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Article

Long-Term Durability of Bilateral Two-Level Stellate Ganglion Blocks in Posttraumatic Stress Disorder: A Six-Month Retrospective Analysis

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Abstract: Posttraumatic stress disorder (PTSD) is a common neuropsychiatric condition with a complex etiology. Stellate Ganglion Block (SGB) is a novel but well-observed procedure for treating the disorder. However, the long-term durability of SGB has yet to be established. The primary objective of this study was to determine if performing ultrasound-guided, bilateral, two-level cervical sympathetic chain block (2LCSB) is associated with PTSD symptom improvement across six months. A secondary objective was to characterize treatment effects between trauma types. A retrospective chart review was conducted, and 75 patients meeting inclusion and exclusion criteria were identified. Posttraumatic stress disorder checklist for DSM-5 (PCL-5) scores were collected throughout a six-month period post-procedure. In addition, patients were asked to identify the category of trauma associated with their PTSD diagnosis. Nearly all (96%) patients showed significant improvement in their PCL-5 scores between the baseline and six months, with an average improvement of 55.48%. This is the first study to be conducted that examines the effects associated with SGB over a time period of greater than one month. Bilateral 2LCSB may provide durable PTSD symptom improvement for six months. However, additional research is necessary to establish causality.

Keywords: stellate ganglion block; stellate ganglion; posttraumatic stress disorder; posttraumatic stress disorder checklist for DSM-5; two-level cervical sympathetic chain block; military medicine; neuropsychiatry; sexual abuse; ultrasound; injection; local anesthetics; ropivacaine; sympathetic ganglion

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1. Introduction

Posttraumatic stress disorder (PTSD) is a well-recognized debilitating mental health condition associated with prior exposure to trauma [1]. The World Health Organization estimates that approximately 70% of people globally will experience a potentially traumatic event during their lifetime [2], but only 5.6% will go on to develop PTSD. An estimated 3.9% of the world population will experience PTSD at some point in their lives [3]. In the general population, up to 12% of adults in the United States will develop PTSD at some point in their lifetimes [4,5]. However, the prevalence of PTSD is likely to be underestimated, as many individuals avoid seeking treatment due to concerns about the stigma associated

with the condition and fear of losing their jobs [6]. Moreover, approximately 50% of people living with PTSD do not seek psychotherapy or receive insufficient treatment [7]. Risk factors for PTSD can be categorized by trauma type [8], sex [9], race/ethnicity [10], prior or comorbid psychiatric disorders [11], occupation [12], genetics [13], personality factors [14], and other psychosocial factors [15].

Moreover, the reported prevalence of PTSD in sexual assault survivors based on World Health Organization (WHO) mental health surveys is approximately 20% [16], while other studies have reported PTSD symptom severity following sexual trauma at nearly 48% [17]. In regards to childhood-related trauma, the National Center for PTSD reports that up to 15% of girls and 1% to 6% of boys who have had at least one trauma develop PTSD [18]. Other studies demonstrate that first responders, who are categorized as law enforcement officers, paramedics, and firefighters, can develop PTSD at rates ranging from 6% to 32% [19–39]. This further illustrates the complexity of the etiology of this disorder and the challenges associated with diagnosis and treatment.

Physical events may generate PTSD in patients, though PTSD may also have eventual onset due to emotional factors that act as a stimulus [40]. From what we understand, PTSD can be known to change brain activity and function by altering neuroinflammatory, oxidative, and excitotoxic mechanisms via disruptions to neural circuitry [41]. These tissue-level disruptions are thought to result in abnormalities of the fronto-cingulo-parietal cognitive control network, manifesting in behavioral and neurological changes in the typical function of cognition, memory, attention, and inhibition of fear processing [42].

Current standard of care options to address individuals with PTSD focus on two distinct modalities: pharmacologic intervention or trauma-focused psychological therapies (TFPTs). These TFPTs are commonly recommended to patients [43], but they appear to have a high drop-out rate [44]. Common pharmacologic interventions for PTSD include selective serotonin reuptake inhibitors (SSRIs) [45], selective norepinephrine reuptake inhibitors (SNRIs) [46], benzodiazepines [47], atypical antipsychotics [48], and α1-adrenoreceptor antagonists [49]. While these methods provide symptomatic improvements, roughly 50% of patients do not improve with an initial course of medication [50]. Moreover, there is evidence to suggest that multimodal care is more effective in treating PTSD symptoms than a single therapy approach [51] and combining treatments that have complementary mechanisms of action may optimize patient outcomes [52]. Unfortunately, conservative care often falls short, failing to address the underlying neuro-degenerative mechanisms of PTSD [53]. Due to the large population burdened by chronic symptoms of PTSD, there is a need to develop more robust interventional options for patients and providers to address unresolved symptoms.

