

Ongoing Dizziness Following Acute COVID-19 Infection: A Single Center Pediatric Case Series

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BACKGROUND: Dizziness is a common concern discussed at adolescent medical visits. In this series, we describe 9 pediatric patients with postacute sequelae of severe acute respiratory syndrome coronavirus disease 2 (SARS-CoV-2) who presented with persistent, debilitating dizziness for weeks to months after their acute infection.

METHODS: Among the 9 patients, median age was 14 years (range: 11 to 17), 6 were female, and 8 had not received any SARS-CoV-2 vaccines. Five patients met diagnostic criteria for postural orthostatic tachycardia syndrome (POTS) by active standing testing and benefited from a combination of nonpharmacologic therapy (NPT) and medication.

RESULTS: NPT alone did not improve symptoms in any patients. Patients who did not meet conventional criteria for POTS, but continued to have symptoms despite NPT compliance, also demonstrated subjective improvement in dizziness when medications were initiated. The majority of patients experienced improvement in dizziness and quality of life, including returning to sports teams and a regular school schedule.

CONCLUSIONS: A review of the postacute sequelae of SARS-CoV-2 literature demonstrates increasing recognition of a subset of patients who develop autonomic dysfunction, including POTS, although the etiology and prognosis are not completely understood. Our case series aims to highlight the phenomenon of dysautonomia after acute SARS-CoV-2 infection and its response to therapy.

A variety of persistent and substantial nonspecific symptoms can be seen following severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infections.¹⁻³ This phenomenon has been described by many names including postacute sequelae of SARS-CoV-2 (PASC), post coronavirus disease (COVID) syndrome, and long COVID. Although these patients may not have a detectable viral load, they report a plethora of symptoms ranging from ongoing respiratory or gastrointestinal (GI) concerns to neurologic disabilities, including difficulty with concentration, focus, and headaches.⁴ A subset have

issues with orthostatic intolerance, which is the focus for this case series.⁵⁻⁷

Risk factors for the development of PASC have not been established. Patients with even mild acute SARS-COVID illnesses can develop PASC. These persistent autonomic symptoms have been described in adult patients,^{8,9} but there have been no reported pediatric case series. In this series, we describe our single center experience treating pediatric PASC patients who present with new onset and persistent dizziness. We hope to enable primary care providers to more easily recognize

abstract

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CONFLICT OF INTEREST DISCLOSURES: The authors have indicated they have no conflicts of interest to disclose. We present our experience treating 9 pediatric and adolescent patients experiencing lingering, and at times debilitating, symptoms of dizziness post coronavirus disease.

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these patients and initiate management.

METHODS

We performed a retrospective chart review for patients referred to pediatric cardiology for persistent dizziness from July to December 2021. This study was reviewed and approved by our center’s Institutional Review Board. All patients were referred from our center’s Pediatric COVID Recovery clinic, which treats patients whose

symptoms persist greater than 4 weeks after acute infection. At the initial cardiology consultation, all patients underwent active standing testing (AST). AST has been reported to be sufficient for diagnosis or treatment initiation in most patients,¹⁰ and was performed in lieu of tilt table testing (TTT) because of the convenience and immediate results of in-office testing. Figure 1 outlines how AST was performed, and how autonomic diagnosis was categorized (ie, postural orthostatic tachycardia

syndrome [POTS], orthostatic hypotension, or orthostatic intolerance).

The pediatric cardiologist obtained a complete history at all visits. This included timing or severity of acute SARS-CoV-2 infection, postacute sequelae symptoms, time between infection and PASC presentation, SARS-CoV-2 vaccination status, and lifestyle questions, including diet and hydration status, sleep hours, and exercise habits. All patients had a baseline electrocardiogram

