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Arthroscopic assisted brachial plexus catheter placement: an alternative to the percutaneous interscalene approach

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A R T I C L E I N F O

Keywords:
Arthroscopy
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Brachial plexus catheter
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Pain management
Analgesia

Level of evidence: Level IV; Case Series; Treatment Study

Background: Brachial plexus catheter placement at the interscalene level is beneficial for shoulder analgesia but presents logistical challenges due to the superficial nature of the plexus at this level, increased patient movement in the neck, and therefore higher likelihood for catheter dislodgement.

Methods: Patients requiring shoulder arthroscopy and suprascapular nerve decompression were identified. Under arthroscopic guidance, a catheter was placed percutaneously into the scalene medius muscle next to the suprascapular nerve and the upper trunk of the brachial plexus. Patients were followed postoperatively for perioperative analgesic outcomes.

Results: Ten patients were identified and consented for intraoperative brachial plexus catheter placement. Patient demographics and surgical details were determined. Postoperative adjunctive pain management and pain scores were variable. Two patients required catheter replacement using ultrasound guidance in the perioperative anesthesia care unit due to poorly controlled pain. There were no incidents of catheter failure due to dislodgement.

Discussion: This study presents the first description of arthroscopically-assisted brachial plexus catheter placement. This method may present an alternative to traditional ultrasound guided interscalene catheter placement. Further study is needed to determine if analgesic outcomes, block success, and dislodgement rates are improved with this method.

Brachial plexus blockade is an effective technique to provide postoperative analgesia after both open and arthroscopic shoulder surgery.[12] The majority of the innervation of the shoulder joint and adjacent soft tissue is supplied by the suprascapular nerve (SSN; C5-C6) and axillary nerve (C5-C6), with minor contributions from the subscapular and lateral pectoral nerves (C5-C6).[3] As a result, an interscalene brachial plexus block performed at the level of the roots or superior trunk (Fig. 1 *A* and *B*) can provide excellent analgesia to the shoulder.

The ultrasound guided interscalene approach, using a single injection or a continuous infusion through a peripheral nerve catheter, is most commonly used when regional anesthesia is desired as an adjuvant for shoulder surgery (Fig. 1 *A* and *B*).[13] Incorporating the use of regional anesthetic techniques within a multimodal analgesic approach of an established orthopedic based clinical pathway appears to improve perioperative outcomes and analgesia, enhance postoperative recovery, and reduce opioid consumption.[7,11] Continuous regional analgesia that is provided via perineural catheters can provide additional benefit as they can prolong neural blockade with a resulting decrease in postoperative opioid requirements beyond 24 hours, potentially altering opioid prescribing practices.[4,10] Furthermore, for outpatient surgery, ambulatory pumps can allow prolonged analgesia which may improve patient satisfaction, reduce hospital resource utilization and improve hospital financial performance by facilitating same day dismissal.

Despite the use of local anesthetic adjuvants (dexamethasone, clonidine, dexmedetomidine) to prolong single injection peripheral nerve blocks, single injection interscalene nerve blocks with local anesthetic adjuvants have not reliably shown to prolong analgesia after 24 hours,[10] can be associated with side effects (eg,. dexmedetomidine dose-dependent bradycardia, sedation, and

