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REVIEW ARTICLE

Sympathetic nervous system and stellate ganglion block under ultrasound for the control of visceral pain: a systematic review

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Abstract

Introduction: Peripheral nerve blocks are becoming increasingly used as adjuvant treatment modalities for a variety of conditions refractory to medical treatment. Right or left stellate ganglion blocks are a specific type of peripheral nerve block that targets the sympathetic blockade of neuronal impulses by injecting local anesthetic and steroids into nerve bundles in the cervical area. **Objective:** It was to present the primary evidence from clinical studies of visceral pain mediated by the sympathetic nervous system through resolution with stellate ganglion block under ultrasound. **Methods:** The systematic review rules of the PRISMA Platform were followed. The search was conducted from January to February 2025 in the Scopus, PubMed, Science Direct, Scielo, and Google Scholar databases. The quality of the studies was based on the GRADE instrument and the risk of bias was analyzed according to the Cochrane instrument. **Results and Conclusion:** 104 articles were found. A total of 28 articles were assessed and 25 were included in this systematic review. Considering the Cochrane tool for risk of bias, the overall assessment resulted in 22 studies with a high risk of bias and 22 studies that did not meet GRADE and AMSTAR-2. Most studies showed homogeneity in their results, with X^2=89.5% >50%. It was evident that stellate ganglion block is an emerging treatment modality for many sympathetically managed processes, resulting in complete resolution of pain. Although promising in the current literature, large multicenter randomized clinical trials are needed in the future to further validate the efficacy of stellate ganglion block. Additional research is also needed to elucidate the timing, laterality, and repetition of blocks for these conditions.

Keywords: Visceral pain. Sympathetic nervous system. Stellate ganglion block. Ultrasound.

Introduction

The autonomic nervous system (ANS) controls heart rate, blood pressure, digestion, respiration, pupillary reactivity, sweating, urination, and sexual arousal, and regulates the functions of internal organs. This system provides homeostasis of cells, tissues, and organs throughout the body and protects against disturbances imposed by external and internal stressors. The ANS has three main divisions: the sympathetic nervous system (SNS), the parasympathetic nervous system (PNS), and the enteric nervous system. In general, the SNS and PNS have opposing effects. Each region belonging to the pain matrix interacts with the ANS. The descending system regulates pain and creates a regulatory effect through the contribution of aminergic neurotransmitters. Hypothalamus, amygdala, and periaqueductal gray matter are the main structures of this regulatory system [1].

In this sense, ANS dysfunction is frequently observed in patients with pain. The SNS induces, facilitates, or potentiates chronic pain. Increased responsiveness of injured sensory nerves to catecholamines, increased expression of α-1 adrenoreceptors in primary afferent nociceptors, and hyperalgesic skin, central sensitization with Aβ mechanoreceptors, increased discharge and sympathetic sprouting in dorsal root ganglia, and central sensitization and dysfunction of pain modulation are proposed mechanisms [1,2].

The SNS is spatially and pathophysiologically related to acute and chronic pain. Acute generalized sympathetic activation, as occurs with the stress response, can temporarily increase the nociceptive threshold through a combination of neural and endocrine effects. Given its trophic and immunomodulatory function, the SNS can exert pro-inflammatory and pro-nociceptive effects, particularly at the tissue level [3].

In this context, blocking regional sympathetic efferent activity may indirectly relieve ischemic pain. Similarly, a regional blockade of sympathetic activity can directly interrupt nociceptive pain transmission from internal organs, as most general visceral afferent fibers travel with sympathetic nerves. The SNS can pathologically evolve into a significant contributor to pain, as occurs in the case of complex regional pain syndrome [2,3].

Thus, selective interventional blockade of sympathetic pathways is commonly used to treat ischemic or sympathetically mediated pain. Most large sympathetic ganglia and plexuses are anatomically separated from somatic nerves in the prevertebral and paravertebral regions and are therefore easily accessible to percutaneous interruption. When indicated, sympathetic blocks can provide significant analgesia without causing somatic sensory deficits. Blocking visceral sympathetic outflow will shift the homeostatic balance in the target region toward parasympathetic prevalence, with corresponding physiological effects [2].

