Annals of Clinical and Analytical Medicine
Original Research

Evaluation of the effect of COVID-19 on static balance in healthy young individuals

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This study was presented as an oral presentation at the I. Internatıonal Boğaziçi Scıentific Research Congress, Istanbul, Turkey, 2023

Abstract

Aim: It is known that COVID-19 infection has various physiological effects. And, it also has negative effects on the balance. This study focused on evaluating the static balance of healthy individuals who either had or did not have a history of COVID-19.

Material and Methods: The study included 30 individuals who were previously diagnosed with COVID-19 infection (positive PCR test), who recovered later on, and 30 individuals as a control group. After the dominant foot of both groups was determined, the flamingo balance test was used to evaluate static balance, and Dizziness Handicap Inventory (DHI) was applied to the group that had a COVID-19 infection history.

Results: A significant difference was found between dominant foot balance and non-dominant foot balance in individuals who had COVID-19 and in the control group.

Discussion: The severity of recent cases of COVID-19 disease that affect the balance system has risen significantly. This study showed that individuals with COVID-19 have problems with static balance compared to those without COVID-19. In our estimation, post-recovery rehabilitation programs for people who have had COVID-19 should include balancing exercises.

Keywords

COVID-19, Static Balance, Dizziness Handicap Inventory, Flamingo Balance Test, Vestibular System

DOI: 10.4328/ACAM.21782 Received: 2023-06-07 Accepted: 2023-07-17 Published Online: 2023-07-21 Printed: 2023-08-01 Ann Clin Anal Med 2023;14(8):759-762
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This study was approved by the Clinical Research Ethics Committee of Bolu Abant Izzet Baysal University (Date: 2022-09-06, No: 2022/179)

Introduction

COVID-19 disease emerged in China in December 2019. The most common symptoms of COVID-19, which initially causes respiratory function disorders were fever, cough, loss of taste and/or smell [20]. Recent studies have revealed the fact that it possesses certain neurological effects on the nervous and muscular systems [19, 20]. Yet, it has not been fully clarified what kind of an effect this disease has on the peripheral and central vestibular system [19, 25].

Static balance is the ability to maintain posture swing with minimal movement on a stable support surface. Obtaining and maintaining optimum posture basically occurs through the integrity of visual, somatosensory and vestibular information [2]. The vestibular organ in the membranous labyrinth and the vestibular nuclei in the medulla oblongata and the pathways between these structures function as the vestibular system. Utricle and saccule, which are also known as otolith organs in this system, position the head according to the posture of the body and thus maintain static balance [11].

Since the disease shows its first and main effects on the respiratory system, studies conducted in the literature have focused primarily on it. Although the pathophysiology of its effect on the auditory and vestibular system is not fully known, there have been accumulating reports indicating its negative effect on balance [12, 16]. Likewise, this study aims to document the effects of the COVID-19 disease on static balance in healthy young individuals by interpreting the results of DHI.

Material and Methods

The study was conducted on the students of the Faculty of Medicine. The study was approved by Bolu Abant Izzet Baysal University Clinical Research Ethics Committee (Decision Date: 06.09.2022, Decision Number: 2022/179). After signing the informed consent form, 30 (15 females, 15 males) individuals between the ages of 18 and 22 who had been diagnosed with COVID-19 with a positive PCR (Polymerase Chain Reaction) test and 30 (15 females, 15 males) individuals between the ages of 18 and 22 with a negative PCR test for COVID-19 were included in the study.

Inclusion criteria were age between 18 and 22, having COVID-19 positive diagnosis with PCR test (study group), having negative COVID-19 diagnosis with PCR test (control group), no hearing loss or a history of ear surgery, no history of balance disorder or a disease of the vestibular system, no using medication affecting the central nervous system.

With reference to Turkish validity and reliability study [1], DHI with 25 questions was administered to the group whose PCR test results were positive to evaluate the effects of dizziness on the participants and to find out balance problems. Dizziness Handicap Inventory (DHI) is among the useful test methods frequently used as reported in the literature [1, 10] to evaluate the complaint of dizziness and balance problems.

Possible answers to the inventory are yes (4 points), no (0 points), and sometimes (2 points). The scores have been evaluated as mild between 16 and 34; as moderate between 36 and 52; as severe when >54. High scores are interpreted as the patient's complaint of dizziness preventing an advanced level of life.

In order to evaluate static balance, the dominant foot of individuals was determined. While determining the dominant foot, the participants were asked to hit the ball that was steady on a flat surface. The foot that the participants used first and most comfortably was noted as the dominant foot [6]. After the dominant foot was determined, the Flamingo balance test was applied to the dominant and non-dominant foot to evaluate static balance. For this test, the participants were asked to stand on a 50 cm long, 3 cm wide and 4 cm high standard balance board for a minute with their eyes open. The number of times the participants lost their balance within the predetermined time was reported, and the stopwatch was stopped each time the participants fell [6].

