Low-Volume Local Anesthetics for C5 and Supraclavicular Nerve Blocks for Mid and Lateral Clavicle Surgery: A Case Series

Sandeep Diwan, MD,* Abhijit Nair, MD,† Luc A. Sermeus, MD, PhD,‡ Atul A. Patil, MS,§ and Dheeraj Somnath Attarde, MS§

After institutional ethics committee approval and informed consent, 20 patients with clavicle fractures were recruited. An ultrasound-guided C5 root block was performed by injecting 3 mL of 0.5% bupivacaine with a subsequent ultrasound-guided supraclavicular nerve (SCN) block with 3 mL of 0.5% bupivacaine. A combination of low-volume C5 root block and SCN block provided reliable awake anesthesia and postoperative analgesia in patients with fractured clavicles. This technique can avoid a general anesthesia for fractures of the mid and lateral clavicle. Further studies should focus on the optimal volume of local anesthetics required for the success of this technique. (A&A Practice. 2020;14:e01322.)

GLOSSARY

ASM = anterior scalene muscle; **BP** = brachial plexus; **EQUATOR** = Enhancing the QUAlity and Transparency Of health Research; **GA** = general anesthesia; **IVF** = intervertebral foramen; **LA** = local anesthetic; **MSM** = middle scalene muscle; **NRS** = numerical rating scale; **PN** = phrenic nerve; **SCM** = sternocleidomastoid muscle; **SCN** = supraclavicular nerve; **SCNB** = supraclavicular nerve blocks; **US** = ultrasound

Regional anesthesia techniques for clavicle surgery commonly include combined superficial cervical plexus and interscalene brachial plexus blocks with or without general anesthesia (GA).[1,2] The innervations of the clavicle are poorly understood and ill defined. We hypothesized that injecting a low volume of local anesthetic (LA) at the level of the C5 root and supraclavicular nerves (SCNs) would be adequate for clavicle surgery.[3–6]

We performed ultrasound (US)-guided blocks by injecting a low volume of LAs for C5 root and supraclavicular nerve blocks (SCNB) in 20 patients presenting for the surgical repair of clavicular fractures. Our institutional ethics committee approved this study. Written informed consent was obtained from all patients. This article adheres to the applicable Enhancing the QUAlity and Transparency Of health Research (EQUATOR) guidelines.

CASE DESCRIPTION

Twenty patients with an American Society of Anesthesiologists physical status of I or II who sustained clavicular fractures (12 men, 8 women; age between 22 and 76 years and a mean weight of 63.8 kg) were recruited for this case series (January 2018 to January 2019). Fourteen patients had middle one-third fractures, and 6 patients had fractures extending from the lateral end of the clavicle. Patients with medial one-third clavicle fractures, difficult airways, associated upper limb fractures, and allergies to the LA were excluded from this study. All blocks were performed by the same anesthesiologist. All patients were examined before block performance for brachial plexus–related neurological deficits (motor and sensory) and hypoesthesia on the side of the operative side. Standard monitoring procedures (eg, electrocardiogram, pulse oximetry, and noninvasive blood pressure monitoring) were used. No premedication, including benzodiazepines, opioids, nonsteroidal anti-inflammatory drugs, or paracetamol, was administered.

Block success was defined as no pain or need for intravenous analgesics. Inadvertent arterial puncture, hematoma formation, ventilatory distress, Horner syndrome, and signs of LA toxicity were noted.

In the supine position with the head tilted toward the opposite side, a linear array high-frequency US transducer (5–12 mHz, Sonosite M-Turbo, Bothell, WA) was deployed to obtain a neck scan after ensuring asepsis. The US probe was oriented transversely across the neck in the supraclavicular fossa, just above the clavicle. The transducer was moved cephalad to examine the transverse process for correct identification of the roots. The C7 root was identified at the exit of the transverse process without an anterior tubercle, and the C6 root exiting at a U-shaped transverse process with a mostly large anterior tubercle (Chassaignac tubercle) followed by the C5 root at a small U-shaped transverse process.

