Cureus
Part of SPRINGER NATURE

Stellate Ganglion Block for the Management of Long COVID Symptoms: A Retrospective Cohort Study

Michael C. Chiang [1], Kathryn M. Satko [1], Christina Shin [2], Beau P. Sperry [1], Meghan L. Cabral [1], Zack Crockett [3], Richard Gao [4], Robert J. Yong [1], Samuel P. Ang [1], Stacey L. Burns [1], Alexander J. Kim [1]

1. Anesthesiology, Brigham and Women's Hospital, Harvard Medical School, Boston, USA 2. Anesthesiology, University of Virginia, Charlottesville, USA 3. Physical Medicine and Rehabilitation, Spaulding Rehabilitation Hospital, Harvard Medical School, Boston, USA 4. Anesthesiology, Allegheny Health Network, Philadelphia, USA

Corresponding author: Alexander J. Kim, akim30@bwh.harvard.edu

Abstract

Introduction

The efficacy of stellate ganglion block (SGB) for managing post-acute sequelae of SARS-CoV-2 (PASC) remains an area of active exploration. In this study, we performed a retrospective analysis of PASC symptom improvements following SGB.

Methods

We performed a retrospective, survey-based cohort study at a single institution of patients with a history of PASC who underwent SGB at one of three different sites within Boston, MA, USA, between September 2022 and September 2024. The intervention was outpatient, office-based, with one or more unilateral SGBs.

Results

Fifty-two patients were included in the analysis. On average, patients underwent three SGB injections. Most patients reported improvement in PASC symptoms after SGB treatment. The most commonly reported symptoms that showed improvement were brain fog, fatigue, dizziness, and headache. A quarter of patients reported experiencing at least one adverse effect that was mostly short-lived.

Conclusion

SGB reduced the severity of many PASC symptoms, although there was high variability in the duration of symptom improvement. Further high-quality randomized clinical trials are warranted to investigate SGBs for the effective treatment of PASC.

Categories: Anesthesiology, Pain Management
Keywords: covid-19, long covid, post-acute sequelae of sars-cov-2 (pasc), stellate ganglion block (sgb), sympathetic hyperactivity

Introduction

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has had a profound impact on public health, giving rise to a global pandemic [1]. Although many recover from the sequelae of an acute infection, a subset of patients continue to experience persistent symptoms beyond four weeks. This syndrome has been termed long COVID, post-COVID syndrome, or post-acute sequelae of SARS-CoV-2 (PASC) [2]. It has been estimated to affect 6.6% to 10.3% of infected patients [3]. Indeed, according to the Centers for Disease Control and Prevention (CDC), among adults who have had acute COVID infection at any point, 8.7% had active long COVID as of August 2024. Furthermore, this syndrome has been codified into the International Classification of Diseases (International Classification of Diseases, 10th Revision, Clinical Modification (ICD-10-CM)) [4].

PASC comprises a constellation of symptoms impacting multiple organ systems. The World Health Organization has provided a clinical definition with symptoms such as brain fog, headache, shortness of breath, post-exertional malaise, tachycardia, and fatigue. PASC has prompted extensive research into understanding and managing these lingering symptoms with a hypothesis that aberrant sympathetic hyperactivity or autonomic dysfunction may underlie the wide range of physiological impact [5-7]. Stellate ganglion blocks (SGBs) are performed for a variety of sympathetically mediated chronic pain syndromes and non-pain indications to modulate autonomic function and reduce sympathetic hyperactivity [8].

SGBs work by targeting the synapse of both preganglionic and postganglionic sympathetic fibers arising from

the first thoracic segments of the sympathetic chain, which converge as the stellate ganglion. These sympathetic fibers provide innervation to the head, neck, upper extremities, and thoracic viscera. The wide range of SGB treatment indications includes complex regional pain syndrome of the upper extremities, peripheral vascular disease, hyperhidrosis, cardiac arrhythmias, and atypical chest pain [8-11]. In terms of cardiac arrhythmias, SGBs have clearly established use in targeting cardiac accelerator (sympathetic) fibers to effectively treat refractory ventricular tachycardia and ventricular fibrillation [12]. Additionally, SGBs have also been used to treat mood and headache disorders, particularly those relating to post-traumatic stress disorder (PTSD) and cluster headaches [13]. It is hypothesized that the constellation of symptoms comprising PASC is at least partially related to sympathetic and autonomic dysfunction, as well as possible mood disturbance. Accordingly, we hypothesized that SGBs would appropriately target and reduce the symptoms found in PASC.

We performed a retrospective analysis of the efficacy of SGB on the improvement of PASC symptoms for patients impacted by the syndrome. Our study aims to help further characterize the efficacy with a focus on delineating successfully treated symptoms and longitudinal durability. This retrospective survey study covers a two-year period of patients undergoing SGB for treatment of PASC.

Materials And Methods

We performed a retrospective cohort study without a control group at a single institution of patients with a history of PASC who underwent SGB at one of three different sites within Boston, MA, USA, between September 2022 and September 2024. The study was performed in accordance with the Mass General Brigham Institutional Review Board (IRB) (approval number: 2023P003108).

Study participants

All adult patients who underwent at least one SGB procedure with the intention of treating PASC at one of the included treatment facilities were included in this study. PASC was identified as new or worsening pre-defined symptoms persisting for at least four weeks after resolution of an acute COVID-19 infection, and which could not be attributed to any other condition. History of COVID-19 infection was determined by a positive polymerase chain reaction (PCR) test or antigen laboratory result, diagnosis by a medical provider, or patient report of a positive COVID-19 test with expected symptoms. All patients had previously been diagnosed with PASC by the referring medical provider and had undergone clinical investigation to rule out other non-COVID underlying conditions. After an evaluation at our pain management centers, patients were offered treatment consisting of consecutive left and right SGBs, a minimally invasive, office-based procedure. This procedure consists of the deposition of local anesthetic and/or steroid at the lower cervical sympathetic chain under ultrasound guidance and was performed by board-certified interventional pain physicians trained in this technique. Real-time ultrasound imaging was used to identify pertinent landmarks, including the C6 or C7 transverse process, thyroid gland, internal jugular vein, carotid artery, and longus colli muscle. The needle was advanced carefully in plane with the ultrasound probe such that the tip and medication deposition were into the plane ventral to the longus colli and dorsal to the carotid artery. The injectate composition and volume varied among providers. The vast majority included 6-10 milliliters of 0.25% bupivacaine. On only a few occasions, the local anesthetic in the injectate was 0.5% lidocaine. Approximately half of the injections were performed with the addition of a non-particulate corticosteroid (10 milligrams of dexamethasone). Contralateral SGB was offered one to two weeks later, and repeat ipsilateral SGB was offered two to three months later if the first procedure provided improvement of symptoms. Following completion of at least one SGB procedure, patients were provided with an electronic survey to assess outcomes, without a minimum amount of time required between SGB and survey completion. Patients who did not ultimately proceed with SGB intervention or did not complete the post-procedure survey were not included in our study.

