Title

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Publication Date

2023-10-01

DOI

10.1016/j.avsg.2023.08.019

ELSEVIER

Clinical Research

Erector Spinae versus Surgically Placed Pain Catheters for Thoracic Outlet Decompression

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Background: Perioperative care after surgery for thoracic outlet syndrome (TOS) involves multimodal pain control. Pain catheters with bupivacaine infusion are a modality to minimize perioperative narcotic use. Our study aims to compare surgically placed pain catheters (SP) with erector spinae pain catheters (ESP) placed by the anesthesia pain service.

Methods: Retrospective review of a prospectively maintained surgical TOS database identified patients undergoing transaxillary first rib resection (FRR) who had either SP or ESP placed for pain control. Patients were matched for age and gender. Data collected included demographics, operative details, and perioperative pain medication use. Narcotic pain medication doses were converted to milligram morphine equivalents (MMEs) for comparison between groups. Pain medications were collected for several time points: intraoperatively, for each postoperative day (POD) and for the entire hospital stay.

Results: Eighty-eight total patients were selected for comparison: 44 patients in the SP and ESP groups. Patients in each group did not differ with regards to age, body mass index, gender, diagnosis, or comorbidities. There were no differences in preoperative narcotic use, preoperative pain score, or Quick Disabilities of Arm, Shoulder, and Hand score. All patients underwent FRR. Concurrent cervical rib resection was performed in 6.8% SP and 6.8% ESP patients ($P = 1.00$), pectoralis minor tenotomy in 34.1% SP and 29.5% ESP patients ($P = 0.65$), and venogram in 31.8% SP and 31.8% ESP patients ($P = 1.00$). Mean operating room time was 90.0 min in SP and 105.3 min in ESP cases ($P = 0.15$). Mean length of stay was 1.9 days for SP and 1.8 days for ESP patients ($P = 0.56$). There were no significant differences in intraoperative narcotics dosing in MME (SP: 22.1 versus ESP: 25.3, $P = 0.018$). On POD 0, there were no differences in total narcotics dosing (MME) (SP: 112.0 versus ESP: 100.7, $P = 0.59$), or in the use of acetaminophen, nonsteroidal anti-inflammatory drugs, or muscle relaxants. A similar trend in narcotics dosing was observed on POD 1 (SP: 58.6 versus ESP: 69.7, $P = 0.43$) and POD 2 (SP: 23.5 versus ESP: 71.3, $P = 0.23$). On POD 1, there was a higher percentage of SP patients taking nonsteroidal anti-inflammatory drugs (63.6% vs. 40.9%, $P = 0.024$); however, this difference was not observed on POD 2. There were no differences in acetaminophen or muscle relaxant use on POD 1 or 2. Total hospital stay MME was similar between groups (SP: 215.9 versus ESP: 250.9, $P = 0.23$).

This study was presented in the scientific session at the 41st Annual Meeting of the Southern California Vascular Surgical Society, La Quinta, California, April 30, 2023.

Conflict of interest: S.D.T.: none, H.A.G.: none, J.G.U.: none, and K.W.: none.

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Author contributions: H.A.G., S.D.T., J.G.U., and K.W. contributed to research; H.A.G., S.D.T., J.G.U., and K.W. contributed to manuscript development; H.A.G., S.D.T., J.G.U., and K.W. contributed to approval; H.A.G., S.D.T., J.G.U., and K.W. contributed to accountability.

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Ann Vasc Surg 2023; ■: 1–6
https://doi.org/10.1016/j.avsg.2023.08.019

Manuscript received: May 11, 2023; manuscript accepted: August 8, 2023; published online: ■ ■ ■

Conclusions: Pain catheters with bupivacaine infusions are helpful adjuncts in postoperative pain control after FRR for TOS. This study compares SP to ESP and demonstrates no difference in narcotics use between SP and ESP groups. SP should be used for pain control in facilities which do not have an anesthesia pain service available for ESP placement.

