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The relationship between balance and flu-like symptoms: A medical condition that needs attention

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Abstract

Aim: In general, while upper respiratory tract viruses cause flu-like complaints, balance problems associated with these viruses are often overlooked. It has been a long time since the first appearance of COVID-19, but unfortunately, there is still no fully effective treatment for this disease. Along with balance manifestations, especially several vestibular symptoms such as dizziness, vertigo, and tinnitus are described as common clinical manifestations in COVID-19. In our study, we investigated the effects of COVID-19 on the balance system with routine balance tests and we tried to localize a possible disorder in the balance system.

Materials and Methods: Volunteers were divided into two groups. The number of volunteers in each group was thirty. The first group consisted of SARS-CoV-2-positive patients and the second group consisted of healthy people. Spontaneous nystagmus determination, Romberg test, Fukuda stepping test (FST), head thrust test (HTT), head shake test (HST), finger-nose test, and tandem walking test were applied.

Results: The lateral fall in the Romberg test, rotation in the FST, and nystagmus in the HST are significant in Group 1 ($p<0.001$), ($p<0.001$), ($p<0.03$). The relationship between the fall side in the Romberg test and the direction of rotation in the FST were found to be significant in Group 1 ($p<0.001$). Similarly, the relationship between the direction of rotation in the FST and the nystagmus direction in the HST, and the direction of the saccadic correction in the HTT were found to be significant ($p<0.026$), ($p<0.010$).

Conclusion: In SARS-CoV-2 positive patients, the balance system, especially the peripheric vestibular system, may be affected even if the patients do not have obvious complaints about balance. Routine balance tests that can be performed quickly in the outpatient clinic can be used effectively for the evaluation of balance.

Introduction

In general, while upper respiratory tract viruses cause flu-like complaints, balance problems associated with these viruses are often overlooked. It has been a long time since the first appearance of Covid-19, but, unfortunately, there is still no fully effective treatment for this disease. Although it is thought that the disease which emerged in 2019 due to the SARS-CoV-2 virus primarily affects the respiratory tract, studies have shown that it is a multisystemic disease. Along with auricular manifestations, several vestibular symptoms such as dizziness, vertigo, and tinnitus are described as common clinical manifestations in COVID-19 patients. In addition, many other reviews have reported that Covid-19 causes dizziness more than vertigo, hearing loss, and tinnitus [1-4].

The pathophysiology of these viral clinical symptoms is still controversial. The virus, which can enter the cell through ACE-2 receptors, can show systemic effects by triggering inflammatory processes and thromboembolic events. Viral pathologies can also be seen in the central and peripheral nervous systems, and the balance system can be affected. It has been reported that the virus may impair blood flow in the audio-vestibular artery due to thromboembolism and cause audio-vestibular complaints such as imbalance and vertigo [4, 5]. A case report linking bilateral sensorineural hearing loss and vertigo with a history of SARS-CoV-2 and bilateral intralabyrinthine hemorrhage was reported. In addition, inflammation indicating damage to the labyrinth was detected in the inner ears of some of the patients with audiological and vestibular complaints who underwent magnetic resonance imaging [6, 7]. A recent study conducted at the Massachusetts Institute of Technology and Massachusetts Eye and Ear

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found that both hair cells and Schwann cells in the inner ear express ACE2 and furin and the transmembrane protease serine 2, two enzymes that help the virus fuse into cells. These findings suggest that SARS-COV-2 infection is directly associated with audio-vestibular dysfunction in COVID-19 [8].

The balance is maintained by processing the inputs from the visual, somatosensory, and vestibular systems to the cerebellum and sending the necessary stimuli to the skeletal and muscular systems from there. Studies on the effects of COVID-19 on balance are generally patient questionnaires in which data are obtained from remote telephone calls. There are also publications consisting of compilations of these studies [3, 4]. Common complaints in patient questionnaires include dizziness, vertigo, and tinnitus. These results obtained according to patient feedback are subjective, and dizziness and vertigo, particularly, are concepts that can be confused with each other. Studies using balance tests are very rare. In these studies, caloric tests and video head impulse test (vHIT) were evaluated, which are more difficult to apply and require more time and close contact with the patient which is not ideal, especially in the case of an airborne virus. A definite conclusion could not be reached based on the results of these studies [9, 10]. Only in one case which was positive for COVID-19 with a definitive diagnosis of vestibular neuritis, it was shown that the head thrust test was positive on the left side and the video head impulse test (v-HIT) showed that the vestibulo-ocular reflex (VOR) gain decreased in the left anterior and lateral canals [11].

