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ORIGINAL REPORT

Stellate Ganglion Blockade for Acute Pain Management After Transoral Robotic Surgery

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ABSTRACT

Objectives: Pharyngeal surgical site pain is a significant concern following transoral robotic surgery (TORS). The use of stellate ganglion blockade (SGB) has been reported as a treatment adjunct for postoperative pain.

Methods: Patients who underwent TORS and neck dissection for oropharyngeal carcinoma between November 2019 and May 2021 by a single surgeon (AHM) were included. Patients underwent either SGB via injection of bupivacaine or no SGB. Inpatient pain and total daily morphine milligram equivalent (MME) usage were calculated. A retrospective chart review was performed to identify time in the OR spent placing the SGB, length of hospitalization, and postoperative complications.

Results: Seventy-three patients were included. Of these, 43 (58.9%) underwent SGB. On average, SGB placement of any kind added 13 min to OR time prior to surgical start time. Patients who underwent SGB had significantly lower average pain scores over the postoperative time course (mean difference 0.75, 95% CI: 0.09–1.41, $p = 0.027$) and lower opioid consumption over time (mean difference 16.37 MME, 95% CI: 6.98–25.77, $p < 0.001$) compared with those who did not undergo SGB.

Conclusion: SGB resulted in less narcotic pain medication use in the immediate postoperative period, without affecting length of hospitalization or rate of adverse events. SGB is a safe and effective adjunct to multimodal therapy for pain control in the postoperative period following TORS for laryngopharyngeal head and neck cancer.

Level of Evidence: 3.

1 | Introduction

Transoral robotic surgery (TORS) has become a primary treatment modality for early-stage oropharyngeal and supraglottic cancers [1, 2]. With the use of TORS, pharyngeal surgical site pain and dysphagia have become significant clinical challenges, contributing to extended hospital stays and hospital readmissions for dehydration [3, 4]. Adequate pain management following surgical ablation of the oropharynx is traditionally associated

with high opioid requirements, leaving head and neck cancer (HNC) patients vulnerable to opioid dependence and overdose [5]. This highlights the potential role of multimodal analgesia (MMA) in addressing postoperative pain for HNC patients.

MMA is an essential component of enhanced recovery after surgery (ERAS) protocols that have increasingly been incorporated into head and neck (H&N) surgery, albeit primarily for open surgical resections [3, 6]. MMA harnesses the synergistic effects

of analgesic medications that target distinct subsections of the anesthetic state. Published protocols combine non-opioid medications such as celecoxib, gabapentin, acetaminophen, ketamine, N-methyl D-aspartate receptor antagonists, and ketorolac [7, 8]. Findings show reductions in perioperative morphine milligram equivalent (MME) consumption, but mixed results regarding postoperative pain. Therefore, additional modalities, such as regional analgesia, capable of reducing postoperative pain are of great value.

The stellate ganglion is a collection of nerves that supplies sympathetic innervation to the upper extremities, head, and neck. Stellate ganglion blockade (SGB) limits systemic release of potent neurotransmitters, such as substance P, in response to noxious stimuli [9]. SGB has been used to treat complex regional pain syndromes, anxiety related to post-traumatic stress disorder, upper limb orthopedic surgery, temporomandibular joint disorder, and even cancer-related facial pain [10]. Our study aims to expand upon these studies by examining the safety and pain control efficacy of SGB compared with case-matched TORS patients without SGB.

2 | Methods

All patients who underwent TORS and a unilateral neck dissection for laryngopharyngeal carcinoma between November 2019 and May 2021 by a single surgeon (AHM) were included in this study. Patients were informed about the option of SGB placement during the pre-operative clinic visit. No patients declined SGB placement during this visit. Patients were subsequently enrolled in the SGB arm of the study if there was an acute pain management team available to perform the blockade on the day of surgery. Informed consent was obtained from patients prior to placement of SGB. Per protocol, patients did not routinely undergo nasogastric tube placement. They underwent bedside swallow trials on the first postoperative day.