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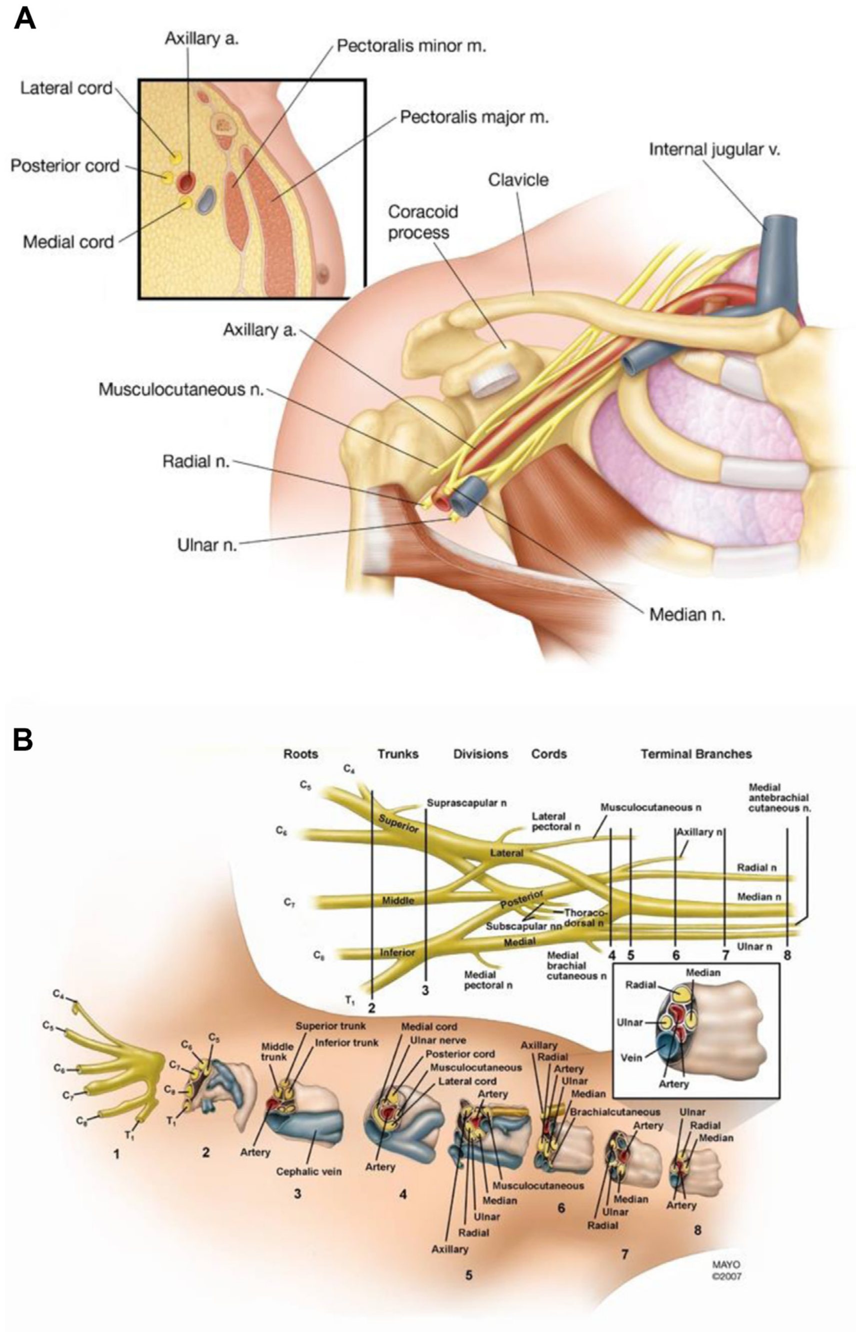

Figure 1 **A**: Overview of brachial plexus anatomy with nearby structures. **B**: Detailed view of brachial plexus anatomy.

hypotension),[14] and do not eliminate the possibility of rebound pain associated with block resolution.[1] Although liposomal bupivacaine (ie, extended-release bupivacaine) was approved for interscalene peripheral nerve blockade, there is no ability to titrate or discontinue the local anesthetic effect, making it dangerous to administer further local anesthetics for the subsequent 96 hours due to potential toxic local anesthetic levels.[5,8] In contrast, continuous regional analgesia via indwelling nerve catheters allows for ongoing administration of local anesthetics with the ability to be discontinued if necessary. Therefore, continuous peripheral nerve blocks continue to be an important method of postoperative analgesia for shoulder surgery particularly after the first 24 postoperative hours.

Of note, the superficial anatomic location of the brachial plexus at the interscalene location can make securing the catheter difficult, resulting in increased failure rates when compared to catheter-based peripheral nerve blocks in other locations.[2] Approaches that increase the distance from the catheter insertion site to the brachial plexus such as tunneling the catheter may mitigate the risk of dislodgement, and therefore increase postoperative analgesic success. However, doing so can present its own challenges due to the proximity to the sterile surgical field. Furthermore, it can result in suboptimal analgesia because of suboptimal positioning of the catheter near the target nerves or unintentional movement of the device intraoperatively.

