

The incidence of endolymphatic hydrops after corona virus

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Abstract

Coronavirus disease (COVID-19) evidently lead to many otolaryngological disorders such as sudden sensorineural hearing loss, tinnitus, vertigo. Endolymphatic hydrops symptoms (vertigo, tinnitus, ear fullness and nausea) following COVID-19 were reported in several studies over the last 2 years. This study was conducted on 258 COVID-19 patients to investigate the influence of the COVID-19 pandemic on the incidence of Endolymphatic hydrops. The study took place between July 2020 and Jan 2022 at the Middle East Hearing and Balance Centre and Al-Ahliyya Amman University. All patients underwent full computerized dynamic posturography (CDP) as well as pure tone audiometry, middle ear assessment, electro-cochleography (EcochG), cervical vestibular evoked myogenic potentials (C-VEMP) tests. The results showed about 48% of the cases had abnormalities in CDP findings, 43% had evidence of endolymphatic hydrops, 67% had abnormal middle ear functions, and only 19% had sensorineural hearing loss. In conclusion: COVID-19 pandemic had significant effects on increasing the incidence of endolymphatic hydrops.

Keywords

Covid-19, Coronavirus, Endolymphatic hydrops, Meniere's disease, CDP, EcochG.

Introduction

Coronavirus disease (COVID-19) is known as a pandemic which mainly affects the respiratory, circulatory and neurological system (Ahmad and Rathore, 2020; Mao et al., 2020; Pasquale et al., 2021). Several authors reported that COVID-19 has a genome sequences which were detected in the brain of stricken patients, with indications of some pathologic changes in the hypothalamus and cortex neurons (Paniz-Mondolfi et al., 2020; Pasquale et al., 2021) and in the cerebrospinal fluids (Huang et al., 2020). It is well documented in several studies that coronavirus patients may suffer from impaired consciousness, headache, dizziness, and olfactory and taste alterations (Wu et al., 2020; Moriguchi et al., 2020). Otolological disorders associated with COVID-19 was reported in about 20 - 30% of patients (Ahmad & Rathore 2020; Fiani et al., 2020; Mao et al., 2020; Ashrafi et al., 2020;

Malayala & Raza, 2020; Pasquale et al., 2021).

Endolymphatic hydrops (EH) is well known as one of the most common inner ear disorders which might be caused by hair cell degeneration in the cochlea, vestibule and semicircular canals. EH is linked to Meniere's disease (MD) and Meniere's syndrome (MS) (Ahmad I, Rathore FA 2020). MD and MS were classified into: typical, Cochlear, vestibular (Recurrent vestibulopathy), and atypical (Paparella, 1985; Lance et al., 2002; Gürkov et al., 2016; Zhang et al., 2016).

Smart EquiTest Computerized Dynamic Posturography (CDP) was first developed in the 1980s by NeuroCom with NASA assistance to evaluate the effects of space flight on vestibular function and balance control in astronauts. The CDP

testing is currently used to isolate and quantify the contribution of vestibular (inner ear system), somatosensory (feet, ankles, joints), vision (eyes) inputs for balance using sensory organization test (SOT) and head shaking test (HS). These sensory inputs interact with the brain, which then drive and control our motor functions and central adaptations. The Smart EquiTest CDP has been accepted to be the standardized quantitative method to isolate, quantify and differentiate between sensory, motor and central impairments in balance control. Computerized Dynamic Posturography in addition to video-nystagmography (VNG), vestibular evoked myogenic potentials (VEMPs), electrocochleography (EcochG) and other clinical tests are used to localize, categorize pathological mechanisms and diagnosis of balance disorders.

Apparently from the literature reviews that significant number of coronavirus patients suffers from dizziness and balance problems. EH seems to be a common suspected disorder of the inner ear after coronavirus infection. However, most of the studies which were conducted to understand the effects coronavirus on neurotological disorders during and post recovery from the disease used questionnaires, and clinical observations (Zhang et al., 2022), This study was carried out to using SOT and HS test to isolate and quantify the contribution of vestibular, somatosensory, and visual inputs for balance and as well as to differentiate between sensory, motor and central impairments in the referred patients to ENT clinic with coronavirus disease. The study was also directed to identify the percentage of patients developed EH after coronavirus disease using C-VEMP, O-VEMP and EcochG tests.

Materials and Methods

This study which was conducted on 258 patients who were referred to ENT clinic to investigate the incidence of EH associated with COVID-19. All patients were diagnosed as having COVID-19 and reported some otoneurologic symptoms such as tinnitus, vertigo and/or balance disturbance. The study was carried out at the Middle East Hearing Association clinic in Amman and the Audiology Departments at Al-Ahliyya Amman University in Jordan between July 2020 and January 2022.