From the *Department of Anesthesiology, Sancheti Hospital, Pune, Maharashtra, India; †Department of Anesthesiology, Basavatarakam Indo-American Cancer Hospital and Research Institute, Hyderabad, Telangana, India; ‡Department of Anaesthesiology, Cliniques Universitaires Saint Luc, Université Catholique de Louvain, Brussels, Belgium; and §Department of Orthopedics, Sancheti Hospital, Pune, Maharashtra, India.

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Address correspondence to Sandeep Diwan, MD, Department of Anesthesiology, Sancheti Hospital, Pune 411005, Maharashtra, India. Address e-mail to sdiwan14@gmail.com.

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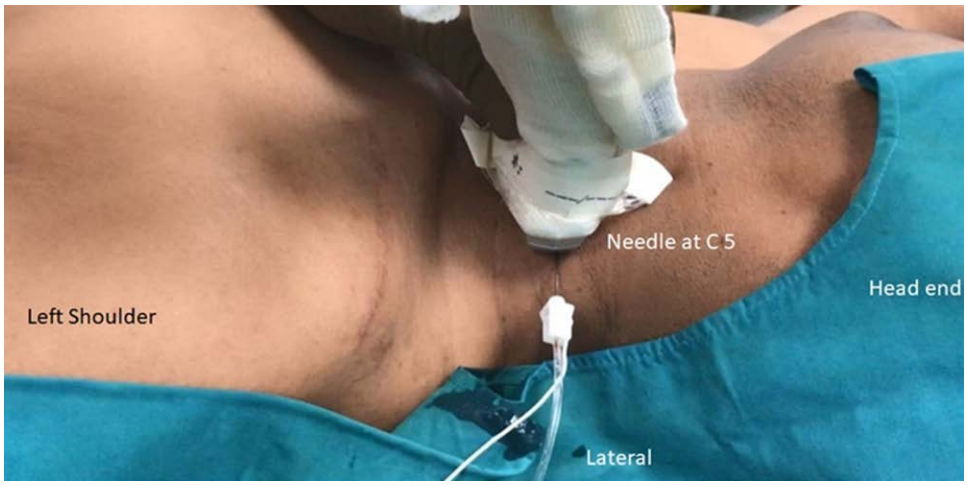

Figure 1. In-plane needle placement in the transverse plane at C5.