In patients who apply to the outpatient clinic, the balance system can be evaluated with various balance tests that can be applied routinely easily, and quickly without the need for any equipment. These tests include the investigation of spontaneous nystagmus, the Romberg test, the Fukuda stepping test (FST), the head thrust test (HTT), the head shake test (HST), the tandem walking test (TWT), and the finger-nose test (FNT).

The Romberg test is mainly used in the evaluation of posterior colon disease. A positive Romberg sign, which occurs when the visual and vestibular components that contribute to maintaining balance, are removed, may identify a neurological disease specifically related to proprioception [12].

The FST is based on the vestibulospinal reflex and is widely used in the evaluation of labyrinth function. Closing the eyes during the FST disables the visual input, and thus the vestibulospinal reflex and otolith organs can be easily evaluated.

In 1988, Michael Halmagyi and Ian Curthoys [13] described a simple and reliable bedside head thrust test that can be used to detect people with unilateral peripheral vestibular deficits. The HTT has been widely accepted as a clinical test used to evaluate angular VOR. Persons with vestibular hypofunction can use a corrective saccade after the head is pushed towards the hypofunction side [14-15].

The HST is sensitive in assessing the peripheral and central vestibular system. Head shake nystagmus (HSN) is produced by an asymmetrical peripheral vestibular input and a central rate storage mechanism that can cause the perseveration of peripheral vestibular signals.

Patients can be evaluated for dysmetria with FNT, and the presence of ataxia can be investigated with TWT. Disorders detected as a result of these tests indicate that people have cerebellar pathologies.

In our study, we investigated the effects of COVID-19 on the balance system by evaluating the patients who had no hospitalization indication with routine balance tests that could be done in the outpatient clinic, and we tried to localize a possible disorder in the balance system due to COVID-19 by evaluating the correlation between the tests. In addition, we aimed to determine whether COVID-19 would affect the balance system even if the patients did not have any complaints about balance.

Materials and Methods

Our study was carried out on patients whose informed consent was obtained. Consent was given by Malatya İnönü University Clinical Research Ethics Committee before the study (2020/159-21.10.2020). Volunteers were divided into two groups. The first group consisted of SARS-CoV-2 positive patients, and the second group consisted of healthy people who applied to the ear nose throat outpatient clinic for screening and did not have any known disease. Patients in Group 1 had flu-like complaints such as cough, runny nose, fatigue, myalgia, and fever (38 degrees Celsius or less). In the detailed anamnesis of the volunteers, it was learned that they did not have any problems with balance. Patients in Group 1 were within the first 14 days of their illness. The study population included persons aged 18-60 years. Patients with a history of smoking, alcohol use, or any drug use; those who use ototoxic drugs or drugs that might affect balance; those with an acute or chronic ear disease on examination; those with diabetes; and those with a disease originating in the central or peripheral nervous system that affected balance; and patients who had undergone otological surgery were excluded from the study. Volunteers were asked if they had any complaints about balance, and those complaints were recorded. The spontaneous nystagmus determination text; the Romberg test; FST, FNT, and TWT; the head thrust test, and the head shake test were applied to the volunteers in each group to evaluate the balance system. Tests were administered by expert audiologists. While investigating spontaneous nystagmus, Frentzel goggles were put on the patients, and the presence of nystagmus was evaluated. The presence of vertical nystagmus supported the possibility of central pathology while horizontal and rotatory nystagmus supported the presence of peripheral pathology. In the Romberg test, the tendency of the patients to fall on either side was evaluated separately for 60 seconds with the feet together and the arms joined to the trunk with their eyes open and closed. The peripheral dorsal proprioceptive sensation was evaluated with eyes open, and the cerebellum was evaluated with eyes closed. In the FST test, patients were asked to stretch their arms forward and take 100 steps with their eyes closed. It was considered positive if the patients made a rotation movement of 45 degrees or more from their position. In FNT, the patient was asked to flex the forearm while looking straight ahead with the arm abducted at 90 degrees and the forearm fully extended, bringing the forearm back to extension by touching the nose with the finger, and repeating this sequentially. In TWT, volunteers were asked to walk ten steps in a straight line with their eyes closed, putting one foot in front of the other, as per the heel of one foot directly in front and in contact with the toes of the other foot. Volunteers who were not able to walk from heel to toe or who fell sideways were deemed to have failed. In HTT, the patient was asked to look steadily at a point, e.g., the tip of the clinician's nose, on the opposite side. The patient's head was suddenly turned 10-15 degrees to one side, and the patient's inability to fix their eyes on the desired point in the direction of rotation of the head or to make a saccadic correction movement on that side showed vestibular damage. In the HST, the patient was asked to shake their head from side to side 20-30 times after tilting their head forward 30 degrees, and then their head was fixed in the middle while Frenzel goggles were worn, and nystagmus was investigated. While investigating spontaneous nystagmus and during the HTT and HST, video recordings of the patient's eye movements were taken with a mobile phone with an android operating system (Android 9.0 pie). Frentzel goggles were used for the evaluation of spontaneous nystagmus and the HST. Later, these recordings were played back at normal speed and in slow motion, and the presence of nystagmus and saccade was evaluated.

