Liminar, Logoaudiometria, Medidas de Imitância Acústica, Emissões Otoacústicas Evocadas e Potenciais Evocados Auditivos de Tronco Encefálico. **Resultados:** Os pacientes, 02 homens, 01 mulher e 01 criança, com idade entre 05 e 76 anos, revelaram na avaliação audiológica, perda auditiva neurossensorial profunda e moderada e um paciente relatou melhora auditiva após o tratamento com corticóide. **Conclusão:** Apresentamos os aspectos clínicos e audiológicos de quatro pacientes com PANS pós-COVID-19 durante a primeira pandemia em Manaus, com acometimento variando de profundo a moderado e cujos mecanismos de perda não são conhecidos.

Palavras-chave: Audição, Audiometria, Perda auditiva súbita, COVID-19, Brasil.

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RESUMEN

Objetivo: Describir los aspectos clínicos y audiológicos de cuatro pacientes que experimentaron episodios de tinnitus y sordera unilateral y buscaron atención médica durante la pandemia de COVID-19 en Manaus-AM. **Métodos:** La evaluación audiológica consistió en Audiometría de Umbral Tonal, Logoaudiometría, Mediciones de Inmitancia Acústica, Emisiones Otoacústicas Evocadas y Potenciales Evocados Auditivos del Tronco Encefálico. **Resultados:** Los pacientes, 02 hombres, 01 mujer y 01 niño, con edades entre 05 y 76 años, revelaron en la evaluación audiológica hipoacusia neurosensorial profunda y moderada y un paciente refirió mejoría auditiva después del tratamiento con corticoides. **Conclusión:** Presentamos los aspectos clínicos y audiológicos de cuatro pacientes con PANS post-COVID-19 durante la primera pandemia en Manaos, con afectación que va de profunda a moderada y cuyos mecanismos de pérdida se desconocen.

Palabras clave: Audición, Audiometría, Pérdida auditiva súbita, COVID-19, Brasil.

INTRODUCTION

Sudden sensorineural hearing loss (SSHL) or sudden deafness is considered an otological emergency defined as a hearing loss greater than 30dB in at least three consecutive frequencies, characterized by the sudden installation or in a maximum time of up to 72 hours without any identifiable cause (PENIDO NO, et al., 2005; MENG X, et al., 2022). The main cause of SSHL is not clear, but the etiology may be viral infection, vascular insufficiency and autoimmune disease, neoplasia, stroke, and irradiation (YOUNG YH, 2020).

Different viral diseases, such as Lassa fever, herpes virus (Simplex, zoster, and varicella), mumps, HIV, mononucleosis, mycoplasma, cryptococcal meningitis, toxoplasmosis, syphilis, cytomegalovirus, rubella, adenovirus, and COVID-19 can cause SSHL (COMACCHIO F, et al., 1996; CUMMINGS D, et al., 1990; CHERN A, et al., 2021; RICCIARDIELLO F, et al., 2011; DEGEN C, et al., 2020).

The SARS-CoV-2 virus is responsible for several neurological manifestations and systemic complications, including auditory and vestibular symptoms, marked by tinnitus, dizziness, hearing loss, and SSHL (KALIYAPPAN K, et al., 2022; KORKMAZ MO, et al., 2021; TANG M, et al., 2023; BOBOSHKO MY, et al., 2022). The exact mechanisms by which SARS-CoV-2 affects the audio-vestibular system are unclear and the worldwide prevalence of SSHL associated with infection is still unknown (MENG X, et al., 2022; MCINTYRE KM, et al., 2021).

A review of case reports postulated that the pathophysiological mechanism of SSHL in COVID-19 can be associated with damage to the auditory center in the temporal lobe, changes in the functions of the microvascular structure of the inner ear, resulting in a thrombus or embolus that interrupts the blood flow to the inner ear and/or direct peripheral injury to sensory cells in the cochlea (UMASHANKAR A, et al., 2022).

Considering hearing loss as one of the clinical symptoms of COVID-19 infection, the relevance of its diagnosis and treatment for possible recovery, and enabling surveillance against the virus, all clinical symptoms of COVID-19 must be considered and studied (TANG M, et al., 2023). We present the clinical and audiological evaluations of four individuals who complained of sudden hearing loss. The audiological evaluation consisted of Pure Tone Audiometry, Logoaudiometry, Acoustic Immittance Measurements, Evoked Otoacoustic Emissions, and Brainstem Auditory Evoked Potentials.

