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ORIGINAL RESEARCH

Effect of Stellate Ganglion Block on Postoperative Pain in Patients with Obstructive Sleep Apnea Syndrome: A Randomized Controlled Trial

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Purpose: This randomized controlled trial aimed to evaluate the efficacy of preoperative ultrasound-guided left stellate ganglion block (SGB) on postoperative pain and opioid consumption in patients undergoing uvulopalatopharyngoplasty (UPPP) for obstructive sleep apnea-hypopnea syndrome (OSAHS).

Patients and Methods: Sixty patients scheduled for UPPP were randomly assigned to receive either preoperative ultrasound-guided left SGB with 6 mL of 1% lidocaine (SGB group, n=30) or no block (Control group, n=30). The primary outcome was postoperative pain intensity measured by the visual analog scale (VAS) at extubation, 6 h, 24 h, and 48 h after surgery. Secondary outcomes included intraoperative sufentanil consumption, number of patient-controlled analgesia (PCA) attempts, hemodynamic parameters, and incidence of postoperative complications.

Results: There was no significant difference in VAS scores and postoperative complications between the two groups at each time point after surgery, but compared with the control group, the intraoperative sufentanil dosage, postoperative PCA compression times in SGB group were significantly reduced (all $p<0.05$).

Conclusion: Preoperative ultrasound-guided left SGB did not significantly reduce postoperative VAS scores in OSAHS patients undergoing UPPP, but it effectively decreased intraoperative opioid use, postoperative analgesic demand. SGB may serve as a valuable adjunct in multimodal analgesia to improve perioperative outcomes in this patient population.

Keywords: stellate ganglion block, obstructive sleep apnea-hypopnea syndrome, uvulopalatopharyngoplasty, postoperative pain

Introduction

Obstructive sleep apnea-hypopnea syndrome (OSAHS) is a common chronic sleep disorder characterized by repeated collapse of the upper airway during sleep, resulting in nocturnal hypoxemia, sleep fragmentation, daytime sleepiness, and systemic complications.[1] Uvulopalatopharyngoplasty (UPPP) is a common surgical treatment for OSAHS patients, including tonsilotomy, uvula and posterior soft palate, particularly those with obvious anatomical obstruction, poor adherence to or intolerance of continuous positive airway pressure (CPAP) therapy, or insufficient response to conservative management.[2] However, due to extensive oropharyngeal tissue resection, patients often experience unbearable pain after surgery. UPPP postoperative analgesia is routinely treated with opioids, but it may bring serious risks such as respiratory depression and worsening of upper airway obstruction to OSAHS patients, and may increase pain sensitivity and reduce pain tolerance.[3] Therefore, developing safe and effective multimodal analgesia strategies for these patients remains a major clinical challenge.

Stellate ganglion, as an important sympathetic ganglion, regulates vascular tone, inflammatory response and nociceptive signal transduction in the head, neck and upper limbs.[4] Stellate ganglion block (SGB) blocks pain pathways by inducing vasodilation and clearing inflammatory mediators, and attenuating pain transmission processes of sympathetic

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components of deep muscle A-δ and C fibers, this intervention has demonstrated significant postoperative analgesic efficacy and has been successfully employed in pain management for various procedures involving the upper extremities and head-neck region.[5,6]

Although SGB offers these advantages, its role in postoperative analgesia for patients with obstructive sleep apnea hypopnea syndrome (OSAHS) remains under-explored. Current peripheral nerve block techniques used in oropharyngeal surgeries typically target sensory nerves—such as the glossopharyngeal, lesser palatine, or vagus nerves—the blockade of which carries the risk of impairing swallowing and respiratory function.[7,8] In contrast to this approach, SGB selectively inhibits sympathetic nerve fibers, providing effective analgesia while preserving both motor and sensory function, thereby presenting a safer alternative. Moreover, the incorporation of ultrasound guidance has substantially improved the precision and safety of SGB procedures, reducing the incidence of complications such as vascular puncture or nerve injury.[9]

This randomized controlled trial was designed to compare the effects of preoperative left lidocaine and blank stellate ganglion block on postoperative VAS scores in UPPP patients, along with intraoperative opioid consumption and the number of postoperative patient-controlled analgesia pump compressions. We hypothesize that SGB will significantly reduce postoperative pain scores. If the results confirm this hypothesis, SGB could emerge as a novel component of multimodal analgesia for OSAHS patients, offering a non-opioid-based strategy to optimize perioperative safety and comfort.