2.1 | SGB Placement

Placement of the stellate ganglion blockade was performed in the operating suite under ultrasound guidance by pain medicine specialty anesthesiologists. Ultrasound-guided lateral approach to SGB was selected to improve visualization of the needle and spread of local anesthetic. We made a slight modification to the originally described methods to increase the accuracy of the block and minimize potential needle damage to structures in the vicinity of the stellate ganglion. We named our approach “Trans-scalene approach to stellate ganglion” and will include a detailed description of this technique in Appendix S1. For single-shot ipsilateral SGB, under ultrasound-guided lateral approach, a 22-gauge needle, 4-in. Stimuplex, B. Braun Medical Inc., was inserted and 6 mL of 0.25% bupivacaine was administered around the stellate ganglion. For continuous catheter placement, we used Arrow STIMUCATH CPNB catheter, Teleflex Medical Inc., to place the catheter in proximity to the stellate ganglion. 6 mL of 0.25% bupivacaine was administered at the time of catheter placement, and continuous infusion of 2 mL/h of 0.25% bupivacaine was initiated in the recovery room. SGB was performed following general anesthesia but prior to surgical intervention in 93.1% of patients; the remaining three



FIGURE 1 | A stellate ganglion catheter secured to the left neck. Patients are given one injection of 0.25% bupivacaine at the time of catheter placement. Continuous infusion of 0.25% bupivacaine at a rate of 2 mL/h is started in the postoperative recovery area.

patients had SGB placed following surgery but prior to emergence from anesthesia (Figure 1).

For patients who underwent catheter placement for continuous infusion of bupivacaine, a mechanical infusion pump was used while they remained in the hospital. Upon discharge, this was exchanged for an elastomeric pump with the same infusion drug and settings before discharge. After discharge, patients were contacted daily by telephone for the duration of their catheter placement. They were asked questions regarding pain and any side effects they were experiencing. If needed, we checked the dressing integrity and catheter depth by video call. On the last day of their continuous bupivacaine infusion, they were provided with instructions on how to remove the catheter.

The first 30 patients who underwent blockade underwent placement of catheter for continuous infusion. The latter 13 underwent single injection. The protocol was changed for the latter 13 patients due to the availability of pumps for patients to go home with.

2.2 | Clinical and Outcomes Measurements

Patient records were reviewed for relevant clinical metrics, including age at the time of surgery, diagnosis, clinical tumor stage, pathologic tumor stage, history of chronic pain, and chronic pain

medication use. Preoperative pain medication use was classified as any patient who reported any narcotic or non-narcotic pain medication use for at least 3 months prior to the date of their surgery. Patient-reported pain per postoperative day was determined by averaging their responses to the visual-analog scale (VAS) of pain intensity (on a scale of 0–10) per 24-h period. MMEs used were similarly averaged over each 24-h period and included all intravenous and oral narcotic pain medications administered. Length of hospital stay, 30-day complication rates including malfunction with catheter placement, emergency room visits, and hospitalizations were identified based on chart review. A Controlled Substance Utilization Review and Evaluation System (CURES) report was run to determine MMEs of narcotic medications prescribed over a 30-day postoperative period.

2.3 | Statistical Analysis

Descriptive statistics were used to summarize patient characteristics and outcomes. Continuous variables were reported as mean (standard deviation, SD) and compared between groups using independent *t*-tests. Categorical variables were reported as frequency (percentage) and compared using chi-square tests. A *p*-value <0.05 was considered statistically significant, and these were run using R V4.4.3 (www.r-project.org, Vienna, AU). To assess the effect of stellate ganglion blocks on postoperative pain scores and opioid consumption, we fit linear mixed-effects models adjusting for postoperative day (POD). Two separate models were constructed: one with average VAS pain scores as the outcome and another with MMEs administered as the outcome. For each model, stellate ganglion block status and postoperative day were included as fixed effects, and a random intercept was specified for each subject to account for repeated measures. The models were fit using PROC MIXED in SAS. Least-squares means were estimated for each group, and post hoc comparisons were conducted using pairwise differences with 95% confidence intervals (95% CI).

Prior to statistical analysis but after data collection, a post hoc power analysis was conducted to assess the smallest detectable effect size given the final sample size, which was determined based on the study timeframe and available resources. Using a two-sample *t*-test, we estimated the minimum detectable difference in outcome measures between groups. Assuming a two-sided $\alpha=0.05$, the analysis indicated that the study had $\geq 80\%$ power to detect a between-group difference as small as 0.70. All research procedures were approved by the Institutional Review Board at the University of California, Los Angeles.

3 | Results

Seventy-three participants were included in this study, of whom 64 (87.7%) were men. The average age was 61.9. In total, 43 patients (58.9%) had squamous cell carcinoma (SCC) of the tonsil, and 26 (35.6%) had SCC of the base of the tongue. A majority (49.3%) had pathologic T2 disease, and all but 10 (14.1%) had cervical nodal involvement.