Statistical analysis

The data obtained from the balance tests were compared between the groups and the effects of COVID-19 on the balance were attempted to be determined. The analysis of the data included in the research was carried out with SPSS (IBM SPSS Statistics 25, Armonk, NY, USA) software. The Shapiro-Wilk Test was used to check whether the data fit the normal distribution. The significance level for comparison tests was taken as $p<0.05$. Since the variables did not have a normal distribution ($p>0.05$), the analysis was continued with nonparametric test methods. Comparisons in independent paired groups were made with the Mann-Whitney U test since the assumption of normality was not provided. In the analysis of categorical data, chi-square (χ^2) analysis was performed by creating cross tables.

Results

Thirty SARS-CoV-2 positive patients and 30 volunteers with no health problems were included in the study. Of the patients who were positive for SARS-CoV-2, 11 were female and 19 were male. Of the healthy volunteers, 14 were female and 16 were male. The ages of the patients ranged between 18 and 60 (mean±SD, 44.77±15.43), and the ages of the healthy volunteers ranged between 19 and 60 (mean±SD, 40.1±14.32). There was no statistically significant difference between the case and control groups according to age and gender in the participants included in the study ($p>0.05$). The groups showed a homogeneous distribution according to age and gender variables. Five (16.6%) of the patients in Group 1 described dizziness. There was no patient with vertigo.

Intergroup comparisons

When spontaneous nystagmus was evaluated with Frentzel goggles, nystagmus was not observed in any of the volunteers in Group 1 and Group 2 ($p>0.05$).

In the Romberg test, while their eyes were open, three patients in Group 1 had a lateral and anterior fall (one to the right, two to the left), while 21 patients had a lateral fall (11 to the right, 10 to the left) with the eyes closed. While no fall was observed with eyes open in Group 2, a lateral fall (three to the right, two to the left) was observed in five patients with eyes closed. In the patient group, falling with eyes closed was significant ($p<0.001$). In FST, rotation was positive in 19 patients in Group 1 (10 to the right, nine to the left), while rotation was positive in five patients in Group 2 (four to the right, one to the left). The rotation was significantly higher in Group 1 than in Group 2 ($p<0.001$). In FNT, two of the patients in Group 1 failed the bilateral test while one patient failed on the left side. All of the participants in Group 2 performed the test correctly. There was no significant difference between the groups for both the right and left sides ($p>0.15$), ($p>0.08$). In TWT, three patients in Group 1 failed the test while no failure was detected in Group 2. The test results of the groups were similar ($p>0.1$). In the HST, nystagmus was detected in eight patients in Group 1 (four patients in the slow phase hitting the right, four patients hitting the left). In Group 2, nystagmus was detected in one person (in the slow phase hitting the left). There was a significant difference between the groups ($p<0.03$).