Materials and Methods

Study Design

A randomized controlled trial was conducted at Lu'an Hospital Affiliated to Anhui Medical University in China from June 1, 2024, to December 31, 2024, which included a left-sided stellate ganglion block group and a blank control group. This study was approved by the Ethics Committee of Lu'an People's Hospital Affiliated to Anhui Medical University (January 11, 2024, Approval No. 2024LL004) and registered at the Chinese Clinical Trial Registry (ChiCTR2400084065) on May 9, 2024. The study protocol adhered to the principles of the Declaration of Helsinki. A total of 60 patients scheduled to undergo uvulopalatopharyngoplasty for obstructive sleep apnea hypopnea syndrome were planned to be enrolled from a single center at Lu'an People's Hospital. Inclusion criteria: Age between 18 and 60 years; American Society of Anesthesiologists (ASA) physical status classification I–III; scheduled to undergo uvulopalatopharyngoplasty for obstructive sleep apnea hypopnea syndrome (OSAHS). Exclusion criteria: Pre-existing severe cardiac, pulmonary, hepatic, or renal dysfunction; chronic use of analgesic or sedative medications; comorbid psychiatric disorders or cognitive impairment; coagulopathy or autoimmune diseases; refusal to provide written informed consent. Written informed consent was obtained from all enrolled participants.

All enrolled participants were randomly assigned to either receive a single injection of ultrasound-guided left-sided stellate ganglion block (SGB group) or to a blank control group (Control group). A randomization sequence was generated in a 1:1 ratio using a random number table Owing to the absence of a sham injection in the control group, blinding of participants was not feasible throughout the observation period. However, all anesthesiologists, postoperative follow-up assessors, data collectors, and data analysts remained blinded to group allocation.

General Anesthesia

Upon entering the operating room, all patients were monitored with 5-lead electrocardiography, non-invasive blood pressure, peripheral pulse oximetry, and bispectral index (BIS). General anesthesia was induced with midazolam (0.02–0.05 $mg \cdot kg^{-1}$), etomidate (0.3–0.5 $mg \cdot kg^{-1}$), sufentanil (0.5–0.7 $\mu g \cdot kg^{-1}$), and cisatracurium besylate (0.2–0.25 $mg \cdot kg^{-1}$). Preoxygenation was performed via facemask for 3–5 minutes. After neuromuscular monitoring confirmed a train-of-four count of zero, 2 mL of 2% lidocaine was topically applied to the oropharynx, glottis, and trachea under visual laryngoscopy guidance using an oronasal aerosol delivery device. A tracheal tube, lubricated with dyclonine mucilage, was then inserted (size: 7.0–7.5 for females, 7.5–8.0 for males). Following intubation, the endotracheal tube was connected to the anesthesia machine, and mechanical ventilation was adjusted according to

intraoperative arterial blood gas analysis. Anesthesia was maintained with propofol (280–400 $mg \cdot h^{-1}$), remifentanil (0.2–0.8 $mg \cdot h^{-1}$), and cisatracurium besylate (3–6 $mg \cdot h^{-1}$). Intraoperative monitoring targets included a bispectral index (BIS) value of 40–60, core body temperature of 36–37 °C, train-of-four (TOF) count of 0–1, and end-tidal carbon dioxide ($ETCO_2$) of 35–45 mmHg. Upon completion of surgery, patients were transferred to the post-anesthesia care unit (PACU) with the endotracheal tube in place. Extubation was performed in the PACU, and a visual analog scale (VAS) score was obtained immediately following extubation.

During the initial 48 hours after surgery, patient-controlled analgesia (PCA) was delivered using a pump loaded with a combination of sufentanil (100 μg), flurbiprofen axetil (100 mg), ondansetron (16 mg), and dexamethasone (10 mg), which was diluted with 0.9% normal saline to a final volume of 150 mL. The PCA parameters were configured as follows: a bolus dose of 2 mL, a demand dose of 1.5 mL, a continuous background infusion of 2 $mL \cdot h^{-1}$, and a lockout time of 20 minutes.