All participated patients were investigated after recovery from the diseases and the PCR results become negative. Exclusion criteria were previous patient history of hearing loss

in at least one ear, acoustic trauma, prolonged noise exposure, presence of known audiological pathologies before the diagnosis of COVID-19. All participants filled a consent form to be included in the study and to the use of anonymized data provided in the responses to the questionnaire.

All participants underwent full audiological investigations including pure tone audiometry, tympanometry, acoustic reflex, EcochG, C-VEMP and CDP tests.

Statistical analysis

Prevalence of symptoms and results were analyzed using ANOVA test and the Statistical Packages for Social Sciences (SPSS), version 23.

Results

Figure 1 shows age distribution of the study participants. The mean age of patients was about 42 years ($SD \pm 9$), (males about 44 years and females about 39 years). None of the patients has perforated ear drum, ossicular disorders, or mastoiditis and none of the included patients had a history of conductive hearing loss before the coronavirus disease.

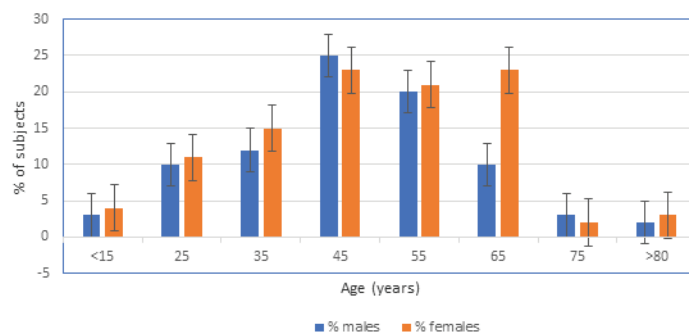


Figure 1: Age (years) distribution of the patients

Analysis of the patient's symptoms revealed that about 65% of patients had ear complaint and 38% of them had also nose and/or throat disorders. It can be seen from Figure 2 that the main otology symptoms for more than 5 days after recovery from covid-19 virus (PCR -ve) were ear fullness (47 patients; 28%), dizziness (44 patients; 26%), vertigo, and/or balance disorders (34 patients; 21%) tinnitus and/ or hearing loss (18 patients; 7%). ANOVA results shows there was no significant difference in the incidence between male and females ($p > 0.05$).

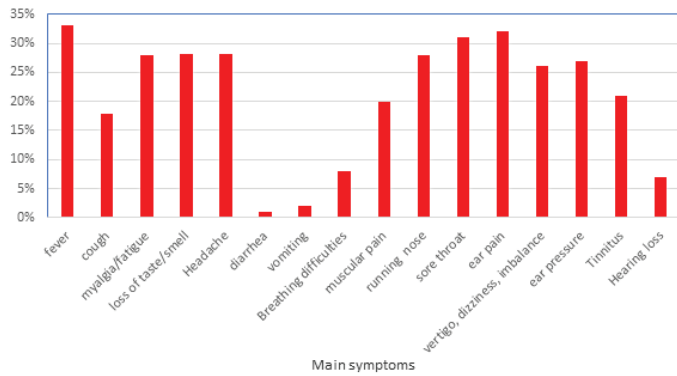


Figure 2: Percentage of the reported symptoms: more than 5 days after recovery from covid-19 and PCR was -ve. (Note: most patients had more than one complaints)

Computerized Dynamic Posturography results are presented in (Table 1). It shows that SOT and HS results were abnormal in 124 patients (about 48 %), 55 of patients (about 21%) had vestibular disorders, 11 patients (about 4%) had visual disorders, 13 patients (about 5%) had somatosensory disorders, and 22 patients (about 9 %) has preference disorders. Table 1 also shows that 23 patients (about 9%) had abnormal HS test which indicate semicircular canals disorders.

Table 1: Summary of the Computerized dynamic posturography (SOT and HS) results of the 258 patients.