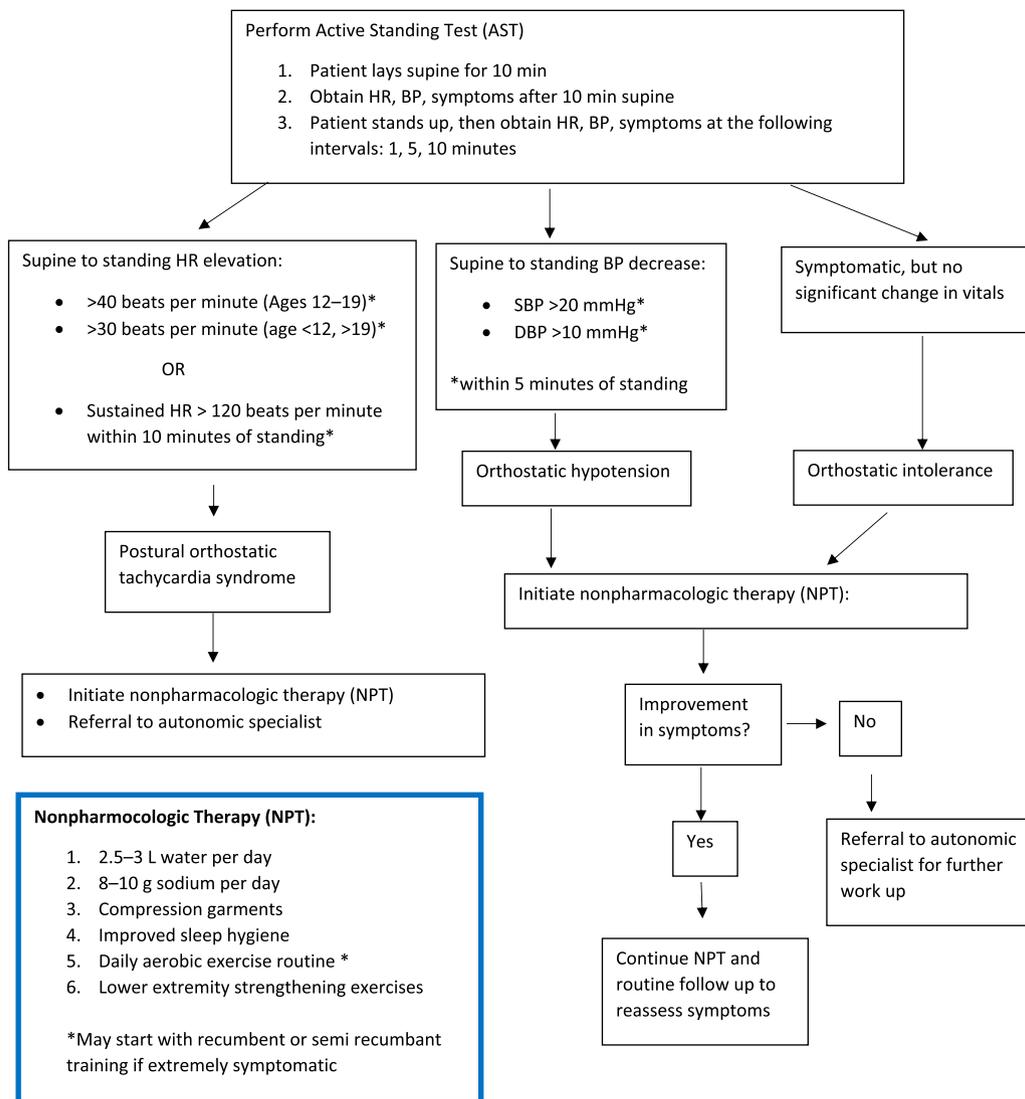


FIGURE 1

Clinical practice algorithm for management of dizzy long COVID patients. AST, active stand testing; BP, blood pressure; DBP, diastolic blood pressure; HR, heart rate, NPT, nonpharmacologic therapy; POTS, postural orthostatic tachycardia syndrome; SBP, systolic blood pressure.