As a corollary, peripheral nerve blocks are becoming increasingly used as adjuvant treatment modalities for a variety of conditions refractory to medical treatment. Right or left stellate ganglion blocks are a specific type of peripheral nerve block that targets the sympathetic blockade of neuronal impulses using the injection of local anesthetic and steroids into nerve bundles in the cervical area. The state of sympathetic overload is created by increased levels of nerve growth factor (NGF), which causes a sympathetic sprouting cascade resulting in increased norepinephrine (NE) systemically. Reversing this cascade by injecting local anesthetic into the stellate ganglion therefore reduces NGF and sympathetic sprouting, subsequently decreasing overall norepinephrine levels [3].

Therefore, the present systematic review study aimed to present the main evidence from clinical studies of visceral pain mediated by the sympathetic nervous system through resolution with stellate ganglion block under ultrasound.

Methods

Study Design

This study followed an international model for systematic review, adhering to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. Available at: http://www.prisma-statement.org/?AspxAutoDetectCookieSupport=1. Accessed on: 02/22/2025. The methodological quality standards of AMSTAR-2 (Assessing the methodological quality of systematic reviews) were also followed. Available at: https://amstar.ca/. Accessed on: 02/22/2025.

Research Strategy and Sources

The literature search process was conducted from January to February 2025 and developed using Scopus, PubMed, Science Direct, SciELO, and Google Scholar, encompassing scientific articles from various periods to the present. The following health sciences descriptors (DeCS/MeSH Terms) were used: Visceral pain. Sympathetic nervous system. Stellate ganglion block. Ultrasound, and using the Boolean operator "and" between MeSH terms and "or" between historical findings.

Study Quality and Risk of Bias

Quality was classified as high, moderate, low, or very low regarding risk of bias, clarity of comparisons, precision, and consistency of analyses. The most evident highlight was for systematic review articles or meta-analyses of randomized clinical trials, followed by randomized clinical trials. Low quality of evidence was attributed to case reports, editorials, and brief communications, according to the GRADE instrument. The risk of bias was analyzed according to the Cochrane instrument through the analysis of the Funnel Plot (Sample size versus Effect size), using Cohen's d test.

Results and Discussion

Summary of Findings

As a corollary to the literature search system, a total of 104 articles were found, which were submitted to eligibility analysis, and subsequently, 25 of the 28 final studies were selected to compose the results of this systematic review. The listed studies presented medium to high quality (Figure 1), considering in the first instance the level of scientific evidence of studies in study types such as meta-analysis, consensus, randomized clinical, prospective, and observational. Biases did not compromise the scientific basis of the studies. According to the GRADE instrument, most studies showed homogeneity in their results, with X^2=89.5%>50%. Considering the Cochrane tool for risk of bias, the overall assessment resulted in 22 studies with a high risk of bias and 22 studies that did not meet the GRADE and AMSTAR-2 criteria.

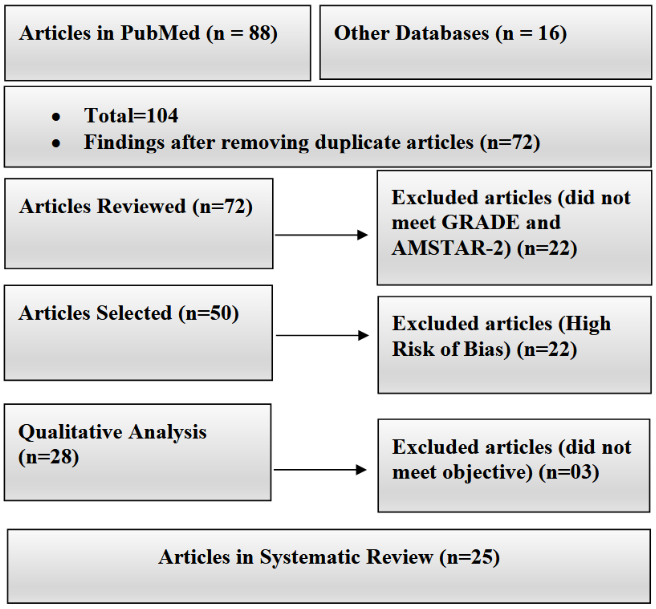

Figure 1. Flowchart showing the article selection process. Source: Own Authorship.

