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Original Research

Effect of stellate ganglion block on lymphedema after breast cancer surgery: An observational and prospective study

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ABSTRACT:

Background: Lymphedema is a common and often intractable complication after breast cancer surgery, particularly following axillary lymph node dissection and radiation therapy. Stellate ganglion block (SGB) has recently been proposed as a potential therapeutic option for managing lymphedema by modulating sympathetic nervous system activity. **Objective:** This observational study aimed to evaluate the efficacy and safety of stellate ganglion block in reducing intractable lymphedema volume, alleviating pain, and improving functional outcomes in patients who had undergone breast cancer surgery. **Methods:** A prospective observational study was conducted on 20 breast cancer patients with intractable lymphedema at the State Cancer Institute, Guwahati. Patients received 2 to 3 doses of SGB at regular intervals. Lymphedema volume (limb circumference), pain scores (Numerical Rating Scale), and functional outcomes (Functional Score) were assessed at baseline, 1 week, and 3 weeks post-procedure. Statistical analysis was performed using paired t-tests. **Results:** After two doses of SGB, there was a significant reduction in lymphedema volume (mean circumference reduction of 6.9% at 1 week), with further reduction observed after three doses (10.5% at 3 weeks) ($p < 0.05$). Pain scores improved substantially from a baseline of 6.8 to 3.5 after three doses ($p < 0.05$). Functional capacity scores increased from 2.7 to 4.1, indicating a marked improvement in daily activity performance ($p < 0.05$). No major adverse events were recorded. **Conclusion:** SGB appears to be a safe and effective treatment for intractable lymphedema, providing significant reductions in limb swelling pain and improved functional outcomes. These findings support further research into the role of SGB in managing lymphedema, particularly for patients unresponsive to conventional treatments.

Keywords: Stellate ganglion block, breast cancer-related lymphedema, sympathetic nervous system, intractable lymphedema, pain relief, functional improvement

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INTRODUCTION

Lymphedema is a significant complication affecting individuals who undergo breast cancer surgery, particularly those who have received axillary lymph node dissection or radiation therapy as part of their treatment. It is characterised by the accumulation of lymphatic fluid in the interstitial tissues due to damage or disruption to the lymphatic system, leading to chronic swelling, discomfort, and reduced mobility in the affected region, most commonly the arms [1]. Lymphedema is often classified into primary and secondary types. Primary lymphedema arises from congenital abnormalities in the lymphatic system, while secondary lymphedema occurs due to trauma, infection, surgery, or radiation, as seen in breast cancer-related lymphedema (BCRL) [2]. Breast cancer surgery remains one of the leading causes of secondary lymphedema, with up to 20-40% of patients developing this condition after undergoing procedures such as mastectomy or lumpectomy combined with lymph node removal [3]. The disruption of lymphatic vessels during surgery and the resultant fibrosis following radiation therapy creates an environment in which lymphatic fluid is unable to drain properly, leading to its accumulation in the tissues [4]. This condition not only affects the physical health of patients but also has profound psychological impacts, leading to anxiety, depression,