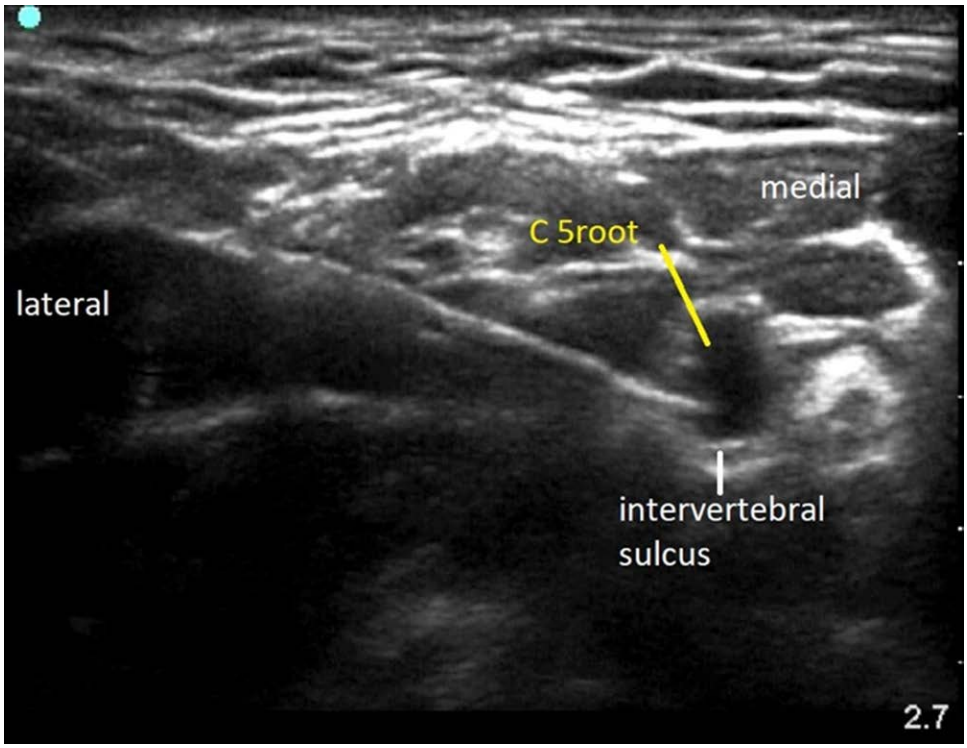

Figure 2. In-plane needle placement posterior and lateral to C5 beyond the posterior tubercle.

In the transverse axis, a 5-cm insulated needle was inserted in plane (Figure 1). The point of entry was lateral to the posterior border of the sternocleidomastoid muscle (SCM), and the needle path was identified through the upper portion of the middle scalene muscle. The needle was carefully guided under US vision until the posterior tubercle was encountered. The probe was slightly angulated cephalad to bypass the posterior tubercle, and consequently, the needle tip was placed lateral to the C5 root at the 7–8 o'clock position (Figure 2). Three milliliters of 0.5% bupivacaine were injected in aliquots of 0.5 mL after negative aspiration. LA spread was identified posterior and lateral to C5, and with each bolus, the root was elevated (Figure 3). Then, the needle was withdrawn until the tip was above the middle scalene muscle. The needle was redirected caudally and advanced toward the posterior border of the SCM under US guidance with a slight oblique tilt of the probe. The needle tip was positioned in the connective tissue lateral to the SCM between the perimysium of the SCM and the middle scalene muscle (Figure 4). Three milliliters of 0.5% bupivacaine were administered in aliquots of 0.5 mL until the SCN was surrounded by the LA. Care was taken to avoid LA spread on the superior aspect of the anterior scalene muscle. Successful block was defined as follows: all sensations (cold, touch, and light pin prick) were blunted in the area of the incision, no incisional pain, no supplementation with intravenous fentanyl during the entire procedure, and no conversion to GA.

At 10 minutes, the sensory block (Table 1) was assessed by light touch and pin prick using a 26-gauge hypodermic needle. A loss of sensation along the surgical site from the cape of the shoulder joint along the lateral aspect of the arm

