Original Article

Selective blockade of supraclavicular nerves and upper trunk of brachial plexus "The SCUT block" towards a site-specific regional anaesthesia strategy for clavicle surgeries - A descriptive study

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ABSTRACT

Background and Aims: Commonly, the superficial cervical plexus and interscalene block were combined to provide surgical anaesthesia for procedures on the clavicle, which are neither selective nor site-specific considering the innervation of the clavicle. The aim was to analyse effectiveness and block dynamics of selectively blocking supraclavicular (SC) nerves and upper trunk (UT) of brachial plexus (SCUT BLOCK) as a site-specific regional anaesthesia strategy for clavicle surgery. **Methods:** SC nerves and UT were blocked with 3-ml and 5-ml local anaesthetic, respectively, in 70 American Society of Anesthesiologists I and II patients aged above 18 years, undergoing clavicle surgery. Sensory-motor conduction blockade was assessed in both the plexus territories, following which surgery ensued. Number of patients who exhibited complete conduction blockade of the targeted nerves, number of surgeries completed under the block, intraoperative rescue analgesics, duration of postoperative analgesia and complications were recorded. **Results:** Sensory and motor mapping showed complete conduction blockade of the targeted nerves in all patients, all other branches were spared. The surgery was completed exclusively under block in 67 (Strategy success rate 96%) out of 70 patients. Intraoperatively, two patients required supplementation of block with a local infiltration and general anaesthesia was administered for one patient. The mean duration of postoperative analgesia was 5 (1.2) hours [mean (standard deviation)]. Only one patient developed ptosis; no other complications were noted. **Conclusions:** "The SCUT block" is an effective site-specific regional anaesthesia strategy for clavicle surgery.

Key words: Brachial plexus blocks, clavicle surgery, regional anaesthesia, ultrasound guided nerve block

INTRODUCTION

Regional anaesthesia is associated with better patient-reported outcomes compared to general anaesthesia for upper limb surgery.[1] However a site-specific regional anaesthesia strategy for clavicle surgery has not been established. Commonly, superficial cervical plexus block (SCPB) and interscalene brachial plexus block (ISBPB) were combined to provide surgical anaesthesia.[2] Tran Q, in a comprehensive anatomical review, stated that four nerves, namely the supraclavicular nerves (SCN) from superficial cervical plexus and nerve to subclavius, suprascapular and long thoracic nerve from the brachial plexus (BP), are responsible for pain transmission from the

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clavicle.[3] Considering these target nerves, SCPB and ISBPB are neither selective nor specific to the surgical site. Selective C5 root block with SCN block and the clavipectoral fascial plane block have been described as possible strategies for clavicle surgery.[4-6] With the introduction of high resolution ultrasound imaging and better understanding of sonoanatomy, currently the SCN and individual components of the BP namely the ventral rami and trunks can be identified for selective blockade with low volumes.[5,7,8] As the nerve to subclavius, suprascapular nerve and two thirds of the fascicles to long thoracic nerve arise from the upper trunk (UT) of BP, we designed this study to analyse and describe the dynamics of selectively blocking the SCN along with the UT of the BP (SCUT BLOCK), towards a selective, site-specific regional anaesthesia strategy for clavicle surgery.

METHODS

This prospective study was conducted at a university teaching hospital between August 2018 and December 2019, after being approved by Institutional Human Ethics Committee (Faculty Project/2018/06/10). The trial was registered with Clinical trial Registry of India, (CTRI/2018/08/015148). Seventy consecutive patients aged above 18 years, with American Society of Anesthesiologists physical status I and II, posted for unilateral clavicle surgery were recruited. Those who refused to participate, allergic to any of the study drugs, having any pre-existing neurological deficit or coagulopathy were excluded.

After thorough pre-anaesthetic assessment, the day before surgery, written informed consent was obtained from all patients. On the day of surgery, patients were shifted to a designated anaesthetic procedure room, an 18-gauge intravenous access was secured and routine monitoring (electrocardiogram; pulsoximetry; and non-invasive blood pressure) initiated, following which blocks were performed. Procedural sedation was administered with 1–3 mg of midazolam intravenously to the patient's comfort. No other benzodiazepines or narcotics were administered unless it was warranted as intraoperative rescue analgesics.

