

The new coronavirus (SARS-CoV-2) as a cause of dizziness in the COVID-19 pandemic

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COVID-19

The pandemic of the coronavirus disease that began in 2019 (COVID-19) has posed a range of challenges for patients and for physicians. Its observed consequences are changing rapidly, and our understanding of the disease itself is evolving.

How COVID-19 attacks the body

The pathogen (technically called “severe acute respiratory syndrome coronavirus type 2” or “SARS-CoV-2”) belongs to a family of coronaviruses, which are single-stranded RNA viruses contained in a lipid bilayer envelope from which there protrude spike glycoproteins that comprise the “hooks” that let the viruses gain entry into host cells, where they replicate and whence they propagate. These “hooks” attach particularly well to angiotensin-converting enzyme receptors (Ceccarelli, Berretta M Fau - Venanzi Rullo et al. 2020, Yan, Zhang et al. 2020) that are densely expressed in cells in the lungs, which is thought to be why some of the initial and most prominent symptoms of infection involve the respiratory tract, though unfortunately, the disease is not limited to the respiratory tract.

How COVID-19 attacks the brain:

The mechanism by which coronaviruses enter the central nervous system (CNS), and the factors that make specific people vulnerable to this, are incompletely understood (Dales 1995, Dube, Le Coupanec et al. 2018), though recent evidence (Baig, Khaleeq et al. 2020) has demonstrated that there are cells within the CNS that express angiotensin converting enzyme receptors — albeit at a lower density than in the lower respiratory tract. In any case, once the viruses have gained entry into the CNS, they appear capable of advancing by axonal transport (Dube, Le Coupanec et al. 2018).

Other members of the coronavirus family have long been known to invade the central nervous system, and have been found the brain/spinal cord tissue or the cerebrospinal fluid of patients suffering from a variety of neurological diseases, prominent among which are multiple sclerosis (Burks, DeVald et al. 1980, Salmi, Ziola et al. 1982, Hovanec and Flanagan 1983), Parkinson’s disease (Fazzini, Fleming et al. 1992), optic neuritis (Dessau, Lisby et al. 1999), encephalitis (Arabi, Harthi et al. 2015, Li, Li et al. 2016, Morfopoulou, Brown et al. 2016, Nilsson, Edner et al. 2020) and acute disseminated encephalomyelitis (Yeh, Collins et al. 2004). In some of these diseases (e.g., optic neuritis, encephalitis and encephalomyelitis) it is reasonable to suspect that the virus itself is the cause of the disease, while in other conditions (e.g., multiple sclerosis, Parkinson’s disease) it is unclear whether the virus has any causative role.

Early in the pandemic it was noted that patients infected with COVID-19 could exhibit neurologic symptoms (Koralnik and Tyler 2020, Pinzon, Wijaya et al. 2020), particularly when the illness was severe enough to warrant hospitalization (Liotta, Batra et al. 2020) and

management in an intensive care unit (Pinna, Grewal et al. 2020). The accumulating evidence (Filatov, Sharma et al. 2020, Nath 2020, Poyiadji, Shahin et al. 2020) specifically about the virus causing COVID-19 suggests that it can affect the CNS similarly to other members of coronavirus family (Zubair, McAlpine et al. 2020), though there are differences as well (Ceccarelli, Berretta M Fau - Venanzi Rullo et al. 2020), such as its apparent predilection to impair smell and taste (Gautier and Ravussin 2020, Giacomelli, Pezzati et al. 2020, Mao, Jin et al. 2020, Mermelstein 2020, Vavougiou 2020). It is thus reasonable to consider whether it might also be the mechanism for other focal neurological manifestations, including the auditory and vestibular disorders that we see in clinic — though to be clear, this disease is so new that there has not yet been adequate opportunity to study this in any systematic fashion. Emerging clinical literature (Saniasiaya and Kulasegarah 2021) describes dizziness as a symptom associated with COVID-19, which matches our own clinical experience; a few months into the pandemic we began encountering patients with a laboratory-confirmed diagnosis of COVID-19 who complained of dizziness.