SGB of any kind was performed in 43 (58.9%) participants. Of those who underwent SGB, 13 (30.2%) underwent a one-time injection of bupivacaine, and the remaining 30 (69.8%) underwent

placement of a catheter for continuous infusion of bupivacaine to the stellate ganglion. Among patients who underwent catheter placement for continuous bupivacaine infusion, the average length of time the catheter remained in place was 12.5 days; only one patient maintained their catheter for fewer than 11 days due to the catheter being pulled out prior to completion of the full treatment. Patients who underwent SGB placement of any kind had a lower BMI on average than patients who did not undergo SGB (26.3 vs. 28.6, $p=0.03$). There were no statistically significant differences in sex or tumor characteristics between patients who underwent SGB placement and those who did not (see Table 1). The average length of hospitalization was 3.9 days, and there was no statistically significant difference in length of hospitalization or rates of 30-day postoperative complications (see Table 2). There were also no significant differences in the proportion of patients with vs. without preoperative chronic pain requiring the use of chronic pain medications (27.9 vs. 13.3, $p=0.13$).

Participants who underwent SGB placement of any kind on average spent 13 more minutes in the OR prior to incision compared with participants who did not undergo SGB (61.9 vs. 48.9, $p=0.002$). There was no significant difference in total operative time following placement of SGB compared to without placement of SGB (283.8 min vs. 299.1 min, $p=0.19$). There was no significant difference in 30-day postoperative complication rates between participants who underwent any SGB placement compared with patients who did not undergo SGB placement (23.3% vs. 13.3%, $p=0.29$). Patients were not routinely prescribed Celebrex in the postoperative period, and there were no differences in rates at which patients were prescribed gabapentin in patients who underwent SGB placement compared with those who did not (14.0 vs. 20.0, $p=0.49$). Patients with SGBs had significantly fewer MMEs utilized in the first three postoperative days compared with those without SGB placement (13.4 vs. 24.8, $p=0.05$; 17.3 vs. 41.2, $p=0.003$; and 18.3 vs. 41.3, $p=0.008$ on POD1, POD2, and POD3, respectively, Table 2). Using the linear mixed-effects model adjusting for postoperative day and repeated measures, patients who underwent SGB had significantly lower average pain scores over the entire postoperative time course (mean difference 0.75, 95% CI 0.09–1.41, $p=0.027$) as well as fewer MMEs used (mean difference 16.37, 95% CI 6.98–25.77, $p<0.001$, Figure 2). There were no significant differences in 30-day total MMEs prescribed following discharge from the hospital for patients who underwent SGB vs. those who did not (438.9 vs. 586.2, $p=0.34$). No data were collected on actual MME usage postoperatively.

A sensitivity analysis was performed comparing the placement of a stellate ganglion catheter for continuous bupivacaine injection vs. a single injection of bupivacaine. Patients who underwent single injections required more time in the OR compared with those who underwent the placement of a continuous catheter; otherwise, there were no significant differences between catheter placement and single injection placement in any of the evaluated categories, including age, sex, BMI, tumor staging, postoperative pain, and MMEs used.

4 | Discussion

Our study demonstrates the effectiveness of using stellate ganglion blockade for postoperative pain management in head and

TABLE 1 | Demographics.

	SGB placement		
	N=43	No SGB N=30	p
Age (SD)	62.6 (10.5)	60.9 (9.1)	0.49
Female (%)	7 (16.3)	2 (6.7)	0.29
BMI (SD)	26.3 (3.6)	28.6 (4.7)	0.03
Preoperative chronic pain medication use (%)	4 (13.3)	12 (27.9)	0.14
p16 positive (%)	42 (97.7)	28 (93.3)	0.36
Tumor subsite			0.46
Tonsil	26 (60.5)	17 (56.7)	
Base of tongue	16 (37.2)	10 (33.3)	
Other	1 (2.3)	1 (3.3)	
Unknown	0 (0.0)	2 (6.7)	
Pathologic T stage (%)			0.22
pT0	3 (7.0)	4 (14.3)	
pT1	10 (23.3)	11 (39.3)	
pT2	25 (58.1)	10 (35.7)	
pT3	5 (11.6)	3 (10.7)	
Pathologic N stage (%)			0.93
pN0	6 (14.0)	4 (14.3)	
pN1	30 (69.8)	21 (75.0)	
pN2	7 (16.3)	3 (10.7)	
Lymphovascular invasion (%)	15 (38.5)	8 (26.7)	0.68
Perineural invasion (%)	4 (10.0)	2 (6.7)	0.99
Extranodal extension (%)	10 (23.3)	8 (26.7)	0.74

Note: Bold values are statistically significant $p < 0.05$.

neck cancer patients, contributing to a growing body of literature supporting multimodal pain management programs in the postoperative period. The findings in this study expand upon the findings reported by Sharbel et al., demonstrating that patients who underwent SGB placement did have decreased postoperative narcotic needs for the first 3 days [11]. Similar to Gostian et al., our study found that patients reported decreased pain following surgery, although this was not statistically significant, and that patients required fewer MMEs in the first three postoperative days. In particular, our study focused on the pain outcomes of patients who underwent transoral robotic surgery for oropharyngeal cancer, as opposed to all patients with head and neck malignancies. A study performed by Gostian et al. studied

TABLE 2 | Clinical outcomes measurements.