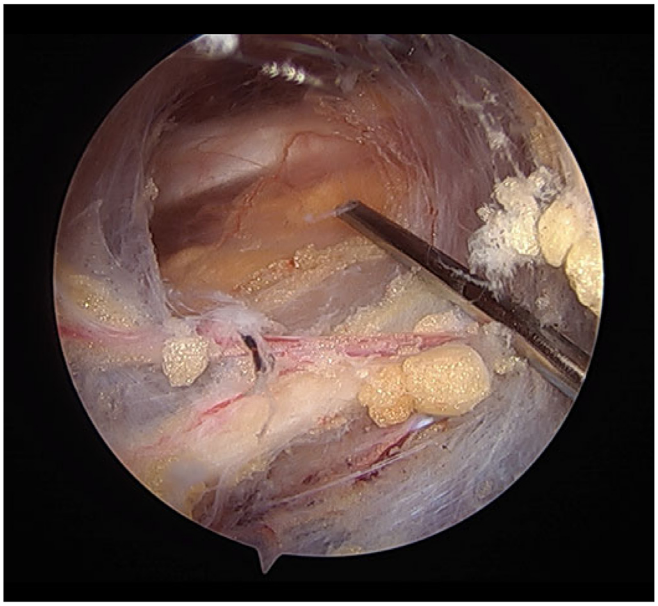

Figure 2 Arthroscopic view of the level of the upper trunk. The suprascapular nerve is highlighted. This is a great intraoperative image showing the suprascapular nerve at the level of the upper trunk. The nerve is pushed distally by the needle.

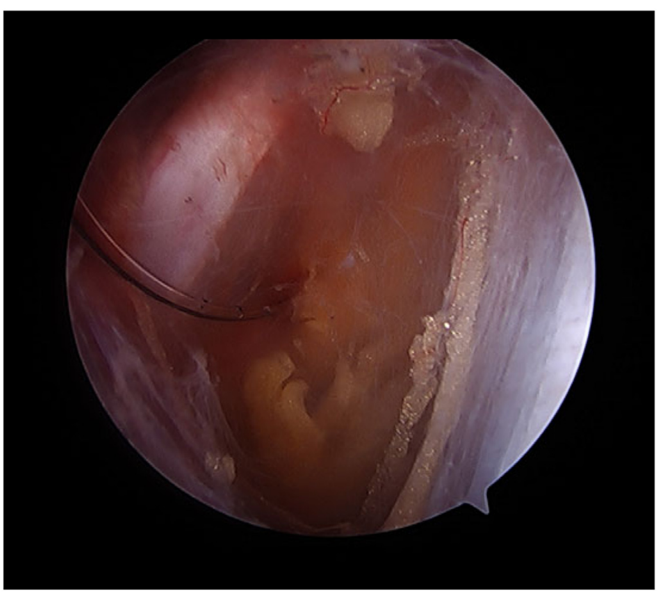

Figure 3 Arthroscopic image showing a catheter placed in the scalene medius slightly distal to the upper trunk. The Suprascapular nerve is not seen because it is more lateral at this level.

In order to improve postoperative analgesia for arthroscopic shoulder procedures, we developed a technique where the catheter is placed under direct arthroscopic visualization during the surgical procedure. We hypothesized that this technique would allow for optimal perineural placement and decrease the chance that the catheter would be dislodged as the length from the insertion point of the catheter to the end of the catheter was increased, and the catheter would be anchored in the scalene medius muscle. Here we report a case series of the first ten

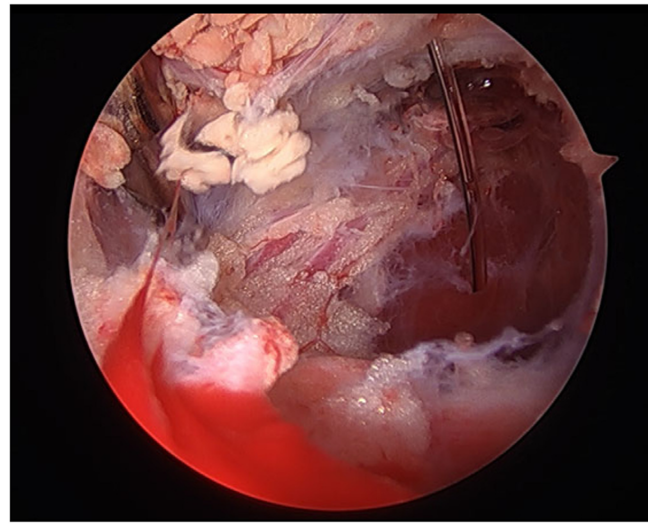

Figure 4 Arthroscopic image showing the catheter in the scalene medius at the end of the case.