The stellate ganglion block (SGB) is a procedure that has been used since the 1920s to treat a variety of conditions. Its first documented use in 1925 was for pain-related conditions as well as a form of posttraumatic stress injury [54]. In 1990, Lebovits et al. first described the positive effects of SGB on the symptoms of PTSD [55]. Since that time, more than thirty-five studies have been published regarding SGB for the treatment of PTSD [56], including a 2019 multi-site randomized controlled trial that showed favorable results [57].

Much of the scientific literature regarding the SGB procedure describes the treatment of the stellate ganglion structure, primarily at the level of the 6th cervical vertebrae. However, there is significant anatomic variation in the course of the cervical sympathetic chain [58] that may result in an incomplete block with a single injection at this level only [59,60]. To address this, in 2020, we began implementing ultrasound-guided two-level cervical sympathetic chain block at the levels of the 4th and the 6th cervical vertebrae and noted superior improvements in PTSD symptoms compared with a single-level SGB [61]. These findings were later validated by Lipov et al. [62]. Although SGB remains the commonly

accepted term for this procedure, due to the significant variability in anatomical structure, "cervical sympathetic block" is a more suitable procedural nomenclature. Thus, we propose the more accurate terminology "two-level cervical sympathetic chain block" (2LCSB) since this procedure targets the sympathetic chain and does not specifically target the stellate ganglion.

In 2015, our practice began performing 2LCSB on the left side in instances where the standard procedure on the right side failed to result in a clinical benefit [63]. Noting that an estimated five percent of patients with PTSD only responded to a left-sided block [64], some providers have begun routinely incorporating bilateral 2LCSB (performed on subsequent days to eliminate the risk of inadvertent bilateral recurrent laryngeal nerve block and subsequent potential respiratory distress). While significant extant literature suggests the safety, acceptability, and effectiveness of SGB for treating PTSD [65–69], no studies have been published to date that either evaluate the durability of SGB beyond one month or illustrate the potential impact of bilateral 2LCSB. The primary purpose of this study is to evaluate the durability of 2LCSB for PTSD throughout a six-month period, with a secondary aim of characterizing the treatment effects between trauma types.

2. Materials and Methods

This retrospective case series was approved by the institutional review board of the Institute of Regenerative and Cellular Medicine (IRCM-2024-412). Seventy-five patients with a prior history of PTSD underwent bilateral 2LCSB treatment between January 2022 and September 2024. Patients were included based on the following criteria: they must have received a behavioral health provider's formal diagnosis of PTSD, and they must have provided an answer to the question "which category of trauma best describes your traumatic experience?". These categories included combat-related, sexual abuse or assault, childhood abuse or neglect, first-responder-related trauma, a life-threatening event (car accident, medical emergency, etc.), or other. Patients were permitted to choose up to two categories that they associated with their PTSD symptoms. Due to the small numbers, if patients chose either "Combat-related" or "First-responder related", they were grouped into a category called "Public-service related trauma". Patients who chose "Other" were recategorized as "Unspecified trauma". Finally, only patients who completed forms at all time points (baseline, one week, one month, three months, and six months relative to procedure time points) were included in the analytic dataset.

The PCL-5 is a 20-item self-reported correspondent measure of the DSM-5 criteria used to screen individuals for PTSD symptoms and monitor post-treatment symptom progression [70]. The instrument has illustrated strong test-retest reliability, internal consistency, and diagnostic utility against the clinician-administered PTSD scale for DSM-5 (CAPS-5) [71–73]. For the PCL-5, respondents rated how much they were affected by a given PTSD symptom in the past month using a five-point scale ranging from "Not at all" to "Extremely". Items were summed to provide a total symptom severity score ranging from 0, indicating "no symptoms", to 80, indicating "severe symptoms". A score of 31–33 is accepted as a valid diagnostic cut-off score and can be used as a provisional PTSD diagnosis for veteran and undergraduate populations [74,75]. Scores lower than this may indicate a patient's symptoms are sub-threshold for PTSD [76]. The National Center for PTSD states a 5-point score decrease is the minimum threshold to determine an adequate response to treatment, while at least a 10-point score improvement is considered clinically meaningful. While these reliable and clinically significant changes are based on evidence for the 17-item PCL for DSM-IV, it is expected that changes to scores for the PCL-5 will be in a similar range [75,77].