Patients were placed in a semi-lateral position, with the affected side non-dependent. The back was supported by a cushion and head placed on a thin pillow, which allowed natural extension of neck and supraclavicular fossa. The block performer sat at the head-end placing the ultrasound machine in front. Scans were performed with the high frequency linear array transducer (HFL 50, 15 – 6 MHz), of the X-Porte Ultrasound system (FUJIFILM SonoSite, Inc, Bothell, USA) with compound imaging capabilities (multibeam). Blocks were performed by anaesthesiologists who had experience of performing these selective blocks. A 25 gauge Quincke spinal needle (BD™, Gurgaon, India) was used for local anaesthetic (LA) deposition near the target nerves. The needle was attached to a 100-cm pressure monitoring line (Romsons, Agra, India) and a 0.5-ml graded 10-ml luer lock syringe. An equal mixture of 2% lignocaine with adrenaline 1:200000 and 0.5% bupivacaine was used for the blocks. Needling was performed using out of plane or in-plane approach, according to convenience of the performer. The SCN were identified as small hypoechoic cluster, sandwiched between two layers of the deep cervical fascia enclosing the sternocleidomastoid (investing layer) and scalene muscles (prevertebral layer) [Figure 1].[9] The SCN cluster was blocked with 3 ml of LA administered as 0.5 ml aliquots at 3 or 9 o' clock position after negative aspiration. The injection point was chosen when the cluster appeared as a single group just lateral to the tapering edge of the sternocleidomastoid muscle [Figure 2a and 2b]. In case the nerve clusters were not identified, the LA was deposited within the intermediate fascial plane, and the strategy was not considered as a "SCUT" block. Systematic UT scanning included identification of the interscalene groove and the ventral rami of the BP which appeared as dark hypoechoic circles within the interscalene groove. Once rami were visualised, back and forth tracing was done to identify individual BP elements. The round, hypoechoic C5 and C6 ventral rami were identified, as they appear to arise from their corresponding transverse processes, then traced distally till they combine and form the UT, which was hyperechoic, larger than the individual rami representing increase in connective tissue among the fascicles [Figure 1a-d].[8] About 5 ml of LA was administered as 0.5 ml aliquots after negative aspiration to the UT. The needle tip was carefully negotiated just below the outer most hyperechoic line within the hyperechoic connective tissue matrix (interfascicular injection) [Figure 3a and b]. Care was taken to avoid the hypoechoic areas (Intrafascicular injection).[10] During block performance, if patients reported pain, discomfort, or paraesthesia, the injection was discontinued, and needle tip was repositioned.

Sensory assessment was done with an ether-soaked cotton ball and motor assessment of upper limb

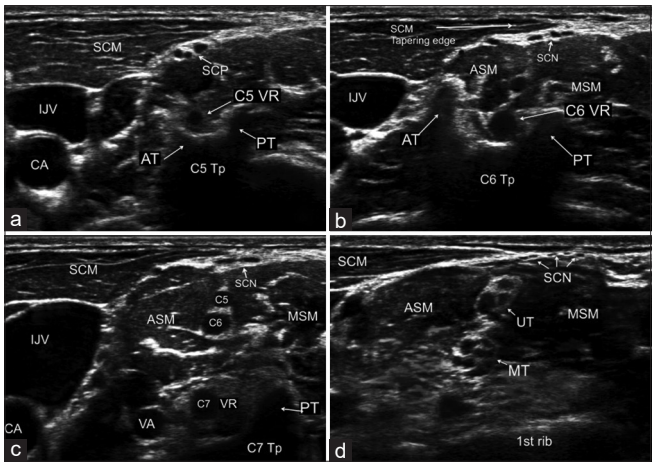

Figure 1: Transverse sonograms showing sonoanatomy relevant for identification of the upper trunk (UT) of brachial plexus and the supraclavicular nerves (SCN) of the superficial cervical plexus(SCP). (a) Sonogram showing the C5 Transverse Process (Tp) with its anterior tubercle (AT) and posterior tubercle (PT) and the hypoechoic C5 ventral ramus (VR) above it and the SCP sandwiched between the Sternocleidomastoid (SCM) muscle and scalene muscles. (b) Sonogram showing the C6 Tp with its prominent AT and PT and the hypoechoic C6 VR above it and the SCN as they migrate laterally beyond the tapering edge of the SCM muscle. (c) Sonogram showing C7 Tp with only a PT and the hypoechoic C7 VR above it. Note the vertebral artery (VA) medial to the C7 VR, and the C5 and C6 rami appear to be combining. The SCN are sandwiched between the SCM and the scalene muscles. (d) Sonogram showing the UT after the C5 and C6 rami appear to combine, with hyperechoic honey-comb appearance. The SCN appear to divide into multiple branches above the middle scalene muscle. SCM – Sternocleidomastoid muscle; ASM – Anterior Scalene Muscle; MSM – Middle Scalene Muscle; IJV – Internal Jugular vein; CA – Carotid artery; SCA – Subclavian artery; SCP – Superficial cervical plexus; SCN – Supraclavicular nerves