COVID-19 as the cause of hearing disorders and vertigo/imbalance

Literature is accumulating regarding an association between COVID-19 and **hearing loss** (Degen, Lenarz et al. 2020, Kilic, Kalcioğlu et al. 2020, Koumpa, Forde et al. 2020, Lamounier, Franco Goncalves et al. 2020, Munro, Uus et al. 2020, Bhatta, Sharma et al. 2021, Chari, Parikh et al. 2021, Chern, Famuyide et al. 2021, Chern, Famuyide et al. 2021, Chirakkal, Al Hail et al. 2021, De Luca, Scarpa et al. 2021, Dusan, Milan et al. 2021, Edwards, Muzaffar et al. 2021, Fancello, Hatzopoulos et al. 2021, Fidan, Akin et al. 2021, Formeister, Chien et al. 2021, Gerstacker, Speck et al. 2021, Gosavi, Nagarajan et al. 2021, Rahimi, Asiyabar et al. 2021, Ricciardiello, Pisani et al. 2021, Saniasiaya 2021, Vielsmeier, Marcrum et al. 2021).

A smaller, but growing literature is also beginning to document an association between COVID-19 and **tinnitus** (Beukes, Baguley et al. 2020, Liang, Xu et al. 2020, Munro, Uus et al. 2020, Beukes, Ulep et al. 2021, Chirakkal, Al Hail et al. 2021, Elibol 2021, Gosavi, Nagarajan et al. 2021, Narozny, Tretiakow et al. 2021).

A large case series (799 patients) from Wuhan described **dizziness** as a symptom in 8% of confirmed COVID-19 patients (Chen, Wu et al. 2020), though another study (214 patients) from Wuhan specifically querying neurological symptoms among confirmed cases of COVID-19 reported dizziness in 16.8% of patients (Mao, Jin et al. 2020); a study from a network of Chicago area hospitals (509 patients) reported dizziness in 29.7% of cases (Liotta, Batra et al. 2020). Reviews of the emerging literature note this variability among studies (Saniasiaya and Kulasegarah 2021), though it is clear that there is increasing recognition of an association between COVID-19 and vestibular disorders (Fancello, Hatzopoulos et al. 2021). The ability of COVID-19 to cause auditory and vestibular symptoms appears to be distinct from the other SARS coronaviruses (Almufarrij, Uus et al. 2020).

In view of the emerging evidence of cochlear symptoms (hearing loss, tinnitus) and vestibular symptoms (dizziness) occurring in the context of COVID-19 infection, most reviews of this

subject are concluding that the relationship between COVID-19 and audiovestibular dysfunction may be causal rather than simply associative (Almufarrij, Uus et al. 2020, Karimi-Galougahi, Naeini et al. 2020, Maharaj, Bello Alvarez et al. 2020, AlJasser, Alkeridy et al. 2021, Almufarrij and Munro 2021, Chao and Young 2021, Fancello, Hatzopoulos et al. 2021, Gallus, Melis et al. 2021, Jafari, Kolb et al. 2021, Tan, Cengiz et al. 2021, Viola, Ralli et al. 2021, Wichova, Miller et al. 2021).

The mechanism by which COVID-19 may cause audiovestibular dysfunction is unclear; since the disease appears to be capable of affecting individual cranial nerves — as happens in anosmia (Gautier and Ravussin 2020, Giacomelli, Pezzati et al. 2020, Mao, Jin et al. 2020, Mermelstein 2020, Vavougios 2020), optic neuritis (Dessau, Lisby et al. 1999) and ophthalmoparesis (Dinkin, Gao et al. 2020) — it is conceivable that it causes vestibular neuritis (Malayala and Raza 2020, Vanaparthi, Malayala et al. 2020, Mat, Noel et al. 2021) and/or cochlear neuritis, or labyrinthitis, though this remains a conjecture requiring further study. Whether COVID-19 increases the risk for specific otologic diseases, such as Ménière's disease (Lovato, Frosolini et al. 2021) and benign paroxysmal positional vertigo (Picciotti, Passali et al. 2021), remains unclear.