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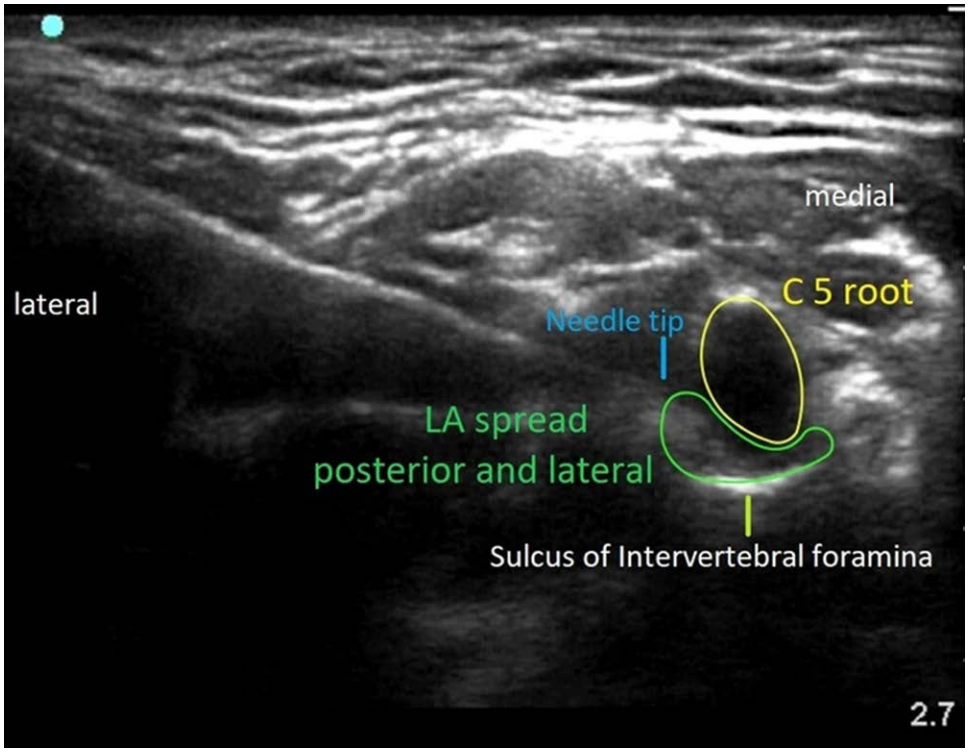

Figure 3. The LA (green) displaces the C5 root (yellow) cephalad from its position; the needle tip is close to C5. The LA (green) squeezes between the sulcus (white line) and the C5 root (yellow). LA indicates local anesthetic.

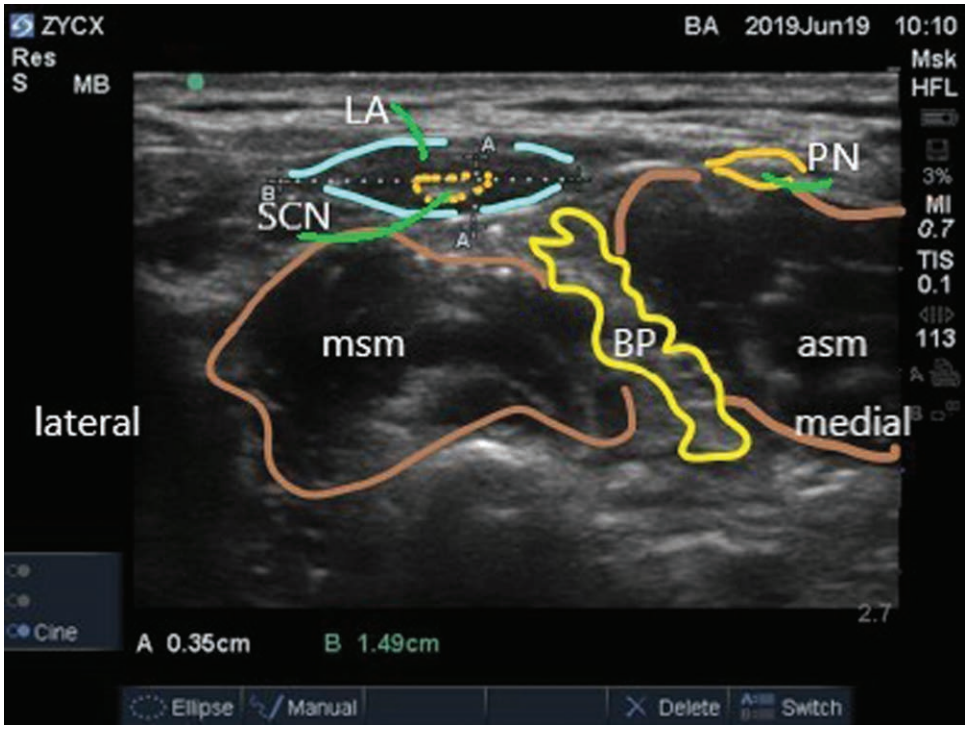

Figure 4. Supraclavicular nerve block. After 3 mL of LA (hypoechoic), the SCN is engulfed (yellow dots). The PN is above the ASM. The BP is sandwiched between the ASM and the MSM. ASM indicates anterior scalene muscle; BP, brachial plexus; LA, local anesthetic; MSM, middle scalene muscle; PN, phrenic nerve; SCN, supraclavicular nerve.

