



Long-term Follow-up Results of Tinnitus and Dizziness Disorders in Patients after SARS-CoV-2 Infection Based on a Questionnaire

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To the Editor,

The effects and pathological changes of severe acute respiratory syndrome-coronavirus 2 (SARS-CoV-2) on hearing and balance are still under investigation. However, only a few studies have reported neurological findings such as impaired headache, consciousness, and dizziness.¹ This study aimed to investigate the association of dizziness and subjective tinnitus in patients with coronavirus disease 2019 (COVID-19) from an online and face-to-face three-stage questionnaire survey caused by the COVID-19 pandemic about two years follow-up in the ENT clinic.

The study included patients with vertigo and dizziness and positive polymerase chain reaction (PCR) nasopharyngeal/oropharyngeal swab for SARS-CoV-2. All data were collected between April 1, 2020, and December 31, 2021, using a researcher-designed online three-staged questionnaire survey. The exclusion criteria were as follows: aged <18 years, intensive care unit hospitalization due to COVID-19, subjective hearing loss, previous ear surgery, audiological pathologies, acoustic trauma, psychiatric and cardiovascular comorbidities, and medical treatment with ototoxic drugs. This study used three questionnaires in three sections: stages: *Tinnitus Handicap Inventory* scores (THI), in which Dr. Aksoy's Turkish version of Newman's questionnaire was used in the study;^{2,3} *features of tinnitus and dizziness* in which author-designed questionnaire in Turkish version was used; and the *visual analog scale* (VAS). We used this score to measure tinnitus and dizziness severity subjectively.⁴

Demographic and other information about the patients were collected. All three questionnaires were translated into Turkish, and their modified Turkish versions were used. Moreover, the question-answer discussion was held in Turkish. Consent was obtained from

all potential study participants for the use of anonymized response data. The questionnaire was administered to 370 patients 30-90 days after the diagnosis of COVID-19 between January 1, 2020, and December 31, 2021.

Statistical analyzes were performed using SPSS Statistics for Windows version 18.0 (SPSS, Chicago, IL, USA). Continuous variables are presented as means \pm standard deviation (SD), whereas discrete variables are presented as numbers and percentages. P -value <0.05 was considered statistically significant.

We evaluated 572 patients with vertigo and tinnitus. Following the screening, the study enrolled only 370 patients with polymerase chain reaction (PCR)-positive nasopharyngeal/oropharyngeal swabs for SARS-CoV-2 30-90 days from enrollment, i.e., from January 1, 2020, to December 31, 2021, with a total of 24 months follow-up. Of the patients, 194 (52.4%) were women, and 176 (47.6%) were men. The mean age was 41.78 (SD \pm 11; median 42; ranged, 18-78) years. Moreover, 75 (20.3%) patients, which included 32 men and 43 women, reported dizziness after the PCR-positive diagnosis for SARS-CoV-2. Of these patients, 71 (94.6%) experienced dizziness, and 4 (5.3%) had acute benign positional paroxysmal vertigo attacks (Figure 1). The mean total VAS score for dizziness was 4.

Of the 370 patients, 93 (25%; 44 (47.3%) women and 49 (52.7%) men) experienced tinnitus after SARS-CoV-2 PCR diagnosis. The characteristics of tinnitus are shown in Figure 2. For tinnitus, the mean VAS score was three. All patients had an average score of 55 on the THI questionnaire; although tinnitus is subjectively noticed in the background noise, daily activities are still feasible.

Viral factors are among the causes of hearing loss, and most of which, by unknown mechanisms, may affect the cells of the inner ear and



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the auditory brainstem. COVID-19 accompanied by neurotological symptoms such as balance disorders and tinnitus have been reported in the literature. SARS-CoV-2 affects the central nervous system by causing vasculitis or vasculopathy, similar to varicella zoster and human immunodeficiency viruses. Moreover, recent studies have reported that SARS-CoV-2 causes disorders of the peripheral and central nervous system and blood circulation by inducing causing hypercoagulation. Inner ear structures are susceptible to ischemia; therefore, vasculitis and vascular circulation pathologies such as hypercoagulation can cause hearing changes and balance disorders. Moreover, compulsory and uncontrolled bed rest at home and long-