Patients were asked to complete the PCL-5 at baseline, one week, one month, three months, and six months post-procedure via a cloud-based, 21 CFR Part 11 compliant, secure data collection system. Only those who completed the measure at all time points were included in the study dataset. Scores were entered into the secure data collection system that is only accessible to select clinical research staff.

The clinical and procedural details of SGB and 2LCSB have been documented elsewhere [63]. Briefly, ultrasound guidance was used to introduce 6–8 mL of 0.5% ropivacaine at the 6th cervical vertebra and 1.5–2 mL of 0.5% ropivacaine at the 4th cervical vertebra on the right side, avoiding the vertebral artery and vein, as well as other vasculature. The procedure was repeated on the left side the following day to eliminate the risk of inadvertent bilateral blockade of the recurrent laryngeal nerve and subsequent potential airway compromise [64]. All procedures were performed by an experienced provider at an established musculoskeletal practice.

We conducted a retrospective analysis of the PCL-5 total symptom severity scores from baseline to six months to determine changes in patient symptoms. The outcomes were separated and analyzed to determine sex-based differences, changes in scores by time point, and changes in scores by trauma type. For all analyses, two-tailed *t*-tests were used, with $\alpha = 0.05$.

3. Results

Procedure Outcomes

Seventy-two of the 75 patients (96%) treated with bilateral 2LCSB in our retrospective analysis saw a decrease in PCL-5 scores and a corresponding improvement in their PTSD symptoms, leaving three patients (4%) who did not improve at the six-month follow-up. The average age for included patients was 51.30 (51.55 for male patients and 50.90 for female patients), and nearly two-thirds of participants were male (n = 46). The mean (SD) PCL-5 score at baseline was 51.34 (16.53) for all participants, with an average (SD) decrease of 28.48 (18.73) points after six months. Between males and females, male participants experienced greater decreases in PCL-5 scores six months post-2LCSB (males: mean change {SD, [95% CI]}, 29.81 {17.44, [24.66, 34.96]}; females, mean change {SD, [95% CI]}, 26.35 {18.78, [19.27, 33.43]}; Cohen *d*, 0.19; effect size, 0.10; $p =< 0.0001$).

These results reinforce the six-month durability of 2LCSB for the indication of PTSD. Moreover, while there was variable improvement across all trauma groups in this study, all sub-groups received at least a 28% improvement in PTSD symptoms from the procedure. These results are validated by markers of statistical significance as well as clinically significant improvements in symptoms. These results are presented in Figure 1 and Table 1.

Table 1. Average PCL-5 Scores by gender according to time point and trauma type.

	Male	**Female**	**Total (SD)**
Count (All trauma types)	46	29	75
Avg. PCL-5 Scores (All Trauma Types)			
Baseline	50.81 (16.92)	52.21 (13.98)	51.34 (16.53)
One week	18.96	18.97	18.96
One month	19.39	18.00	18.85
Three months	21.15	20.72	20.99
Six months	21.00 (17.35)	25.86 (18.60)	22.86 (18.09)
Percent improvement from Baseline	58.67%	50.46%	55.48%

Table 1. *Cont.*

	Male	Female	Total (SD)
Count (Public Service Trauma)	33	3	36
Avg. PCL-5 Scores (Public Service Trauma)			
Baseline	52.91	62.33	53.69
One week	17.00	37.67	18.72
One month	23.18	12.79	17.36
Three months	20.12	39.00	21.69
Six months	23.91	25.43	24.76
Percent improvement from Baseline	60.88%	28.20%	57.53%
Count (Childhood Abuse Trauma)	3	7	10
Avg. PCL-5 Scores (Childhood Abuse Trauma)			
Baseline	39.00	52.00	48.10
One week	17.67	14.57	15.50
One month	20.00	18.29	18.80
Three months	16.00	15.86	15.90
Six months	11.67	20.43	17.80
Percent improvement from Baseline	70.09%	60.71%	62.99%
Count (Sexual Assault Trauma)	1	2	3
Avg. PCL-5 Scores (Sexual Assault Trauma)			
Baseline	11.00	52.00	48.33
One week	9.00	16.00	13.67
One month	9.00	16.50	14.00
Three months	8.00	15.00	12.67
Six months	6.00	9.50	8.33
Percent improvement from Baseline	45.45%	81.73%	72.26%
Count (Life Threatening Trauma)	0	4	4
Avg. PCL-5 Scores (Life Threatening Trauma)			
Baseline	NA	46.50	46.50
One week	NA	19.50	19.50
One month	NA	19.25	19.25
Three months	NA	14.75	14.75
Six months	NA	25.25	25.25
Percent improvement from Baseline	NA	45.70%	45.70%
Count (Unspecified Trauma)	11	14	25
Avg. PCL-5 Scores (Unspecified Trauma)			
Baseline	47.55	51.86	49.96
One week	24.36	16.43	19.92
One month	23.18	12.79	17.36
Three months	24.91	20.57	22.48
Six months	23.91	25.43	24.76
Percent improvement from Baseline	49.71%	50.96%	50.44%