and a decreased quality of life [5]. Lymphedema is a chronic, progressive condition. The initial stage involves protein-rich fluid accumulation in the interstitial space, leading to tissue swelling. Over time, this accumulation stimulates chronic inflammation, fibrosis, and adipose tissue deposition, which worsen the symptoms [6]. The impairment of lymphatic drainage results in the stagnation of interstitial fluid, creating an environment conducive to infections like cellulitis. As the disease progresses, the skin can become thickened, leathery, and prone to infection, further complicating patient care [7]. The pathophysiology of lymphedema involves both mechanical and inflammatory components. The mechanical aspect stems from physical disruption or damage to the lymphatic system, whereas the inflammatory response includes increased production of pro-inflammatory cytokines, leading to tissue fibrosis [8]. The condition is exacerbated by the lymphatic fluid's high protein content, which acts as a potent stimulus for fibroblasts, cells that synthesise collagen and contribute to tissue thickening [9]. The standard treatment for lymphedema is primarily conservative, involving a combination of physical therapy, manual lymph drainage, compression therapy, and exercise [10]. These therapies aim to reduce swelling, promote lymphatic fluid movement, and prevent further progression of the condition. However, these modalities often provide only symptomatic relief and do not address the underlying lymphatic dysfunction. For many patients, particularly those with severe or intractable lymphedema, conservative treatments are insufficient, and the condition can persist despite aggressive management [11]. In more advanced cases of lymphedema, surgical interventions such as lymphovenous anastomosis (LVA), vascularised lymph node transfer (VLNT), and liposuction may be considered [12]. While these surgical options can offer long-term benefits, they are invasive, costly, and associated with potential complications. Moreover, not all patients are suitable candidates for these procedures, and the outcomes can vary depending on the extent of lymphatic damage [13]. Recent research has highlighted the potential role of the sympathetic nervous system in the pathogenesis of lymphedema [14]. The sympathetic nervous system plays a critical role in regulating vascular tone and lymphatic contraction, both of which are essential for maintaining lymphatic flow. The stellate ganglion, part of the sympathetic nervous system, innervates the upper extremities and plays a key role in regulating vasoconstriction, which can affect lymphatic function [15]. Sympathetic overactivity has been proposed as a contributing factor to the development and persistence of lymphedema. It has been hypothesised that increased sympathetic activity may lead to vasoconstriction and reduced lymphatic contraction, impeding lymphatic drainage [16]. This has led to the exploration of therapeutic modalities aimed at modulating sympathetic activity, such as the stellate ganglion block (SGB) [17]. The stellate ganglion block is a procedure used to anaesthetise the stellate ganglion, a collection of nerves located in the lower cervical and upper thoracic regions of the body. This ganglion plays a critical role in regulating autonomic nervous system functions, including the modulation of blood flow and lymphatic drainage in the upper extremities [18]. By blocking the stellate ganglion, sympathetic nerve activity is reduced, potentially improving blood flow, decreasing vasoconstriction, and enhancing lymphatic drainage [19].

MATERIAL AND METHODS

Study Design

This study was designed as a prospective observational study conducted at the State Cancer Institute, Guwahati, Assam. The primary goal was to observe the effects of stellate ganglion block on the symptoms of intractable lymphedema in breast cancer patients. The study spanned over 7 months following ethical approval from the Institutional Ethical Committee. A prospective observational study is ideal for this purpose, as it allows for the careful monitoring and recording of changes in lymphedema-related outcomes following the intervention without randomisation or a control group. The primary focus was on the real-world effects of SGB on the severity of lymphedema, pain scores, and functional capacity in patients already experiencing long-term complications from breast cancer treatment.

Study Population

The study enrolled patients from the Pain & Palliative Care outpatient department (OPD) at the State Cancer Institute. Participants included adult patients who had developed intractable lymphedema following breast cancer surgery, particularly those who had undergone axillary lymph node dissection and radiation therapy.

Inclusion and Exclusion Criteria

Inclusion Criteria

Age: Participants aged 18 years and above were included in the study to ensure an adult population, as lymphedema after breast cancer surgery predominantly affects adult women.

Breast Cancer Surgery: All patients had undergone surgery for breast cancer, including procedures like mastectomy or lumpectomy, followed by axillary lymph node dissection.

Diagnosis of Intractable Lymphedema: The patients selected for this study had a diagnosis of intractable lymphedema, characterised by persistent swelling of the upper extremities despite conventional management with physical therapy, compression garments, and manual lymphatic drainage.

Eligibility for SGB: Patients were deemed eligible for SGB based on their overall health status and absence of contraindications to the procedure. This determination was made by the treating physician.

Consent: Only patients who provided informed consent to participate in the study were included.

Exclusion Criteria

Contraindications to SGB: Patients with medical contraindications to stellate ganglion block, such as bleeding disorders, infections at the injection site, or those on anticoagulation therapy, were excluded from the study.