	SGB N=43 (SD)	No SGB N=30 (SD)	p
Length of hospitalization (days)	3.7 (2.1)	4.3 (2.8)	0.31
Minutes in OR prior to incision	61.9 (17.2)	48.9 (15.6)	0.002
Number of 30-day postoperative complications (%)	10 (23.3)	4 (13.3)	0.29
Gabapentin use	6 (14.0)	6 (20.0)	0.49
Average pain score (0–10)			
POD1	1.8 (1.5)	2.4 (1.9)	0.16
POD2	2.3 (2.0)	3.0 (1.6)	0.11
POD3	2.4 (2.3)	3.6 (2.6)	0.06
Morphine milligram equivalents (MME) used			
POD1	13.4 (20.3)	24.8 (28.6)	0.05
POD2	17.3 (22.3)	41.2 (42.4)	0.003
POD3	18.3 (27.3)	41.3 (38.6)	0.008

Note: Bold values are statistically significant $p < 0.05$.

patients who underwent ablative head and neck surgery who underwent cervical plexus blockade with ropivacaine and found that these patients had lower self-reported pain scores. Another report by Sharbel et al. has described stellate ganglion nerve blockade following H&N cancer (HNC) surgery, noting substantially lower average daily MME requirements (23.3 mg/day) with satisfactory pain scores [11]. However, this study included only two of nine total patients who underwent TORS with no internal controls. As patients with oropharyngeal surgical resections are known to report high levels of pain and require more analgesic control, our study demonstrating decreased MME use is particularly novel.

Patients in our study who did not undergo SGB on average had higher BMI than patients who underwent SGB placement. Although patient body habitus was not a documented consideration for determining candidacy for SGB placement, this difference seen in our population may reflect some selection bias present in our non-blinded study design. Despite this, given studies that have demonstrated that obesity is an independent risk factor for increased postoperative pain [12, 13], our findings may underrepresent the effect of SGB on decreasing postoperative pain.

With regard to patient tolerability of the SGB, only one patient out of 30 who had long-term catheters placed had their catheter removed early, suggesting that the catheter was well tolerated in the postoperative period despite its remaining in place for longer than documented in previous studies. The rate of bupivacaine infusion used in our study is similar to those seen in