METHODS

This is an observational case series study that describes the clinical and audiological characteristics of four individuals of both sexes, who complained of sudden hearing loss and sought medical attention during the COVID-19 pandemic in Manaus, Amazonas from May to October 2020 in the Fundação de Medicina Tropical Doutor Heitor Vieira Dourado (FMT-HVD). During this period, in Manaus, there were 59,724 confirmed cases and 9,944 deaths due to COVID-19 (FUNDAÇÃO DE VIGILÂNCIA EM SAÚDE, 2023) and the beta variant (Variant B.1.1.28) of SarS-Cov-2 was circulating (NAVECA FG, et al., 2021).

SarS-Cov-2 infection was diagnosed through qualitative detection of IgG class antibodies using rapid tests (immunochromatographic), carried out according to the manufacturer's instructions (SARS-CoV-2 antibody

test® by Wondfo) (AUSTRALIA BIOTECH, 2023) or by polymerase chain reaction carried out following a local hospital protocol based on WHO recommendations (CORMAN VM, et al., 2020).

The otorhinolaryngological and audiological evaluations were carried out in a private speech therapy clinic (Casa Caracol, Manaus, Brazil). Initially, an otorhinolaryngological evaluation and interview were carried out to investigate the clinical history covering symptoms, associated comorbidities, pre-existing diseases, previously performed hearing exams, family history and history of hearing loss. Ear canal inspection was performed using a Riester® Penscope otoscope to rule out the excess cerumen, which could compromise the audiological evaluation. Next, the individuals underwent complete audiological evaluation consisting of the following tests:

a) Tone Threshold Audiometry: the frequencies of 250Hz to 8KHz by air conduction, and from 500Hz to 4KHz by bone conduction, in an acoustic booth, with supra-aural headphones were evaluated in tonal audiometry, using the AD-629B audiometer (Interacoustics®). Hearing loss was classified according to the type according to Silman e Silverman (2017) in: i) conductive, bone conduction thresholds less than or equal to 15 dB HL and airway thresholds greater than 25 dB HL, with air-bone gap greater than or equal to 15 dB; ii) sensorineural, bone conduction thresholds greater than 15 dB HL and airway thresholds greater than 25 dB HL, with an air-bone gap of up to 10 dB HL, or iii) mixed, bone conduction thresholds greater than 15 dB HL and airway thresholds greater than 25 dB NA, with an air-bone gap greater than or equal to 15 dB.

As for the degree, it was classified according to the World Health Organization (2023) considering the average of the tonal thresholds of the frequencies of 500Hz, 1KHz, 2KHz and 4KHz (quadruple tone mean), as a limit of normality for the airway, 20dBHL. In logoaudiometry, the Speech Recognition Threshold (SRT) was investigated and patients with no or great difficulty in recognizing speech were evaluated regarding the Speech Detection Threshold (LDF). The SRT was performed with lists of three-syllable words and stipulated as LRF at the lowest intensity in which the subject correctly repeated 50% of the words presented (SISTEMA DE CONSELHOS DE FONOAUDIOLOGIA, 2017).

b) Impedance tests: tympanograms were performed, and the ipsilateral and contralateral acoustic reflexes were established, at the frequencies of 500 Hz, 1000 Hz, 2000 Hz, and 4000 Hz, using a 226 Hz probe in an immittance device model AT235 manufactured by Interacoustics. The curves were classified according to Jerger (1970) in: 1) Type A curve, with presence of tympanometric peak from +50 to -100daPa and volume from 0.3 to 1.65ml, suggestive of normal mobility of the tympanic system ossicular; 2) Type B curve, flat curve without admittance peak with pressure variation, suggestive of fluid in the middle ear and 3) Type C curve, shifted admittance peak to negative pressure at a value greater than -100 daPa, regardless of tympanometric height, suggestive of a tubal dysfunction.

The acoustic reflexes were performed with ipsilateral and contralateral stimulis, at frequencies of 0.5Hz, 1.0KHz, 2.0KHz and 4.0KHz. They were considered normal when present and triggered between 70 and 100 dB above the airway threshold (JERGER S, JAMES J, 1989). c) Transient Otoacoustic Emissions (TOAEs): were performed by transient stimulus at frequencies of 1.5KHz, 2.0KHz, 2.8KHz and 4.0KHz using the ILO equipment manufactured by Otodynamics, with click stimulus at an intensity of 75-83 dBpeSPL. TEOAE was considered present when the signal-to-noise ratio per frequency band was >3 dB for 1.5KHz and >6 dB for 2.0KHz, 2.8KHz and 4.0KHz.