Inability to Provide Consent: Patients unable to provide informed consent due to cognitive impairments or language barriers were excluded.

Concurrent Treatment: Patients who were undergoing other invasive interventions for lymphedema management during the study period were excluded to avoid confounding results.

Sample Size

The sample size for the study was set at 20 patients. This size was chosen based on previous pilot studies that assessed the effect of SGB on various chronic pain and autonomic dysfunctions. Though small, this sample size was deemed appropriate for an observational study aimed at gathering preliminary evidence about the efficacy of SGB in managing intractable lymphedema.

Baseline Assessment

Before the stellate ganglion block was administered, all patients underwent a thorough baseline assessment, which included:

Demographic Data: Age, gender, weight, medical history, and time since breast cancer surgery were recorded.

Medical History: A detailed history of breast cancer treatment, including the type of surgery, axillary lymph node dissection, and any history of radiation therapy, was collected.

Lymphedema Severity: The severity of lymphedema was assessed using limb circumference measurements at multiple points (e.g., wrist, forearm, and upper arm), as well as a subjective evaluation using the Numerical Rating Scale (NRS) for pain.

Pain and Functional Scores: Baseline pain scores were recorded using the NRS, where patients rated their pain on a scale from 0 (no pain) to 10 (worst imaginable pain). Functional capacity was assessed by measuring the range of motion in the affected limb and asking patients to report any limitations in daily activities.

Stellate Ganglion Block (SGB) Procedure

The SGB was administered under sterile conditions in the outpatient procedure room at the Pain & Palliative Care department. The procedure involved the following steps:

Positioning: The patient was positioned supine with a slight extension of the neck.

Anatomic Landmark Identification: The C6 transverse process was identified as the landmark for the injection. Ultrasound guidance was used in some cases to enhance accuracy and minimise the risk of complications.

Local Anesthetic: A local anaesthetic, typically lidocaine and dexamethasone + Normal Saline, was injected into the region of the stellate ganglion. The volume of anaesthetic used ranged from 6 to 8 mL, depending on patient size and anatomy.

Monitoring: Patients were monitored for immediate adverse reactions, including changes in vital signs, and were observed for 30-60 minutes post-procedure to assess for potential complications like Horner's syndrome (ptosis, miosis, and anhidrosis) or vascular injury.

Each patient received one SGB initially, with the option for repeated blocks based on their response to the initial treatment. The follow-up SGB procedures, if needed, were performed at intervals of 3 to 4 weeks.

Outcome Measures

Primary Outcome

Reduction in Lymphedema Volume: The primary outcome of the study was the reduction in lymphedema volume, as measured by limb circumference. The circumferential measurements were taken at baseline, 1 week, and 3 weeks post-procedure to monitor changes over time.

Secondary Outcomes

Pain Reduction: The secondary outcome was the reduction in pain as measured by the NRS. Pain scores were recorded at baseline and each follow-up visit (1 week and 3 weeks post-SGB).

Functional Improvement: Improvement in the range of motion and the ability to perform daily activities were recorded as secondary outcomes. Patients were asked to complete a brief questionnaire on their ability to perform specific tasks, such as lifting objects or reaching overhead.

Adverse Events: Any adverse events related to the SGB procedure, such as transient Horner’s syndrome, hoarseness, or vascular complications, were recorded.

Data Collection and Statistical Analysis

Data were collected at three-time points: baseline (pre-SGB), 1 week post-procedure, and 3 weeks post-procedure. The circumferential measurements of the affected limb, pain scores, and functional capacity were documented and analysed. Descriptive statistics were used to summarise demographic and clinical characteristics of the study population.

Paired t-tests were performed to compare changes in lymphedema volume, pain scores, and functional outcomes before and after the stellate ganglion block. A p-value of less than 0.05 was considered statistically significant. All statistical analyses were performed using SPSS version 23.

RESULTS

A total of 20 patients were included in the study. The primary outcomes assessed were the reduction in lymphedema volume, pain relief, and functional improvement following 2 to 3 doses of SGB.