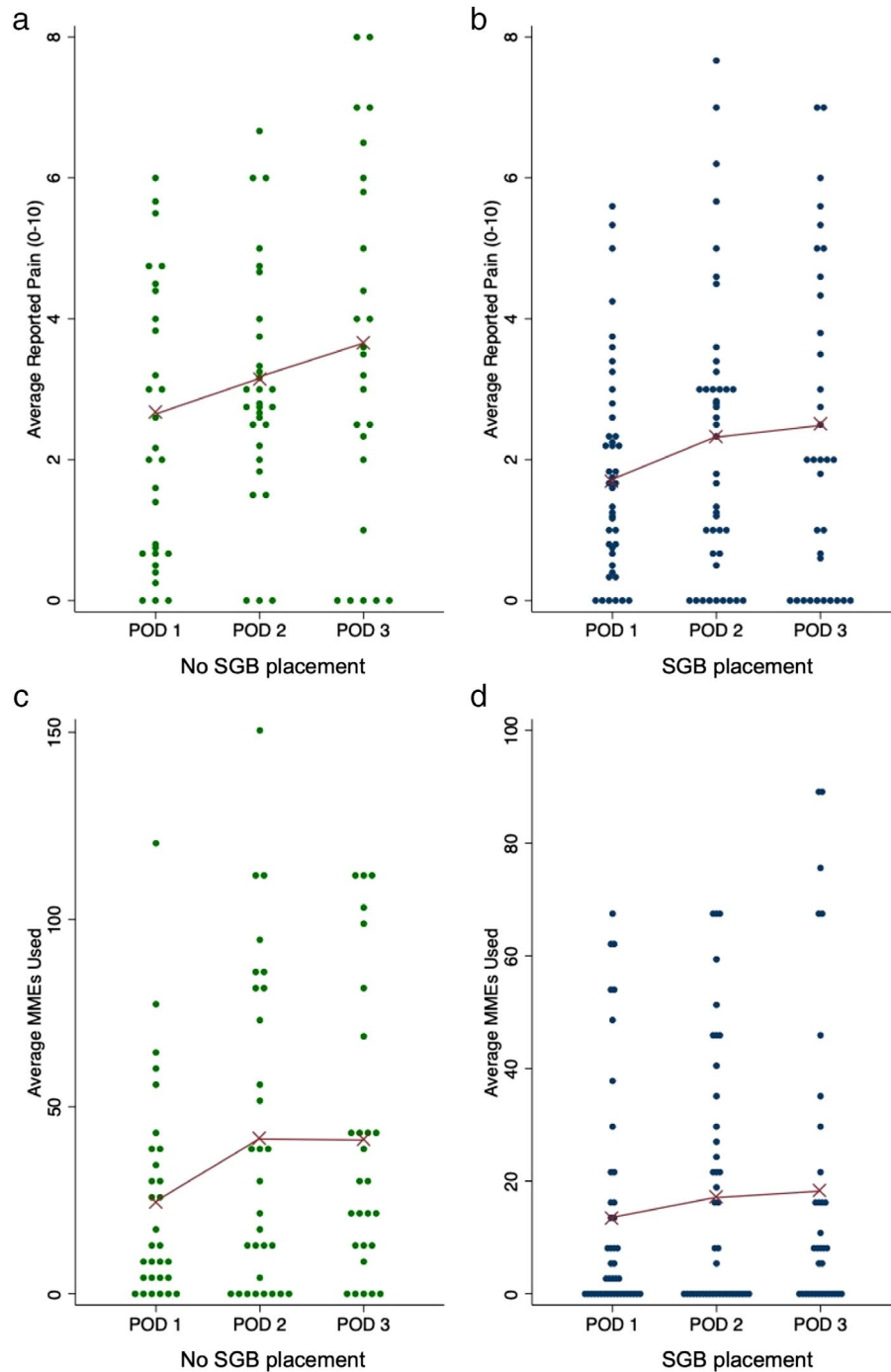


FIGURE 2 | Average reported pain on a scale of 0–10 for (a) patients without SGB placement and (b) patients with SGB placement. Average recorded MMEs used following TORS for (a) patients without SGB placement and (b) patients with SGB placement.

other studies in orthopedic surgery literature, and we reported no complications related to catheter placement, which is consistent with previously reported studies [14, 15].

Our findings show similar trends to previous studies reporting on the use of multimodal analgesia and the ERAS protocols to reduce the use of perioperative narcotic use. Castellanos et al. demonstrated decreased MME usage in the first three postoperative days after using a multimodal analgesia protocol including the use of celecoxib, gabapentin, and acetaminophen [6]. Ganti et al. also demonstrated similar findings using a formal ERAS protocol, documenting decreased MME usage over the first

72h compared with individuals who received hydrocodone-acetaminophen without the adjunctive non-narcotic pain medications [3]. Neither of these ERAS protocols included local nerve blockade, and it remains to be seen whether the addition of SGB can further reduce opioid use in the postoperative period.

There are several limitations to our study. Adjunctive non-narcotic pain regimens were not standardized in our study, and thus may introduce variability in the direct benefit of the SGB in our patient population. Placement of SGB was dictated by the availability of anesthesiologists trained to perform this procedure, and therefore it is possible that selection bias played

a role in differences in patient characteristics between the two groups. However, due to the randomness of patient scheduling, we do not expect that this introduced a significant source of bias. Our study also focuses on reported pain and MMEs used in the first 3 postoperative days; therefore, limiting our understanding of pain control with SGB after the third postoperative day. Although we did not find any differences in MMEs prescribed in a 30-day period, the majority of patients in our study never requested refills on their narcotic pain medications postoperatively, and therefore MMEs used in the postoperative period are likely lower than those prescribed. Systematic documentation of total MME pain medication use was not performed in the outpatient setting, which might shed additional light on narcotic pain medication usage rates in the outpatient setting.

5 | Conclusions

Our study shows that SGB is a promising and well-tolerated adjunctive therapy for acute pain management in patients undergoing transoral robotic surgery for oropharyngeal head and neck malignancies. Future directions include implementing targeted survey results and more granular pain medication usage documentation to better understand pain levels throughout the entire postoperative recovery period.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section. **APPENDIX S1:** Approach to performing ultrasound-guided trans-scalene placement of stellate ganglion block.