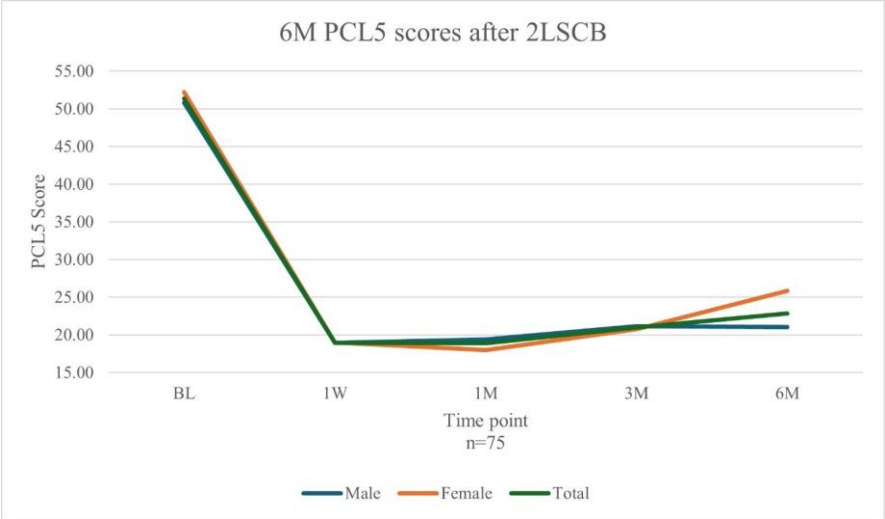

Figure 1. Patients reported durable, significant decreases in their PCL-5 scores six months post-2LCSB. Time points include baseline (BL), one week (1W), one month (1M), three months (3M), and six months (6M) post-2LCSB.

In summary, 96% of the patients treated with bilateral 2LCSB experienced a statistically significant decrease in PCL-5 scores. Public-service and childhood abuse patients experienced the greatest symptom improvement at the first primary time point of one week, overall patients and unspecified trauma patients experienced the greatest improvement at one month, life-threatening patients' greatest improvement at three months, and finally, sexual abuse patients experienced the greatest improvement at six months. The symptom improvement from all groups was found to be relatively durable out to six months.

4. Discussion

The primary aim of this study is to assess the durability of 2LCSB throughout a six-month period in patients with PTSD. SGB has been established as an effective treatment for PTSD with durable improvements through one month, suggesting its safety, acceptability, and effectiveness. While there is support for 2LCSB for PTSD at one week and one month [63,78], there are no studies that seek a longer-term evaluation of symptom improvements or that explore the effect of 2LCSB on specific types of trauma associated with PTSD. This retrospective analysis is the first of its kind and shows continued improvement in PTSD symptoms for an extended period following 2LCSB. This suggests that 2LCSBs may represent a possible adjunct in the treatment of patients with PTSD. Our secondary aim was to assess differences in outcomes based on trauma type. To our knowledge, this is the first such study to assess outcomes based on trauma type.

In this retrospective case series, the use of bilateral ultrasound-guided 2LCSB resulted in greater than 55% improvement in PTSD symptoms, as measured by PCL-5 scores, up to six months post-procedure. Women reporting sexual assault-related trauma experienced the greatest improvement in symptoms between the baseline and six months (81%). Conversely, women who reported military or first responder-related trauma experienced the least improvement (26%). It is unclear to us why there was such a stark difference in improvement between these two groups. While the relative number of patients in the childhood life-threatening incident and sexual abuse groups is small, the six-month outcome measures suggest that these patients may still benefit. When considering both service- and non-combat-related traumas, our findings suggest that 2LCSB is an effective and durable treatment for various forms of PTSD. However, due to the small sample sizes of each of these categories of patients, we encourage caution when interpreting these results.