Overall reproducibility considered was >50% and probe stability >70%. In the absence of these responses, absent otoacoustic emissions were considered. d) Distortion-Product Otoacoustic Emissions (DP-OAEs): were performed by two pure tones, with an f1 intensity of 65 dB SPL, and f2 of 55 dB SPL, with 2 f1-f2 ratios at frequencies of 2KHz, 3KHz, 4KHz, and 5KHz. Signal-to-noise ratio (SNR) values higher than or equal to 6 dB were considered as otoacoustic emissions.

e) Auditory Brainstem Response (ABR): was performed using a click stimulus, rarefied polarity, and speed of 27.7/sec, 100-3000 Hz filter with alternating polarity and 2000 stimuli by Eclipse 25 equipment from Interacoustics. Initially, the skin on the forehead and mastoids was cleaned with abrasive paste (Nuprep®) to remove oiliness and facilitate the attachment of surface electrodes. Insert Ear-Tone 3A earphones and

disposable surface electrodes (Meditrace) were used on the forehead Fz (active) and Fpz (ground) and on the right and left mastoids (M2 and M1). The electrode impedance was kept below 3Ω. For the examination, the patient was in natural sleep in a reclining chair. To research ABR, the click stimulus was used, by air conduction, at an intensity of 80 dBnHL, and the presence and absolute latencies of waves I, III and V, the interpeak intervals I-III, III-V and I-V and the interaural difference of the absolute latencies of waves V, according to normality values for the age group.

Two measurements were performed for each intensity evaluated, in order to verify the reproducibility of the waves. This research was approved by the Research Ethics Committee of the Tropical Medicine Foundation Doctor Heitor Vieira Dourado (CAAE nº 35663120.7.0000.0005, with approval number: 4.322.604). The participants and the mother's child who agreed with the participation signed the Free and Informed Consent Form after the due explanations regarding the objectives and procedures of the study.

RESULTS

Table 1 summarizes the clinical characteristics and **Table 2** describes the audiological findings of the research subjects. Among the cases, two were men, one woman and one child, age range of 05 to 76 years. No individual presents comorbidity. Symptoms were varied and included fever, myalgia, cough, coryzal, diarrhea, and taste dysfunction. Only one patient was hospitalized (case 1), who was admitted to an intensive care unit, without, however, requiring mechanical ventilation. None of the patients tested positive for HIV, syphilis or VDRL.

Hearing complaints were tinnitus and unilateral deafness. No changes were evident in magnetic resonance of inner ear and mastoid. The time from the onset of symptoms to auditory dysfunction varied between 02 to 60 days. The child had due to contact with infected adult in the same household. Audiological tests revealed profound (cases 1 and 4) and moderate (case 2) sensorineural hearing loss. Case 3 reported improvement in hearing after the treatment with corticoid.

Table 1 – Clinical characteristics of individuals with sudden deafness post-COVID-19.

Case	Age, sex	Symptoms	Time from symptom onset to hearing dysfunction (days)	PCR	Rapid Test (IgG) COVID-19	IgG Positive serology results	Hearing complaints
1	56y, M	Fever, myalgia, diarrhea and taste dysfunction	02	POS	POS	CMV, Herpes, Rubella, Toxo, Adeno, Mumps	Tinnitus and deafness in the left ear
2	76y, F	Fever, dysfunction of smell and taste	60	NR	POS	CMV, Herpes, Toxo, Adeno, Mumps	Deafness in the left ear
3	46y, M	Fever, cough, myalgia, dyspnea and taste dysfunction	20	NR	POS	CMV, Herpes, Rubella, Toxo, Adeno, Mumps	Tinnitus and deafness in the right ear
4	05y, M	Coryzal and diarrhea	03	NR	POS	CMV, Rubella, Adeno, Mumps	Deafness in the left ear

Legend: y=years, M=male, F=female, NR= not carried out; PCR= polymerase chain reaction, POS= positive, NEG= negative, CMV= cytomegalovirus, IgG= immunoglobulin G, IgM= immunoglobulin M, Toxo= toxoplasmosis, Adeno= adenovirus.
Source: Dantas ANM, et al., 2024.

Table 2 – Audiological findings in individuals with sudden deafness post-COVID-19, Manaus – AM.