TABLE 1 Clinical Characteristics of Patients

| Patient | Age | Sex | Ethnicity | COVID Vaccine Status Before Chronic Symptoms | Acute COVID Presentation | Most Prominent Post-COVID Symptoms | Autonomic Disorder | Treatment | Patient-Reported Dizzy Symptoms at Follow Up Appointment | Additional Information |
|---------|-----|-----|-----------|--|---|--|--------------------|----------------------|--|--|
| 1 | 17 | F | C | No | Mild: respiratory syndrome, pharyngitis, anosmia | Difficulty concentrating, fatigue, dizziness, DOE, anxiety | POTS | NPT, fludrocortisone | Symptoms resolved, returned to sports | <ul style="list-style-type: none"> • HS athlete, stopped sports; • history of anxiety, depression, migraines; • hospitalization for anxiety before treatment |
| 2 | 13 | M | C | No | Mild: fever, respiratory syndrome, anosmia, dysgeusia | Dizziness, DOE | POTS | NPT, atenolol | Symptoms resolved, returned to sports | <ul style="list-style-type: none"> • History of gastric ulcer and nonalcoholic fatty liver disease; • HS athlete; stopped sports |
| 3 | 13 | F | C | No | Mild: fever, respiratory syndrome, pharyngitis, dysgeusia | Dizziness, fatigue, anxiety | OI | NPT, CBT | Residual symptoms, noncompliant with NPT | <ul style="list-style-type: none"> • History of anxiety |
| 4 | 11 | F | C | No | Mild: respiratory syndrome, pharyngitis, anosmia, dysgeusia | Dizziness, fatigue, HA | POTS | NPT, midodrine | Symptoms improved, but has occasional flairs | <ul style="list-style-type: none"> • History of asthma, anxiety, recurrent UTIs; • trialed fludrocortisone without improvement first |
| 5 | 13 | F | H | No | Mild: GI symptoms, anosmia, dysgeusia | Dizziness, CP | POTS | NPT, fludrocortisone | Symptoms resolved, back in school | <ul style="list-style-type: none"> • Modified school schedule secondary to PASC symptoms; • history of ADHD, anxiety • History of mild positional dizziness |
| 6 | 15 | F | C | Yes | Mild: fever, respiratory syndrome | Dizziness, fatigue | OI | NPT, fludrocortisone | Symptoms resolved | <ul style="list-style-type: none"> • History of mild positional dizziness |
| 7 | 13 | F | C | No | Mild: respiratory syndrome, anosmia, dysgeusia | Dizziness, GI syndrome | POTS | NPT, fludrocortisone | Symptoms resolved, returned to sports | <ul style="list-style-type: none"> • Previously healthy athlete; • HS athlete, stopped sports |
| 8 | 14 | M | C | No | Mild: respiratory syndrome, anosmia, dysgeusia | GI syndrome, dizziness, fatigue | OI | NPT, midodrine | Residual symptoms, ongoing work up. | <ul style="list-style-type: none"> • Previously healthy; • HS athlete, stopped sports, attending school with modified schedule • no improvement on fludrocortisone. • Previously healthy |
| 9 | 14 | M | C | No | Mild: fever | Dizziness, fatigue | OI | NPT, fludrocortisone | Symptoms improved, but has occasional flairs | <ul style="list-style-type: none"> • Previously healthy |

ADHD, attention hyperactivity deficient disorder; C, Caucasian; CBT, cognitive behavioral therapy, CP, chest pain; DOE, dyspnea on exertion; GI, gastrointestinal; H, Hispanic; HA, headache; HS, high school; NPT, nonpharmacologic treatment (increased fluids and salt intake, compression stockings, exercise, sleep training); OI, orthostatic intolerance; PASC, post-acute sequelae of SARS-CoV-2; POTS, postural orthostatic hypotension.

performed. If indicated, patients underwent additional testing, including echocardiogram, cardiac monitor, cardio-pulmonary exercise testing, and/or laboratory testing.

The severity of symptoms was categorized per National Institute of Health guidelines as mild, moderate, or severe. Mild signs and symptoms included fever, cough, sore throat, malaise, headache, myalgia, GI symptoms, and loss of taste or smell, in the absence of shortness of breath, dyspnea, or abnormal chest imaging. A patient had moderate disease symptoms if there was clinical evidence of lower respiratory disease or SpO₂ <94%. Severe symptoms included SpO₂

<94% on room air, PaO₂ or FIO₂ <300 mm Hg, respiratory rate >30 breaths per minute, or lung infiltrates >50%.¹¹

All patients were seen for outpatient follow-up 1 to 2 weeks after therapy initiation or subsequent change in therapies and have outcomes reported through 2 months.

RESULTS

A total of 9 patients (67% female) with median age 14 (range: 11 to 17) were included. All patients reported daily dizziness, lightheadedness, or unsteadiness with positional changes. The interval from acute SARS-CoV-2 infection to symptom onset was a median of

7 days (range 0–120 days). Before their acute illness, all patients attended school, and many participated in competitive sports. Four patients had been previously diagnosed with anxiety. One patient reported occasional positional dizziness before SARS-CoV-2 infection. Patient clinical characteristics and a summary of findings are listed in Table 1 and 2 respectively.

Acute Illness

All patients experienced mild acute symptoms of SARS-CoV-2 infection and the majority reported fever and upper respiratory symptoms. Only 1 patient had been fully vaccinated before SARS-CoV-2 infection.