Statistical Analyses

Statistical analyses were conducted with Minitab® 21.2 (64-bit) program. The normality of the distribution of variables was tested with the Anderson-Darling test. Mean and standard deviation (sd) values of parametric variables and median, minimum (min.) and maximum (max.) values of non-parametric variables were calculated. Intergroup differences of non-parametric variables were tested with the non-parametric Mann- Whitney U test. $p<0.05$ was considered significant.

Ethical Approval

Ethics Committee approval for the study was obtained.

Results

The mean and sd values of parametric variables, median, min, and max values of non-parametric variables, and p-value of the Mann-Whitney U test, used for finding out the difference between individuals who had COVID-19 and those who did not, are shown in Table 1. BMI, balance on the dominant foot (DFB) and balance on the non-dominant foot (NDFB) were measured.

Upon the analyses conducted for DFB, the median value was found to be 4.00 in individuals who had COVID-19 and 4.00 in individuals who did not have COVID-19. A statistically significant difference was found between individuals who had COVID-19 and those who did not in the variable for which the Mann-Whitney U test was applied.

Upon the analyses conducted for NDFB, the median value was found to be 8.00 in individuals who had COVID-19 and 4.00 in individuals who did not have COVID-19. A statistically significant difference was found between individuals who had COVID-19 and those who did not in the variable for which the Mann-Whitney U test was applied.

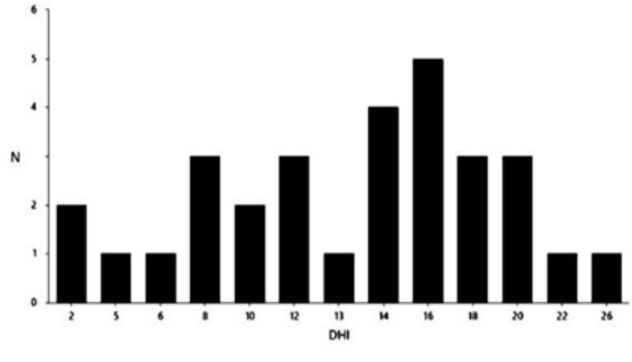

Figure 1. Bar chart for DHI (Dizziness Handicap Inventory) variable.

Table 1. Descriptive statistics (median (min.-max.) and mean±sd.) of the variables and p-value for COVID-19(+) and COVID-19(-) individuals, obtained using the Mann-Whitney U test.

Variables	COVID-19(+) (N=30)	COVID-19(-) (N=30)	p- value
BMI (kg/m²)	23.57 (18.33-30.11)[a]	20.89 (16.90-32.79)[a]	0.038[c]
DFB	4.00 (0.00-20.00)[a]	4.00 (0.00-16.00)[a]	0.028[c]
NDFB	8.00 (0.00-32.00)[a]	4.00 (0.00-16.00)[a]	0.001[c]
DHI	13.53±5.76[b]	2.16±0.83[b]	p<0.001[d]

COVID-19 (+): Individuals who had COVID-19, COVID- (19) (-): Individuals who did not have COVID-19, a: Median (min.-max.), b: Mean±sd., c: p-value obtained by the Mann-Whitney U test, d: p-value obtained by Two Sample T-test, BMI: Body mass index, DHI: Dizziness Handicap Inventory, DFB: Dominant foot balance, NDFB: Non-dominant foot balance.

Upon the analyses conducted for DHI, the mean and standard deviation were 13.53 and 5.76 for the individuals who had COVID-19. It was predicted to be 2.16 and 0.83 for individuals who did not have COVID-19. The distribution of this variable is shown in Figure 1.

Discussion

The vestibular system is of great importance to perform tasks of locomotor movements related to balance and to ensure their orientation [22]. Postural balance and stability is a system that coordinates changes occurring spontaneously or with an external intervention by keeping the body's center of mass constant [9]. As with other types of viruses, coronaviruses have been shown to affect the olfactory nerves by showing herpes simplex virus DNA in vestibular nerve fibers [11]. When the literature is reviewed, in addition to symptoms such as fever, headache, upper respiratory tract symptoms, muscle pain, joint pain, diarrhea, loss of taste and smell in COVID-19 patients, it has been reported that there are also symptoms affecting balance system [4, 5, 12, 15, 16]. In our study, dizziness and balance disorders have been observed in people who had COVID-19.

