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AUDIO-VESTIBULAR SYSTEM INJURY IN CORONAVIRUS DISEASE 2019

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Abstract. *Coronavirus disease 2019 is a pandemic disease, which commonly presents with fatigue, loss of smell, fever and ground-glass opacities on diagnostic imaging of the lungs. After the first few months of the pandemic, we noticed a tendency for audio-vestibular complaints on out-patient visits post-hospitalization for COVID-19.* ***Objective.*** *The aim of this study was to study the prevalence of audio-vestibular complaints in COVID-19.* ***Materials and methods.*** *This study included 57 patients with audio-vestibular complaints during and after hospitalization for COVID-19 at University Hospital Kaspela in Plovdiv, Bulgaria. The patients underwent both auditory and vestibular tests, as well as a computed tomography of the cranial brain.* ***Results.*** *The ratio of males to females was 1,35:1, with most belonging to the age group of 51 to 70 years (63,2%). All 57 patients had sudden hearing loss – unilateral in 36 (63,2%) and bilateral in 21 (36,8%), while 17 patients (29.8%) additionally had subjective tinnitus. Forty-eight patients (84,2%) had vestibular complaints – general dizziness in 46 (95,8%) and rotatory vertigo in two (4,2%). Two patients had spontaneous nystagmus (3,5%), 43 (75,4%) – saccades, and 25 (43,9%) – smooth pursuit and gaze disturbances. Romberg with closed eyes was positive in two patients (3,5%), and Fukuda lateralized to the healthy ear also in two patients (3,5%). Dix-Hallpike was positive in one patient (1,8%). The video head-impulse test was positive in two patients (3,5%). Vascular encephalopathy was found on computed tomography in 33 patients (57,9%).* ***Conclusions.*** *Coronavirus disease 2019 may be associated with vestibulocochlear nerve damage, and in most cases, it is an isolated injury to the auditory nerve. Complaints of dizziness are most likely due to vascular changes in the central nervous system.*

Key words: *hearing loss, tinnitus, vertigo, coronavirus, COVID-19, SARS-CoV-2*

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INTRODUCTION

Coronavirus disease 2019 (COVID-19), caused by the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), was officially declared a global pandemic by the World Health Organization on the 11th of March, 2020. The disease, which can manifest in a variety of ways, can additionally show great variability in severity and duration. Eighty-one percent of patients develop a mild disease with the clinical presentation of fever, fatigue, dry cough, ground-glass opacities and pneumonia on diagnostic imaging of the lungs. Severe and critical cases present with dyspnea and acute respiratory distress syndrome, respectively. Some infected patients, especially children and young adults, remain

asymptomatic [1]. The disease course of COVID-19 may be acute (lasting up to 4 weeks), ongoing (lasting 4-12 weeks), or lasting more than 12 weeks – long COVID-19.

Similarly to most of the world, the SARS-CoV-2 infection began its spread in Bulgaria at the beginning of 2020, with official announcement of the pandemic situation in March of the same year. As the number of COVID-19 patients increased, so did the number of hospitalizations, reaching 10,649 out of 68,977 active cases on 5 April, 2021, which is 15.4% [2]. This placed additional stress on medical workers, already found to be experiencing high levels of stress and burn-out syndrome [3].

For the period from March 2020 to October 2021, a total of 2017 patients were treated for COVID-19 at University Hospital Kaspela, Plovdiv, Bulgaria, from which a total of 1440 patients attended follow-up appointments. After the first months of the pandemic, a clear tendency for audio-vestibular complaints was discovered on out-patient visits post-hospitalization for COVID-19, encouraging us to examine the phenomenon scientifically.

AIM OF THE STUDY

The aim of this study was to study the prevalence of audio-vestibular complaints in COVID-19.

MATERIALS AND METHODS

The study included 57 patients who had audio-vestibular complaints during and after hospitalization for COVID-19 at University Hospital Kaspela in Plovdiv, Bulgaria. The patients underwent a battery of both auditory and vestibular tests. The auditory tests included otoscopy and audiometry. The vestibular tests included spontaneous nystagmus and coordination (Finger-to-nose test) testing, the Romberg, Fukuda and Babinski-Wail gait tests, Dix-Hallpike maneuver with Frenzel goggles and videonystagmography (VNG). In addition, a computed tomography of the cranial brain was performed in all patients.

The study was performed after receiving approval of the Institutional Ethics Committee and patient informed consent, and in accordance with the principles of the Declaration of Helsinki. The statistical program Microsoft Excel 2013 (Microsoft Corporation, Redmond, Washington, U.S.) was used to analyze the data.

RESULTS

The ratio of male to female patients was 1,35:1 (27 males : 20 females). The average duration of in-patient non-intensive care treatment for COVID-19 was 7.2 days. The distribution by age of the patients with audio-vestibular complaints showed that most were in the age group of 51 to 70 years (63,2%) (Figure 1). The youngest patient was 27 years old, while the oldest one – 77 years old.