Outcomes

Study outcomes were derived from a 54-item electronic survey sent to patients identified as having received one or more SGB for treatment of PASC (Appendix A). The survey was constructed after careful review of the existing literature of survey reports that assess patient outcomes, for which, at the time, no PASC-specific validated surveys existed. Questions on the diagnosis of COVID-19, the occurrence of PASC symptoms, and the severity of symptoms were derived from the CDC National Center for Health Statistics Household Pulse Survey. Patients were also asked to rate the severity of their PASC symptoms before and after SGB using a 10-point scale. Similar scales have been widely implemented in clinical and research settings [14-16]. Outcomes were also assessed using the Patient Global Impression of Change (PGIC) measure, which has been widely adopted in clinical trials for pain [16].

This survey collected patients' baseline characteristics as well as information on patients' specific PASC symptoms, symptom severity, and duration of illness. The following PASC symptoms were included in the survey: abnormal movements, headache, fatigue, dizziness, difficulty thinking or concentrating (brain fog), anxiety, chest pain, sleep disturbance, anosmia, palpitations, depression, issues with sexual desire or capacity, gastrointestinal symptoms, worsening of symptoms after mild physical or mental activity (post-exertional malaise), or increased thirst. Patients were invited to report additional symptoms under the category of "other." From the completed surveys, additional reported symptoms included the following:

dysautonomia, myalgia, orthostasis, shortness of breath, arthralgia, tinnitus, dysesthesia, dysgeusia, hair loss, nausea, parosmia, and unsteadiness. The surveys also collected information on the number of SGB treatments and outcomes. The perceived overall change in PASC symptoms was rated on a six-point scale from "much better," "better," "slightly better," "no change," "slightly worse," to "much worse." In addition to overall change, patients were further queried on specific symptom severity prior to and after their SGB treatment on a severity rating scale of 0-10, with 10 rated as markedly severe and debilitating. Additionally, the surveys collected reports of any adverse outcomes experienced after the SGB treatments. Horner's syndrome is an expected finding of SGB and, therefore, was not considered an adverse effect. Patients received a short explanation of Horner's syndrome and were asked to exclude its manifestations when reporting adverse effects post-SGB injection.

Statistical analysis

The responses of the patients were reported with the mean with standard deviation (SD) for numerical variables and count (percentage) for categorical variables. The median was reported for the severity of symptom ratings pre- and post-treatment. Analysis of descriptive data was performed using R (The R Core Team, R Foundation for Statistical Computing, Vienna, Austria) per the Brigham and Women's Hospital Department of Anesthesiology research staff. All data were handled per Mass General Brigham Human Research Affairs Office regulations and practices.

Results

From September 2022 to September 2024, a total of 125 patients presented to the Brigham and Women's Hospital Pain Management Centers with a diagnosis of PASC. One hundred and two patients underwent one or more ultrasound-guided SGB for treatment of their PASC symptoms. Twenty-three patients did not move forward with SGB due to a variety of reasons, including lack of insurance coverage, high out-of-pocket expense, necessity for further medical evaluation, or patient preference. Ultimately, 52 patients completed the survey and were included in this retrospective study.

The baseline characteristics of the 52 patients are presented in Table *1*. The mean (SD) age of the patients was 45.8 (12.7) years. Thirty-three (63.5%) patients identified as female, and 43 (82.7%) patients identified as White. The mean (SD) duration of PASC symptoms prior to survey completion was 2.6 (0.9) years.

2025 Chiang et al. Cureus 17(7): e88680. DOI 10.7759/cureus.88680

3 of 25

Parameters	n (%)
Age, years (SD)	45.8 (12.7)
Education	
Associate's degree	2 (3.8%)
Bachelor's degree	20 (38.5%)
Graduate or professional degree	20 (38.5%)
High school diploma or GED	1 (1.9%)
Professional certification and/or license	1 (1.9%)
Some college	7 (13.5%)
Some graduate school	1 (1.9%)
Income	
$25,001 - $35,000	1 (1.9%)
$35,001 - $50,000	3 (5.8%)
$50,001 - $75,000	3 (5.8%)
$75,001 - $100,000	10 (19.2%)
Above $100,000	27 (51.9%)
Below $15,000	3 (5.8%)
I decline to answer	5 (9.6%)
Race	
American Indian or Alaska Native	1 (1.9%)
Asian	1 (1.9%)
Hispanic, Latino, or Spanish	3 (5.8%)
Middle Eastern or North African	1 (1.9%)
White	43 (82.7%)
None	2 (3.8%)
Prefer not to answer	1 (1.9%)
Gender	
Female	33 (63.5%)
Male	19 (36.5%)
Symptom duration, years (SD)	2.6 (0.9)

TABLE 1: Demographic information of the study group

GED: General Educational Development

The prevalence of all reported PASC symptoms is presented in Table 2. The symptoms most frequently reported in the survey were fatigue and brain fog (both 73.1%), and most patients reported both symptoms. Post-exertional malaise (48.1%), dizziness (34.6%), sleep disturbance (30.8%), and headache (30.8%) were also commonly reported. Twenty-one patients (40.4%) reported additional symptoms categorized as "other" (Appendix B). An overwhelming majority of patients (86.5%) reported that their symptoms significantly impacted their quality of life.

Symptom	N (%)
Abnormal movements	1 (1.9%)
Headache	16 (30.8%)
Fatigue	38 (73.1%)
Dizziness	18 (34.6%)
Brain fog	38 (73.1%)
Anxiety	10 (19.2%)
Chest pain	10 (19.2%)
Sleep disturbance	16 (30.8%)
Anosmia	8 (15.4%)
Palpitations	12 (23.1%)
Depression	4 (7.7%)
Sexual dysfunction	2 (3.8%)
Other	21 (40.4%)
GI symptoms	6 (11.5%)
Post-exertional malaise	25 (48.1%)
Increased thirst	1 (1.9%)
Symptom severity	
Mild	1 (1.9%)
Moderate	6 (11.5%)
Severe	45 (86.5%)

TABLE 2: Prevalence of reported symptoms

Across the 52 patients, a total of 147 SGBs were performed. Twenty-five (48.1%) of the study patients received bilateral SGBs, performed at separate visits. Six (11.5%) patients received only one injection, and 13 (25%) patients received an SGB four or more times. The distribution of the number of SGBs performed in a single patient is reported in Table 3. There was a mean (SD) interval of 1.6 (0.9) years between PASC onset and first SGB treatment.

Time to first injection, years (SD)	1.6 (0.9)
Injections per patient	n (%)
1	6 (11.5%)
2	25 (48.1%)
3	8 (15.4%)
≥ 4	13 (25.0%)
Total N	147
Average # per patient	3 (2)

TABLE 3: Number of SGBs per patient

SGB: stellate ganglion block

Data on patient outcomes after SGB treatment were collected via a survey. We assessed the following dimensions of SGB treatment outcome: degree of overall improvement, duration of improvement, and change in individual symptom severity. Twenty-nine (55.8%) patients reported at least short-term improvement in their PASC symptoms after SGB treatment. Twelve patients (23.1%) reported symptom improvement for months, and seven (13.5%) reported persistent improvement up to the time of the survey. Eight patients reported improvement of limited duration-from just a few hours (5.8%) to several days (9.6%). Overall, 17 patients (32.7%) reported the greatest improvement after the first injection (Table 4).