Stellate Ganglion Block

Fifteen minutes before general anesthesia induction, the patient's head was turned to the right side. The operative area was disinfected with povidone-iodine and covered with a sterile drape. A high-frequency linear array probe (Mindray Bio-Medical Electronics Co., Ltd., Shenzhen, China) was coated with coupling gel and covered with a sterile sheath. Using the high-frequency linear transducer, the left side of the neck was scanned at the level of the C6/C7 vertebrae to identify the carotid artery and longus colli muscle (Figure 1). Under in-plane needle guidance, the disposable sterile injection needle (0.7mm specification, Shandong Ande Medical Products Co., Ltd., China) was advanced from the lateral side. After penetrating the prevertebral fascia, the needle tip was positioned superficial to the longus colli muscle. Aspiration was performed to confirm the absence of blood, followed by injection of 6 mL of 1% lidocaine hydrochloride (National Drug Approval No. H31021072; specification: 5 mL:0.1 g) (Figure 2). Observe the patient for any possible adverse reactions such as recurrent laryngeal or phrenic nerve block or other effects after drug injection, Horner's syndrome is considered to be a marker of successful blockade.[10]

All SGB procedures were performed by the same attending anesthesiologist with over five years of dedicated experience in ultrasound-guided regional anesthesia. The patient was monitored for 5–10 minutes post-injection for the appearance of ipsilateral Horner's syndrome, which served as the clinical confirmatory sign of a successful block. This consistent sign across all patients in the SGB group, achieved by a single operator, supports the technical uniformity of the intervention.

Control Group

Patients in the control group received no block intervention before general anesthesia.

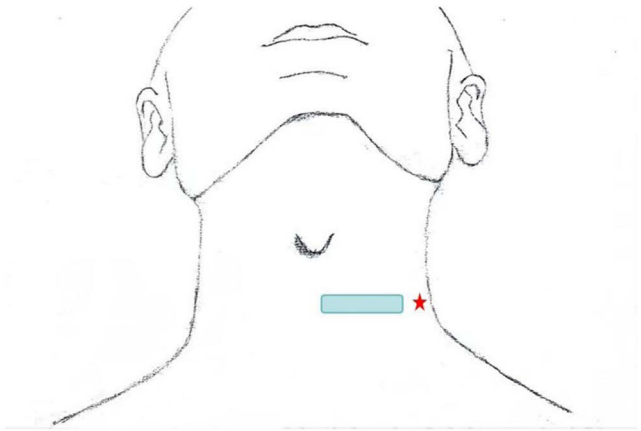

Figure 1 Probe and puncture point. Blue rectangular box, represents the ultrasonic probe placement position. Red star, puncture point.

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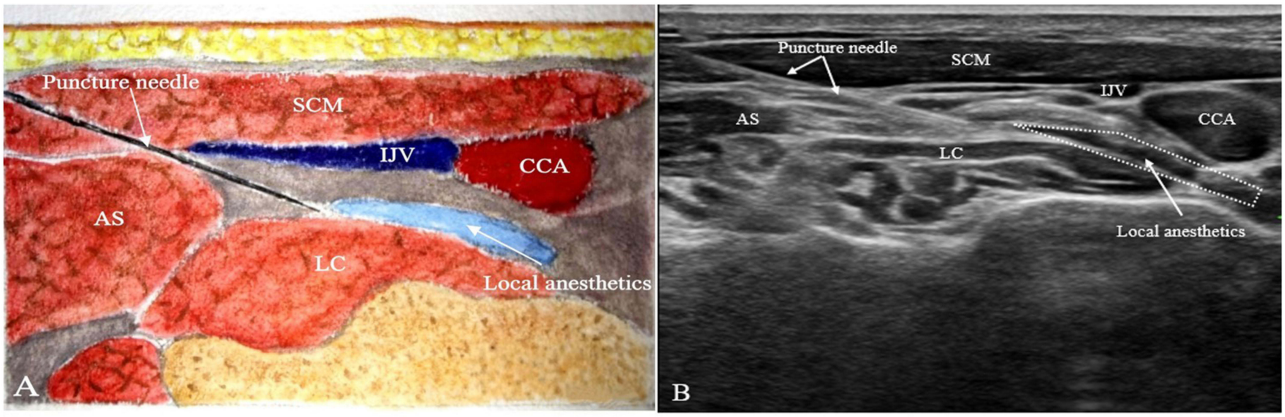

Figure 2 (**A**) hand-drawn anatomy. (**B**) Stellate Ganglion Block after Local Anesthesia.
Abbreviations: SCM, Ster-nocleidomastoid muscle; CCA, Common carotid artery; IJV, Internal jugular vein; AS, Anterior scalene muscle; LC, Longus colli muscle; White dotted area, local anesthetic diffusion area.