INTRODUCTION

Thoracic outlet syndrome (TOS) encompasses a range of conditions involving compression of neurovascular structures as they course through the outlet formed by the first rib, scalene muscles, and clavicle. Compression of the brachial plexus, subclavian artery, or subclavian vein results in neurogenic TOS (NTOS), arterial TOS, and venous TOS (VTOS), respectively. NTOS patients present with symptoms including neck pain, upper extremity numbness and tingling, upper extremity pain, pallor, and/or cyanosis. Common etiologies of TOS include repetitive overhead arm motion, cervical ribs, muscular hypertrophy, and physical trauma.[1] Patients with VTOS most often present with subclavian vein compression and deep venous thrombosis. TOS cases may require decompression via first rib resection (FRR) and/or resection of the cervical rib, at times accompanied by pectoralis minor tenotomy to relieve compression of affected structures.[2]

Perioperative care following surgical decompression for TOS uses multimodal pain control. This may include the use of a combination of local anesthetics, opioids, nonsteroidal anti-inflammatory drugs (NSAIDs), and/or muscle relaxants. Surgically placed pain catheters (SP) for bupivacaine infusion have been employed as standard of care at our institution as part of a multimodal approach to minimize perioperative narcotic use. Research has shown that such paravertebral pain catheters provide effective analgesia following FRR.[3]

Erector spinae pain catheters (ESP) are a newer modality of infusion catheters that deliver local anesthetic in the plane between the transverse process and erector spinae muscle group. The routine use of ESP catheters in management of TOS patients is novel. This study aims to compare these 2 types of catheters (SP and ESP), with the hypothesis that ESP catheters are as effective as SP catheters in the adjunctive management of postoperative pain following TOS decompression surgery.

METHODS

A prospectively maintained database of surgical patients undergoing thoracic outlet decompression was reviewed for patients undergoing FRR who had either SP or ESP placed for postoperative pain control. Patients were matched for age and gender. Patients who underwent a prior operation for TOS were excluded from our analysis. Demographics, operative details, and perioperative pain medication administration data were collected.

Diagnosis of TOS

The Society for Vascular Surgery reporting standards were used in the diagnosis of TOS.[4] The diagnosis of NTOS was based on symptoms of radicular pain, paresthesia, and weakness in addition to physical examination findings consistent with the diagnosis of TOS. Patients underwent diagnostic testing, consisting of a combination of cervical spine X-rays, cervical magnetic resonance imaging, nerve conduction testing, and anterior scalene muscle blocks. TOS-specific physical therapy was the initial treatment of NTOS. Patients with severe symptoms which persisted after targeted physical therapy were offered treatment with Botox for chemical denervation or surgical decompression. Surgery was reserved for those with severe, intractable, and disabling symptoms.

VTOS cases were diagnosed based on clinical symptoms, including limb swelling, pain, and discoloration in conjunction with confirmation by ultrasonography and venography. Thrombolysis was routinely conducted for patients who presented within 2 weeks of symptom onset, followed by anticoagulation. Patients with evidence of extrinsic venous compression and persistent congestive symptoms were offered surgery. TOS decompression was achieved by means of transaxillary FRR.

TOS decompression was achieved in all patients by means of transaxillary resection of first and/or cervical rib with subtotal scalenectomy.[5–7] Cervical rib resection and pectoralis minor tenotomy were performed simultaneously when indicated. Preoperative and postoperative Somatic Pain Scale and Quick Disabilities of Arm, Shoulder, and Hand scores were calculated for each patient using patient-reported instruments.[8]

Catheter Placement

Pain catheters included either SP or ESP. SP catheters were placed in the operating room by the surgeon prior to wound closure. The SP consists of an epidural catheter placed through the surgical

Table I. Demographics.