Parameters	N (%)
Most helpful injection	
First	17 (32.7%)
Second	6 (11.5%)
Third	3 (5.8%)
Fourth	3 (5.8%)
Duration of improvement	
Hours	3 (5.8%)
Days	5 (9.6%)
Weeks	2 (3.8%)
Months	12 (23.1%)
Persistent improvement	7 (13.5%)
Rated change in symptoms	
Much better	11 (21.2%)
Better	9 (17.3%)
Slightly better	4 (7.7%)
No change	18 (34.6%)
Slightly worse	7 (13.5%)
Much worse	3 (5.8%)

TABLE 4: Effectiveness of SGB reported by patients.

SGB: stellate ganglion block

Global change in symptom severity was reported on a six-point Likert scale. Twenty-four patients (46.2%) reported that their symptoms were "slightly better", "better", or "much better". It should be noted that some patients who reported short-term symptom improvement (hours or days) reported no change on the Likert scale at the time of survey completion.

The improvement in individual symptom severity was reported as the difference between median pre- and post-SGB scores (Table 5, Figure 1). The most commonly reported symptoms to show improvement were brain fog, fatigue, dizziness, and headache. The improvement in post-SGB symptom severity was by three, three, three, and 4.5 points, respectively. The greatest improvement (nine points) was seen in the symptom of abnormal movements, albeit this particular symptom was reported only in one patient. The least improvement was seen in GI symptoms (0.5 points) and post-exertional malaise (0 points). The highest percentage of patients reporting improvement of individual symptoms included those reporting abnormal movements (100%), sexual dysfunction (100%), headache (81.3%), anosmia (75%), anxiety (70%), and brain fog (65.8%).

2025 Chiang et al. Cureus 17(7): e88680. DOI 10.7759/cureus.88680

7 of 25

Symptoms	Pre	Post	Difference	N with improvement (%)
Abnormal movements	10	1	9	1 (100%)
Headache	8.5	4	4.5	13 (81.3%)
Fatigue	8	5	3	22 (57.9%)
Dizziness	6.5	3.5	3	10 (55.6%)
Brain fog	8	5	3	25 (65.8%)
Anxiety	7	4.5	2.5	7 (70%)
Chest pain	7	4.5	2.5	4 (40%)
Sleep disturbance	8	6	2	6 (37.5%)
Anosmia	9	7.5	1.5	6 (75%)
Palpitations	6	4.5	1.5	5 (41.7%)
Depression	7	5.5	1.5	2 (50%)
Sexual dysfunction	4.5	3	1.5	2 (100%)
Other	7	5.5	1.5	13 (61.9%)
GI symptoms	6.5	6	0.5	2 (33.3%)
Post-exertional Malaise	7	7	0	11 (44%)
Thirst	8	8	0	0 (0%)

TABLE 5: Change in PASC symptoms before and after SGBs

Median scores of symptom severity before and after SGB. The number of patients reporting symptom improvement is shown on the right-most column.

SGB: stellate ganglion block; PASC: post-acute sequelae of SARS-CoV-2
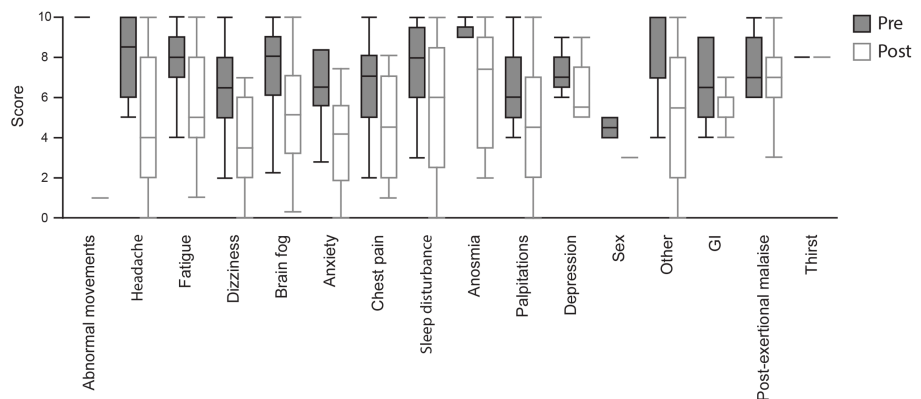
FIGURE 1: Pre- and post-SGB PASC symptom severity (top)

Summary of patients' symptom severity before (gray) and after (white) SGB. Data are presented as median with quartiles and error bars in SD.

SGB: stellate ganglion block; PASC: post-acute sequelae of SARS-CoV-2

Data on any adverse effects following SGB treatment were collected via a survey. Thirteen patients (25%) reported an adverse effect after receiving an SGB (Table 6). New-onset headaches and worsened post-exertional malaise were the most frequently reported (three patients). Additional reported adverse events included worsened fatigue, pain at the injection site, palpitations, increased startle, nausea, dizziness, hoarseness, restlessness, and shortness of breath. These events were reported to last from hours to months.

Adverse event	Frequency	Duration
New onset headache	3	Days
Worsened post-exertional malaise	3	Weeks - months
Worsened fatigue	2	Days - weeks
Pain at injection site	2	Days
Palpitations	2	Hours
Increased startle	1	Weeks
Nausea/dizziness	1	Weeks
Hoarseness	1	Hours
Restlessness	1	Weeks
Shortness of breath	1	Hours

TABLE 6: Prevalence of adverse events

Duration was reported on a scale of hours (less than 24 hours), days (between one and seven days), weeks (between one and four weeks), or months (> 4 weeks).

Discussion

The global prevalence of long COVID or PASC has been conservatively estimated at 65 million patients [17, 18]. From the 2022 National Health Interview Survey by the CDC, 36.6% of American adults reported ever having COVID-19, and 17.7% of those adults reported ever having long COVID. Among those, 48.5% reported having recovered. In addition, specific diagnostic details of PASC remain somewhat vague due to the high variability of presenting symptoms and lack of confirmatory laboratory or radiologic diagnosis. An NIH study did not find evidence of persistent viral infection, autoimmunity, or abnormal immune activation in those with PASC [19]. Another study showed that most patients with PASC do not show lesions on magnetic resonance imaging of the brain [20].

Overall, there is a substantial healthcare and societal burden. Despite the large total number of patients affected, no specific treatment options have been validated as the gold standard among medical professionals, nor is there a Food and Drug Administration (FDA)-approved treatment available. Depending on the spectrum of symptoms, which has proved to be very heterogeneous, management may include lifestyle modification, rehabilitation, medications, psychotherapy, acupuncture, or other non-pharmacologic interventions [21,22].

Rehabilitation strategies have been used to target cardiovascular and pulmonary symptoms and may entail the following: aerobics, endurance, resistance, strength, stretching, and motor or balance training. Patients exhibiting cognitive symptoms may also undergo cognitive rehabilitation. Thus far, the evidence of the therapeutic benefit of rehabilitation for PASC remains mixed but overall positive. Recent systematic and meta-analyses have shown improvements in functional outcomes (six-minute walk test, sit-to-stand test, and hand grip) [23-25], respiratory function (forced expiratory volume in the first second, forced vital capacity, and modified Medical Research Council dyspnea scale) [25-27], and cognitive symptoms [28].

