Overall, 15 papers were retrieved and 6 were included (Table 1).

In 5 French hospitals, over the period February-May 2020, comparing with 2018 and 2019, no significant increase in admission for acute peripheral vestibulopathy (APV) was observed. Moreover, significant differences among hospitals located in COVID-19 high- and low-risk zones, or significant increase in the severity of the APV cases was observed. Accordingly, a retrospective review of acute cochleovestibular disorders after and before pandemic conducted at our department found no significant changes regarding incidence of APV.

Only 6 cases of instrumentally confirmed VN simultaneous to COVID-19 have been reported to date, and two more cases occurred at our department. Differential diagnosis has to be considered regarding a first episode of Ménière’s disease or vestibular migraine attack, thus an accurate diagnostic workout should be mandatory.

The mechanism by which SARS-CoV-2 can cause VN is unclear and speculative. Motawea et al. supported viral and post-viral inflammatory disorders. Indeed, the cell receptor angiotensin-converting enzyme 2 (ACE2), which allows intracellular entry of SARS-CoV-2, has been found in nasal tissues in murine and human model and in Eustachian tube, middle ear and cochlear tissues in murine model. On the other hand, physical and emotional stress experienced by infected people could play a role in the expression of vestibular symptoms – as occurred for headache patients – or could have triggered the reactivation of possible latent viruses (e.g., HSV-1). The latter mechanism could be hypothesised especially in patients in which VN was not present at COVID-19 symptoms onset but later during the course of the disease [4, 5].

Dear Editor,

We read with interest the article by Motawea et al. reporting the case of a sudden vertigo in a 60-year-old woman with a confirmed Coronavirus-Disease-19 (COVID-19) [1]. The authors concluded that Severe-Acute-Respiratory-Syndrome-Coronavirus-2 (SARS-COV-2) may lead to vestibular neuritis (VN), but more well-designed observational studies with a larger sample size are needed to establish a definite association between COVID-19 and vertigo.

The incidence of vestibular disorders in COVID-19 patients is still unknown and varies across different studies. We reviewed the international literature of COVID-19-related vestibular disorders and the electronic database at our department, a tertiary referral centre for audiovestibular disorders. In January 2022 a structured search of the English literature published on PubMed was performed by searching the terms “vestibular neuritis” and “COVID-19”. Only inherent reports with SARS-CoV-2-positive patients, as confirmed by molecular nasopharyngeal swab, and with detailed clinical and diagnostic data were considered.

1 Department of Medicine - DIMED, University of Padua, Treviso, Italy
2 Department of Neurosciences, University of Padua, Treviso, Italy
3 Unit of Otolaryngology, Treviso Hospital, AULSS 2, Treviso, Italy
4 Unit of Audiology, Treviso Hospital, AULSS 2, Treviso, Italy
5 Unit of Otolaryngology and Regional Centre for Head and Neck Cancer, Treviso Hospital, AULSS 2, Treviso, Italy

Keywords SARS-CoV-2 · COVID-19 · Audiovestibular disorders · Vertigo · Dizziness · Audiovestibular evaluation

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Letter to the Editor in Reference to “New Onset Vertigo After COVID-19 Infection” – COVID-19-related Vestibular Neuritis: Case Series and Review of the Literature

Andrea Frosolini2,4✉ · Daniela Parrino2,4✉ · Cristoforo Fabbris1,3✉ · Giacomo Spinato3,4,5✉ · Cosimo de Filippis2,4✉

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✉ Correspondence: Cristoforo Fabbris
cristoforo.fabbris@gmail.com

Cristoforo Fabbris

1 Department of Medicine - DIMED, University of Padua, Treviso, Italy
2 Department of Neurosciences, University of Padua, Treviso, Italy
3 Unit of Otolaryngology, Treviso Hospital, AULSS 2, Treviso, Italy
4 Unit of Audiology, Treviso Hospital, AULSS 2, Treviso, Italy
5 Unit of Otolaryngology and Regional Centre for Head and Neck Cancer, Treviso Hospital, AULSS 2, Treviso, Italy