Figure 2 presents the results of the risk of bias of the studies using the Funnel Plot, showing the calculation of the Effect Size (Magnitude of the difference) using Cohen's d test. Precision (sample size) was determined indirectly by the inverse of the standard error (1/Standard Error). This graph showed a symmetrical behavior, not suggesting a significant risk of bias, both among studies with small sample sizes (lower precision) shown at the bottom of the graph and studies with large sample sizes shown at the top.

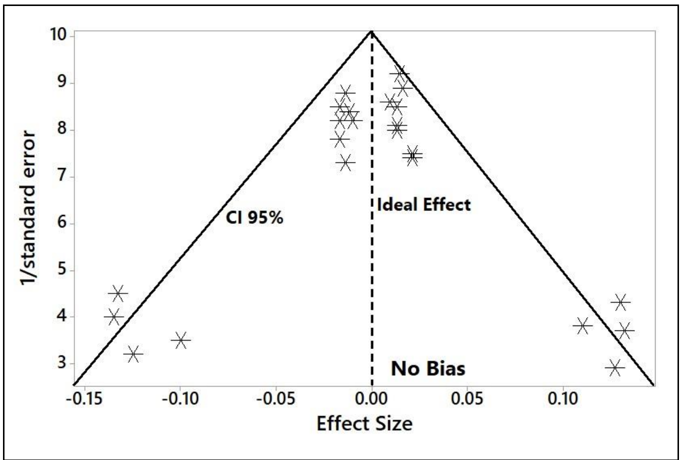

Figure 2. The symmetrical funnel plot does not suggest a risk of bias among the small sample size studies shown at the bottom of the graph. Studies with high confidence and high recommendation are shown above the graph (n=25 studies). Source: Own Authorship.

Evidence from Key Clinical Findings

Current literature findings support the use of stellate ganglion block (SGB) with promising results in patients with symptoms refractory to existing treatment algorithms. In the sympathetic nervous system, sympathetic preganglionic neurons are located in segments T1 to L2 of the thoracolumbar spinal cord. These preganglionic neurons show selective activity in response to orthostatic stress, temperature change, hypoglycemia, bleeding, exercise, or a specific emotion [4].

In this sense, norepinephrine (NE) and epinephrine (E) act through different α1, α2, and adrenoceptor subtypes. α1 adrenergic receptors mediate the stimulation of smooth muscles in blood vessels, iris, vas deferens, bladder neck, and internal rectal sphincter. Alpha-2 adrenergic receptors are primarily located in presynaptic terminals and mediate presynaptic inhibition of NE release from sympathetic terminals. Visceral structures (thoracic, abdominal, and pelvic organs) are highly sensitive to distension, stretching, volume, pressure, ischemia, or inflammation. Visceral nociceptive information reaches spinal centers via visceral afferents. Visceral afferents are carried by peripheral nerves that also carry autonomic efferents. Visceral pain is poorly localized and felt more diffusely than somatic pain and is frequently associated with autonomic symptoms. It can even be referred to. Referred pain is pain perceived in a location different from the site of the painful stimulus/origin. Nerve fibers from sensory inputs from higher regions (such as the skin) and nerve fibers from lower sensory inputs (such as the visceral organs) converge at the same level of the spinal cord. This can result in confusion about where the sensation/pain is coming from [5].