In HTT, a saccadic correction movement was observed in five patients in the first group (one to the right, four to the left), while no pathology was detected in the second group. There was no significant difference between the groups ($p>0.07$) (Table 1).

Inter-test correlations

The direction of the fall in the Romberg test significantly correlated with the direction of rotation in the FST in Group 1 ($p<0.001$) (Table 2). The direction of rotation in the FST significantly correlated with the direction of the nystagmus in the HST and the saccade direction in HTT in Group 1 ($p<0.026$), ($p<0.010$) (Table 3). The direction of saccades in the HTT significantly correlated with the direction of the nystagmus in the HST in Group 1 ($p<0.001$) (Table 4).

Discussion

Balance integration is critical in human life and is carried out in the central nervous system which depends on information from the vestibular, ocular, and proprioceptive systems and which provides cerebellum coordination. Diagnosing which system is affected in the detection of balance disorders is very important in terms of treatment. It has been reported that COVID-19 can affect the balance system. However, most patients' balance assessments were made using questionnaires and telephone interviews instead of objective methods and balance tests. Some of the studies using objective methods were conducted on people who survived the disease, and yet clear information could not be obtained [2, 16-20].

Table 1. Comparison of the results of balance tests between groups.

Tests			Group 1	Group 2	Total	Test value	p-value
Romberg	Fall (-)	n	9	25	34	0.540	0.001
		%	30.00%	83.30%	56.70%		
	Fall to right (+)	n	11	3	14		
		%	36.70%	10.00%	23.30%		
	Fall to left (+)	n	10	2	12		
		%	33.30%	6.70%	20.00%		
Fukuda stepping test	Rotation (-)	n	11	25	36	0.490	0.001
		%	36.70%	83.30%	60.00%		
	Right rotation (+)	n	10	4	14		
		%	33.30%	13.30%	23.30%		
	Left rotation (+)	n	9	1	10		
		%	30.00%	3.30%	16.70%		
Finger-nose test (right)	Unsuccessful	n	3	0	3	0.230	0.080
		%	10.00%	0.00%	5.00%		
	Successful	n	27	30	57		
		%	90.00%	100.00%	95.00%		
Head shake test	Nystagmus(-)	n	22	29	51	0.340	0.030
		%	73.30%	96.70%	85.00%		
	Right bitting nystagmus(+)	n	4	0	4		
		%	13.30%	0.00%	6.70%		
	Left bitting nystagmus(+)	n	4	1	5		
		%	13.30%	3.30%	8.30%		
Head thrust test	Saccade (-)	n	25	30	55	0.300	0.070
		%	83.30%	100.00%	91.70%		
	Right corrective saccad (+)	n	1	0	1		
		%	3.30%	0.00%	1.70%		
	Left corrective saccade (+)	n	4	0	4		
		%	13.30%	0.00%	6.70%		

n: number of samples; test value: chi-square value(χ^2).

We conducted our study on Covid-19 patients who applied to the outpatient clinic and had mild pneumonia but did not have an indication for hospitalization. Balance was evaluated by performing spontaneous nystagmus detection; the Romberg test; and the FST, FNT, TWT, HST, and HTT without the need for a special device. The lateral fall in the Romberg test, rotation in the FST, and nystagmus in the HST are significant in Group 1. The relationship between the fall side in the Romberg test and the direction of rotation in the FST were found to be significant in Group 1. Similarly, the relationship between the direction of rotation in the FST and the nystagmus direction in the HST and the direction of the saccadic correction in the HTT were found to be significant. Moreover, there was also a significant correlation between the HST and HTT. The results of the TWT and FNT were similar between the groups. These findings showed that in COVID-19 patients with mild involvement both the vestibular system and the dorsal proprioceptive senses could be affected while the cerebellum was not. The significant direction relationship between the tests was supportive of our conclusion about vestibular system affection. During the tests, we took video recordings of the volunteers' eyes to detect nystagmus and saccades with a smartphone. Then we watched the footage at normal and slow speeds. This evaluation was very easy, and we were able to evaluate eye movements as effectively than looking with the naked eye.