In some patients COVID-19 appears to provoke autonomic dysfunction (Eshak, Abdelnabi et al. 2020, Dani, Dirksen et al. 2021, Goodman, Khoury et al. 2021, Lo 2021, Shouman, Vanichkachorn et al. 2021), so another mechanism by which COVID-19 may provoke dizziness is through orthostatic intolerance, usually as postural orthostatic tachycardia (Kanjwal, Jamal et al. 2020, Miglis, Prieto et al. 2020, Novak 2020, Blitshteyn and Whitelaw 2021, Goldstein 2021, Johansson, Ståhlberg et al. 2021, Schofield 2021).

Vaccines for COVID-19

As of this writing several vaccines have received emergency-basis permission from the FDA for use (Polack, Thomas et al. 2020, Baden, El Sahly et al. 2021, Sadoff, Gray et al. 2021). We have received questions from patients regarding whether the vaccines themselves can cause otovestibular symptoms, or exacerbate a pre-existing otovestibular diseases. There are still insufficient data to answer these questions. Our experience so far has been that (1) apparent adverse effects from the vaccines have been transient, lasting up to several days; (2) although symptoms from COVID-19 infection itself can be very mild, they can also be devastating (if a patient survives) or lethal. On the whole, the potential protection conferred by receiving the vaccines appears greatly to outweigh the risk of the vaccines.

Can the vaccines for COVID-19 cause dizziness?

The literature regarding adverse effects from the **Pfizer** vaccine (BNT162b2 mRNA) is somewhat difficult to interpret as it pertains to this symptom. The original trial (Polack, Thomas et al. 2020) of 43,548 participants (of whom 21,720 received the intervention) does not list dizziness/vertigo as an adverse event, even in the supplementary material. In contrast, in a much smaller study Kadali, Janagama et al. 2021) of 1,245 recipients of the vaccine, of 803 patients with “generalized” or “neurological” symptoms, 67 (8.34%) reported “dizziness,” and

20 (2.49%) reported “vertigo.” There has been a case report of postural orthostatic tachycardia occurring after administration of this vaccine (Reddy, Reddy et al. 2021).

The literature regarding adverse effects from the **Moderna** vaccine (mRNA-1273) is also difficult to interpret as it pertains to this symptom. The original trial (Baden, El Sahly et al. 2021) studied 30,420 participants (15,210 received the vaccine), and the supplementary material reported adverse effects of “dizziness” and “vertigo” as occurring in zero individuals. In contrast, a much smaller study (Kadali, Janagama et al. 2021) of 432 vaccine recipients (Kadali, Janagama et al. 2021) stated that 15 (3.47%) reported “vertigo like symptoms” and 63 (14.58%) reported “dizziness.”

The original trial (Sadoff, Gray et al. 2021) of the **Johnson & Johnson** vaccine (Ad26.COV2.S) studied 39,260 participants (of whom 19,630 received the vaccine). The trial’s supplementary material reported “dizziness” in 0 vaccine recipients, and “vertigo” in 0 vaccine recipients. However, the product monograph (<https://www.rcdhu.com/wp-content/uploads/2021/03/janssen-covid-19-vaccine-product-monograph.pdf>) reviewed data from 43,783 participants (of whom 21,895 received the vaccine) stated that the symptom of “vertigo” was reported by 13 patients in the treatment group and 7 patients in the placebo group.

Can the vaccines for COVID-19 cause hearing loss?

As of this writing, an analysis of publicly available data from the Centers for Disease Control’s Vaccine Adverse Effects Reporting System (CDC VAERS) pertaining to the two mRNA vaccines (Pfizer and Moderna) revealed 40 cases of what was believed to be unilateral sensorineural hearing loss (confirmed on audiometric testing) deemed “most likely” to be attributable to the vaccines themselves (Formeister, Chien et al. 2021). These data suggested that the unilateral hearing loss occurred within 3 weeks (mean 4 days) of having received the vaccines, and had an incidence of 0.3 cases per 100,000 individuals (i.e., 3 per million).

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