1 3
| 1st Author (year of publication) | Sex, age | Comorbidity and any AV past history | COVID-19 classification - duration - symptoms | AV Symptoms, - Days from COVID-19 positivity to onset | Evaluation | Vestibular signs | Diagnosis | Therapy | Follow-up and outcome |
|---------------------------------|----------|-----------------------------------|---------------------------------------------|---------------------------------------------|-----------|----------------|----------|---------|----------------------|
| Mat (2021)<sup>1</sup>          | F, 13    | NR                               | Mild - NR                                   | Rotatory vertigo, vomiting – 0              | VNG; vHIT; ENT and neurological evaluation; audiometry | Right spontaneous Ny; left deviation (Fukuda test) | Left COVID-19-induced vestibular neuritis | VR | 1 month, symptom resolution |
| Vanaparthy (2020)<sup>2</sup>   | F, 63    | Aplastic anemia, mitral valve prolapse, celiac disease. Motion sickness | Mild - 2 month - GS, facial spasm, anosmia, disgeusia, skin rash, Raynaud’s phenomenon | Rotatory vertigo, vomiting, unsteady gait – 65 | VNG, ENT and neurological evaluation | Right spontaneous Ny | Left COVID-19-induced vestibular neuritis | 60 mg oral prednisone, 10 days tapered; VR | NR |
| Malayala (2021)<sup>3</sup>     | F, 31    | NR                               | Mild - NR - GS                              | Rotatory vertigo, unsteady gait – 13        | MRI brain; ENT and neurological evaluation; audiometry | NR | COVID-19-induced vestibular neuritis | 60 mg oral prednisone, 10 days tapered; VR | 1 month, symptom resolution |
| Malayala (2021)<sup>3</sup>     | F, 29    | NR                               | Moderate - NR - NR                          | Rotatory vertigo, vomiting – 0              | CT chest; CT cerebral; MRI brain; ENT and neurological evaluation; audiometry | NR | COVID-19-induced vestibular neuritis | Intra-venous steroids (DNS); VR | NR |
| Giannantonio (2021)<sup>4</sup>| M, 13    | NR                               | Mild - NR - GS                              | Rotatory vertigo, vomiting, unsteady gait – 0 | MRI brain; ENT evaluation; audiometry | Right spontaneous Ny, positive HIT | Left COVID-19-induced vestibular neuritis | 20 mg intra-venous prednisone, 10 days tapered | 1 month, symptom resolution |
| Aasfara (2021)<sup>5</sup>     | F, 36    | Pregnancy (37 weeks)            | Mild - NR                                   | Rotatory vertigo, vomiting, right ear hipoacusia – 42 | MRI brain, VNG with Caloric test, ENT evaluation, audiometry, electromyography, lumbar puncture | Left spontaneous Ny, Hyporeflexia | Right COVID-19-induced cochlear-vestibulopathy and facial palsy | Intra-venous steroids (DNS); VR | 1 month, symptom resolution |

Table 1 Clinical data, evaluation, diagnosis treatment and outcome of the patients from literature review on vestibular neuritis and COVID-19, including the present cases report.
To the best of our knowledge, even if COVID-19 infection seems not to increase the risk of VN occurrence, it would be appropriate to routinely test for SARS-CoV-2 infection patients with diagnosed VN. Moreover, prospective studies on a large series of COVID-19 patients should try to better define the epidemiology of cochlear-vestibular involvement and elucidate the SARS-CoV-2-related prognosis on peripheral and central audiovestibular functions. Among patients that can’t be easily visited due to quarantine regimen, a telemedicine evaluation could be helpful.

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Conflict of Interest No funds, grants, or other support was received. The authors have no relevant financial or non-financial interests to disclose.

Table 1 (continued)

| 1st Author (year of publication) | Sex, Age | Comorbidity and any AV past history | COVID-19 classification - duration - symptoms | AV Symptoms, - Days from COVID-19 positivity to onset | Evaluation | Vestibular signs | Diagnosis | Therapy | Follow-up and outcome |
|---------------------------------|---------|-------------------------------------|-------------------------------------|-------------------------------------|-----------|----------------|-----------|---------|----------------------|
| Frosolini (present letter)      | F, 31   | None                                | Mild – 1 month - GS anosmia, dysgeusia | Rotatory vertigo, vomiting, unstable gait – 2 | VNG with Caloric test, ENT evaluation, audiometry | Hyporeflexia | Left COVID-19 induced vestibular neuritis | VR       | 1 month, symptom resolution |
| Frosolini (present-M, 44 None)  | None    | Mild – 9 days - GS anosmia, dysgeusia | Rotatory vertigo, vomiting, unstable gait – 32 | VNG with Caloric Left spontaneous Ny, positive HIT | Right COVID-19 induced vestibular neuritis | VR       | 50 mg oral prednisone, symptom resolution | 10 days tapered; VR |

Abbreviations: Audiovestibular (AV), Coronavirus Disease 19 (COVID-19), Computed Tomography (CT), Drug Not Specified (DNS) Ear Nose and Throat (ENT), General symptoms like fever, fatigue, miastenia, and cough (GS), Head Impulse Test (HIT), Magnetic Resonance Imaging (MRI), Not Reported (NR), Nystagmus (Ny), video Head Impulse Test (vHIT), Videonystagmography (VNG), Vestibular Rehabilitation

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