Auditory complaints

All of the 57 patients included in the study complained of sudden hearing loss – unilateral in 36 (63,2%) and bilateral in 21 (36,8%) patients. In three of the patients (5,3%), the symptoms were reported up to the 3rd day post discharge, in 12 patients (21,1%) up to the 10th day post discharge, and in 42 patients (73,7%) – after the 10th day – between 48 and 92 days after the first positive PCR test for SARS-CoV-2. Subjective tinnitus was observed in a total of 17 patients (29.8%) – in nine of those with unilateral hearing loss (25%), and in eight with bilateral hearing loss (38,1%). Only two of the patients with tinnitus had bilateral tinnitus (28%). None of the studied patients reported otalgia.

Auditory testing

The largest group of patients fell in the group of 71-90 dB thresholds on pure tone audiometry (43,9%) (Figure 2). Only two patients had a hearing loss threshold of above 90 dB (3,5%) – both in cases of unilateral neuritis.

Otoscopy was unremarkable in all patients.

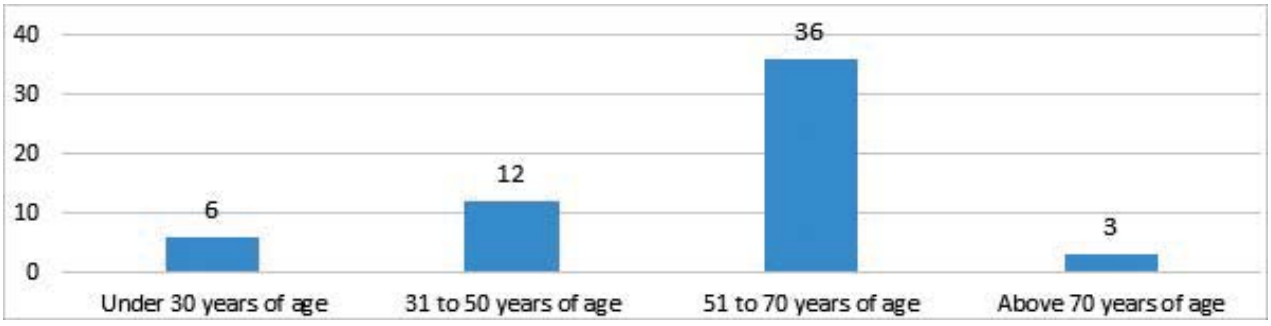


Fig. 1. Distribution by age of the patients with audio-vestibular complaints related to COVID-19

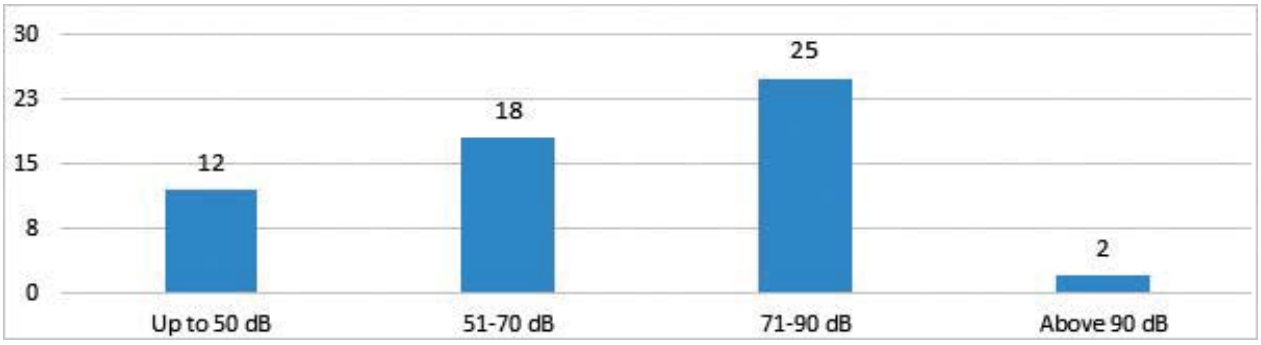


Fig. 2. Distribution by hearing thresholds on pure tone audiometry of patients with audio-vestibular symptoms related to COVID-19

Vestibular complaints

Forty-eight of the 57 patients (84,2%) with auditory complaints had vestibular complaints at presentation. Forty-six of them (95,8%) complained of a general dizziness, while two patients (4,2%) described their symptoms differently, in line with rotatory vertigo.