Demographic Characteristics

The demographic characteristics of the participants were analysed, including their age, weight, time since surgery, and duration of lymphedema. The mean age of the participants was 56.3 years (± 8.2 years), and the average duration of lymphedema was 14.2 months (± 3.6 months). All patients had previously undergone axillary lymph node dissection and radiation therapy.

The findings indicate a relatively homogenous population in terms of time since surgery and the duration of lymphedema, supporting the use of a consistent protocol for administering SGB.

Table 1: Baseline Characteristics of Participants

Characteristic	Value (Mean ± SD)
Age (years)	56.3 ± 8.2
Weight (kg)	68.7 ± 10.3
Time since surgery (months)	22.5 ± 4.1
Duration of lymphedema (months)	14.2 ± 3.6
Number of axillary nodes removed	12.8 ± 2.5
Radiation therapy (Yes/No)	100% Yes

Reduction in Lymphedema Volume

The primary outcome of the study was the reduction in limb circumference after 2 to 3 doses of SGB. Measurements were taken at baseline, 1 week, and 3 weeks following the initial SGB procedure. Notably, significant reductions in limb circumference were observed after two doses of SGB, with a further decrease after the third dose.

At baseline, the average circumference of the affected limb at the mid-forearm was 30.4 cm. After the second dose of SGB, this reduced to 28.3 cm and further declined to 27.2 cm following the third dose. The reductions in limb circumference were statistically significant ($p < 0.05$) at both time points compared to baseline.

Table 2: Reduction in Limb Circumference after 2-3 Doses of Stellate Ganglion Block

Time Point	Mean Circumference (cm)	Percentage Reduction (%)
Baseline	30.4 ± 1.2	-
1 week after 2nd dose	28.3 ± 1.0	6.9%
3 weeks after 3rd dose	27.2 ± 0.9	10.5%
p-value (compared to baseline)	-	$p < 0.05$

Pain Relief

Secondary outcomes included pain reduction as measured using the Numerical Rating Scale (NRS). Patients reported significant pain relief after receiving two doses of SGB. At baseline, the mean pain score was 6.8 (on a scale of 0-10). After the second dose, the pain score decreased to 4.2, and following the third dose, it dropped to 3.5. This represents a substantial improvement in pain management, with p-values < 0.05 for both post-SGB time points compared to baseline.

Table 3: Pain Score Reduction Following Stellate Ganglion Block

Time Point	Mean NRS Pain Score (0-10)	Percentage Reduction (%)
Baseline	6.8 ± 1.3	-
1 week after 2nd dose	4.2 ± 0.9	38.2%
3 weeks after 3rd dose	3.5 ± 0.8	48.5%
p-value (compared to baseline)	-	$p < 0.05$

Functional Improvement

Functional improvement was assessed based on the patient's ability to perform daily activities, including lifting objects, reaching overhead, and completing household chores. A subjective improvement score was recorded, where patients rated their ability to perform tasks on a scale of 1-5 (1: unable, 5: no limitation). At baseline, the mean score for functional capacity was 2.7. After two doses of SGB, the mean score improved to 3.8, and after three doses, it further improved to 4.1.

This indicates that SGB contributed not only to a reduction in lymphedema volume and pain but also enhanced patients' ability to engage in daily activities, significantly improving their quality of life.

Table 4: Functional Improvement After Stellate Ganglion Block

Time Point	Mean Functional Score (1-5)	Percentage Improvement (%)
Baseline	2.7 ± 0.6	-
1 week after 2nd dose	3.8 ± 0.5	40.7%
3 weeks after 3rd dose	4.1 ± 0.4	51.9%
p-value (compared to baseline)	-	$p < 0.05$

Adverse Events

No major adverse events were reported during the study. One patient experienced transient Horner's syndrome (ptosis, miosis, and anhidrosis), which resolved within 24 hours. No cases of vascular injury, infection, or other complications were observed. This suggests that SGB is a relatively safe procedure for this patient population when administered under careful monitoring.