	SP	ESP	
	$n = 44$	$n = 44$	P value
% female	63.6%	61.4%	0.83
Mean age	35.4 ± 12.2	35.3 ± 12.3	0.97
BMI (kg/m^2)	25.3 ± 4.8	27.5 ± 5.3	0.05
Primary diagnosis			1.00
VTOS	31.8%	31.8%	
NTOS	68.2%	68.2%	
Secondary diagnosis—PMS	25.0%	27.3%	0.81
Symptom laterality			0.18
Right	47.7%	29.5%	
Left	29.5%	45.5%	
Bilateral	22.7%	25.0%	
Symptoms in dominant hand	69.0%	54.5%	0.26
Comorbidities			
Other Arm/Shoulder/Hand Pathology	11.4%	9.1%	0.73
Pain Syndromes	2.3%	6.8%	0.31
Anxiety/Depression	20.5%	18.2%	0.79
Preoperative Narcotic Use	11.4%	9.1%	0.73
Preoperative Pain Score	5.4 ± 3.0	6.1 ± 2.8	0.29
Preoperative QuickDASH Score	55.2 ± 25.1	52.3 ± 26.7	0.63

ESP, erector spinae pain catheters; NTOS, neurogenic thoracic outlet syndrome; PMS, pectoralis minor syndrome; QuickDASH, Quick Disabilities of Arm, Shoulder, and Hand; SP, surgically placed pain catheters; VTOS, venous thoracic outlet syndrome.

wound with the tip positioned at the T-1 transverse process (where the first rib is separated from the spine). The SP is secured to the skin with a Steri-Strip and a Tegaderm. The time required for placement of SP is included in the operative time.

ESP catheters are placed immediately prior to surgery by the anesthesia pain team under ultrasound guidance and are secured with Tegaderm. The time required for ESP placement is not included in the operative time.

Both SP and ESP catheters deliver bupivacaine infusions at set rates without titration or bolus dosing. The bupivacaine infusions are started in the postanesthesia care unit and are continued until the catheter is removed at the time of discharge.

Pain Medications

Pain medications were collected for several time points: intraoperatively, for each postoperative day (POD) and for the entire hospital stay. Narcotic pain medication doses were converted to milligram morphine equivalents (MMEs) for comparison between groups.[9]

Analysis of Outcomes

Demographics, operative details, and pain medication administration were compared between ESP and SP patients using Chi-square test for categorical variables and Kruskal-Wallis test for continuous variables. Statistical significance was defined as $P < 0.05$.

Approval for this work was granted by the UCLA Institutional Review Board.

RESULTS

Demographics

A total of 88 patients were included in the analysis, with 44 patients in the SP and 44 in the ESP groups. Demographic and clinical presentation data are presented in Table I. The cohort was comprised of 62.5% females (SP 63.6% versus ESP 61.4%, $P = 0.83$). Mean age was 35.3 years and did not differ between SP and ESP groups (35.4 vs. 35.3, $P = 0.97$). Body mass index was slightly higher in the ESP group, but did not reach statistical significance (25.3 kg/m^2 versus 27.5 kg/m^2, $P = 0.05$). Primary diagnosis was VTOS in 31.8% and NTOS in 68.2% of each group ($P = 1.00$). Pectoralis minor syndrome was present in 25.0% of SP and 27.3% of ESP patients ($P = 0.81$). Symptoms were present in the dominant hand in 69% of SP and 54.5% of ESP patients ($P = 0.26$).

There were no differences in comorbidities between groups, including unrelated arm/shoulder/hand pathology (SP 11.4% versus ESP 9.1%,

Table II. Operative details.

Operative variable	SP $n = 44$	ESP $n = 44$	P value
Primary Operation—FRR	100%	100%	1.00
Concurrent Operation			
CRR	6.8%	6.8%	1.00
PMT	34.1%	29.5%	0.65
Venogram	31.8%	31.8%	1.00
Mean OR Time, min	90.0 ± 43.8	105.3 ± 42.8	0.15
EBL			0.16
<25 mL	81.8%	61.4%	
<50 mL	15.9%	34.1%	
<100 mL	0.0%	2.3%	
>100 mL	2.3%	2.3%	
Length of Stay, days	1.9 ± 1.0	1.8 ± 0.8	0.56

CRR, cervical rib resection; ESP, erector spinae pain catheters; FRR, first rib resection; OR, operating room; PMT, pectoralis minor tenotomy; SP, surgically placed pain catheters.