Symptoms related to the central and peripheral nervous system and musculoskeletal systems were observed in 36.4% of COVID-19 patients. In otolaryngology practice, a large number of COVID-19 patients with complaints of taste and smell disorders, hearing loss, and balance disorders are encountered [2, 9]. Mao et al. [2] reported dizziness as the most common neurological symptom of COVID-19 based on reports of 36 of 214 hospitalized patients (16.8%). In the study of Viola et al. [18] who used online questionnaires, 18.4% of patients diagnosed with COVID-19 reported balance disorder after diagnosis. In addition, Sia et al. [21] suggested that the presence of dizziness while walking, along with the inability to stand still, might be an early clinical sign of SARS-CoV-2 infection. Alde et al. [22] conducted their study on 1512

Table 2. Correlation of Romberg test with Fukuda stepping test, head shake test, and head thrust test.

			Romberg test			
			(-)	Right (+)	Left (+)	P φ values
Fukuda stepping test	Rotation (-)	Count	9	1	1	<0.001
		% within FST	81.8%	9.1%	9.1%	
		% within Romberg test	100.0%	8.3%	11.1%	
	Right Rotation (+)	Count	0	10	0	
		% within FST	0.0%	100.0%	0.0%	
		% within Romberg test	0.0%	83.3%	0.0%	
	Left Rotation (+)	Count	0	1	8	
		% within FST	0.0%	11.1%	88.9%	
		% within Romberg test	0.0%	8.3%	88.9%	
Head shake test	Nystagmus (-)	Count	9	7	6	0.108
		% within FST	40.9%	31.8%	27.3%	
		% within Romberg test	100.0%	58.3%	66.7%	
	Right bitting nystagmus (+)	Count	0	3	1	
		% within FST	0.0%	75.0%	25.0%	
		% within Romberg test	0.0%	25.0%	11.1%	
	Left bitting nystagmus (+)	Count	0	2	2	
		% within FST	0.0%	50.0%	50.0%	
		% within Romberg test	0.0%	16.7%	22.2%	
Head thrust test	Saccade (-)	Count	9	10	6	0.136
		% within FST	36.0%	40.0%	24.0%	
		% within Romberg test	100.0%	83.3%	66.7%	
	Right corrective saccade (+)	Count	0	1	0	
		% within FST	0.0%	100.0%	0.0%	
		% within Romberg test	0.0%	8.3%	0.0%	
	Left corrective saccade (+)	Count	0	1	3	
		% within FST	0.0%	25.0%	75.0%	
		% within Romberg test	0.0%	8.3%	33.3%	

φ: The likelihood ratio test was used; FST: Fukuda stepping test; HST: head shake test; HTT: head thrust test.

patients, and based on the answers given by the patients, they detected dizziness in 251 (16.6%) patients, most of them patients with drowsiness. Thirty (12%) of the patients with dizziness described vertigo. Dizziness and vertigo were found to be more common in women compared to men. In a recent systematic review and meta-analysis of the audiovisual symptoms of COVID-19, the combined estimates of the prevalence of hearing loss, tinnitus, and rotatory vertigo were 7.6%, 14.8%, and 7.2%, respectively [23]. In a study based on self-reports, it was reported that patients diagnosed with COVID-19 were more likely to report rotatory vertigo than patients without COVID-19, the rate of rotatory vertigo was recorded as 5%, but the differential diagnosis of vertigo was not discussed [24]. However, given the low level of evidence (i.e., studies without a control group), poor data collection (i.e., using self-reports and/or medical records), and high heterogeneity among the studies reviewed, these results should be interpreted with caution in all of these studies. In our study, in patients with COVID-19, the dizziness rate was 16.5%, and vertigo was not detected.