Outcome Measures

The primary outcome was the postoperative visual analog scale (VAS) score, which was recorded immediately after extubation (T3), and at 6 hours (T4), 24 hours (T5), and 48 hours (T6) after surgery. Secondary outcomes included mean arterial pressure (MAP) and heart rate (HR) measured at the following time points: upon entering the operating room (T0), immediately after successful tracheal intubation (T1), at the end of surgery (T2), immediately after extubation (T3), and at 6 hours postoperatively (T4).

Additional secondary outcomes consisted of intraoperative sufentanil consumption, duration of surgery, number of postoperative PCA attempts, and the incidence of complications such as nausea, vomiting, and hoarseness. All outcome data were collected by an independent researcher who was blinded to group allocation.

Statistical Analysis

Statistical analysis was performed using SPSS version 27 (IBM Corporation, Armonk, NY, USA). The normal distribution of the measured data was assessed using the Kolmogorov–Smirnov test, and homogeneity of variances was tested using Levene's test. Normally distributed data were compared using the independent sample *t* test and expressed as mean ± standard deviation; non-normally distributed data were compared using the Mann–Whitney *U*-test and expressed as median (25th-75th percentile); categorical variables were expressed as numbers (%). For the time-dependent variables, repeated measures analysis of variance (ANOVA) was used, and post hoc tests were performed after statistically significant effects were found. Categorical variables were analyzed using the chi-square test or Fisher's exact test, as appropriate. Two-sided p values less than 0.05 were considered statistically significant.

Results

Participants and Baseline Characteristics

During the enrollment period from June 1 to December 31, 2024, a total of 70 eligible candidates were screened. Of these, 64 met the inclusion criteria, and 60 completed the full study protocol and were included in the final analysis (30 per group; Figure 3). Baseline characteristics are presented in Table 1. No significant differences were observed between the two groups in demographic data or operative duration.

Primary Outcomes

Comparative analysis of postoperative pain revealed that visual analog scale (VAS) scores did not differ significantly at any time point (Table 2). The VAS score showed significant changes over time (initially increasing and then decreasing), but no statistical difference was found between left SGB intervention and blank treatment in improving VAS score. The trend of the two groups' ratings changing over time is basically consistent.