Medication management strategies may be tailored to symptoms that are neuropsychiatric in nature, such as use of antidepressants or anxiolytics; symptoms involving fatigue or brain fog, such as use of stimulants; or symptoms involving orthostasis, such as use of fludrocortisone or midodrine. Other proposed medication options have included low-dose naltrexone, pyridostigmine, nicotinamide adenine dinucleotide (NAD+), or supplements such as N-acetylcysteine or coenzyme Q10 [29-31].

SGB treatments have been reported as beneficial in treating symptoms of PASC in small retrospective or case-series studies [31,32]. Prior initial studies comprised case reports that demonstrated significant efficacy of SGB for PASC with complete resolution of symptoms following two SGB treatments [10, 33-35]. Since these promising results demonstrated improvement in PASC symptoms and Short Form-36 Health Survey (SF-36) outcomes, interest has grown in evaluating SGB efficacy on larger scales.

More recently, Pearson et al. evaluated 41 patients who received either single or multiple SGB and found that 86% of patients reported improvement in at least one PASC symptom [36]. Fatigue, brain fog, and post-

2025 Chiang et al. Cureus 17(7): e88680. DOI 10.7759/cureus.88680

9 of 25

exertional malaise were the most commonly presenting symptoms, consistent with our study. Furthermore, they showed SGB provided improvement for the majority of patients with symptoms of fatigue (77%), brain fog (79%), and post-exertional malaise (74%). Impressively, the authors found all but two patients experienced persistent relief up to 12 months following SGB treatment. In comparison, we found that 55.8% of our patients reported some degree of improvement across all symptoms, and only 13.5% reported ongoing improvement from the time of SGB treatment to the time of survey completion. The large difference may partially arise from recall bias within our population. Whereas Pearson et al. reported rather rapid improvement in symptoms, we evaluated patient-reported outcomes following SGB at longer and variable time points. We found that SGB treatments sometimes resulted in improvement on the order of hours to weeks, and surveys were often completed after this amount of time. Another factor may be the variability in the severity of PASC symptoms. In our study, 86.5% of patients reported "severe" symptoms. Furthermore, patients reported a mean duration of PASC symptoms of 1.6 years prior to the first SGB treatment. This may suggest that our patient population reflected different symptom severity levels or chronicity in PASC. One interpretation is that PASC patients may respond better to earlier SGB intervention and that such responses may persist longer. Together, the relationship between symptom severity and duration and the efficacy of SGB treatment remains a critical factor that warrants further exploration.

A second important retrospective cohort study involved 27 patients in which Duricka et al. performed subgroup analysis of those who had satisfactory (durable responders, n=10), partial (partial responders, n=9), satisfactory but non-sustained (non-durable responders, n=6), or no response (non-responders, n=2) at one-month follow-up after serial SGB treatments [37]. While their sample size precluded statistical evaluation of demographic variability across these groups, the authors collected data on medical history such as body mass index, hypertension, depression, and tobacco use. Nevertheless, they showed large changes in 12 PASC symptoms, such as mean improvements in fatigue (4.7 points), problems concentrating (3.3 points), and worsened symptoms after physical activity (5.9 points), albeit with sample sizes of n = 7, 9, and 7, respectively. Compared to our changes in symptom severity scores, we found smaller improvements, i.e., three points each with fatigue and brain fog. The small sample sizes may underlie the discrepancy we see between our scores as compared to the findings by Duricka et al. However, their overall percentage of durable and non-durable responders more closely approximated our results. Durable responders at one month accounted for 37% of their patients, while 36.5% of our patients reported improvement for months or longer. Non-durable responders (less than one month) accounted for 22.2% of their patients, while 19.2% of our patients reported improvement lasting from hours to weeks. Interestingly, we were not able to replicate the improvement in the specific symptom of post-exertional malaise, which was a common symptom reported by our cohort.

Overall, our study contributes to the growing body of literature investigating the role of SGB in the management of PASC symptoms. An advantage of our retrospective study is that we evaluated the efficacy of SGBs for patients experiencing PASC symptoms for a mean (SD) duration of 2.6 (0.9) years, with the mean (SD) time to first SGB of 1.6 (0.9) years after initial diagnosis. Thus, our data may better represent the real-world patient experience from the time of initial diagnosis of PASC to first SGB and subsequent evaluation. The patient characteristics in our study were consistent with CDC data, which reported a higher prevalence of PASC in the age range of 40-59 years, in women, and in White patients. The number of queried symptoms, as well as patient-reported additional symptoms in the category of "other," helps highlight the diverse presentation of PASC symptomatology. The majority of our patients reporting the most common symptoms (headache, fatigue, dizziness, brain fog) reported improvement of that symptom, except for post-exertional malaise. The post-SGB severity scores of these symptoms showed substantial improvement, though the sample size limits further conclusions. On a Likert scale, 46.2% of our patients reported an overall improvement. Again, it was possible for patients to report short-term improvement but answer "no change" on this scale at the time of survey completion. Overall, our results help delineate which specific symptoms appear to have a greater response and likelihood of response, help define the durability of improvement, and also report patients' overall impression of change.

Of note, throughout our experience during this study, we noted SGB treatments have sometimes been cost-prohibitive due to a lack of insurance coverage and/or high out-of-pocket expenses. The expense of treatment may preclude patients, particularly those who belong to marginalized groups, from pursuing SGB treatment for PASC symptoms, perpetuating health disparities already intrinsically tied to COVID-19 infection. As multiple studies, including our own, have demonstrated the efficacy of SGB for managing PASC symptoms, in addition to the mixed efficacy and potential adverse effects of medication management, consideration should be made to increase accessibility for this potentially helpful procedure. Continued research would clearly be helpful in this regard.

We identified several significant limitations of the study. Notably, our study lacked adequate power to quantitatively analyze the data. Consequently, we can only infer from the descriptive data the efficacy of SGB performed at our institution. Patient self-reported assessments were performed retrospectively; thus, significant recall bias may have affected differences between patients' improvement shortly after the SGB procedure as compared to the time delay to survey completion. Nevertheless, this study may provide a realistic picture of patients' assessment of improvement, in other words, whether patients reported long-term significant benefit from the procedure. An additional limitation reflects the lack of standardization for patient follow-up and assessment. The vast majority of our patients (approximately 90%) received more than

one SGB. Therefore, more frequent assessments can better characterize the impact of laterality and multiple injections on PASC symptoms. Another potential source of variability may be proceduralist technique and differences in injectate (addition of corticosteroid with local anesthetic). We did not have a control group, so we cannot directly assess for confounding variables, such as the degree of placebo effect. Future prospective cohort studies may incorporate a control group, randomization, blinding, larger sample sizes, and standardized evaluation times to better characterize the efficacy of SGB treatments on PASC symptomatology.

Conclusions

The results from our retrospective study suggest reductions in the severity of many PASC symptoms, consistent with previous studies. There was a high level of variability in the duration of symptom improvement, with substantial heterogeneity in types of reported symptoms. Thus, further high-quality randomized clinical trials are warranted to investigate SGBs for the effective treatment of PASC.

Appendices

Appendix A

Electronic Survey Sent to Patients

2025 Chiang et al. Cureus 17(7): e88680. DOI 10.7759/cureus.88680

11 of 25

COVID-19 and SGB Survey

Thank you for agreeing to participate in this survey to help analyze the State Utility After Chronic Lower Back Pain!

This is survey 2 of 9.