TABLE 2 Summary of Findings: PASC and POTS

| | Number of Patients (%) |
|--|------------------------|
| Sex | |
| Female | 6 (67) |
| Male | 3 (33) |
| Preexisting conditions | |
| None | 4 (44) |
| Positional dizziness | 1 (11) |
| Anxiety | 3 (33) |
| Asthma | 1 (11) |
| Acute COVID infection severity | |
| Asymptomatic | 0 (0) |
| Mild | 9 (100) |
| Moderate | 0 (0) |
| Severe | 0 (0) |
| Critical | 0 (0) |
| Acute COVID-19 presentation | |
| Fever | 6 (67) |
| Upper respiratory symptoms | 5 (56) |
| GI symptoms | 1 (11) |
| Anosmia and/or ageusia | 5 (56) |
| Postacute sequelae symptoms | |
| Dizziness | 9 (100) |
| Fatigue | 7 (78) |
| Headaches | 2 (22) |
| Difficulty concentrating | 1 (11) |
| Dyspnea on exertion | 2 (22) |
| Nausea, vomiting, or depressed appetite | 1 (11) |
| Anxiety | 2 (22) |
| Active standing test results | |
| POTS | 5 (56) |
| Negative | 4 (44) |
| Self-reported symptoms at time of 1–2 wk follow up | |
| Symptoms resolved | 5 (56) |
| Some improvement but occasional flairs | 2 (22) |
| No change | 2 (22) |
| Worsening symptoms | 0 (0) |
| COVID vaccination status | |
| Fully vaccinated before PACS diagnosis | 1 (11) |
| Fully vaccinated after PACS diagnosis | 3 (33) |
| Never vaccinated | 5 (56) |

Post COVID 19

In addition to the cohort's common symptom of dizziness, several patients also reported extreme fatigue. Many reported alterations in their activities of daily living, with 4 athletes reporting cessation of sport participation and 2 modifying school schedules. Additionally, 2 of the 4 patients with pre-COVID 19 anxiety did report a significant increase in anxiety symptoms and one required hospitalization for anxiety.

AST results were consistent with a POTS diagnosis in 5 patients. The

other 4 patients had a normal heart rate and blood pressure response for age and were diagnosed with orthostatic intolerance. All patients were first counseled on nonpharmacologic therapy (NPT), which included increased fluid and salt intake, use of compression garments, isometric exercises, increased caloric intake, and improved sleep hygiene (Fig 1). Additionally, all patients continued treatment through the COVID Recovery Clinic, and some received supplementary therapies including dietary modifications, acupuncture, massage, cognitive behavioral

therapy, or medications for comorbid conditions such as anxiety, headaches, or GI concerns.

All patients' electrocardiograms were normal. Patients who underwent additional cardiac or laboratory testing had no abnormal findings.

Response to Therapy

No patient experienced a subjective improvement in dizziness with NPT alone. All POTS patients were initiated on medications. Although several medications are used for treatment of POTS, we used fludrocortisone, midodrine, or β blockers based on the clinical scenario. Each medication was trialed for 1 to 2 weeks to determine effectiveness before dose or medication changes. Three patients without POTS also trialed medications as they had persistent daily symptoms despite compliance with nonpharmacologic therapy.

Although follow-up times were not standardized because of retrospective nature of the study, 4 of 5 patients with POTS and 1 patient without POTS described near full resolution of dizzy symptoms within 1 week after medication optimization. Many also reported significant improvement in concentration and reduction in fatigue. All improved sufficiently to returned to school and sports, with the exception of 1 patient without POTS who continued to experience symptoms despite NPH compliance and medication trials. Work-up is ongoing (Table 2).

DISCUSSION

In our case series, we found that POTS and other common autonomic disorders can persist for weeks to months following a mild SARS-CoV-2 infection in teenagers. These symptoms can be challenging to manage and can affect adolescents'

TABLE 3 Characteristics of POTS Versus Non-POTS Cohorts

| Characteristics of POTS Versus Non-POTS Cohorts | | |
|--|---------------|-------------------|
| | POTS Patients | Non-POTS Patients |
| Number of patients | 5 | 4 |
| Age range (median) | 11–17 (13) | 13–15 (14.5) |
| % Female | 100 | 50 |
| No preexisting conditions, <i>n</i> (%) | 2 (40) | 2 (50) |
| Improvement with NPT alone, <i>n</i> (%) | 0 (0) | 0 (0) |
| Medications trialed, <i>n</i> (%) | 5 (100) | 3 (75) |
| Outcomes with NPT or medications: self-reported symptom resolution, <i>n</i> (%) | 4 (80) | 1 (25) |
| Self-reported symptom improvement, <i>n</i> (%) | 1 (20) | 1 (25) |
| No change in symptoms, <i>n</i> (%) | 0 (0) | 2 (50) |

NPT, nonpharmacologic therapy (increased water and salt intake, compression stockings, improved diet, improved sleep hygiene); POTS, postural orthostatic tachycardia syndrome.

school and exercise participation. Most of our patients demonstrated significant improvement after a combined regimen of lifestyle modifications and medications commonly used in the management of POTS.