In this respect, visceral pain can be related to a wide spectrum of etiology; angina pectoris, peptic ulcer, kidney stones, cystitis, and pelvic causes, etc. The contribution of sympathetic activation in visceral pain is important. Adrenergic activation has been demonstrated in patients with chronic bladder pain due to interstitial cystitis [6].

Acute pain is predominantly mediated by extrinsic afferents from the gastrointestinal tract to the CNS. Extrinsic afferents project to the spinal cord within the splanchnic nerves, which contain both extrinsic afferents and sympathetic fibers. Parasympathetic fibers do not normally play a major role in the transmission of visceral pain, but may be indirectly involved. The vagus nerve and other parasympathetic afferents normally mediate non-painful sensations, but they can activate brainstem centers responsible for descending inhibition of peripheral input and thus dampen pain. The CNS can also be affected by autonomic reflexes, such as bowel paralysis and associated symptoms [7]. Visceral hypersensitivity related to ANS dysfunction is proposed. In many studies, increased SNS activity and decreased PNS activity have been implicated in patients with irritable bowel syndrome (IBS) [8,9].

In this scenario, the stellate ganglion is present in approximately 80% of the population as a fusion of the lower cervical and first thoracic sympathetic ganglia at the level of the C7 transverse process [10]. In the other 20% of patients, the two ganglia are not fused, so the lower cervical ganglion is designated as the stellate ganglion. Anatomically, the stellate ganglion is anterolateral to the longus colli muscle, medial to the scalene muscles, anterior to the transverse process and prevertebral fascia, and is separated from the posterior cervical pleura by the suprapleural membrane. Medial to the stellate ganglion are the trachea, esophagus, and vertebral column. The vascular structures surrounding the stellate ganglion include the vertebral vessels anterolaterally, the carotid artery anteriorly, the superior intercostal artery laterally, and the costocervical trunk of the subclavian artery inferiorly [10].

For SGB, before starting the procedure, care must be taken with proper patient positioning. The patient is placed at a semi-reclined angle of 30-45 degrees with a slight extension of the neck. The head is then turned to the contralateral side. Before the use of ultrasound and fluoroscopy, SGB was performed using anatomical landmarks by palpating the anterior tubercle of the C6 transverse process (Chassaignac's tubercle) between the sternocleidomastoid muscle and the trachea, then pushing the carotid artery laterally. The landmark technique is rarely performed now due to concerns about the unpredictability of needle position and the spread of local anesthetic agents [11].

Currently, ultrasound or fluoroscopy-guided techniques are preferred. During an ultrasound-guided block, a curvilinear transducer is placed on the cricoid cartilage perpendicular to the tracheal axis and moved inferiorly until the thyroid gland is visualized. Next, the transducer is moved laterally to visualize the anterior aspect of Chassaignac's tubercle. In this position, multiple structures can be identified, including the carotid artery, internal jugular vein, thyroid gland, trachea, longus colli and capitis muscles, prevertebral fascia, and C6 spinal nerve root [12].

According to the present case report, the literature shows that image-guided SGB significantly reduces complication rates compared to older literature [13-16]. However, it is still associated with the risk of injury to adjacent structures (e.g., cricoid cartilage, carotid artery and other vessels, lung parenchyma, thyroid and parathyroid glands, and esophagus), as well as the risk of intravascular injection and infection [13,14]. SGB at the C6 transverse process is preferred over C7 due to the lower risk of intra-arterial injection into the vertebral artery. Furthermore, a lateral approach demonstrates fewer complications due to improved visualization of anatomical landmarks under fluoroscopy at the lateral tracheal border compared to the anterior approach [12-14,17]. The difficulty in visualizing this area with an anterior approach results in a higher incidence of esophageal injury or risk of perforation [13].