patients who underwent arthroscopic shoulder surgery and SSN decompression with arthroscopic guided placement of a brachial plexus catheter for postoperative analgesia.

Methods

Patient selection

Arthroscopic assisted brachial plexus catheter placement (AABPCP) is performed and indicated in shoulder cases when additional SSN release is performed. Ten patients requiring SSN release were identified for AABPCP and provided informed consent for intraoperative catheter placement.

Surgical technique

With the patient under general endotracheal anesthesia in the beach chair position, the arthroscope is placed in a lateral port and instrumentation is placed through an antero-lateral port (Fig. 5 *A* and *B*). Dissection is performed medial to the level of the coraco-acromial ligament to reach and define the coracoclavicular ligament. A Neviaser port is placed at the level of the upper trapezius through which a blunt switching stick is introduced. While visualizing from the lateral port, we use the Neviaser port to perform blunt dissection from the coracoclavicular ligament more medially and slightly posteriorly to expose the suprascapular ligament. The suprascapular artery and vein are identified in most cases on top of the ligament. The SSN is identified deep to the suprascapular ligament (Figs. 2-4). An additional port is created 2 cm medial and posterior to the Neviaser port and arthroscopic scissors are placed in this port. The switching stick that was placed in the Neviaser port is pushed deep to the suprascapular ligament lateral to the SSN and we use it to protect the SSN by guiding it medially. The scissors are used to release the ligament fully lateral to the probe and once the release is accomplished we introduce the arthroscope into the Neviaser port while we use a blunt switching stick or a rod in the accessory portal to perform blunt dissection.