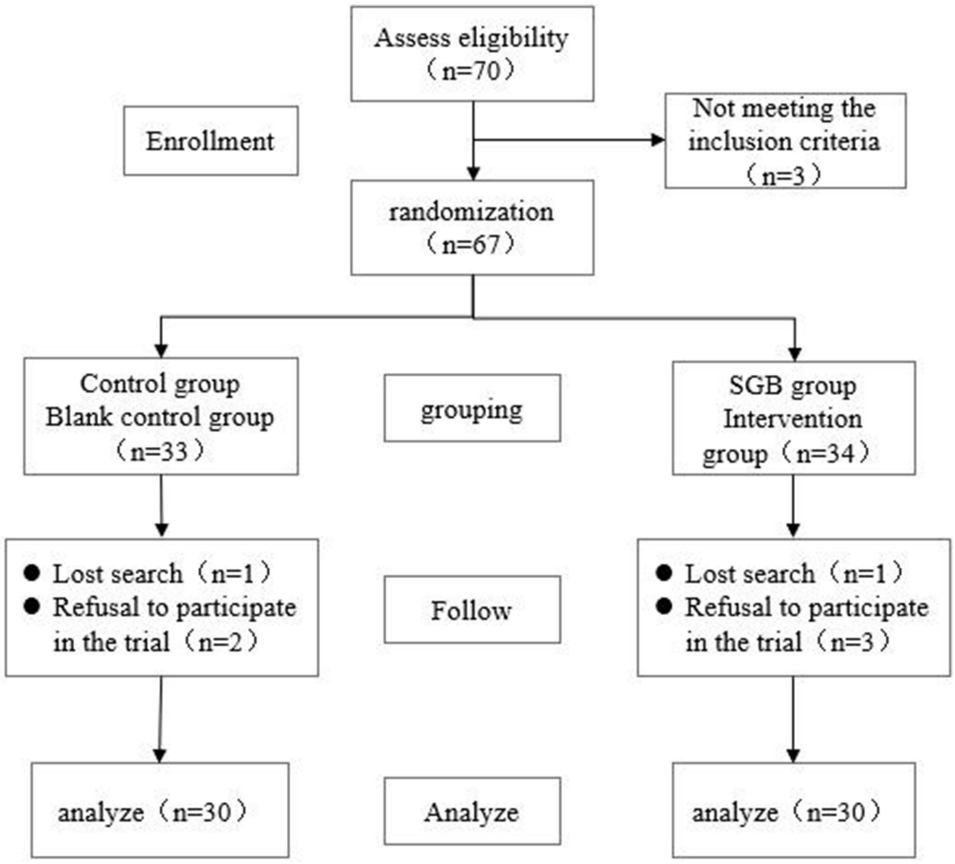

Figure 3 CONSORT diagram of study recruitment.

Secondary Outcomes

There were no significant differences in mean arterial pressure and heart rate measured at any time point between the two groups (Table 3). The SGB group showed a significant reduction in intraoperative sufentanil consumption compared with the control group (46.50 ± 2.62 vs 49.13 ± 3.10 μg, $p = 0.006$). Similarly, the number of postoperative PCA attempts was significantly lower in the SGB group (0.50 (1–2) vs 1.00 (1–2), $p = 0.001$). (Table 4). There were no postoperative complications such as nausea or vomiting in both groups.

Table 1 Baseline Characteristics of Study Population

Characteristic	Control group (n=30)	SGB group (n=30)	*P* value
Age	38.9±8.8	40.4±8.5	0.600
Sex, n (%)			0.470
Male	27 (90)	24 (80)	
Female	3 (10)	6 (20)	
Body mass index	27.9±3.6	29.9±2.5	0.051
ASA status, n (%)			0.243
I	10 (33.3)	6 (20)	
II	20 (66.7)	24 (80)	
Duration of surgery (min)	62.4±17.4	68.6±15.5	0.238

Notes: Continuous variables are expressed as mean ± standard deviation; categorical variables are expressed as number of cases (percentage). The independent sample *T* test was used for normally distributed data, and the chi-square test was used for categorical variables.
Abbreviation: ASA, American Society of Anesthesiologists.

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Table 2 Postoperative Pain Scores Between Groups

Group	V3	V4	V5	V6	Intergroup Effect F (*P*)	η^2
Control group (n=30)	2.1±1.2	3.7±1.3	3.0±1.4	2.4±1.2	3.21 (0.081)	0.078
SGB group (n=30)	2.7±1.1	3.9±1.4	3.4±1.2	2.7±1.1		
Time effect F (*P*)	68.57 (0.001)					
Interaction effect F (*P*)	2.22 (0.106)					

Notes: Data are presented as mean ± standard deviation. VAS scores were assessed at the following time points: V3, immediately after extubation; V4, 6 hours postoperatively; V5, 24 hours postoperatively; V6, 48 hours postoperatively. Repeated-measures analysis of variance (ANOVA) was used to analyze the main effects of time and group, as well as their interaction effect. η^2 represents partial eta squared as a measure of effect size.
Abbreviation: SGB, stellate ganglion block.

Table 3 Mean Arterial Pressure and Heart Rate Data of the Two Groups at T0, T1, T2, T3 and T4

Outcome Measures	SGB Group (n=30)	Control Group (n=30)	*P* value
MAP (T0)	96.0±13.1	101.9±12.3	0.147
MAP (T1)	100.7±9.9	104.9±13.7	0.280
MAP (T2)	86.6±6.4	82.6±9.3	0.127
MAP (T3)	91.55±8.6	95.2±11.8	0.277
MAP (T4)	89.2±9.7	89.8±8.7	0.838
HR (T0)	84.2±8.9	83.7±13.3	0.889
HR (T1)	90.8±9.3	90.9±14	0.969
HR (T2)	74.3±7.9	77.2±12.2	0.386
HR (T3)	82.4±8.1	78.3±10.4	0.172
HR (T4)	80.4±5.8	81.3±8.1	0.671

Notes: Data were analyzed using repeated measures analysis of variance, data are presented as mean ± standard deviation. T0, upon entering the operating room; T1, immediately after tracheal intubation; T2, at the end of surgery; T3, immediately after extubation; T4, 6 hours postoperatively.
Abbreviations: MAP, mean arterial pressure; HR, heart rate; SGB, stellate ganglion block.