Results	Number	Percentage
Normal	134	52 %
Vestibular	55	21%
Visual	11	4%
Somatosensory	13	5%
Preference	22	9%
Semicircular canals	23	9%

EcochG and C-VEMP results revealed that 56 patients had SP/AP ratio more than 40%, prolong latency of N1 and/or low amplitude of P1/N1. These results are consistent with endolymphatic hydrops. The majority of patients with abnormal vestibular CDP pattern had abnormal EcochG (63%) and abnormal C-VEMP (60%) results. On the other hand, only two patients out of the 134 patients who had normal CDP had evidence of endolymphatic hydrops as shown from abnormal EcochG and C-VEMP results. Pure tone audiogram shows only 18 patients (about 7%) out 258 has mild and mild to moderate sensorineural hearing loss mainly at the low frequencies. All of the 18 patients have abnormal CDP, EcochG and C- VEMP results. Interestingly, only 7% of patients with evidence of endolymphatic hydrops after COVID-19 disease had sensorineural hearing loss.

Table 2 summarize the relationship between Computerized dynamic posturography (SOT and HS), EcochG, and C-VEMP results for the 258 patients. It can be seen from this tables that about 62% of patients with vestibular loss have abnormal EcochG and C-VEMP results. For the patients with abnormal Head shaking (HS) results, 70% of them have abnormal EcochG and 48% have abnormal C-VEMP results. There is strong correlation between vestibular abnormality EcochG and C-VEMP (0.89 and 0.86 respectively).

Table 2: Percentage and number of patients with CDP abnormality with a possibility of endolymphatic hydrops according to EcochG, and C-VEMP results

Results	CDP No & %	Abnormal EcochG No & %	Abnormal C-VEMP No & %
Normal	134 (52 %)	2 (1.4 %)	0
Vestibular	55 (21%)	34 (63%)	33 (60%)
Visual	11 (4%)	1 (9%)	0
Somatosensory	13 (5%)	1 (7%)	0
Preference	22 (9%)	1 (4%)	1 (4.5%)
Abnormal HS (Semicircular canals abnormality)	23 (9%)	16 (70)	11 (48)

Discussions

The reported symptoms by the patients in this study are comparable to these symptoms reported in the literatures. However, the percentage of symptoms reported in this study is lower than the reported percentage in literature (p< 0.05) (Roberto et al., 2021). This finding is as expected since almost all patients (258) in this study were diagnosed during the national screening program mainly at airport and none of them has been hospitalized or critically ill.

Cohen et al., (2014), Pasquale et al., (2021), and Abramovich & Prasher (1986) reported that pandemic coronavirus studies illustrate that about 12% - 20% of patients have inner ear disorders which may cause dizziness, vertigo hearing loss and/or damage to other areas of the brain which might cause abnormalities in organizing motion and position (Malayala & Raza, 2020; Munro et al., 2020). This study shows that 21% of the patients has a vestibular disorder which is similar to the published findings in literatures and support their conclusions. ANOVA illustrates there is no significant difference between this

study and the published literatures ($p>0.05$).

Additional to the 21% of patients had vestibular disorder (Table 1), the CDP results of this study clearly demonstrate that about 7% of patients had sensorineural hearing loss and about 18% of the patients had disorders in the visual, somatosensory, and preference systems. The effects of coronavirus on the audio-vestibular system, neural system are well documented over the last two years and its most likely due to the infection or vascularity disorder in the inner ear structures, similarly to varicella zoster virus (VZV) and human immunodeficiency virus (HIV) (Sriwijitalai & Wiwanitkit, 2020; Pasquale et al., 2021). The CDP results facilitate understanding the effects of coronavirus on gait control systems and quantify severities of loss in the peripheral vestibular system, vestibular nuclei, or extra-ocular muscles or in their connections. It has been reported in literatures that EcochG test has excellent sensitive and specificity in diagnosis of endolymphatic hydrops (Taha et al., 2022). The sensitivity and specificity of c-VEMP and o-VEMP for diagnosis of endolymphatic hydrops range from low to high depends on the type of Meniere's disease (MD) (Sulin et al., 2015). Evidently, the results of this study demonstrate that CDP tests are very useful to identify peripheral vestibular loss. Applying EcochG, and VEMPs tests for patients who have abnormal CDP results are strongly recommended to diagnosed endolymphatic hydrops regardless the patient have hearing loss or not. The VEMPs are very important to identify the site of lesions which may include the utricle, saccule, inferior vestibular nerve, superior vestibular nerve, extraocular muscles or their central connections.

Conclusion

It can be concluded from this study that audiovestibular disorders are common complains of patients after recovering from coronavirus. CDP tests are very important to be applied for every coronavirus patients to evaluate the balance and dizziness. EcochG and VEMPs are evidently needed to include in assessments batteries for every patient with abnormal CDP results to help in diagnosis of endolymphatic hydrops and site of lesion.

Conflict of interests

The author declares that there is no conflict of interest.

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