ID	PTA	SRT/SDT	TIMP	AR	TEOAE	DPOAE	ABR	Summary of findings
1	RE: AC:0,25:25 / 0,5:20 / 1K:20/ 2K:15/ 3K:20/ 4K:35/ 6K:30/ 8K:40 BC:0,5:NR/ 1K:NR/ 2K:NR/ 3K:NR/ 4K:35. LE: AC:0,25:85/ 0,5:90/ 1K:95/ 2K:95/ 3K:95/ 4K:100/ 6K:100/ 8K:Abs. BC:0,5:Abs/ 1K:Abs/ 2K:Abs/ 3K:Abs/ 4K:Abs.	RE: 25dBNA (SRT) LE: 85dBNA (SDT)	RE: A LE: A	RE: P LE:Abs	RE: P LE:Abs	RE: P LE:Abs	RE: Nl LE:Abs	RE: Sensorineural Hearing Loss in high frequencies (4 to 8KHz). LE: Profound Sensorineural Hearing Loss
2	RE: AC:0,25:20/0,5:20/ 1K:15/ 2K:20/ 3K:35/ 4K:30/6K:45/8K:65 BC:0,5:NR/ 1KNR/ 2K:NR/ 3K:35/ 4K:30.			RE: P	RE: P		RE: Nl	RE: Sensorineural Hearing Loss in

	LE:AC:0,25:55/ 0,5:55/ 1K:55/ 2K:50/ 3K:55/ 4K:55/ 6K:65/ 8K:70. BC:0,5:55/1K:50/2K:45/ 3K:55/4K:55.	RE: 20dBNA (SRT) LE: 60dBNA (SRT)	RE: A LE: A	LE: Abs	LE: Abs	RE: Abs LE: Abs	LE: Abs	high frequencies (3 to 8KHz). LE: Moderate Sensorineural Hearing Loss.
3*	RE: AC:0,25:10/0,5:10/ 1K:15/ 2K:15/ 3K:25/4K:35/6K:30/ 8K:15 BC:0,5:NR/1K:NR/2K:NR/ 3K:NR/4K:35. LE: AC:0,25:10/ 0,5:15/ 1K:10/ 2K:5/ 3K:20/ 4K:40/ 6K:35/ 8K:10 BC:0,5:NR/1K:NR/ 2K:NR/ 3K:NR/ 4K:40.	RE: 15dBNA (SRT) LE: 15dBNA (SRT)	RE: A LE: A	RE: P LE: P	RE: P LE: P	RE: P LE: P	RE: Nl LE: Nl	RE: Sensorineural Hearing Loss in high frequencies (4 and 6KHz). LE: Sensorineural Hearing Loss in high frequencies (4 and 6KHz).
4	RE: AC:0,25:15 /0,5:10 / 1K:15/ 2K:10/ 3K:10/4K:05/6K:10/ 8K:05 BC:0,5:NR/ 1K:NR/ 2K:NR/ 3K:NR/ 4K:NR. LE: AC:0,25:85/ 0,5:90/1K:95/ 2K:95/3K:95/4K:100/6K:95/8K:95 BC:0,5:Abs/ 1K:Abs/ 2K:Abs/ 3K:Abs/ 4K:Abs.	RE: 15dBNA (SRT) LE: 85dBNA (SDT)	RE: A LE: A	RE: P LE: Abs	RE: P LE: Abs	RE: P LE: Abs	RE: Nl LE: Abs	RE: Auditory thresholds in normal pattern. LE: Profound Sensorineural Hearing Loss.

Legend: * At the time of the audiological assessment the patient already had improved hearing.PTA: Pure tone audiometry; RE: Right ear; LE: Left ear; AC: Air-conduction; BC: Bone-conduction; NR = Not researched; SRT: Speech recognition threshold; SDT: Speech detection threshold; Timp: Timpanometry; A: type A tympanometric curve ; C: type C tympanometric curve; AR: Acoustic reflex; P: present; Abs: absence of response; TEOA: Transient evoked otoacoustic emissions; DPOAE: Distortion product otoacoustics emissions; ABR: Auditory brasinterm response with click; Nl: absolute latencies of waves I, III and V and values of interpeaks latencies within the normal range; Al: absolute latencies of waves I, III and V increased of values of interpeak latencies.
Source: Dantas ANM, et al., 2024.

DISCUSSION

Viral infections can cause congenital or acquired, unilateral or bilateral hearing loss (COHEN BE, et al., 2014). Viruses can cause sudden hearing loss in acute infection, but the latent form, with possible viral reactivation, has also been considered in the mechanism of aggression to the cochlea (LAZARINI PR, CAMARGO AC, 2006). A growing body of scientific evidence suggests a possible relationship between COVID-19 and sudden hearing loss (RICCIARDIELLO F, et al., 2011; DEGEN C, et al., 2020; LAMOUNIER P, et al., 2020; CHERN A, et al., 2021; KALIYAPPAN K, et al., 2022; UMASHANKAR A, et al., 2022).