Table 4 Comparison of Intraoperative Opioid Consumption and Postoperative Analgesia Requirements

	SGB Group (n=30)	Control Group (n=30)	*P* value
Intraoperative opioid use	46.50±2.62	49.13±3.10	0.006
PCA number of presses	0.50 (1–2)	1.00 (1–2)	0.001

Notes: The independent sample *T* test was used for normally distributed data, Non-normally distributed data were compared using the Mann–Whitney *U*-test and expressed as median (25th to 75th percentile). Data are presented as mean ± standard deviation for intraoperative opioid use and median (25th-75th percentile) for PCA number of presses.
Abbreviations: PCA, patient-controlled analgesia; SGB, stellate ganglion block.

Discussion

This study is the first to investigate the effect of stellate ganglion block (SGB) on postoperative pain in patients with obstructive sleep apnea hypopnea syndrome (OSAHS). The results demonstrated that although the SGB group did not show statistically significant differences in pain scores (VAS) at any postoperative time point, it exhibited significant improvements in secondary outcomes compared to the control group, including reduced intraoperative opioid consumption, fewer postoperative PCA attempts. These findings suggest that SGB may contribute to enhanced postoperative recovery quality by reducing opioid requirements.

Stellate ganglion block (SGB) is commonly employed in the treatment of chronic neuropathic pain.[10,11] While the involvement of sympathetic blockade in the development of chronic pain is well recognized, its contribution to acute pain

conditions remains poorly understood. Emerging evidence, including studies in patients having breast cancer surgery or undergoing video-assisted thoracoscopic lung resection, has indicated that SGB may reduce postoperative pain, supporting its potential applicability in the management of acute pain.[12,13]

Stellate ganglion block (SGB) alleviates pain transmission by promoting vasodilation, clearing inflammatory mediators, and suppressing nociceptive signaling mediated by sympathetic components in deep muscle A-δ and C fibers.[5] In contrast to conventional glossopharyngeal or lesser palatine nerve blocks frequently used in oropharyngeal surgeries, SGB has little influence on swallowing or respiratory function in postoperative OSAHS patients and does not markedly impair sensory or motor function.[7,8] These characteristics render it a suitable adjunct analgesic method for individuals undergoing uvulopalatopharyngoplasty (UPPP). Nevertheless, the results of this study show that although SGB decreased intraoperative opioid use and reduced the number of postoperative patient-controlled analgesia (PCA) demands, it did not exhibit a significant impact on postoperative VAS scores.

The presence of Horner's syndrome on the blocked side is widely regarded as a sign of successful SGB. Its clinical features comprise miosis, ptosis, enophthalmos, anhidrosis or hypohidrosis on the ipsilateral facial side, conjunctival injection, facial flushing, erythema of the auricle, nasal congestion resulting from mucosal congestion, and elevated skin temperature.[14] The consistent presentation of Horner's syndrome in all patients within the left-sided SGB group confirms technically accurate administration of the block. Nevertheless, the findings revealed no statistically significant reduction in VAS scores at any time point after surgery when compared with the blank control group. This inconsistency implies that mechanisms beyond sympathetic blockade may have contributed to the observed results.