DISCUSSION

The purpose of this observational study was to assess the efficacy and safety of stellate ganglion block (SGB) in managing intractable lymphedema in breast cancer patients who had undergone axillary lymph node dissection and radiation therapy. The results indicate that SGB significantly reduced limb circumference, alleviated pain, and improved functional outcomes in the majority of the patients after 2-3 doses. These findings have important implications for the management of lymphedema, which remains a persistent and often debilitating condition after breast cancer surgery. In this discussion, we elaborate on the key findings of the study, compare them with the current literature, discuss potential mechanisms of action, address limitations, and provide suggestions for future research.

Comparison with Existing Literature

Lymphedema remains one of the most common long-term complications following breast cancer surgery, affecting 20-40% of patients [1]. Current management strategies, such as compression therapy, manual lymphatic drainage, and physical exercise, primarily offer symptomatic relief and do not target the underlying lymphatic dysfunction [2]. Surgical interventions, such as lymphovenous anastomosis or lymph node transplantation, offer some promise but are invasive and not without risks [3]. In this context, the use of stellate ganglion block presents a novel, minimally invasive alternative. Several previous studies have explored the use of stellate ganglion block for pain management in various conditions, including complex regional pain syndrome (CRPS) and hot flashes in postmenopausal women [4,5]. However, its application in managing lymphedema is relatively new. A case report by Thorsen et al. described significant improvements in upper extremity lymphedema after SGB in a breast cancer patient [6]. Similarly, Patel et al. reported positive outcomes in a small cohort of patients with refractory lymphedema, showing reduced limb circumference and improved quality of life [7]. Our study aligns with these findings, providing further evidence that SGB can effectively reduce lymphedema volume, alleviate pain, and improve functionality in a larger cohort of patients.

Mechanisms of Action

The exact mechanisms by which SGB alleviates lymphedema are not fully understood, but several hypotheses have been proposed. The stellate ganglion is part of the sympathetic nervous system and plays a key role in regulating vascular tone and lymphatic function in the upper extremities [8]. One potential mechanism is the reduction of sympathetic nerve activity, which may improve blood flow and decrease vasoconstriction, thus enhancing lymphatic drainage [9]. Sympathetic overactivity has been implicated in lymphatic dysfunction, and by blocking the stellate ganglion, it is hypothesised that SGB reduces this overactivity, facilitating the movement of lymphatic fluid [10]. Additionally, the anti-inflammatory effects of SGB may contribute to its efficacy in managing lymphedema. Chronic inflammation is a key component of lymphedema pathophysiology, characterised by the accumulation of pro-inflammatory cytokines that lead to fibrosis and tissue damage [11]. SGB may modulate the release of these cytokines, reducing inflammation and tissue fibrosis, which in turn facilitates lymphatic drainage [12]. Another possible mechanism is the direct influence of SGB on lymphatic pump function. Lymphatic vessels rely on rhythmic contractions to propel lymph fluid toward the central circulation. Studies have shown that sympathetic nerve activity can impair this pump function, and by blocking the stellate ganglion, SGB may restore normal lymphatic contractility, improving fluid movement and reducing oedema [13]. Further research is needed to confirm these mechanisms and explore the long-term effects of SGB on lymphatic function.

Pain Relief and Functional Improvement

In addition to its effect on lymphedema volume, SGB also provided significant pain relief in this study. Patients reported a reduction in pain scores from an average of 6.8 at baseline to 3.5 after three doses of SGB. This finding is consistent with previous research showing that SGB is effective in managing chronic pain conditions, including CRPS and neuropathic pain [14]. The reduction in pain is likely due to the interruption of sympathetic nerve activity, which plays a role in the maintenance of chronic pain states [15]. By reducing this activity, SGB may

decrease pain sensitivity and improve overall pain management in patients with lymphedema. The improvement in functional capacity observed in our study is also noteworthy. Many patients with lymphedema experience significant limitations in their ability to perform daily tasks, such as lifting objects or reaching overhead, due to the swelling and discomfort associated with the condition. After receiving SGB, patients in our study reported a marked improvement in their ability to perform these activities, with functional scores improving from 2.7 at baseline to 4.1 after three doses. This suggests that SGB not only reduces lymphedema volume but also enhances patients' quality of life by restoring their functional abilities [16].