movements was done in both plexus territories as described in Table 1. Sensory and motor blockade were separately graded using a three-point qualitative scale as follows: Grade 0 indicated the presence of cold and touch and normal motor function (Power 5/5, 4/5); Grade 1 indicated the loss of cold but touch intact and decreased motor function (Power 3/5, 2/5); and Grade 2 indicated the loss of both cold and touch and no motor power (Power 0/5, 1/5). Assessments were done every 10 minutes up to 30 minutes or until grade 2 sensory-motor blockade, which was considered as complete conduction blockade (CCB). At the end of 30 minutes if the patient did not register CCB, then it was noted as block failure and further course of action was decided by the attending anaesthesiologist. Patients who achieved CCB were subsequently shifted to the operating room to proceed with surgery.

In the operating room, patients were positioned supine with back propped up 20 to 30 degrees and a soft cushion was placed below the scapulae to elevate the clavicle. The patient's head was turned to the opposite side, rested comfortably on a soft head ring. Sterile surgical drapes were strategically placed to avoid discomfort over the patient's face. During surgery if the patient complained of pain or discomfort, intravenous fentanyl was administered at 0.5 $\mu g.kg^{-1}$ as a rescue dose till pain was relieved or to a maximum of 2 $\mu g.kg^{-1}$. If the pain was not relieved with maximum dose of fentanyl, further management was decided by the consultant either by supplemental LA infiltration, propofol or ketamine administration or conversion to general anaesthesia (GA), and the SCUT block was considered as a strategy failure. Percentage of block success (number of patients who attained CCB), strategy success (number of patients completing surgery after attaining CCB without supplemental analgesic interventions), and any complications were recorded.

Postoperatively where the strategy was successful, patients were instructed to report the time when they first perceived pain at the surgical site, for which intravenous acetaminophen 1 gm and ketorolac 30 mg was administered. Subsequently, they received round the clock, multimodal analgesic regimen as per acute pain service protocol in the institute. The duration between the block time and the first perception of pain by the patient was taken as duration of analgesia. All patients were enquired for the presence of symptoms like persistent sensory-motor deficit in the territories of nerves blocked, 24 hours postoperatively and at the 1-week follow-up visit.

Based on a pilot study conducted in 24 patients, we observed strategy failure in two patients (8.33%). Assuming alpha of 0.05 and a precession of 0.07 (7%), the sample size of 60 was calculated using the sample size calculator Gower (version 3.1). Taking dropouts and missing data into account, 70 patients were recruited. All data was entered and analysed using Jeffrey's Amazing Statistics Program (JASP Team version 0.11.1). Quantitative variables were expressed as mean, standard deviation, 95% confidence interval. Qualitative variables were expressed as percentage.

RESULTS

In this prospective observational study, 82 patients were approached, seven patients did not consent, three patients were excluded due to presence of haematoma at the site of injection and two patients were excluded as they had sustained multiple rib fractures as well.

Table 1: Assessment and incidence of complete conduction blockade in the branches of superficial cervical plexus and terminal branches of the brachial plexus

Nerves	Sensory assessment	Motor assessment	Incidence of complete blockade (%)	
			Sensory	Motor
Superficial cervical plexus branches				
Supraclavicular nerves	Skin over the clavicle	Not Applicable	100	Not Applicable
Transverse cervical	Skin over the ipsilateral thyroid cartilage	Not Applicable	20	Not Applicable
Greater auricular	Skin in front of the tragus	Not Applicable	0	Not Applicable
Lesser occipital	Skin over the mastoid process	Not Applicable	0	Not Applicable
Brachial plexus branches				
Suprascapular Nerve	Not Applicable	Shoulder abduction from 0 to 30°	Not Applicable	100
Axillary Nerve	Skin over the lower half of the deltoid muscle	Shoulder abduction beyond 30°	100	100
Musculocutaneous Nerve	Anterolateral surface of the forearm	Elbow Flexion	100	100
Median nerve	Tip of the Middle finger	Thumb opposition.	0	0
Radial Nerve	Skin over the anatomical snuff box	Thumb abduction	20	0
Ulnar Nerve	Tip of the little finger	Thumb adduction	0	0