to the proximal one-third of the arm and along the posterior aspect of the spine of the scapula was confirmed (Figure 5; Table 1). Shoulder abduction was weak in 8 of 16 patients, indicating a block of the axillary nerve. The posterior and medial cords were not blocked, with flexion and extension of the arm and wrist preserved.

Blocks were successful in 16 patients, and the hemodynamic levels were well maintained throughout the surgical procedure. None of these 16 patients received a sedative, benzodiazepines, or propofol infusion. Block failures were observed in 4 of 20 patients. Three of the patients with lateral end clavicle fractures experienced discomfort during manipulation of the fractured clavicle fragments. In these patients, intermittent boluses of intravenous fentanyl and intravenous midazolam were given to facilitate surgical procedures. One patient with a midshaft clavicle fracture

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Table 1. C5-SCN Block: Sensorimotor and Analgesic Efficacy After a C5-Supraclavicular Nerve Block for Mid and Lateral Clavicle Surgery

Case	Dermatomes	Motor Block	Adequate Analgesia	Additional Analgesia (Intraoperatively)	NRS for the First 12 h	Duration of the Sensory Block (h)
1	C4, 5	None	Yes	None	1–2	10
2	C4, 5, 6	Weak biceps	Yes	None	1–2	8.5
3	C4, 5	None	Yes	None	2–3	9
4	C3, 4, 5	Weak biceps	Yes	None	1–2	11.5
5	C4, 5, 6	Weak biceps	Yes	None	1–2	11
6	C4, 5	None	No	Fentanyl	3–4	6.5
7	C4, 5	None	No	Fentanyl	3–4	5.5
8	C3, 4, 5	Weak biceps	Yes	None	2–3	12
9	C4, 5	None	No	GA	3–4	Failed block
10	C4, 5	None	Yes	None	1–2	12
11	C4, 5, 6	Weak biceps	Yes	None	1–2	8
12	C4, 5	None	Yes	None	2–3	9.5
13	C4, 5, 6	Weak biceps	Yes	None	1–2	9.5
14	C4, 5, 6	Weak biceps	Yes	None	1–2	10
15	C4, 5	None	Yes	None	1–2	8.5
16	C4, 5	None	Yes	None	1–2	9
17	C4, 5, 6	Weak biceps	Yes	None	1–2	10.5
18	C4, 5	None	Yes	None	2–3	9.5
19	C4, 5	None	No[a]	Fentanyl	3–4	9
20	C4, 5	None	Yes	None	1–2	10.5

Abbreviations: GA, general anesthesia; NRS, numerical rating scale; SCN, supraclavicular nerve.
[a]Inadequate analgesia.