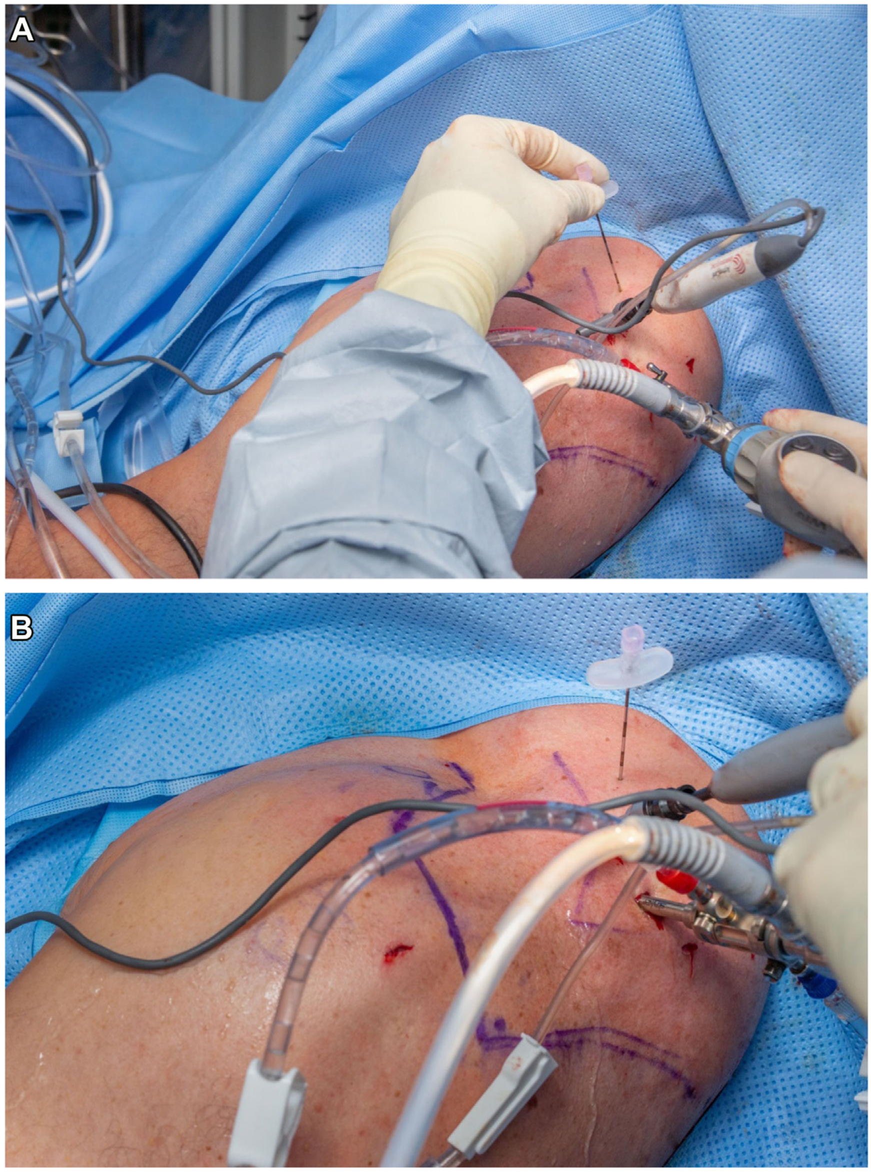

Figure 5 **A**: Port placement and percutaneous needle insertion shown. **B**: Port placement and percutaneous needle insertion shown.

Catheter placement

With the arthroscope visualizing the SSN proximally, the nerve is bluntly dissected more medially towards the level of the upper trunk. At this level we can identify the scalene medius muscle. We aim to place the catheter in the substance of the scalene medius just medial to the SSN and at the level of the upper trunk (Figs. 2-4). To accomplish this, we place an 18-gauge 10 cm Touhy epidural needle percutaneously more medial and either in the substance or slightly anterior to the upper trapezius (Fig. 5 *A* and *B*). Under arthroscopic guidance, we follow the needle and we see it entering next to the SSN and the upper trunk to the level of the scalene medius. Then we intentionally go through the muscle itself to anchor the catheter. The catheter is threaded and confirmed to be in the scalene medius (Fig. 4). The needle is removed and we visually keep an eye on the catheter to make sure it is still in place. Then, we use adhesive barrier dressings over the catheter at the level of the skin so that it will not displace. The remainder of the surgery is performed. At the end of the procedure we introduce the arthroscope again through the Neviaser port to confirm that the catheter did not displace and ensure catheter securement at the skin.

Catheter management

After surgery, a test dose of epinephrine-containing local anesthetic was administered and then the catheter was loaded with 10-20 ml of local anesthetic (mepivacaine 1.5%, bupivacaine 0.25%, or bupivacaine 0.5% all with 1:200,000 epinephrine). Postoperative analgesia and evidence of upper extremity peripheral nerve blockade was then assessed and an outpatient infusion device (ON-Q Pain Relief System, Avanos, Alpharetta, Georgia) connected. The infusion device provided a continuous infusion of bupivacaine 0.1% at a rate of 10 mL/hr (10 mg/hr). All patients were assessed and managed by an acute pain service experienced in nerve catheter management. Numeric pain scores were determined at time of perioperative anesthesia care unit

Table I
Patient characteristics and analgesic outcomes.