What year did your Long COVID symptoms begin?	◯ 2023 ◯ 2022 ◯ 2021 ◯ 2020 ◯ 2019
What month did your Long COVID symptoms being?	◯ January ◯ February ◯ March ◯ April ◯ May ◯ June ◯ July ◯ August ◯ September ◯ October ◯ November ◯ December
Please identify any symptoms lasting 3 months or longer that 1) you did not have prior to having coronavirus or COVID-19 or 2) worsened significantly after having COVID-19?	☐ Fatigue ☐ Dizziness ☐ Difficulty thinking or concentrating (Brian Fog) ☐ Sleep Disturbance ☐ Anxiety ☐ Depression ☐ Headache ☐ Worsening of symptoms after mild physical or mental activity (Post-Exertional Malaise) ☐ Gastrointestinal Symptoms ☐ Issues with sexual desire or capacity ☐ Changes to or loss of smell or taste ☐ Increased Thirst ☐ Chest Pain ☐ Heart Palpitations ☐ Abnormal Movements ☐ Other
If you have experienced "Other" symptoms than those listed above. Please describe them.	_____
Did these long-term symptoms reduce your ability to carry out day-to-day activities compared with the time before you had COVID-19?	◯ Yes, a lot ◯ Yes, a little ◯ Not at all
How many stellate ganglion block injections did you receive from our clinic?	◯ 1 ◯ 2 ◯ 3 ◯ 4 or more
If you only had one injection, did that injection result in improvement?	◯ Yes ◯ No

10/01/2024 3:15pm

projectredcap.org

REDCap

FIGURE 2: Page 1 of the survey

2025 Chiang et al. Cureus 17(7): e88680. DOI 10.7759/cureus.88680

12 of 25

If you have had more than one injection, which injection resulted in the greatest amount of improvement?	○ First ○ Second ○ Third ○ Fourth or more ○ None
If you experienced improvement, how long did you experience improvement?	○ Hours ○ Days ○ Weeks ○ Months ○ I still have improvement at the time of this survey
Did your Long COVID symptoms return after your stellate ganglion block treatments?	○ No I continue to have improvement to this date ○ Yes, my symptoms initially improved but then returned ○ My symptoms did not improve

Please rate the severity of your FATIGUE on a scale of 1-10 BEFORE undergoing any stellate ganglion block injections at our pain clinic.

1 is considered as a very mild symptom with minimal to no impact on your daily function and quality of life.

10 is considered as a very severe symptom with significant impact on your daily function and quality of life.

1   10

(Place a mark on the scale above)

Please rate the severity of *FATIGUE on a scale of 1-10 at the time of this survey,AFTER undergoing stellate ganglion block injections at our pain clinic.

1 is considered as a very mild symptom with minimal to no impact on your daily function and quality of life.

10 is considered as a very severe symptom with significant impact on your daily function and quality of life.

1   10

(Place a mark on the scale above)

Please rate the severity of *DIZZINESS on a scale of 1-10 BEFORE undergoing any stellate ganglion block injections at our pain clinic.

1 is considered as a very mild symptom with minimal to no impact on your daily function and quality of life.

10 is considered as a very severe symptom with significant impact on your daily function and quality of life.

1   10

(Place a mark on the scale above)

10/01/2024 3:15pm   projectredcap.org   REDCap®

FIGURE 3: Page 2 of the survey

Please rate the severity of DIZZINESS on a scale of 1-10 at the time of this survey, AFTER undergoing stellate ganglion block injections at our pain clinic.

1 is considered as a very mild symptom with minimal to no impact on your daily function and quality of life.

10 is considered as a very severe symptom with significant impact on your daily function and quality of life.

1   10

(Place a mark on the scale above)

Please rate the severity of DIFFICULTY THINKING OR CONCENTRATION (BRAIN FOG) on a scale of 1-10 BEFORE undergoing any stellate ganglion block injections at our pain clinic.

1 is considered as a very mild symptom with minimal to no impact on your daily function and quality of life.

10 is considered as a very severe symptom with significant impact on your daily function and quality of life.

1   10

(Place a mark on the scale above)

Please rate the severity of DIFFICULTY THINKING OR CONCENTRATION (BRAIN FOG) on a scale of 1-10 AFTER undergoing any stellate ganglion block injections at our pain clinic.

1 is considered as a very mild symptom with minimal to no impact on your daily function and quality of life.

10 is considered as a very severe symptom with significant impact on your daily function and quality of life.

1   10

(Place a mark on the scale above)

Please rate the severity of SLEEP DISTURBANCE on a scale of 1-10 BEFORE undergoing any stellate ganglion block injections at our pain clinic.

1 is considered as a very mild symptom with minimal to no impact on your daily function and quality of life.

10 is considered as a very severe symptom with significant impact on your daily function and quality of life.

1   10

(Place a mark on the scale above)

FIGURE 4: Page 3 of the survey

Please rate the severity of SLEEP DISTURBANCE on a scale of 1-10 AFTER undergoing any stellate ganglion block injections at our pain clinic.

1 is considered as a very mild symptom with minimal to no impact on your daily function and quality of life.

10 is considered as a very severe symptom with significant impact on your daily function and quality of life.

1 _____ 10

(Place a mark on the scale above)

Please rate the severity of ANXIETY on a scale of 1-10 BEFORE undergoing any stellate ganglion block injections at our pain clinic.

1 is considered as a very mild symptom with minimal to no impact on your daily function and quality of life.

10 is considered as a very severe symptom with significant impact on your daily function and quality of life.

1 _____ 10

(Place a mark on the scale above)

Please rate the severity of ANXIETY on a scale of 1-10 AFTER undergoing any stellate ganglion block injections at our pain clinic.

1 is considered as a very mild symptom with minimal to no impact on your daily function and quality of life.

10 is considered as a very severe symptom with significant impact on your daily function and quality of life.

1 _____ 10

(Place a mark on the scale above)

Please rate the severity of DEPRESSION on a scale of 1-10 BEFORE undergoing any stellate ganglion block injections at our pain clinic.

1 is considered as a very mild symptom with minimal to no impact on your daily function and quality of life.

10 is considered as a very severe symptom with significant impact on your daily function and quality of life.

1 _____ 10

(Place a mark on the scale above)

10/01/2024 3:15pm

projectredcap.org REDCap

FIGURE 5: Page 4 of the survey

2025 Chiang et al. Cureus 17(7): e88680. DOI 10.7759/cureus.88680

15 of 25

Please rate the severity of DEPRESSION on a scale of 1-10 AFTER undergoing any stellate ganglion block injections at our pain clinic.

1 is considered as a very mild symptom with minimal to no impact on your daily function and quality of life.

10 is considered as a very severe symptom with significant impact on your daily function and quality of life.

1   10

(Place a mark on the scale above)

Please rate the severity of HEADACHE on a scale of 1-10 BEFORE undergoing any stellate ganglion block injections at our pain clinic.

1 is considered as a very mild symptom with minimal to no impact on your daily function and quality of life.

10 is considered as a very severe symptom with significant impact on your daily function and quality of life.

1   10

(Place a mark on the scale above)

Please rate the severity of HEADACHE on a scale of 1-10 AFTER undergoing any stellate ganglion block injections at our pain clinic.

1 is considered as a very mild symptom with minimal to no impact on your daily function and quality of life.