Moreover, complications of SGB can be broadly divided into local and systemic. The most common systemic complications of SGB are hoarseness and dizziness [18]. Case reports have also shown severe arterial hypertension after SGB, likely due to spread to the surrounding carotid sheath, resulting in vagal blockade [19]. In addition, short-term and persistent coughs have been observed after SGB, likely due to recurrent laryngeal nerve paralysis [20,21]. The most common local complications include aspiration of blood during injection, intraprocedural bleeding, and hematoma formation. However, SGB is a relatively safe procedure, with only five case reports to date documenting late hematoma formation requiring tracheostomy and prolonged hospitalization [22-25].

Finally, although image guidance has improved visualization of appropriate targets, anatomical variants or incorrect identification of relevant structures may result in block failure [15]. Due to the proximity of multiple vessels in the head/neck, inadvertent incorrect injection can be harmful [12,13,15,26]. Bhatia et al. demonstrated vulnerability of the vertebral artery in approximately 12% of cases involving ultrasound-guided SGB [13]. The inferior thyroid artery can also be unpredictable, as it ascends anterior to the vertebral artery and curves medially behind the carotid sheath [12,15]. Injuries to it can cause a retropharyngeal hematoma, leading to serious airway problems. Finally, intra-arterial injection can result in spasms, hematoma, seizures and other complications, including local anesthetic systemic toxicity (LAST) [27,28].

Limitations

There are few randomized clinical trials or other types of well-designed clinical studies with significant sample sizes.

Conclusion

It was concluded that stellate ganglion block is an emerging treatment modality for many sympathetically driven processes, resulting in complete resolution of pain. Although promising in the current literature, large multicenter randomized clinical trials are needed in the future to further validate the efficacy of the stellate ganglion block. Additional research is also needed to elucidate the timing, laterality, and repetition of blocks for these conditions.

CRediT

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Informed Consent

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Data Sharing Statement

No additional data are available.

Conflict of Interest

The authors declare no conflict of interest.

Similarity Check

It was applied by Ithenticate@.

Application of Artificial Intelligence (AI)

Not applicable.

Peer Review Process

It was performed.

References

1. Arslan D, Ünal Çevik I. Interactions between the painful disorders and the autonomic nervous system. Agri. 2022 Jul;34(3):155-165. English. doi: 10.14744/agri.2021.43078.
2. Lipov E, Ritchie EC: A review of the use of stellate ganglion block in the treatment of PTSD . Curr Psychiatry Rep. 2015, 17:599. 10.1007/s11920-0150599-4.
3. Doroshenko M, Turkot O, Dua A, Horn DB. Sympathetic Nerve Block. 2024 Feb 12. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan–. PMID: 32491569.
4. Kirkpatrick K, Khan MH, Deng Y, Shah KB. A Review of Stellate Ganglion Block as an Adjunctive Treatment Modality. Cureus. 2023 Feb 19;15(2):e35174. doi: 10.7759/cureus.35174.
5. Gebhart GF, Bielefeldt K. Physiology of visceral pain. Compr Physiol 2016;6:1609–33.
6. Charrua A, Pinto R, Taylor A, Canelas A, Ribeiro-da-Silva A, Cruz CD, et al. Can the adrenergic system be implicated in the pathophysiology of bladder pain syndrome/interstitial cystitis? A clinical and experimental study. Neurourol Urodyn 2015;34:489–96.
7. Drewes AM, Olesen AE, Farmer AD, Szigethy E, Rebours V, Olesen SS. Gastrointestinal pain. Nat Rev Dis Primers 2020;6:1.
8. Manabe N, Tanaka T, Hata J, Kusunoki H, Haruma K. Pathophysiology underlying irritable bowel syndrome--from the viewpoint of dysfunction of autonomic nervous system activity. J Smooth Muscle Res 2009;45:15–23.
9. De Winter BY, Deiteren A, De Man JG. Novel nervous system mechanisms in visceral pain. Neurogastroenterol Motil 2016;28:309–15.
10. Mehrotra M, Reddy V, Singh P: Neuroanatomy, Stellate Ganglion. StatPearls Publishing, Treasure Island; 2022. 19:2022.
11. Elias M: Cervical sympathetic and stellate ganglion blocks . Pain Physician. 2000, 3:294-304.
12. Piraccini E, Munakomi S, Chang KV: Stellate Ganglion Blocks. StatPearls, Treasure Island; 2022.
13. Bhatia A, Flamer D, Peng PW: Evaluation of sonoanatomy relevant to performing stellate ganglion blocks using anterior and lateral simulated approaches: an observational study. Can J Anaesth. 2012, 59:1040-7. 10.1007/s12630-012-9779-4
14. Kapral S, Krafft P, Gosch M, Fleischmann D, Weinstabl C: Ultrasound imaging for stellate ganglion block: direct visualization of puncture site and local anesthetic spread. A pilot study. Reg Anesth. 1995, 20:323-8.
15. Soneji N, Peng PW: Ultrasound-guided pain interventions - a review of techniques for peripheral nerves. Korean J Pain. 2013, 26:111-24. 10.3344/kjp.2013.26.2.111
16. Wulf H, Maier C: [Complications and side effects of stellate ganglion blockade. Results of a questionnaire survey]. Anaesthesist. 1992, 41:146-51.