Age (yrs)	Gender	Weight (kg)	PMH	Procedure	Intraoperative analgesics	PACU analgesics	Bolus and/or infusion	POD 0/PACU	POD1	POD2	Catheter replaced?
71	M	114	HTN, OSA	Diagnostic arthroscopy, biceps tenotomy, débridement supraspinatus and subcapularis, arthroscopic suprascapular nerve decompression	fentanyl 400 mcg dexamethasone 4 mg	fentanyl 25 mcg ketorolac 15 mg acetaminophen 1000 mg oxycodone 5 mg	15 ml 0.5% bupivacaine with initial placement 25 ml 0.5% bupivacaine with replacement 0.2% bupivacaine 10 ml/hr	pain 6-0 after replacement	pain 0	pain 0	Yes (PACU)
50	M	130	asthma, chronic pain	arthroscopic suprascapular release, débridement, subpectoral tenodesis of the biceps tendon	ketamine 20 mg celecoxib 400 mg fentanyl 250 mcg oxycodone 20 mg	meperidine 50 mg fentanyl 100 mcg ketamine 10 mg oxycodone 10 mg	mepivacaine 1.25% 10 ml 0.5% bupivacaine	pain 3-5	pain 0	pain 6	No
60	M	109	HTN, 10 cups coffee daily	arthroscopic débridement labral tear, biceps tenotomy, subpectoral tenodesis, suprascapular release	ketamine 20 mg fentanyl 125 mcg hydromorphone 1mg	ketamine 10 mg acetaminophen 1000 mg hydromorphone 0.8 mg morphine 1 mg	20 ml 0.5% bupivacaine	post op infraclavicular catheter by US	pain 2	pain 3	Yes (PACU)
20	M	74.6	shoulder trauma	arthroscopy, repair subscapularis, suprascapular exploration and release, axillary nerve exploration, biceps tenotomy and subpectoral tenodesis	ketamine 140 mg dexamethasone 4 mg fentanyl 250 mcg hydromorphone 1.6 mg	acetaminophen 1000 mg hydromorphone 0.6 mg oxycodone 10 mg	0.2% bupivacaine 10 ml/hr	pain 6	n/a	pain 2-3	No
51	F	55.4	chronic pain, smoker	arthroscopic suprascapular release	ketamine 20 mg dexamethasone 4 mg fentanyl 100 mcg	acetaminophen 1000 mg oxycodone 5 mg	0.2% bupivacaine 10 ml/hr	pain 5	Pain 8	pain 7	No
35	F	91	HTN, seizures, fibromyalgia, OSA, chronic pain	pec minor release, brachial plexus neurolysis, suprascapular release	dexamethasone 4 mg hydromorphone 1 mg	meperidine 25 mg clonidine 0.2 mg	20 cc 0.25% bupivacaine, repeat with 10 ml 2 hours post placement	pain 7-8	pain 8	pain 7-9	No
32	M	81.8	CAD, seizures, smoker	arthroscopic subscapular release, pec minor release, brachial plexus neurolysis	ketamine 20 mg tylenol 1000 mg celexocib 400 mg fentanyl 200 mcg	ketorolac 30 mg oxycodone 2 mg fentanyl 100 mcg	No bolus charted	pain 6-8	pain 7	n/a	No
16	M	62.6	None	arthroscopic suprascapular release, brachial plexus neurolysis	fentanyl 200 mcg dexamethasone 4 mg ketamine 20 mg hydromorphone 0.6 mg	None	20 ml 0.25% bupivacaine 0.2% bupivacaine at 10 hr/hr	"little" unable to give a score	pain 7	pain 3-5	No
49	F	89.7	HTN, migraine	arthroscopic suprascapular release	tylenol 1000 mg celecoxib 400 mg dexamethasone 4 mg fentanyl 100 mcg	fentanyl 50 mcg	20 ml 0.5% bupivacaine	pain 0	pain 0	pain 1	No
48	F	75.3	OSA	arthroscopic subacromial suprascapular nerve release, pectoralis minor release and brachial plexus neurolysis	fentanyl 250 mcg dexamethasone 4 mg	fentanyl 50 mcg acetaminophen 1000 mg	2 × 30 ml 0.25% bup boluses 3.5 hours apart 0.2% bupivacaine 10 ml/hr	pain 4 to 5	pain 5	n/a	No

PMH, past medical history; *PACU*, perioperative anesthesia care unit; *POD*, postoperative day; *HTN*, hypertension; *OSA*, obstructive sleep apnea; *US*, ultrasound; *CAD*, coronary artery disease.

(PACU) dismissal and postoperative day one and two in person or via daily phone call follow-up. Patient queries included pain scores at rest, with movement, and maximum over the last 24 hours. Patients were also asked about sensory blockade, motor blockade, and evidence of systemic local anesthetic toxicity.