In Brazil, the first case of SSHL was reported in November 2020, the patient presented sudden hearing loss in the right ear and disabling tinnitus (LAMOUNIER P, et al., 2020). In the present study, we reported hearing changes in four patients diagnosed with COVID-19. All patients presented episodes of unilateral sudden hearing loss and two patients (cases 1 and 3) presented tinnitus.

Pure Tone Audiometry, Logoaudiometry, Acoustic Immittance Measurements, Evoked Otoacoustic Emissions, and Brainstem Auditory Evoked Potentials were done to evaluate the sudden deafness post-covid-19. The type and degree of hearing loss were assessed by pure tone audiometry. All patients presented profound and moderate sensorineural hearing loss, thus demonstrating variable impairment, the degree of which appears to be independent of the time from symptom onset to hearing dysfunction.

In Acoustic Immittance Measurements, about tympanometry, all patients had type A tympanograms (suggestive of normal middle ear) in both ears. Three patients (cases 1, 2 and 4) had absence of acoustic reflexes in one ear, and had no responses in the TEOAE and in ABR in this same ear. These findings audiological demonstrated a greater degree of impairment in the ear wich patients refered the sudden deafness.

The mechanism of auditory impairment in SARS-CoV-2 infection is not well known. However, it may be related to 1- adhesion of the virus to angiotensin-converting enzyme 2 (ACE2) receptors in sensory cells and neurons and their involvement and 2- changes or failure in the speed of coagulation with thrombosis. occlusion of the cochleovestibular artery or one of its afferent vessels (SINDHAR S, LIEU JE, 2021).

This causes transient SSHL, tinnitus, and dizziness and increases the possibility of damage to the hair cells of the inner ear, which can cause stress and an increase in the concentration of reactive oxygen species due

to transient hypoxia in the cochlea (VIOLI F, et al., 2020). The individual effects are not well described in the literature or in the present study, although we showed different degrees of involvement three patients (cases 1, 2 and 3) presented bilateral involvement, although unilateral sudden sensorineural hearing loss is the most common hearing loss reported (POKHAREL S, et al., 2021; TAN M, et al., 2022; MUSTAFA MW, 2020; SWAIN SK, et al., 2021).

However, it is interesting to consider the more advanced age of adult patients (cases 1, 2 and 3) who presented bilateral hearing loss even though they reported complaints in only one ear. The battery of tests performed in this study demonstrated hearing loss in the higher frequencies in the ear where the patient did not report hearing complaints. This can be explained by the common age-related hearing loss that happens predominately at higher frequencies (HOMANS NC, et al., 2017).

Sensorineural Hearing Loss is responsible for around 45% of unilateral in children and has a variety of etiologies, including genetic, autoimmune and infectious (SINDHAR S, LIEU JE, 2021). Various viral infections can cause hearing loss, including cytomegalovirus (CMV), herpes simplex virus (HSV) types 1 and 2, human immunodeficiency virus (HIV), mumps, rubella, varicella-zoster virus and ZV infections (COHEN BE, et al., 2014).

Other viral infections like SARS-CoV-2 may cause sudden sensorineural deafness by directly invading cells of the nervous system (VIOLI F, et al., 2020). Case series described most infections in children due to contact with an infected adult in the same household (LIGUORO I, et al., 2020; WU Q, et al., 2020). In this study, the child (case 4) presented unilateral sensorineural hearing loss and had due to contact with infected adults in the same household.

The long-term outcomes of the four patients in this study were not evaluated, although patient 3 at the time of evaluation reported hearing improvement. The patient in question was evaluated after treatment with corticosteroids. Patients with sudden sensorineural hearing loss treated with prednisolone reported partial improvement in hearing (KOUMPA FS, et al., 2020; LANG B, 2020) or complete recovery, with only vestibular symptoms such as tinnitus, dizziness and vertigo persisting (LITTLE C, COSETTI MK, 2021).

This fact suggests that, as shown in other studies, in addition to reducing death and hospitalizations (WAGNER C, et al., 2021), corticosteroid therapy can reduce hearing loss. This study has limitations inherent to the study design. Despite the small sample, a complete audiological assessment was carried out with all the tests necessary for an audiological diagnosis. To date, there have been no studies on hearing and COVID-19 in Amazonas.

CONCLUSION

In conclusion, we present the clinical and audiological aspects of four patients with post-COVID-19 SSHL during the first pandemic in Manaus, the epicenter of the pandemic in Brazil. The patients presented involvement ranging from profound to moderate and whose loss mechanisms are not known. Better studies to uncover how such changes occur and are related to the SarS-CoV-2 virus and how to intervene to improve symptoms must be carried out.

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