Recently, enough literature has accumulated on the COVID-19 disease affecting the balance system. In a case report conducted in 2020, it was reported that the PCR test of a patient who was referred to the emergency service with sudden and severe dizziness, nausea and vomiting, was positive [15]. Again, the first acute cerebellitis case evaluated in the literature related to COVID-19 reported complaints of moderate ataxia and dizziness and as a result restriction of daily activities in a 47-year-old male patient. On cerebellar examination, impaired tandem gait, large sole and ataxic gait have been reported [4]. In a COVID-19 patient who underwent eye examination at regular intervals, even approximately three weeks after the first known symptoms of COVID-19 (fever, cough, sore throat, runny nose, etc.), dizziness and nystagmus continued for a while [5]. In individuals with COVID-19, the virus affects the inner ear directly, causing the involvement of the central vestibular system and its connections, hypoxia and coagulation. It has also been reported that specific utricle and saccule disorder causes symptoms such as tingling, tremors and falling sensation in diagnosed individuals [23]. Evaluation of neurological observations in COVID-19 patients has shown that balance has decreased in these patients. In our study, balance assessment was performed with the static balance test for the dominant and non-dominant foot and also with DHI. A significant difference was found between the groups.

A study conducted on 150 children between the ages of 8 and 12 in Spain evaluated balance performances before and after the COVID-19 quarantine. It was found that postural balance in children worsened after the quarantine. It was also found in this literature that physically active children showed a statistically significant deterioration after the quarantine period compared to non-active children. As a result, a significant decrease was found in balance performance after the quarantine period and regular physical activity benefited postural control [17]. Another study performed on individuals between the ages of 20 and 40 in Iran assessed the static balance in individuals diagnosed with COVID-19, the conditions of these individuals one and three months after their recovery and in the control group. While the postural disorders in some tests were found to be higher in the third month after infection compared to the first month, no significant difference was found. A significant difference was found between the control group and patient groups in most of the tests. These findings suggest that COVID-19 disease, induces postural deviation in COVID-19 patients [18]. In our study, a separate test was not performed to evaluate postural instability, and we think that balance disorder also affects postural instability. We think that studies evaluating postural instability should be done in the future.

In a study conducted in 2021, examining the effect of prone position on oxygenation and static respiratory system compliance, and in a study conducted in 2022 researching COVID-19-related acute respiratory distress syndrome, COVID-19 was found to have effects on the vestibular system [7, 21]. In another study evaluating static and dynamic balance in healthy individuals and individuals with COVID-19, it was emphasized that balance variables affected the quality of life [13]. In research conducted on healthy individuals, no statistically significant difference was found between balance performance results on the right-left and dominant-non-dominant single foot [8, 14].

In the DFB and NDFB tests conducted to evaluate static balance in our study, a significant difference was found between the groups, which had COVID-19 and those who did not have COVID-19. DHI, which was developed in 1990 [10], is an inventory evaluating dizziness and balance disorders and is the most used inventory for this purpose.

In addition, it is thought that in DHI, the described vestibular symptoms are not specific to any disease. For this reason, we used this inventory in our study.

The first study that used DHI to evaluate the complaints of COVID-19 patients who experienced balance problems and the effects of this on quality of life was conducted in Turkey in 2021 [3]. As a result of the evaluation, the total mean score of the inventory was found as 35.90 [3]. In a study conducted in 2023 examining the effects of COVID-19 on vestibular system with DHI, 50 individuals diagnosed with COVID-19 were evaluated. As a result of the inventory conducted during the infection, while the score was found to be 16.04 (10.5-21.5), this score was found to decrease in the period after infection

[25]. In a study conducted in 2022 to evaluate the effects of COVID-19 on vestibulo-ocular system with DHI, the mean score was found to be 18 [24]. In our study, while the mean score was found to be 13.53 in individuals who had COVID-19, it was 2.16 in individuals who did not have COVID-19. A mild balance disorder was found in individuals who had COVID-19. Overall, the DHI data and the results were found to be consistent with the literature.

Vestibular system functions were found to decrease in patients. Weakness in vestibular system can cause postural control disorders, causing dizziness, which in turn leads to an increased possibility of falls. For these reasons, we believe that balance exercises should be added to post-recovery rehabilitation programs for individuals who had COVID-19. It is important to prevent falls, especially in individuals with advanced age. There is also a need to conduct further studies on different age groups to focus on balance problems in COVID-19 patients.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

Funding: *None*

Conflict of interest

The authors declare no conflict of interest.

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How to cite this article:
Gamze Taşkın Şenol, İbrahim Kürtül, Abdullah Ray, Gülçin Ahmetoğlu. Evaluation of the effect of COVID-19 on static balance in healthy young individuals. Ann Clin Anal Med 2023;14(8):759-762

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