Due to the intrinsic clinical features of patients with obstructive sleep apnea-hypopnea syndrome (OSAHS), they often exhibit recurrent nocturnal hypoxemia and sleep fragmentation.[1] Research has shown that hypoxic conditions stabilize the expression of HIF-α protein, which in turn promotes the translocation of PKCε to the cell membrane and facilitates phosphorylation of the TRPV1 channel. This molecular cascade reduces the activation threshold of TRPV1, resulting in increased sensitivity of nociceptors to painful stimuli.[15] Animal studies have employed mice subjected to chronic intermittent hypoxia (CIH) to mimic the hypoxic conditions seen in patients with OSAHS. These studies have demonstrated that CIH facilitates the recruitment and activation of macrophages, which in turn stimulates the release of pro-inflammatory cytokines. Such inflammatory processes subsequently contribute to neuronal sensitization and ultimately lead to hyperalgesia.[16] In the current investigation, this mechanism of hyperalgesia induced by hypoxia—resulting from the underlying pathophysiology of OSAHS—may have complicated the evaluation of postoperative pain in these individuals. Conversely, the nearly ubiquitous occurrence of sleep fragmentation among OSAHS patients may render them more susceptible to a state of hyperalgesia even prior to surgery.[17] Postoperative pain can further disrupt sleep architecture, thereby establishing a vicious cycle of "pain–sleep disturbance–hyperalgesia".[18] This effect may introduce bias in postoperative VAS evaluations, potentially masking the analgesic benefits of SGB. It is conceivable that hyperalgesia resulting from hypoxia and sleep fragmentation could obscure the genuine analgesic effect of stellate ganglion block (SGB).

Additionally, during UPPP surgery, epinephrine is routinely administered in the irrigation solution to induce vasoconstriction, reduce bleeding, and maintain a clear surgical field for the operator. The impact of locally absorbed epinephrine on SGB remains unclear. In a study investigating SGB for acute pain following arthroscopic shoulder surgery, it was suggested that epinephrine-containing irrigation solution, when absorbed either locally or systemically, may exacerbate pain due to its sympathomimetic effects.[19] This mechanism could similarly mask the analgesic efficacy of SGB. Further research is warranted to elucidate the influence of epinephrine on pain perception and its potential systemic effects.

A key strength of this study lies in its pioneering investigation into the effects of ultrasound-guided stellate ganglion block on postoperative pain in patients with obstructive sleep apnea hypopnea syndrome (OSAHS) undergoing uvulopalatopharyngoplasty (UPPP), a topic that has not been previously explored in the literature. However, several limitations should be acknowledged. First, the relatively short duration of action of lidocaine used for stellate ganglion blockade may have limited its long-term analgesic efficacy. Future studies could consider employing long-acting local anesthetics or continuous catheter techniques to prolong the duration of sympathetic blockade. Second, the relatively small sample size may have reduced statistical power, potentially preventing the detection of subtle yet clinically meaningful differences in

pain scores between groups. Larger, multi-center trials would help enhance the generalizability and robustness of the findings. Third, the control group did not receive a sham injection intervention, meaning patients were aware of their group assignment. This may have introduced performance bias. Although outcome assessors and statisticians were blinded to group allocation, patients' expectations could have influenced self-reported pain scores and analgesic consumption. Finally, the assessment of static pain scores using VAS at predefined time points (6h, 24h, 48h) was conducted while patients had unrestricted access to the PCA pump. This design means that a patient experiencing rising pain could immediately self-administer an analgesic bolus, likely leading to a rapid decrease in their reported VAS score by the time of assessment. Consequently, VAS measurements in both groups may have been systematically drawn toward the lower end of the scale, potentially obscuring a true treatment effect on pain intensity. This methodological limitation is an important consideration when interpreting the primary outcome. In addition, routine use of adrenaline-containing irrigants during UPPP may produce systemic sympathomimetic effects, potentially counteracting the sympathetic block induced by SGB.

Future studies should consider incorporating a sham-block control, employing long-acting local anesthetics or continuous catheter techniques, enrolling larger multi-center cohorts, and incorporating objective pain-related biomarkers or dynamic pain assessments to better capture the analgesic efficacy of SGB in this population.

Conclusion

This study demonstrated that although preoperative ultrasound-guided left stellate ganglion block (SGB) did not significantly reduce static VAS pain scores at any time point after uvulopalatopharyngoplasty (UPPP) in patients with obstructive sleep apnea hypopnea syndrome (OSAHS), it effectively decreased intraoperative sufentanil consumption, reduced the number of patient-controlled analgesia (PCA) attempts within 48 hours postoperatively. These findings suggest that SGB, through its sympathetic blockade effects, partially reduces perioperative opioid requirements and may contribute to improved recovery quality in these patients.

Data Sharing Statement

All data generated or analyzed during this study are included in the published article. Participant data will be provided upon corresponding reasonable request. The data will be accessible for 5 years after release.

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Disclosure

The authors report no conflicts of interest in this work.

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