Studies using objective tests with a higher level of evidence on COVID-19 patients are few. Bozdemir et al. [10] in their study using caloric tests and vHIT could not find a significant difference between the COVID-19 patients and the control group in terms of caloric test results, presence of canal paresis, and directional superiority ($p>0.05$). In the same study, only the right lateral semi-circular canal gains from the vHIT results were found to be significantly lower in patients compared to controls ($p = .008$), but the gains of all remaining semicircular canals were similar between the groups (p>0 .05). Gallus et al. [9] applied pure tone audiometry, vHIT, and suppression head impulse tests to 48 patients who had survived COVID-19 two weeks after their illness and compared results with the control group; the differences between the two groups were minimal, and the findings were within the normal range. In addition, they reported that vestibular symptoms were transient in most of the patients participating in this study. From the perspective of COVID-19, the risk of transmission of SARS-CoV-2 would increase as more time is required for patients to perform these tests. In addition, although these tests are objective, the devices used are costly. The tests used in this study do not have any cost, and the risk of SARS-CoV-2 transmission is low because they can be done quickly in an outpatient clinic.

Table 3. Correlation of Fukuda stepping test with head shake test and head thrust test.

			Fukuda stepping test			
			(-)	Right (+)	Left (+)	P φ values
Head shake test	Nystagmus (-)	Count	11	6	5	0.026
		% within HST	50.0%	27.3%	22.7%	
		% within FST	100.0%	60.0%	55.6%	
	Right bitting nystagmus (+)	Count	0	3	1	
		% within HST	0.0%	75.0%	25.0%	
		% within FST	0.0%	30.0%	11.1%	
	Left bitting nystagmus (+)	Count	0	1	3	
		% within HST	0.0%	25.0%	75.0%	
		% within FST	0.0%	10.0%	33.3%	
Head thrust test	Saccade (-)	Count	11	9	5	0.010
		% within HST	44.0%	36.0%	20.0%	
		% within FST	100.0%	90.0%	55.6%	
	Right corrective saccade (+)	Count	0	1	0	
		% within HST	0.0%	100.0%	0.0%	
		% within FST	0.0%	10.0%	0.0%	
	Left corrective saccade (+)	Count	0	0	4	
		% within HST	0.0%	0.0%	100.0%	
		% within FST	0.0%	0.0%	44.4%	

φ: The likelihood ratio test was used; FST: Fukuda stepping test; HST: head shake test; HTT: head thrust test.

Table 4. Correlation of head thrust test with head shake test.

			Head thrust test			
			(-)	Right (+)	Left (+)	P φ values
Head shake test	Nystagmus (-)	Count	22	0	0	<0.001
		% within HST	100.0%	0.0%	0.0%	
		% within HTT	88.0%	0.0%	0.0%	
	Right bitting nystagmus (+)	Count	2	1	1	
		% within HST	50.0%	25.0%	25.0%	
		% within HTT	8.0%	100.0%	25.0%	
	Left bitting nystagmus (+)	Count	1	0	3	
		% within HST	25.0%	0.0%	75.0%	
		% within HTT	4.0%	0.0%	75.0%	

φ: The likelihood ratio test was used; HST: head shake test; HTT: head thrust test.

The dorsal column is a three-row neuronal pathway that acts as a method of signal transmission along the spinal cord to the brainstem. This pathway specifically controls the conscious understanding of vibration, fine touch, two-point discrimination, and proprioception. The Romberg test can be used as a clinically accurate tool to evaluate proprioception. This test is positive if the person is unable to stand upright in the absence of vision or the dark. It is very important to note that both dorsal column and cerebellar damage can result in ataxia. Because of its high specificity, a positive Romberg sign is highly suggestive of diagnosing a dorsal column and medial lemniscus tract deficit [25]. In our study, although the patients did not exhibit a significant ataxic gait, we observed lateral falls with eyes closed in 21 of 30 patients which was significant when compared to the control group. This was the first time we evaluated COVID-19 patients with this test, and the results indicated that proprioception could be affected.