10 is considered as a very severe symptom with significant impact on your daily function and quality of life.

1   10

(Place a mark on the scale above)

Please rate the severity of MILD PHYSICAL OR MENTAL ACTIVITY (POST-EXERTIONAL MALAISE) on a scale of 1-10 BEFORE undergoing any stellate ganglion block injections at our pain clinic.

1 is considered as a very mild symptom with minimal to no impact on your daily function and quality of life.

10 is considered as a very severe symptom with significant impact on your daily function and quality of life.

1   10

(Place a mark on the scale above)

10/01/2024 3:15pm   projectredcap.org   **REDCap**

FIGURE 6: Page 5 of the survey

Please rate the severity of MILD PHYSICAL OR MENTAL ACTIVITY (POST-EXERTIONAL MALAISE) on a scale of 1-10 AFTER undergoing any stellate ganglion block injections at our pain clinic.

1 is considered as a very mild symptom with minimal to no impact on your daily function and quality of life.

10 is considered as a very severe symptom with significant impact on your daily function and quality of life.

1   10

(Place a mark on the scale above)

Please rate the severity of GASTROINTESTINAL SYMPTOMS on a scale of 1-10 BEFORE undergoing any stellate ganglion block injections at our pain clinic.

1 is considered as a very mild symptom with minimal to no impact on your daily function and quality of life.

10 is considered as a very severe symptom with significant impact on your daily function and quality of life.

1   10

(Place a mark on the scale above)

Please rate the severity of GASTROINTESTINAL SYMPTOMS on a scale of 1-10 AFTER undergoing any stellate ganglion block injections at our pain clinic.

1 is considered as a very mild symptom with minimal to no impact on your daily function and quality of life.

10 is considered as a very severe symptom with significant impact on your daily function and quality of life.

1   10

(Place a mark on the scale above)

Please rate the severity of ISSUES WITH SEXUAL DESIRE OR CAPACITY on a scale of 1-10 BEFORE undergoing any stellate ganglion block injections at our pain clinic.

1 is considered as a very mild symptom with minimal to no impact on your daily function and quality of life.

10 is considered as a very severe symptom with significant impact on your daily function and quality of life.

1   10

(Place a mark on the scale above)

10/01/2024 3:15pm   projectredcap.org   REDCap®

FIGURE 7: Page 6 of the survey

Please rate the severity of ISSUES WITH SEXUAL DESIRE OR CAPACITY on a scale of 1-10 AFTER undergoing any stellate ganglion block injections at our pain clinic.

1 is considered as a very mild symptom with minimal to no impact on your daily function and quality of life.

10 is considered as a very severe symptom with significant impact on your daily function and quality of life.

1   10

(Place a mark on the scale above)

Please rate the severity of CHANGES TO/LOSS OF SMELL OR TASTE on a scale of 1-10 BEFORE undergoing any stellate ganglion block injections at our pain clinic.

1 is considered as a very mild symptom with minimal to no impact on your daily function and quality of life.

10 is considered as a very severe symptom with significant impact on your daily function and quality of life.
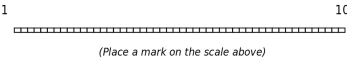
1   10

(Place a mark on the scale above)

Please rate the severity of CHANGES TO/LOSS OF SMELL OR TASTE on a scale of 1-10 AFTER undergoing any stellate ganglion block injections at our pain clinic.

1 is considered as a very mild symptom with minimal to no impact on your daily function and quality of life.

10 is considered as a very severe symptom with significant impact on your daily function and quality of life.

1   10

(Place a mark on the scale above)

Please rate the severity of INCREASED THIRST on a scale of 1-10 BEFORE undergoing any stellate ganglion block injections at our pain clinic.

1 is considered as a very mild symptom with minimal to no impact on your daily function and quality of life.
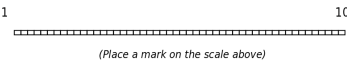
10 is considered as a very severe symptom with significant impact on your daily function and quality of life.

1   10

(Place a mark on the scale above)

10/01/2024 3:15pm   projectredcap.org **REDCap®**

FIGURE 8: Page 7 of the survey

Please rate the severity of INCREASED THIRST on a scale of 1-10 AFTER undergoing any stellate ganglion block injections at our pain clinic.

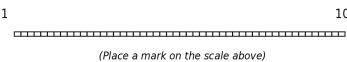1 is considered as a very mild symptom with minimal to no impact on your daily function and quality of life.

10 is considered as a very severe symptom with significant impact on your daily function and quality of life.

1   10

(Place a mark on the scale above)

Please rate the severity of CHEST PAIN on a scale of 1-10 BEFORE undergoing any stellate ganglion block injections at our pain clinic.

1 is considered as a very mild symptom with minimal to no impact on your daily function and quality of life.
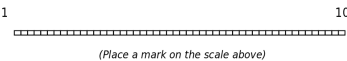
10 is considered as a very severe symptom with significant impact on your daily function and quality of life.

1   10

(Place a mark on the scale above)

Please rate the severity of CHEST PAIN on a scale of 1-10 AFTER undergoing any stellate ganglion block injections at our pain clinic.

1 is considered as a very mild symptom with minimal to no impact on your daily function and quality of life.

10 is considered as a very severe symptom with significant impact on your daily function and quality of life.

1   10

(Place a mark on the scale above)

Please rate the severity of HEART PALPITATIONS on a scale of 1-10 BEFORE undergoing any stellate ganglion block injections at our pain clinic.

1 is considered as a very mild symptom with minimal to no impact on your daily function and quality of life.

10 is considered as a very severe symptom with significant impact on your daily function and quality of life.

1   10

(Place a mark on the scale above)

10/01/2024 3:15pm   projectredcap.org   REDCap®

FIGURE 9: Page 8 of the survey

Please rate the severity of HEART PALPITATIONS on a scale of 1-10 AFTER undergoing any stellate ganglion block injections at our pain clinic.

1 is considered as a very mild symptom with minimal to no impact on your daily function and quality of life.

10 is considered as a very severe symptom with significant impact on your daily function and quality of life.

1   10

(Place a mark on the scale above)

Please rate the severity of ABNORMAL MOVEMENTS on a scale of 1-10 BEFORE undergoing any stellate ganglion block injections at our pain clinic.

1 is considered as a very mild symptom with minimal to no impact on your daily function and quality of life.

10 is considered as a very severe symptom with significant impact on your daily function and quality of life.

1   10

(Place a mark on the scale above)

Please rate the severity of ABNORMAL MOVEMENTS on a scale of 1-10 AFTER undergoing any stellate ganglion block injections at our pain clinic.

1 is considered as a very mild symptom with minimal to no impact on your daily function and quality of life.

10 is considered as a very severe symptom with significant impact on your daily function and quality of life.

1   10

(Place a mark on the scale above)

Please rate the severity of OTHER SYMPTOMS on a scale of 1-10 BEFORE undergoing any stellate ganglion block injections at our pain clinic.

1 is considered as a very mild symptom with minimal to no impact on your daily function and quality of life.

10 is considered as a very severe symptom with significant impact on your daily function and quality of life.

