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**REVIEW ARTICLE**

**SARS COV-2 and its association with vertigo**

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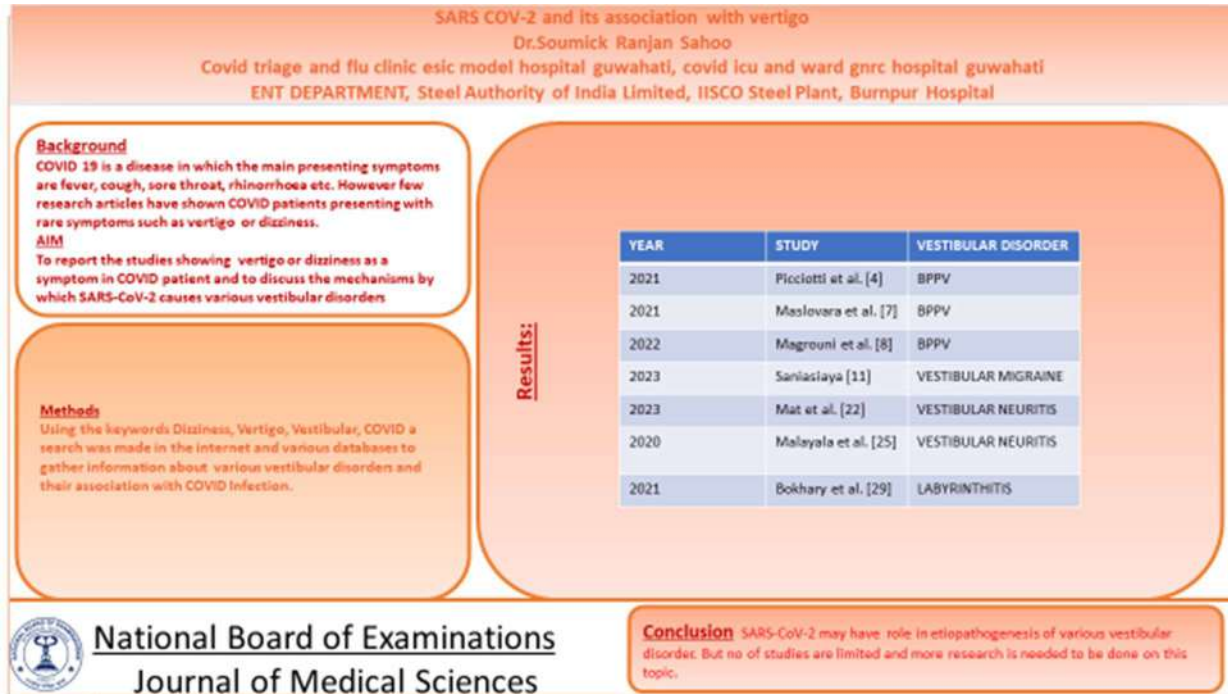
**Abstract**

COVID-19 is a disease which has affected many systems of the body such as respiratory, cardiovascular, gastrointestinal systems. New research has shown that the nervous system also gets affected by COVID. A small number of COVID patients have presented with dizziness as a primary chief complaint with few presenting with acute vertigo. Studies have found association between COVID and various important balance disorders such as BPPV, Vestibular Migraine Menieres Disease, Vestibular Neuritis, Labyrinthitis. In this article a brief discussion of the mechanism by which SARS-CoV-2 virus causes these various vestibular disorders is explained.

**Keywords:** Dizziness, Vertigo, Vestibular, COVID

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## Graphical Abstract



### Introduction

The COVID-19 Pandemic is one of the greatest challenging situation faced by mankind in modern times. The various complaints for which patients visited hospitals include sore throat, rhinorrhoea, cough, dyspnoea etc. From the otorhinolaryngology point of view in addition to these clinical features, anosmia was a chief complaint found in many patients. One of the rare complaints for which COVID patient visited the hospital was dizziness. The incidence of dizziness ranges from 7–12% in COVID patients [1]. As per a study conducted 18.4% of COVID patients had balance disorder, amongst them 94.1% reported dizziness and 5.9% reported severe vertigo attack [2]. In other study dizziness was reported in 31.8% and true vertigo in 6% of the patients [3,4]. In this article a brief discussion will be held on COVID and association with balance

disorders such as BPPV, Vestibular migraine, Menieres disease, Vestibular neuritis and Labyrinthitis.