Results

Ten patients (six male, four female) received arthroscopic guided brachial plexus catheter placement (Table 1). Age ranged from 16-71 years of age (mean 41 year old). Intraoperative analgesics consisted of fentanyl (mean 187 micrograms, 0-400 mcg), hydromorphone (0.42 milligrams, 0-1.6 mg), ketamine (24 mg, 0-140 mg) and acetaminophen (200 mg, 0-1000 mg). Postoperative analgesia in the PACU consisted of fentanyl (32 mcg, 0-50 mcg), hydromorphone (0.1 mg, 0-0.8 mg), ketamine (2 mg, 0-10 mg), oxycodone (2.7 mg, 0-10 mg), ketorolac (4.5 mg, 0-30), and/or acetaminophen (500 mg, 0-1000 mg).

Upon dismissal from the PACU, six patients had visual analog pain scores of 0-4 while three had pain scores greater than 6 (mean 3.1, 0-7). On the day after surgery, five patients reported pain scores 0-4 and four had pain scores greater than 6 (3.9, 0-8). On the second day after surgery, six (60%) of patients reported pain scores 0-4 and two (20%) had pain scores greater than 6 (4.0, 0-8). Two patients required catheter replacement in the PACU due to poorly controlled pain. There were no reported catheter related infections or catheter dislodgement or any signs or symptoms of local anesthetic toxicity. Upon completion of the local anesthetic infusions, patients removed the catheters at their respective home locations.

Discussion

We report the first series of AABPCP for postoperative analgesia for arthroscopic SSN decompression. Procedures involving SSN decompression can be challenging to provide effective postoperative analgesia via the traditional ultrasound-guided interscalene approach due to issues with dislodgement. In this small case series, no direct catheter related complications, such as bleeding, infection, or nerve damage were seen, and none of the patients required readmission for pain control.

Despite the advantages of a continuous peripheral nerve block technique, one potential complication is block failure due to catheter dislodgement or an inability to place the catheter in an optimal location. Reported failure rates are quite variable, from 1.5 to 30%.[2,6,9] One reason for the higher failure rate for catheters placed above the clavicle may be the superficial location of brachial plexus in the neck, limited adjacent soft tissue and muscle to anchor the catheter, and increased patient head/neck movement which can dislodge the catheter. Various devices and/or methods exist to reduce the risk of catheter dislodgement such as catheter tunneling, using adhesive or glue with a barrier dressing, and various catheter securement devices.[9] However, even with these precautions, dislodgement is still common. Insertion of the brachial plexus catheter at the site of the trapezius muscle with arthroscopic guidance in close proximity to the brachial plexus and SSN may result in a lower rate of catheter dislodgment due to improved anchoring and increased distance from skin to the target nerve. When the catheter is placed intraoperatively by the surgeon, this also reduces the challenges associated with catheters being in the surgical field or working around surgical dressings.

Of note, two patients in this series required catheter replacement in the PACU due to poorly controlled pain. It is unclear whether this was related to suboptimal placement of the catheter near the SSN, inadequate bolus dosing, or catheter dislodgement. Indeed, ultrasound-guided interscalene blockade postoperatively served as an adequate rescue for these patients, but is suboptimal in patients who have undergone arthroscopic procedures and may have altered anatomy. In these cases, alternative rescue options may need to be identified.

This case series has a number of limitations, including the small patient sample size from which no definitive statistical conclusions can be made. Although these patients were all undergoing SSN decompression and shoulder arthroscopy, they had variable comorbidities and multimodal pain management perioperatively. No blinding was performed for this series, so bias in reporting and assessing pain is possible. In addition, for institutions to implement a technique of perineural catheter placement, specific infrastructure including an acute pain service and plan for patient follow-up needs to be in place. This may limit the widespread applicability of this technique.

Conclusions

This is the first case series of the use of intraoperative arthroscopically guided catheter placement. Additional studies need to be performed to determine the optimal positioning of the catheter and to compare it with traditional approaches. Importantly, this approach is likely not feasible for routine arthroscopic or open shoulder surgical procedures where nerve exploration and exposure is not performed as part of the procedure. However, our series suggests that arthroscopic guided brachial plexus catheter placement for SSN decompression provides an alternative analgesic option that may offer distinct advantages to the traditional approach.

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