17. Peng PW, Narouze S: Ultrasound-guided interventional procedures in pain medicine: a review of anatomy, sonoanatomy, and procedures: part I: nonaxial structures. Reg Anesth Pain Med. 2009, 34:458-74. 10.1097/AAP.0b013e3181aea16f.
18. Goel V, Patwardhan AM, Ibrahim M, Howe CL, Schultz DM, Shankar H: Complications associated with stellate ganglion nerve block: a systematic review. Reg Anesth Pain Med. 2019, 10.1136/rapm-2018-10012.
19. Kimura T, Nishiwaki K, Yokota S, Komatsu T, Shimada Y: Severe hypertension after stellate ganglion block. Br J Anaesth. 2005, 94:840-2. 10.1093/bja/aei13.
20. Atici S, Akoz K: Transient cough attacks after right stellate ganglion block . Reg Anesth Pain Med. 2010, 35:318-9. 10.1097/AAP.0b013e3181de12d2
21. Naveira FA, Snell JA, Rauck RL: Blocks of the sympathetic nervous system . Phys Med Rehabil. 1996, 10:245- 288.
22. Okuda Y, Urabe K, Kitajima T: Retropharyngeal or cervicomediastinal haematomas following stellate ganglion block. Eur J Anaesthesiol. 2003, 20:757-9. 10.1017/s0265021503231239
23. Takanami I, Abiko T, Koizumi S: Life-threatening airway obstruction due to retropharyngeal and cervicomediastinal hematomas following stellate ganglion block. Thorac Cardiovasc Surg. 2009, 57:311-2. 10.1055/s-2008-1038845
24. Uchida T, Nakao S, Morimoto M, Iwamoto T: Serious cervical hematoma after stellate ganglion block . J Anesth. 2015, 29:321. 10.1007/s00540-014-1914-7
25. Kashiwagi M, Ikeda N, Tsuji A, Kudo K: Sudden unexpected death following stellate ganglion block . Leg Med. 1999, 1:262-265. 10.1016/S1344-6223(99)80048-0
26. Siegenthaler A, Mlekusch S, Schliessbach J, Curatolo M, Eichenberger U: Ultrasound imaging to estimate risk of esophageal and vascular puncture after conventional stellate ganglion block. Reg Anesth Pain Med. 2012, 37:224-227.
27. Huntoon MA: The vertebral artery is unlikely to be the sole source of vascular complications occurring during stellate ganglion block. Pain Pract. 2010, 10:25-30. 10.1111/j.1533-2500.2009.00310.x.
28. Fujiwara S, Komasawa N, Kido H, Minami T: A rare case of accidental arterial local anesthetic injection under ultrasound-guided stellate ganglion block. J Clin Anesth. 2016, 29:3-4. 10.1016/j.jclinane.2015.10.010.