As previously discussed, PTSD is a nuanced disorder that may manifest from a myriad of traumatic exposures, isolated experiences, or repeat incidents. The nature of PTSD-related traumas is often multifactorial [15], as evidenced by two patients in this dataset who reported both childhood trauma and sexual assault-related trauma. The different degrees of improvement seen between these may suggest a relationship to the unique etiologies of different traumas. Additional studies may be able to determine the true effectiveness of the procedure. For example, we were unable to control for potential confounders such as demographic or clinical characteristics due to the retrospective, clinical nature of the data. Future research would benefit from an examination of these and other characteristics so that a clearer picture may emerge regarding the true effect of this procedure.

There are several limitations to this study that should be considered when interpreting our findings. As this study is a retrospective review of clinical data, there is no control arm, which limits the generalizability of the findings as well as the strength of the conclusions that can be drawn. A placebo group included in a formal RCT is needed to be able to further assess the long-term effective durability of the treatment with respect to PSTD-specific symptoms for an extended time period.

As many of these patients were seeking adjunct therapies to address their PTSD symptoms at the time of undergoing the 2LCSB, it is difficult to ascribe improvements in symptoms to this procedure alone. However, nearly all (96%) patients in this analysis experienced a PCL-5 symptom score change of at least 10 points after undergoing the 2LCSB, which is considered by the National Center for PTSD to be the minimum threshold for determining clinically significant improvement [75]. While determining the effectiveness of 2LCSB alone will be important for future research, this finding supports our belief that bilateral 2LCSB should be considered in combination with psychopharmacological and/or psychotherapeutic interventions [77].

While we do subset patient outcomes by trauma type, some would not disclose the nature of the traumatic incident associated with their PTSD, leading to a sizeable unspecified category. As such, our findings regarding trauma type should be considered exploratory and interpreted with caution. Other research has noted the challenges associated with reliably establishing the type of trauma associated with symptom onset future research would do well to address this challenge insofar as it is possible. An appropriately powered randomized controlled trial may help address this limitation. In such a study, more specific classifications of trauma could be included for analysis and then collapsed if the numbers are low. Given that the etiology of PTSD resulting from differing trauma types may itself be different, this seems an important topic for future consideration.

Given the high rates of comorbidity between PTSD and other mental health conditions [79–81], it is difficult to characterize the degree to which symptoms showing improvement here are associated with PTSD. Still, a significant reduction in symptomatology for any disorder is likely to result in improvements in quality of life, productivity, and overall well-being [82,83]. In this regard, our findings regarding bilateral 2LCSB suggest an improvement in these factors.

Finally, it is possible that the symptom improvements reported here may be due to the placebo effect, which has been reported to be as high as 50% with injection procedures [84]. However, these findings were in reference to subcutaneous delivery of placebo migraine medication and may not be generalizable to sympathetic blocks which result in observable Horner's syndrome. Still, an appropriately powered trial with effective randomization may help minimize the effect of a placebo on outcomes.

5. Conclusions

PTSD significantly impacts millions of patients' quality of life and is associated with a high burden on the American healthcare system. The findings of this retrospective case series suggest that bilateral 2LCSB may be an effective adjunct treatment for PTSD. Decreases in symptoms, whether due to this treatment, others, or a combination, will result in notable improvements in the quality of life and functioning of those suffering from this often debilitating disorder. Future studies should include randomized controlled trials to better establish the effectiveness of the procedure. Such studies may also suggest a mechanism of action that could enable more targeted interventions for PTSD.

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Institutional Review Board Statement: This case series was conducted according to the guidelines of the Declaration of Helsinki and approved by the institutional review board of the Institute of Regenerative and Cellular Medicine (IRCM-2024-412) on 12 September 2024.

Informed Consent Statement: Informed consent was obtained from all subjects involved in this study. Written informed consent has been obtained from the patient(s) to collect patient-reported outcome measures (PROMs) and enrollment in data collection for this case series.

Data Availability Statement: The data that support the findings of this study are available from the corresponding author on request due to privacy issues in accordance with the consent provided by the participants. All data are freely accessible.

Conflicts of Interest: The authors do not have any conflicts of interest, although the one physician author does perform SGBs as part of their normal practice of medicine. This physician was not involved in the collection or analysis of the data.

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