Vestibular testing

Spontaneous nystagmus was observed in only two patients (3,5%). Saccades were found on examination in 43 patients (75,4%), while smooth pursuit and gaze disturbances were observed in 25 patients (43,9%). Dysmetria in coordination testing was observed in 53 patients (57,9%). Romberg testing with open eyes was negative for all patients and positive when tested with closed eyes in two patients (3,5%). Fukuda testing lateralized to the healthy ear in two patients (3,5%), while in the rest it was symmetric. Ataxic Babinski-Wail gait was observed in 28 patients (49,1%). The Dix-Hallpike maneuver was positive in one patient (1,8%). The video head-impulse test (VNG-HIT) was positive in two patients (3,5%). The nine patients (15,8%) without vestibular complaints, had non-pathologic results from the vestibular tests.

Computed tomography

Vascular encephalopathy was found to a varying degree in 33 patients (57,9%), all from the group 51-70 years of age. In the rest of the patients, no cerebral pathology that could be associated with audio-vestibular symptoms was found on computed tomography.

DISCUSSION

Coronavirus disease 2019, caused by SARS-CoV-2, has proven to be a far-reaching disease, affecting numerous systems of the human body, including the audio-vestibular system. Our results show that audio-vestibular complaints in COVID-19 predominately occur in adults of middle age, with a slight predilection to males. We postulate that this may be caused by the more severe disease course among adults in this age group, especially as it pertains to hospitalization for treatment of COVID-19.

While our study specifically examined audio-vestibular injury in relation to hospitalization for COVID-19, Mustafa et al. discovered that even asymptomatic COVID-19 PCR-positive cases show reduced amplitudes of transient evoked otoacoustic emissions [4]. Thus, auditory injury may be much more common than previously thought, as well as related to disease severity. For example, Munro et al. found that more than 1 in 10 patients self-report a change in their hearing status post-hospitalization for COVID-19 eight weeks after discharge [5]. The results of our study show a much lower percentage for hearing loss – 4,0%, but it was objectively confirmed by pure-tone audiometry, not only self-reported. Additionally, we found that slightly less than a third of our patients had tinnitus, which was purely subjective and could not be further studied.

Important for understanding the function of the vestibular division of the vestibulocochlear nerve is vertigo. According to Almufarrij et al., vertigo has an estimated prevalence of 7.2% in COVID-19 patients, with many researchers using the symptoms vertigo and dizziness interchangeably [6]. We studied the two separately and discovered that dizziness is 24 times more commonly reported. It is important to mention that, as Piker and Jacobson have found, it is difficult for people to differentiate accurately between the symptoms of dizziness, vertigo and unsteadiness [7]. A thorough discussion with patients, explaining the differences, is paramount for accurate study of vestibular complaints.

Our study found that in most patients with vestibular complaints, the damage to the auditory nerve prevailed over damage of the vestibulocochlear nerve in its entirety. Only the two patients, who had rotatory vertigo, showed peripheral damage to the vestibular system – presence of spontaneous nystagmus,

positive Romberg test, Fukuda lateralization to the healthy ear, positive VNG-HIT. Out of these two patients, one had a positive Dix-Hallpike test, diagnosing benign paroxysmal positional vertigo. The other patient with rotatory vertigo was diagnosed with neuritis of the vestibulocochlear nerve in its entirety. We can deduct from this that in our series of patients, the vestibulocochlear nerve was affected by SARS-CoV-2 in its entirety in only one patient.

The computed tomography of the cranial brain in our series of patients found that the majority were affected by vascular encephalopathy, and most importantly, it also excluded other pathology that could lead to audio-vestibular complaints. The high prevalence of vascular encephalopathy could once again be attributed to the prevailing age of our patients, but may also be caused by vascular changes caused by the virus itself.

The mechanism of spread of SARS-CoV-2 into the central nervous system, and audio-vestibular system in particular, is not completely understood. While some have postulated the spread of SARS-CoV-2 into the nervous system through the olfactory nerve and bulb, linking olfactory and audio-vestibular symptoms, others have considered the hematogenous spread of the virus to the brain, medulla oblongata and auditory system using angiotensin-converting enzyme 2 (ACE2) receptors in glial cells and neurons [6, 8]. On the other hand, many authors agree on the inflammatory effects of the virus as the type of injury caused, with some even directly mentioning the effect on the audio-vestibular system [9, 10, 11]. Further studies are needed to understand the specific effects of SARS-CoV-2 on the audio-vestibular system, including by different SARS-CoV-2 variant and patient vaccination status.

While prevention of infection with SARS-CoV-2 is the primary goal in avoiding audio-vestibular injury caused by the virus, possibilities for prevention of audio-vestibular injury during and post-infection need to be studied to aid in the efforts of tertiary prevention.

CONCLUSIONS

Coronavirus disease 2019 may be associated with vestibulocochlear nerve damage, and in most cases, it is an isolated injury to the auditory nerve. Complaints of dizziness are most likely due to vascular changes in the central nervous system.

Disclosure Summary: *The authors have nothing to disclose.*

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