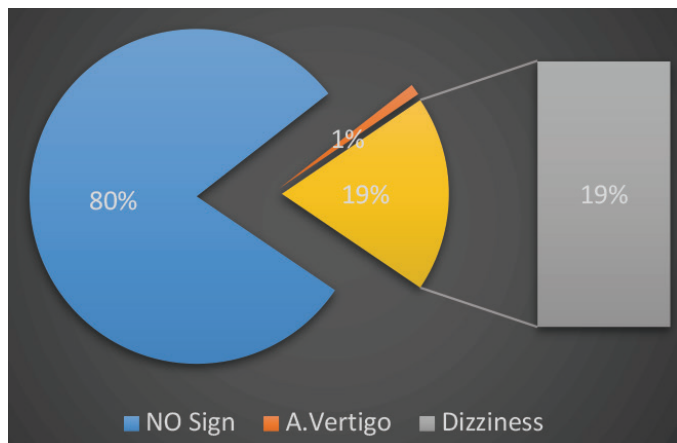


FIG. 1. Vertigo and dizziness in our sample after COVID-19 PCR positive leading group.

COVID-19, coronavirus disease-19; PCR, polymerase chain reaction.

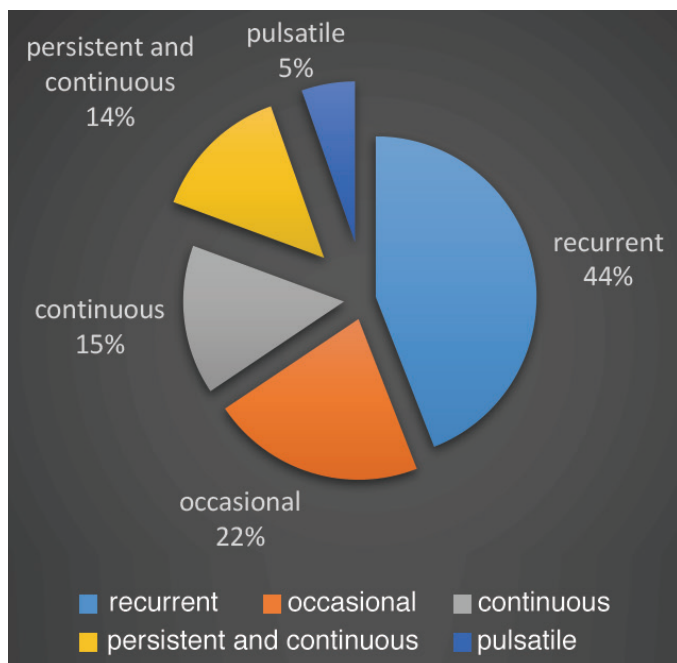


FIG. 2. Characters of tinnitus in our sample after COVID-19 PCR positive leading group.

COVID-19, coronavirus disease-19; PCR, polymerase chain reaction.

term hospitalization may cause otolith detachment and subsequently benign positional paroxysmal vertigo attacks or dizziness disorders in patients with COVID-19. Studies on COVID-19 accompanied by audiovestibular symptoms are limited in the literature, and the mechanism of action and incidence are unknown.⁵⁻⁷ Therefore, further research is needed on the relationship between COVID-19 and audiovestibular manifestations.

We think that our study is one of the first studies to show the relationship between subjective neurotological symptoms such as balance disorders and tinnitus in patients with COVID-19. The results will be an addition to the literature and guide other studies. The present study differs from other studies because it included many patients, and the screening and follow-up continued for 2 years.

Although our study had many advantages, it also had limitations. First, the patients were not clinically evaluated properly in the ENT department (otoscopy and audiovestibular examination). Thus, we cannot distinguish between central or peripheral dizziness, psychological factors, and objective and subjective tinnitus. Second, as regards the COVID-19 treatment protocol, we do not know the drugs' differential kinetic and pharmacodynamic effects on the virus itself, body, brain, and auditory system.

The results of this study, which were based on a large-scale patient data, revealed that COVID-19 causes subjective neurotological symptoms such as balance disorders and tinnitus. However, further studies are needed to know the long-term neurotological mechanisms of action of SARS-CoV-2 and the actual frequency of hearing problems and balance impairment and investigate the progression into possible chronic conditions.

Ethics Committee Approval: Ethical approval was obtained from the scientific Research Ethics Committee of The Catholic University of The Korea, College of Medicine (EKOL-AA01-15082021).

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

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