Dysautonomia is a broad term that encompasses multiple disorders of the autonomic nervous system (ANS). The ANS controls involuntary body functions such as breathing, digestion, and heart rate and blood pressure regulation. The most common forms of dysautonomia in younger patients involve orthostatic intolerance, which includes POTS and orthostatic hypotension.

It has been recognized that SARS-CoV-2 infection can affect the ANS,¹² but many questions remain regarding etiology, prognosis, and treatment.¹³ Proposed causal theories include direct viral damage to the ANS, an endogenous inflammatory response, and an immune-mediated response triggered by viral component(s).¹

POTS is the most common type of dysautonomia in youth and occurs with greater frequency in females. In addition to a significant increase in HR following positional changes, a number of other symptoms are commonly associated with POTS, including nausea and abdominal

pain, fatigue, disturbed sleep, and headaches. Understanding of pathophysiology is incomplete, but contributing factors may include excessive venous pooling, hypovolemia with volume dysregulation, peripheral autonomic neuropathy, hyperadrenergic states, mast cell activation disorders, or autoimmunity.¹⁴ Antecedent infection has been reported as the inciting factor for many adolescent patient with POTS. Although POTS is considered to be a chronic illness, 1 study reports that the vast majority of adolescents do experience improvement in symptoms but only 19% of patients report complete symptom resolution 5 years after initial onset of symptoms.¹⁵ Another prospective study in adults reported symptomatic improvement at 1 year at which time one-third of patients no longer met tilt table test criteria for POTS.¹⁶

We acknowledge the limitations in this series that include the retrospective design, the absence of a control group, small sample size, limited testing equipment, subjective determination of severity of symptoms, and short term follow-up. Given these limitations, we cannot say if our patients with POTS will follow the typical trajectory of sustained symptom

improvement, but our initial results are encouraging.

We also acknowledge that we cannot draw a firm association between POTS and anxiety because of to the small sample size of our series. Further studies should focus on this possible association. Current literature has suggested anxiety related to POTS may be somatic anxiety (rather than cognitive) as a response to patients' increase mindfulness of physical symptoms.^{17,18} There may be a role for psychotherapy in these patients.

Additionally, although we promote SARS-CoV-2 vaccine safety and efficacy with our families, vaccine refusal reasons were not documented. Future studies should examine the spectrum of PASC symptoms in vaccinated versus unvaccinated patients.

Given our limited experience, we suspect refractory cases of orthostatic intolerance may benefit from medication prescribed by an ANS specialist in addition to NPT to optimize treatment (Fig 1). Despite not meeting standardized POTS criteria, symptoms from our 4 patients without POTS were nearly identical to the POTS group. Ultimately, 3 of 4 adolescents were treated in the same way as the POTS cohort given that patient symptoms persisted despite compliance with NPT. Once medications and NPT were optimized, 2 patients did report improvement suggesting a similar etiology to our patients with POTS. These patients may have met criteria for POTS if they underwent further testing such as TTT given the ability to obtain more vital signs over a longer period than simple standing testing. One study did demonstrate that the TTT and AST were not always interchangeable.¹⁹ As stated earlier, 1 patient without POTS continues to report no change in symptoms despite conventional

treatment. Work-up is ongoing. (Table 3).

Dizziness following SARS-CoV-2 infection is becoming an increasingly common, yet frustrating problem. Our case series demonstrates promising symptom improvement with a combination of lifestyle changes and medication therapy. Well-powered multicentered, prospective studies and analysis of universal cohorts, such as the National Institutes of Health SARS-CoV-2 Recovery Cohort, will be important for improved prognostication and determination of most effective treatments.

ABBREVIATIONS

AST: active standing test

PASC: postacute sequelae of severe acute respiratory syndrome coronavirus disease 2

POTS: postural orthostatic tachycardia syndrome

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