1   10

(Place a mark on the scale above)

10/01/2024 3:15pm   projectredcap.org   REDCap

FIGURE 10: Page 9 of the survey

Please rate the severity of OTHER SYMPTOMS on a scale of 1-10 AFTER undergoing any stellate ganglion block injections at our pain clinic.

1 is considered as a very mild symptom with minimal to no impact on your daily function and quality of life.

10 is considered as a very severe symptom with significant impact on your daily function and quality of life.

1   10

(Place a mark on the scale above)

Overall, how have your symptoms changed since you came to the Pain Management Clinic for treatment of your long COVID-19 symptoms?

- ○ Much Better
- ○ Better
- ○ A Little Better
- ○ No Change
- ○ A Little Worse
- ○ Worse
- ○ Much Worse

Did you experience any adverse effects after the stellate ganglion block?

- ○ Yes
- ○ No

Please note that a number of side effects may occur immediately after the injection which are collectively known as "Horner's Syndrome". These symptoms are NOT unexpected and should not be included in your assessment of adverse events.

These symptoms include but not limited to the following:
-Red Eye
-Droopiness of Eye Lid
-Flushing of Skin
-Headache

Please describe the adverse effect

_____

Did these side effects resolve?

- ○ Yes
- ○ No

Please note that this survey is for research purposes only. If you experienced any adverse effects that are concerning, please discuss with your physician.

10/01/2024 3:15pm   projectredcap.org   **REDCap®**

FIGURE 11: Page 10 of the survey

Demographic Information Survey

Thank you for agreeing to participate in this survey to help analyze the State Utility After Chronic Lower Back Pain!

Please complete all surveys.

Thank you again and have a great day!

This is survey 1 of 9.

1)	Have you ever tested positive for COVID-19 (rapid point of care test, self test or laboratory test) or been told by a doctor or other health care provider that you have or had COVID-19?	○ Yes ○ No
2)	Have you experienced any COVID-19 symptoms at least a month after your positive test? (This may be referred to as Long COVID-19.)	○ Yes ○ No
3)	Have you received a Stellate Ganglion Block (SGB) at one of Brigham and Women's Pain Management or Spine Centers for the treatment of Long COVID-19 symptoms?	○ Yes ○ No
4)	Please Indicate your First and Last name	_____
5)	What is your date of birth?	_____
6)	Which of these categories describe you (select all that apply):	☐ American Indian or Alaska Native ☐ Asian ☐ Black or African American ☐ Hispanic, Latino, or Spanish ☐ Middle Eastern or North African ☐ Native Hawaiian or other Pacific Islander ☐ White ☐ None of these fully describe me ☐ Prefer not to answer
7)	Educational Level	○ Some high school ○ High school Diploma or GED ○ Some college ○ Associate's degree ○ Bachelor's Degree ○ Some Graduate School ○ Graduate or Professional Degree ○ Professional Certification and/or License ○ Other ○ I decline to answer
8)	Annual Household Income	○ Below $15,000 ○ $15,001 - $25,000 ○ $25,001 - $35,000 ○ $35,001 - $50,000 ○ $50,001 - $75,000 ○ $75,001 - $100,000 ○ Above $100,000 ○ I decline to answer

10/01/2024 3:14pm

projectredcap.org

REDCap®

FIGURE 12: Demographic information

Appendix B

Symptom	Frequency	Severity
Dysautonomia	4	Severe
Myalgia	3	Severe
Orthostasis	3	Severe
Shortness of breath	3	Severe
Arthralgia	2	Severe
Tinnitus	2	Severe
Dysesthesia	1	Severe
Dysgeusia	1	Severe
Hair loss	1	Severe
Nausea	1	Severe
Parosmia	1	Severe
Unsteadiness	1	Severe

TABLE 7: Patient-reported symptoms categorized as "Other"

Severity was reported on a three-point Likert scale.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Acquisition, analysis, or interpretation of data: Michael C. Chiang, Alexander J. Kim, Kathryn M. Satko, Christina Shin, Beau P. Sperry, Meghan L. Cabral, Zack Crockett, Richard Gao, Robert J. Yong

Drafting of the manuscript: Michael C. Chiang, Alexander J. Kim, Kathryn M. Satko, Christina Shin, Meghan L. Cabral, Zack Crockett

Critical review of the manuscript for important intellectual content: Michael C. Chiang, Alexander J. Kim, Christina Shin, Beau P. Sperry, Zack Crockett, Richard Gao, Samuel P. Ang, Stacey L. Burns, Robert J. Yong

Concept and design: Alexander J. Kim, Christina Shin, Richard Gao, Samuel P. Ang, Stacey L. Burns, Robert J. Yong

Supervision: Alexander J. Kim

Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. Mass General Brigham Institutional Review Board (IRB) issued approval (2023P003108). **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

Acknowledgements

The authors would like to thank Muhammad Rehman and Samuel A., Justice for statistical support.

References

1. Mallah SI, Ghorab OK, Al-Salmi S, et al.: COVID-19: breaking down a global health crisis . Ann Clin Microbiol Antimicrob. 2021, 20:35. 10.1186/s12941-021-00438-7

2. Huang L, Yao Q, Gu X, et al.: 1-year outcomes in hospital survivors with COVID-19: a longitudinal cohort study. Lancet. 2021, 398:747-58. 10.1016/S0140-6736(21)01755-4

3. Hastie CE, Lowe DJ, McAuley A, et al.: True prevalence of long-COVID in a nationwide, population cohort study. Nat Commun. 2023, 14:7892. 10.1038/s41467-023-43661-w

4. National Center for Health Statistics- ICD-10-CM. (2025). Accessed: 2025: https://icd10cmtool.cdc.gov/? fy=FY2025.

5. Castanares-Zapatero D, Chalon P, Kohn L, et al.: Pathophysiology and mechanism of long COVID: a comprehensive review. Ann Med. 2022, 54:1473-87. 10.1080/07853890.2022.2076901

6. Dani M, Dirksen A, Taraborrelli P, Torocastro M, Panagopoulos D, Sutton R, Lim PB: Autonomic dysfunction in 'long COVID': rationale, physiology and management strategies. Clin Med (Lond). 2021, 21:e63-7. 10.7861/clinmed.2020-0896

7. Soriano JB, Murthy S, Marshall JC, Relan P, Diaz JV: A clinical case definition of post-COVID-19 condition by a Delphi consensus. Lancet Infect Dis. 2022, 22:e102-7. 10.1016/S1473-3099(21)00703-9

8. Liao CD, Tsauo JY, Liou TH, Chen HC, Rau CL: Efficacy of noninvasive stellate ganglion blockade performed using physical agent modalities in patients with sympathetic hyperactivity-associated disorders: a systematic review and meta-analysis. PLoS One. 2016, 11:e0167476. 10.1371/journal.pone.0167476

9. Huang HD, Tamarisa R, Mathur N, Alam M, Makkar A, Birnbaum Y, Afshar-Kharaghan H: Stellate ganglion block: a therapeutic alternative for patients with medically refractory inappropriate sinus tachycardia?. J Electrocardiol. 2013, 46:693-6. 10.1016/j.jelectrocard.2012.12.010

10. Liu LD, Duricka DL: Stellate ganglion block reduces symptoms of Long COVID: a case series . J Neuroimmunol. 2022, 362:577784. 10.1016/j.jneuroim.2021.577784

11. Piraccini E, Munakomi S, Chang KV: Stellate ganglion blocks. StatPearls [Internet]. StatPearls Publishing , Treasure Island, FL; 2025.