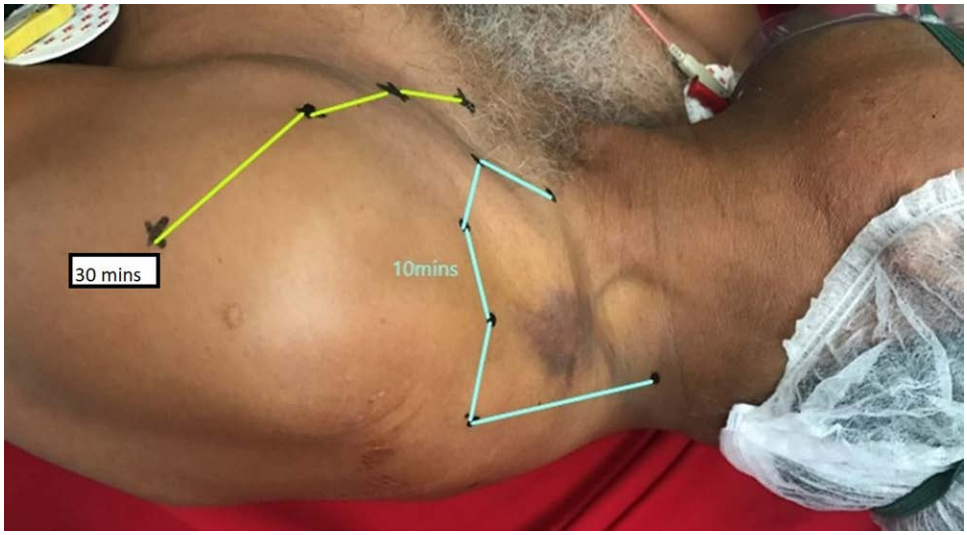

Figure 5. Preoperative sensory block distribution 10 min post block (blue lines) and 30 min postblock (light yellow lines). Ecchymosis secondary to the fractured clavicle is noted.

noted pain at the incision site despite a proper assessment before the start of surgery, and this case was converted to GA. The surgical procedures lasted from 30 to 90 minutes. All patients received 1 g intravenous paracetamol every 8 hours in the postoperative period and 100 mg intravenous tramadol for breakthrough pain for a numerical rating scale (NRS) of >4. There were no surgical- or block-related complications.

DISCUSSION

The innervation of the clavicle is complex, uncertain, and undetermined (Figure 6). Various nerves are implicated in the innervation of the clavicle (ie, the subclavian, supraclavicular, suprascapular, lateral anterior thoracic, and long thoracic nerves).[7] All nerves except for the SCN (C3–C4) originate between C4 and T1. We hypothesized that a limited injection of LA solution blocking the sensory part of C5, together with a block of the SCN, might be enough to perform surgery on the clavicle.

Many techniques are described in the literature for blocking nerves innervating the clavicle, with or without GA (Table 2). In contrast, with a clavipectoral fascia block, our technique involves the injection of smaller volumes for both C5 root blocks and SCN blocks. In a report of interventional pain procedure for a C5 radiculopathy, the nerve root was successfully visualized emerging between the anterior and posterior tubercles, with the needle tip close to the C5 root beyond the posterior tubercle.[8]

Neuraxial spread is possible with the C5 root block which was exhibited by the injection of methylene blue dye in 1 of 4 cadavers.[9] The researchers suggested a more distal block for the acute pain management of distal clavicle fractures. In our cases, the needle tip was well visualized lateral and posterior to the C5 roots. In the transverse scan, injection

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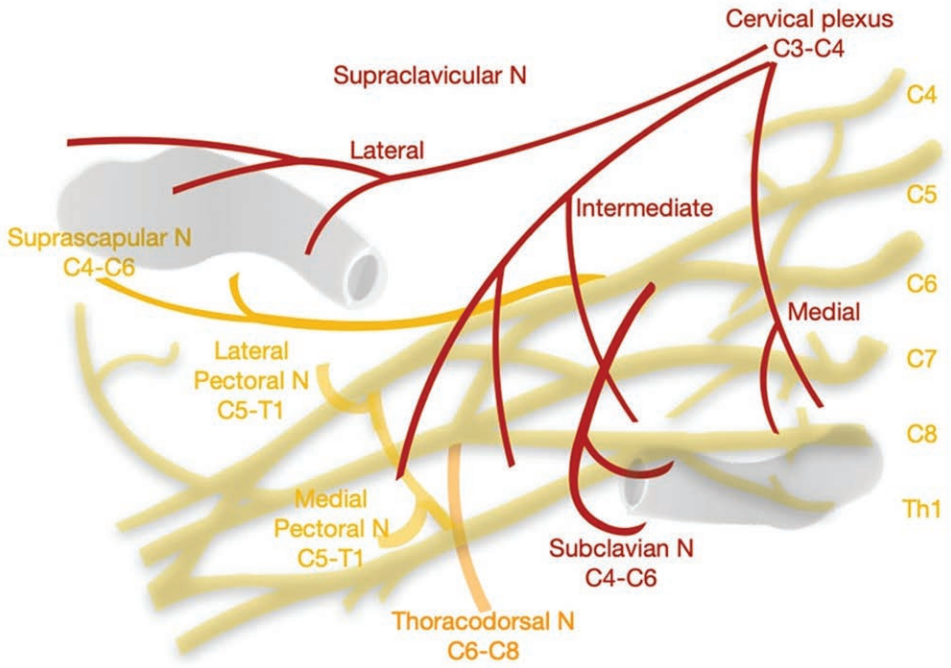