### BPPV

BPPV is the most common of the peripheral vestibular disorders seen by otorhinolaryngologists. Most of the cases are idiopathic while there may be certain secondary causes like menieres disease, vestibular neuritis, otologic and nonotologic surgeries, herpes zoster oticus, inner ear ischaemia [4]. The clinical features consist of rotational vertigo lasting less than 1 minute, caused by head positional change [5]. The proposed mechanism are canalolithiasis and cupulolithiasis. Post canal BPPV accounts for 60-90% while horizontal canal BPPV accounts for 5-30% [6].

Some cases of BPPV have been reported among COVID patients. A study reported two cases of BPPV in COVID patient [7]. In the first case who had tested positive for SARS-CoV-2, patient developed acute attack of circular dizziness when changing position. The vertigo attack was preceded by occipital headaches and followed by nausea and vomiting. Dix Hallpike test was positive and confirmed the diagnosis of BPPV. The patient was managed by Epley procedure. The second patient experienced a mild COVID-19 course which started with a moderate frontal headache accompanied by musculoskeletal pain, vomiting, diarrhea, and general weakness. This was followed by acute attack of circular dizziness along with nausea on turning to right side and getting out of bed without any audiological or neurological symptoms. The case was diagnosed as BPPV and treated by epley procedure.

A retrospective study reported 8 cases of BPPV in COVID patients [4]. All of them had rotatory vertigo attacks triggered by position change along with associated symptoms like nausea, vomiting and unsteadiness. They were treated by Epley maneuver, Semont maneuver, Lempert maneuver, and Gufoni maneuver.

A case was also reported where a 30 year old female health worker developed attacks of positional vertigo, consistent with BPPV after 3 weeks of developing COVID Symptoms. Diagnosis of BPPV was made according to history and positive Dix-Hallpike maneuver [8].

The possible mechanism by which SARS- CoV-2 virus is implicated in the pathogenesis of BPPV are as follows:

1. Drugs and inflammation cause decalcification and damage the otoconia and cause BPPV [5].
2. Endothelial dysfunction involving cerebral venous hemodynamics [9].
3. Direct effect of the viral infection on the otolith membrane [10].
4. Direct cytopathic effect of virus, inflammatory response, cytokine storm, vascular event is also proposed [4].

Horizontal BPPV more than typical forms as patient placed in prone position to improve oxygenation modifies the course of positional vertigo [4].

### **Vestibular Migraine**

Numerous studies in vestibular migraine reported involving children, adolescent, adults [11,12]. It is defined as occurrence of migraine headache with either vertigo or non specific dizziness [13]. Risk factors include motion sickness or first degree relative with migraine [11].

Two cases of vestibular migraine were reported in COVID patients of paediatric age group. In the 1<sup>st</sup> case a previously healthy girl in middle childhood presented with intermittent dizziness, headache localized over the frontotemporal region, photophobia which precipitated following COVID infection. The case was diagnosed as vestibular migraine of childhood and was treated with Home-based vestibular rehabilitation [11].

The 2<sup>nd</sup> patient developed bilateral, throbbing temporal region headaches and imbalance following COVID-19 infection. The associated symptoms included photophobia and phonophobia. The case was

diagnosed as vestibular migraine of childhood. The patient was treated with flunarizine 5 mg daily, lifestyle modifications and home-based vestibular rehabilitation [11].

The possible mechanism by which SARS- CoV-2 virus is implicated in the pathogenesis of vestibular migraine are as follows:

1. Altered neural activity within the trigeminovascular system [14].
2. Substance P and calcitonin gene related peptide which are the main neuropeptides of trigeminovascular system cause vasodilatation and neurogenic inflammation leading to migraine headache are also expressed in vestibular system and thereby causing dizziness [14]. The substance P elevated in COVID [15].

Elevated neurotransmitter which triggered the trigeminovascular system may lead to vestibular migraine in children with COVID [11].

Stress found in COVID children could be a triggering factor for vestibular migraine [11].

### **Menieres Disease**

This disease affects people between 40-60 years and is characterized by stiffening of stereocilia that line the cochlea along with clinical features such as tinnitus, deafness, vertigo, dizziness and loss of balance leading to increase risk of falls [16–18]. Falls in case of menieres disease come without warning or loss of consciousness or neurologic symptoms and

are known as Tumarkin drop attacks or otolithic crisis [18].