12. Chouairi F, Rajkumar K, Benak A, et al.: A multicenter study of stellate ganglion block as a temporizing treatment for refractory ventricular arrhythmias. JACC Clin Electrophysiol. 2024, 10:750-8. 10.1016/j.jacep.2023.12.012

13. Peterson K, Bourne D, Anderson J, Mackey K, Helfand M: Evidence Brief: Effectiveness of Stellate Ganglion Block for Treatment of Posttraumatic Stress Disorder (PTSD). Department of Veterans Affairs (US), Washington, D.C.; 2017. https://www.ncbi.nlm.nih.gov/books/NBK442253/.

14. Butt BB, Kagan D, Gagnier J, Wasserman R, Nassr A, Patel R, Aleem I: Do patients accurately recall their pain levels following epidural steroid injection? A cohort study of recall bias in patient-reported outcomes. Pain Physician. 2022, 25:59-66.

15. Gong DC, Muralidharan A, Butt BB, Wasserman R, Piche JD, Patel RD, Aleem I: Do patients accurately recall pain levels following sacroiliac joint steroid injection? A cohort study of recall bias in patient-reported outcomes. Pain Physician. 2024, 27:169-74.

16. Scott W, Hann KE, McCracken LM: A comprehensive examination of changes in psychological flexibility following acceptance and commitment therapy for chronic pain. J Contemp Psychother. 2016, 46:139-48. 10.1007/s10879-016-9328-5

17. Azhir A, Hügel J, Tian J, et al.: Precision phenotyping for curating research cohorts of patients with unexplained post-acute sequelae of COVID-19. Med. 2025, 6:100532. 10.1016/j.medj.2024.10.009

18. Davis HE, McCorkell L, Vogel JM, Topol EJ: Long COVID: major findings, mechanisms and recommendations. Nat Rev Microbiol. 2023, 21:133-46. 10.1038/s41579-022-00846-2

19. Sneller MC, Liang CJ, Marques AR, et al.: A longitudinal study of COVID-19 sequelae and immunity: baseline findings. Ann Intern Med. 2022, 175:969-79. 10.7326/M21-4905

20. Kubota T, Kuroda N, Sone D: Neuropsychiatric aspects of long COVID: a comprehensive review . Psychiatry Clin Neurosci. 2023, 77:84-93. 10.1111/pcn.13508

21. Lam WC, Wei D, Li H, et al.: The use of acupuncture for addressing neurological and neuropsychiatric symptoms in patients with long COVID: a systematic review and meta-analysis. Front Neurol. 2024, 15:1406475. 10.3389/fneur.2024.1406475

22. Zeraatkar D, Ling M, Kirsh S, et al.: Interventions for the management of long COVID (post-COVID condition): living systematic review . BMJ. 2024, 387:e081318. 10.1136/bmj-2024-081318

23. Fugazzaro S, Contri A, Esseroukh O, et al.: Rehabilitation interventions for post-acute COVID-19 syndrome: a systematic review. Int J Environ Res Public Health. 2022, 19:5185. 10.3390/ijerph19095185

24. Martínez-Pozas O, Meléndez-Oliva E, Rolando LM, Rico JA, Corbellini C, Sánchez Romero EA: The pulmonary rehabilitation effect on long COVID-19 syndrome: a systematic review and meta-analysis. Physiother Res Int. 2024, 29:e2077. 10.1002/pri.2077

25. Zheng C, Chen XK, Sit CH, Liang X, Li MH, Ma AC, Wong SH: Effect of physical exercise-based rehabilitation on long COVID: a systematic review and meta-analysis. Med Sci Sports Exerc. 2024, 56:143-54. 10.1249/MSS.0000000000003280

26. Meléndez-Oliva E, Martínez-Pozas O, Cuenca-Zaldívar JN, Villafañe JH, Jiménez-Ortega L, Sánchez-Romero EA: Efficacy of pulmonary rehabilitation in post-COVID-19: a systematic review and meta-analysis . Biomedicines. 2023, 11:2213. 10.3390/biomedicines11082213

27. Pouliopoulou DV, Macdermid JC, Saunders E, et al.: Rehabilitation interventions for physical capacity and quality of life in adults with post-COVID-19 condition: a systematic review and meta-analysis. JAMA Netw Open. 2023, 6:e2333838. 10.1001/jamanetworkopen.2023.33838

28. Piva T, Masotti S, Raisi A, et al.: Exercise program for the management of anxiety and depression in adults and elderly subjects: is it applicable to patients with post-COVID-19 condition? A systematic review and meta-analysis. J Affect Disord. 2023, 325:273-81. 10.1016/j.jad.2022.12.155

29. Bellone S, Siegel ER, Santin AD: N-acetylcysteine (NAC) supplementation improves dyspnea and may normalize von Willebrand plasma levels in gynecologic patients with post-acute-COVID-sequela

(PASC)/long COVID. Gynecol Oncol Rep. 2025, 57:101682. 10.1016/j.gore.2025.101682

30. Haloot J, Bhavaraju-Sanka R, Pillarisetti J, Verduzco-Gutierrez M: Autonomic dysfunction related to postacute SARS-CoV-2 syndrome. Phys Med Rehabil Clin N Am. 2023, 34:563-72. 10.1016/j.pmr.2023.04.003

31. Isman A, Nyquist A, Strecker B, Harinath G, Lee V, Zhang X, Zalzala S: Low-dose naltrexone and NAD+ for the treatment of patients with persistent fatigue symptoms after COVID-19. Brain Behav Immun Health. 2024, 36:100733. 10.1016/j.bbih.2024.100733

32. Dietz TK, Brondstater KN: Long COVID management: a mini review of current recommendations and underutilized modalities. Front Med (Lausanne). 2024, 11:1430444. 10.3389/fmed.2024.1430444

33. Treadwell JR, Wagner J, Reston JT, Phillips T, Hedden-Gross A, Tipton KN: Treatments for Long COVID autonomic dysfunction: a scoping review. Clin Auton Res. 2025, 35:5-29. 10.1007/s10286-024-01081-w

34. Vinyes D, Muñoz-Sellart M, Caballero TG: Local anesthetics as a therapeutic tool for post COVID-19 patients: a case report. Medicine (Baltimore). 2022, 101:e29358. 10.1097/MD.0000000000029358

35. Kalava A, Benyahia SA, Tico Calzada R, Staat CM: Efficacy of stellate ganglion block in treating long-term COVID-19-related olfactory and gustatory dysfunction: a case series. Cureus. 2023, 15:e40929. 10.7759/cureus.40929

36. Pearson L, Maina A, Compratt T, Harden S, Aaroe A, Copas W, Thompson L: Stellate ganglion block relieves long COVID-19 symptoms in 86% of patients: a retrospective cohort study. Cureus. 2023, 15:e45161. 10.7759/cureus.45161

37. Duricka D, Liu L: Reduction of long COVID symptoms after stellate ganglion block: a retrospective chart review study. Auton Neurosci. 2024, 254:103195. 10.1016/j.autneu.2024.103195

2025 Chiang et al. Cureus 17(7): e88680. DOI 10.7759/cureus.88680

25 of 25