$P = 0.73$), pain syndromes (2.3% vs. 6.0%, $P = 0.31$), or anxiety/depression (20.5% vs. 18.2%, $P = 0.79$). Few patients reported preoperative narcotic use (11.4% vs. 9.1%, $P = 0.73$). Mean preoperative somatic pain score (5.4 vs. 6.1, $P = 0.29$) and preoperative Quick Disabilities of Arm, Shoulder, and Hand score (55.2 vs. 52.3, $P = 0.63$) were not significantly different between groups.

Operative Details

Operative details are presented in Table II. All patients underwent FRR. Concurrent operations included cervical rib resection (SP 6.8% versus ESP 6.8%, $P = 1.00$), pectoralis minor tenotomy (34.1% vs. 29.5%, $P = 0.65$), and venogram (31.8% vs. 31.8%, $P = 1.00$). Operative time was not significantly different between groups (90.0 min versus 105.3 min, $P = 0.15$). Length of stay was similar in SP and ESP groups (1.9 days versus 1.8 days, $P = 0.56$).

Pain Medication

Narcotic dosing is presented in Table III. There were no differences in narcotics dosing intraoperatively, on POD 0, POD 1, POD 2, or total hospital stay between the 2 groups. Appendix 1 provides additional breakdown of pain medication dosing.

Non-narcotic pain medication dosing was also similar between groups for the same time periods. Acetaminophen utilization was 95.5% for SP patients and 100.0% for ESP patients on POD 0 ($P = 0.86$), 95.5% for SP and 93.2% for ESP on POD 1 ($P = 0.93$), and 60.0% for SP and 75.0% for ESP on POD 2 ($P = 0.46$). NSAIDs were administered in 20.5% SP and 13.6% ESP patients on POD 0 ($P = 0.40$), 63.6% SP and 40.9% ESP patients on POD 1 ($P = 0.024$), and 34.5% SP and 54.2% ESP patients on POD 2 ($P = 0.15$). Muscle relaxants were used in 13.6% SP and 22.7% ESP patients on POD 0 ($P = 0.27$), 56.8% SP and 61.4% ESP on POD 1 ($P = 0.67$), and 34.5% SP and 45.8% ESP patients on POD 2 ($P = 0.40$).

DISCUSSION

Postoperative management of TOS patients involves multimodal pain management. Increased use of non-narcotic adjuncts has been successful in the reduction of postoperative opioid utilization.[3,10,11] This study details our experience with both SP and ESP in TOS decompression surgery. We found no statistically significant difference in total narcotic dosing in the perioperative period for the 2 groups. Although the ESP group on POD 1 had a higher percentage of NSAID utilization, this had no effect on total opioid dosing on POD 1 or total hospital stay.

Our findings add to existing research on the topic of catheter use in multimodal pain control. A previous study by Patel et al.[3] demonstrated that while paravertebral blocks (similar to the SP catheters in this study) are effective in reducing postoperative pain, they did not significantly decrease opioid usage in the multimodal pain regimen. However, a report by Kalava et al. and Motyl et al. found that paravertebral blocks performed prior to FRR for TOS reduced opioid use intraoperatively, during the first 48 hr and through the entire hospital stay.[10,11]

Table III. Narcotics dosing throughout hospital stay in milligram morphine equivalents.