Figure 6. Proposed clavicular innervation by the subclavian nerve and supraclavicular nerves (red), with a limited part of the lateral clavicle innervated by the suprascapular and lateral pectoral nerves (dark yellow).

Table 2. Anesthetic Techniques for Clavicle Surgery

Technique	Block Characteristics	Study Adverse Effects
Combined interscalene-cervical plexus block[1,2]	Insensate limb Large volume with LA	Phrenic nerve block
Isolated superior trunk block with targeted propofol anesthesia[4]	Relatively low volume with GA	Single case report Suprascapular nerve block
C5 root block and GA[5,a]	Low volume with GA	2 case reports
Clavipectoral fascia block without supraclavicular nerve block[7]	Large volume	Probably blocks only the supraclavicular nerves

Abbreviations: GA, general anesthesia; LA, local anesthetic.
[a]General anesthesia was administered due to inadequate analgesia.

of 3 mL of the LA displaced the root from the sulcus of the intervertebral foramen.

The first description of selective SCN block was reported with 0.4 mL of 0.5% lidocaine for the lateral and 0.8 mL for the intermediate and medial branches of the SCN, providing 2 hours of analgesia.[10] In our cases, the final needle tip position was in the connective tissue between the SCM and the middle scalene muscle, proximal and lateral to the interscalene groove. This approach was taken to avoid spread of the LA toward the phrenic nerve.

If we consider that some fibers from the suprascapular and lateral pectoral nerves innervate a small portion of the clavicle and that the major part of the clavicle is innervated by the subclavian nerve, our hypothesis of a C5 root block along with an SCN block is appropriate to block clavicle innervation (Figure 5).[7,11,12]

We did not assess diaphragmatic function, patient satisfaction scores at the end of surgery, or muscle weakness of the upper limb on the surgical side. An LA volume <4.3 mL is less likely to produce hemidiaphragmatic paresis.[13] These are limitations of this study. This is a limited single-center case series. We recommend a prospective, randomized study with a good sample size to prove the efficacy of this technique for clavicle surgery and to detect possible disadvantages.

This C5 root block must be categorized as an advanced block taking into consideration the closeness of the needle to the cervical root. It should be administered only by clinicians proficient in US-guided blocks. This procedure seems to have many important advantages, such as no requirement for sedation or GA, the avoidance of phrenic nerve block, and feasible for ambulatory surgery.

DISCLOSURES

Name: Sandeep Diwan, MD.
Contribution: This author helped design and define intellectual content, write the first draft of the manuscript, recruit patients, and collect data.
Name: Abhijit Nair, MD.
Contribution: This author helped review the manuscript, review the literature, and analyze the data.
Name: Luc A. Sermeus, MD, PhD.
Contribution: This author helped edit the manuscript, review the literature, and draft the final manuscript.
Name: Atul A. Patil, MS.
Contribution: This author helped collect data and recruit patients.

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Name: Dheeraj Somnath Attarde, MS.
Contribution: This author helped collect data and recruit and follow patients.
This manuscript was handled by: BobbieJean Sweitzer, MD, FACP.

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