The rotation occurs in unilateral labyrinth pathologies in the presence of otitis media when middle ear aeration is impaired, when positive or negative pressure is applied to the external auditory canal, and when caloric stimulation or rotary stimulation is applied with cold water in the FST. In healthy people, rotation not exceeding 45 degrees can be seen after 100 steps. Fukuda [26] reported that the stepping test is more sensitive than nystagmus in detecting labyrinth pathology. McCaslin et al. [27] reported the sensitivity of the FST as 70% in unilateral vestibular hypofunction similar to the findings of Moffat et al. [28] (71%). No evaluation has been made in COVID-19 patients using the FST before. In our study, we found significant rotation in 19 of 30 SARS-CoV-2-positive volunteers. Moreover, there was a significant correlation between the direction of the FST, HST, and HTT. These findings, especially the correlation we found between tests, supported the concept that the vestibular system can be affected by COVID-19.

It has been reported that the HST is a sensitive screening test for editing peripheral and central vestibular system diseases. Kamei et al. [29] documented the presence of HSN in 86% of vertigo patients. Takahashi [30] stated that in 19 patients with unilateral vestibular system disorder, 68% of cases (n = 13) HSN showed a rapid phase forward to the healthy ear, and the direction of the initial rapid phase of HSN may also hit the affected ear in 19% of the patients. In most patients with VN, abnormal HSN was found in 94% of patients in the acute phase and 89% at follow-up, indicating that HSN is a good indicator of vestibular hypofunction even at follow-up. It has been reported that HSN is closely associated with the vestibular imbalance and is more common in patients with peripheral vestibular dysfunction (Menière's disease, 58%; VN, 50%). The incidence of HSN has been reported to increase with increasing canal paresis (CP) [31]. The presence of pathological CP seems to be the only prerequisite for HSN formation [32]. The HST results, which we applied for the first time to evaluate the vestibular system of COVID-19 patients, were found to be significantly positive in Group 1. These findings showed that there may be a peripheral vestibular disorder or imbalance in COVID-19 patients. The correlation between the HST and HTT showed that the vestibular system was most likely affected.

The head thrust test is the most effective method of detecting loss of vestibular function at the bedside in which the horizontal VOR is evaluated [13]. In the HTT, the corrective saccade shows a lack of VOR on the side of head rotation and indicates a peripheral vestibular lesion on the ipsilateral side [33]. It is reported to have a higher specificity (82 to 100%) than the sensitivity (34 to 39%) of this test [34-36]. In another study, the overall sensitivity of HTT in identifying subjects with vestibular hypofunction was 75%, and the overall specificity was 82% [37]. While HTT is more accurate in individuals with complete vestibular loss, it is less sensitive in a person with mild to moderate loss of function [36]. Approximately 50% of the canal paresis is needed for the test to be positive [38]. Although we detected more corrective saccades in Group 1, there was no difference between the groups.

The cerebellum plays a role in the balance and coordination of the trunk and extremities. TWT can be used in the diagnosis of cerebellar and peripheral vestibular disorders [39]. We used TWT specifically to assess whether there is a cerebellar disorder (ex. ataxia). Patients with cerebellar ataxia will not be able to walk from heel to toe or in a straight line and fall sideways. In cerebellar disorders, FNT is used to detect dysmetria in the upper extremity. Patients with cerebellar pathology may have dysmetria and cannot perform FNT correctly [40]. Nystagmus may also be seen in patients with cerebellar pathology. In our study, nystagmus was not detected in patients, and the test results of the groups were found to be similar. These findings supported the absence of cerebellar involvement in the patient group.

Conclusion

In patients with SARS-CoV-2 positive and mild disease, the balance system may be affected even if the patients do not have obvious complaints about balance. Proprioception, especially the peripheral vestibular system, may also be affected. Routine balance tests can be performed quickly in the outpatient clinic for preliminary evaluation of COVID-19 patients before more detailed tests are performed. Thus, patients with normal tests will be excluded, and the cost of further tests will be avoided. In addition, the risk of contamination due to close contact with detailed tests will be reduced. Smartphones can be an alternative for the evaluation of nystagmus and saccade in vestibular disorders. More study is needed on this topic.

Ethical approval

Consent was given by Malatya İnönü University Clinical Research Ethics Committee before the study (2020/159-21.10.2020).

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