	SP	ESP	
	$n = 44$	$n = 44$	*P* value
Intraoperative	22.1 ± 10.5	25.3 ± 10.3	0.17
POD 0	112.0 ± 79.2	100.7 ± 57.1	0.59
POD 1	58.6 ± 50.8	69.7 ± 77.4	0.43
POD 2	23.5 ± 34.7	71.3 ± 209.1	0.23
TOTAL	215.9 ± 127.7	250.9 ± 227.8	0.38

ESP, erector spinae pain catheters; POD, postoperative day; SP, surgically placed pain catheters.

Few reports studies have studied erector spinae catheter use in multimodal pain management, especially in the setting of TOS decompression. A case study by McCance et al.[12] found continuous ESP block to be an effective mode of analgesia in combination with NSAIDs and opioids but did not include direct comparison to paravertebral blocks such as the surgically placed catheters in the present study. Guffey et al.[13] performed a comparative study of single-injection erector spinae injections and continuous perineural infusion catheters, finding that the injections were not inferior to the infusion catheters. Wang et al.[14] compared ESP block use for injection of local anesthetic in thoracotomy patients, concluding that the ESP block was more effective in providing postoperative analgesia and reduced opioid requirements.

While both SP and ESP catheters are helpful adjuncts to pain management in early postoperative TOS surgery patients, there are significant differences between these techniques which may influence the choice one over the other. A notable disadvantage of SP catheter infusions is the occasional occurrence of paresthesia or mild paresis in the operated limb. This may occur as the catheter infusion is in proximity to the C8 and T1 nerve roots. These symptoms resolve promptly with cessation of the infusion; however, until resolved, they give rise to concern. An advantage of ESP catheters is that they do not cause paresthesia or paresis of the operated limb, thus allowing for more accurate evaluation of postoperative symptoms. The participation of an anesthesia pain team in placing and managing ESP catheters is particularly advantageous in patients with severe chronic pain.

One concern with ESP catheters is that the catheters are placed in the preoperative unit using local anesthesia while the patient is awake. Some patients have found this anxiety-provoking and were unable to tolerate catheter placement. Another concern is that on occasion, the anesthesiologists are unable to place the catheter. Finally, since the management, dosing, and removal of ESP catheters is under the care of the anesthesia pain team, the need for added coordination and specialized personnel may occasionally result in late surgery start or delayed hospital discharge. ESP catheters require formal consultation with anesthesia pain team with professional charges billed, resulting in greater cost per hospital admission.

SP catheters are placed in the operating room during the TOS decompression operation. Unlike the ESP catheters, they can always be placed and are done so in the course of the TOS surgery while the patient is under general anesthesia, relieving the concerns of anxious patients. There is no billing code for SP catheters and so this present minimal incremental cost to the hospitalization. The management of the catheters is under the care of the surgical team, so that the SP catheter can be removed by the surgical team when it best suits patient needs and does not impede discharge.

Other types of local anesthetic injections may also be employed in multimodal pain control as well. Thompson et al.[15] showed that single-shot perineural brachial plexus block is not inferior to continuous brachial plexus catheter and is less likely to present barriers to discharge, thereby being associated with shorter hospital stays. The use of a pectoral block both independently and in combination with an erector spinae block has been explored by Goeteyn et al.,[16] revealing that both the combination and pectoral block alone reduce subjective pain ratings and opioid use following TOS decompression.

Ultimately, the selection of SP or ESP may depend on institutional resources, as not all hospitals have anesthesia pain services that would provide such catheters. In such instances, use of SP catheters is a simple, effective, and widely available technique.

CONCLUSION

Our study demonstrates equivalent benefit of SP and ESP catheters as adjuncts in postoperative pain management of patients undergoing TOS

decompression surgery. Differences in the ability to place the catheter, the patient tolerance to catheter placement, and cost may favor SP catheters; however, the lack of paresthesia and the benefit of the expertise of anesthesia pain team is a significant advantage for ESP catheters. Local institutional factors influence the choice of which technique is used.

SUPPLEMENTARY DATA

Supplementary data to this article can be found online at https://doi.org/10.1016/j.avsg.2023.08.019.

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