Safety and Adverse Events

The safety profile of SGB in this study was favourable, with no major adverse events reported. One patient experienced transient Horner's syndrome, a known and typically benign side effect of SGB characterised by ptosis, miosis, and anhidrosis. This condition resolved spontaneously within 24 hours, and no further complications were observed. Previous studies have also reported a low incidence of adverse events with SGB, making it a relatively safe procedure when performed by trained professionals [17]. The absence of significant complications in our study reinforces the safety of SGB as a therapeutic option for managing intractable lymphedema.

Limitations of the Study

While the results of this study are promising, there are several limitations that must be acknowledged. First, the sample size was relatively small, with only 20 patients enrolled in the study. Although the findings are consistent with previous reports, larger studies are needed to confirm the efficacy and safety of SGB in a broader population of breast cancer survivors with lymphedema. Additionally, this was an observational study without a control group, which limits the ability to draw definitive conclusions about the effectiveness of SGB compared to other treatments. Another limitation is the short follow-up period. Patients were assessed up to 3 weeks after receiving their third dose of SGB, but longer-term follow-up is necessary to determine whether the effects of SGB are sustained over time. Lymphedema is a chronic condition, and the benefits of SGB may diminish after the procedure is discontinued. Future studies should include extended follow-up periods to assess the durability of the treatment effects. Finally, the study did not assess the impact of SGB on other aspects of lymphedema management, such as the use of compression garments or physical therapy. It is possible that combining SGB with conventional treatments could enhance outcomes, but this was not evaluated in the current study. Further research should explore the potential for multimodal approaches that incorporate SGB into comprehensive lymphedema management plans.

Implications for Clinical Practice

Despite these limitations, the findings of this study have important implications for clinical practice. For patients with intractable lymphedema who have not responded to conventional therapies, SGB offers a promising alternative that is minimally invasive and associated with few side effects. The procedure is relatively simple to perform and can be administered on an outpatient basis, making it accessible to a wide range of patients. The significant reductions in lymphedema volume, pain relief, and functional improvement observed in this study suggest that SGB may play a valuable role in the management of lymphedema, particularly for patients who have exhausted other treatment options. However, it is important for clinicians to carefully assess each patient's suitability for SGB and to ensure that the procedure is performed by experienced practitioners to minimise the risk of complications.

Future Directions

Future research should focus on addressing the limitations of the current study and expanding the evidence base for the use of SGB in managing lymphedema. Large-scale, randomised, controlled trials are needed to confirm the efficacy of SGB and to compare it with other treatments. Additionally, studies with longer follow-up periods are necessary to determine the long-term effects of SGB on lymphedema outcomes. Further research is also needed to explore the mechanisms of action of SGB in lymphedema management. While the current study provides some insights into potential mechanisms, such as the modulation of sympathetic nerve activity and inflammation, more detailed studies are required to fully understand how SGB influences lymphatic function. This could pave the way for new therapeutic approaches that target the sympathetic nervous system in the treatment of lymphedema. Finally, future studies should explore the potential for combining SGB with other treatments, such as compression therapy, physical therapy, or surgical interventions. Multimodal approaches may offer the best outcomes for patients with intractable lymphedema, and further research is needed to identify the most effective treatment combinations.

CONCLUSION

In summary, this study demonstrates that stellate ganglion block is an effective and safe treatment option for managing intractable lymphedema in breast cancer patients. Significant reductions in limb circumference, pain relief, and functional improvement were observed after 2-3 doses of SGB, with minimal adverse events. While further research is needed to confirm these findings and explore the long-term effects of SGB, the results of this study

suggest that SGB may offer a valuable alternative for patients who do not respond to conventional lymphedema therapies.

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