COVID induced Menieres Disease causes impact on physical, social, psychological and financial dimensions of health [16].

The possible mechanism by which SARS- CoV-2 virus is implicated in the pathogenesis of Menieres disease are as follows:

1. Cochleitis can be caused by viral involvement of cochlea and perilymphatic tissues.
2. Embolus formation can cause disruption of microvascular structure in the inner ear and increase endolymph volume [19,20].
3. Damage to sensory cells of the cochlea may cause stiffening of stereocilia which line the cochlea [18,20]
4. Autoimmune dysfunction with viral antibodies attacking inner ear antigen [20].
5. Haemorrhage within the labyrinth [21].

### **Vestibular Neuritis**

Vestibular neuritis is a acute vestibular syndrome which is characterized by sudden onset of vertigo, nausea and vomiting, unsteady gait, head motion intolerance and spontaneous nystagmus lasting days to weeks [22,23]. This disorder is not associated with any auditory deficit [24].

Some of the cases of vestibular neuritis reported in COVID patients are as follows

A 13 year old girl with proven COVID-19 infection had severe sudden onset continuous rotatory vertigo, intractable vomiting, right spontaneous horizontal

nystagmus on physical examination, head impulse test positive for left side. Based on the findings a diagnosis of left side vestibular neuritis was made and vestibular rehabilitation was started [22].

Malayala et al. reported a case of vestibular neuritis in a COVID patient. The case was a female covid patient with intractable vertigo, nausea, vomiting diagnosed as vestibular neuritis [25].

The possible mechanism by which SARS- CoV-2 virus is implicated in the pathogenesis of Vestibular Neuritis are as follows:

1. SARS COV2 entry depends on ACE2 and TMPRSS2 receptors [26]. In mice these receptors found in mucosal epithelium in middle ear and also in inner ear [27]. These receptors act as a gate for virus to enter inner ear and cause vestibular neuritis.
2. Ischaemia of the vasa nervorum and demyelination caused by inflammatory process could cause vestibular neuritis [28].
3. Trigger reactivation of herpes simplex virus [24].

**Labyrinthitis**

This may be defined as inflammation of the membranous labyrinth of ear.

Peripheral vertigo is the hallmark symptom of labyrinthitis. The presence of hearing loss and tinnitus helps in differentiating it from vestibular neuritis and BPPV [29,30].

Common etiology are viral URTI, bacterial spread from infected middle ear meninges, autoimmunity, HIV, syphilis.

A labyrinthitis case was reported in which patient had a presentation of vertigo, hearing loss, tinnitus, and aural fullness. The patient was diagnosed as positive for COVID-19 by reverse transcription-polymerase chain reaction (RT-PCR) nine days prior to developing these symptoms. Patient was symptomatically treated with prochlorperazine thrice a day for up to four weeks [29].

The possible mechanism by which SARS- CoV-2 virus is implicated in the pathogenesis of Labyrinthitis is as follows:

1. The virus has neurotrophic and neuroinvasive properties which can affect several areas of nervous system which includes inner ear and cause labyrinthitis. The important studies discussed in this review article have been summarized in Table 1.

Table 1. Summary of studies reporting vestibular disorders in Covid-19 Patients

YEAR	STUDY	VESTIBULAR DISORDER
2021	Picciotti et al. [4]	BPPV
2021	Maslovara et al. [7]	BPPV
2022	Magrouni et al. [8]	BPPV
2023	Saniasiaya [11]	VESTIBULAR MIGRAINE
2023	Mat et al. [22]	VESTIBULAR NEURITIS
2020	Malayala et al. [25]	VESTIBULAR NEURITIS
2021	Bokhary et al. [29]	LABYRINTHITIS

### Conclusion and Future Directions

From the above discussion it is clear that SARS-CoV-2 may have role in etiopathogenesis of various vestibular disorder. Although the number of studies is very scarce and future research is to be done on this aspect of otorhinolaryngology.

Research may be conducted on this topic under the guidance of ICMR and Department Of Health Research [Ministry Of Health And Family Welfare] by which a database of patients who had dizziness/vertigo as a symptom during COVID Infection or Long COVID/Post COVID Syndrome may be created.

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### Ethics declarations

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### Conflict of interest

The author declare that they have no competing interests.

### Ethics approval, Consent to participate, Consent to publish, Availability of data and material, Code availability

Not applicable.

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