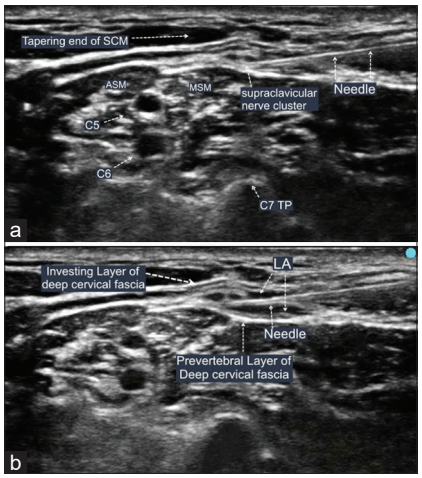

Figure 2: Sonogram shows the in-plane injection of Local Anaesthetic (LA) around the supraclavicular nerves (SCN) cluster at the level of C7, where it appears as a single group. (a) Sonogram showing the Block needle near the SCN cluster at the tapering edge of the SCM. (b) Sonogram showing deposition of LA. TP – Transverse Process; SCM – Sternocleidomastoid muscle; ASM – Anterior Scalene Muscle; MSM – Middle Scalene Muscle; IJV – Internal Jugular vein; CA – Carotid artery

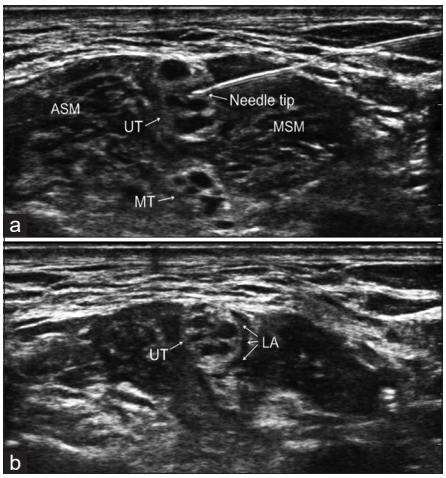

Figure 3: Sonogram shows the injection of Local Anaesthetic (LA) in the UT, just below the outermost hyperechoic line. (a) Sonogram showing the in-plane injection of LA in the UT. (b) Sonogram showing spread of LA around the UT, following injection of LA. UT- upper trunk; MT – Middle Trunk

The physical characteristics, surgical procedures and the average surgical duration in the 70 patients who were recruited are depicted in Table 2. The SCN and the UT were successfully identified in all 70 patients. CCB was achieved in SCN, suprascapular, axillary, and musculocutaneous nerve territories in all patients, by the end of 30 minutes [Figure 4]. The mean time to achieve CCB of the 4 nerves was 11 ± 4.2 [mean ± standard deviation (SD)] minutes. The territories of the other branches of superficial cervical plexus and BP were either spared or partially involved [Table 1].

Sixty-seven patients completed the surgery successfully under the SCUT block without any supplemental analgesic intervention (Strategy success rate 96%). Among the patients where strategy was successful, the mean duration of analgesia was 5 ± 1.2 (mean ± SD) hours. Amongst the three patients where strategy was inadequate, two patients experienced pain during exposure of lateral fragment of the clavicle which subsided with supplemental subcutaneous infiltration performed by the surgeon, at the lateral end of the incision as well as intravenous fentanyl 1 μg/kg bolus. In the third patient, a general anaesthetic was administered when he complained of pain during osteotomy to align a malunited clavicle fracture. One patient developed ptosis on the blocked side, which was subsided over a period of 3 hours and no other patient reported any hoarseness of voice or difficulty in breathing. All patients recovered complete

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Table 2: Physical characteristics of the study cohort, type of surgical procedures and the average surgical duration (*n*=70)

Study parameter	Measurement
Age/years (mean±SD)	36.6±14.3
Sex M/F	59/11
ASA I/II	52/18
BMI (mean±SD)	25±3
Side RT/LT	32/38
*Type of Surgery a/b/c/d	45/15/5/5
Surgical duration/minutes (mean±SD)	63.4±47.7

*The surgical procedures clavicle fracture of the Middle third or lateral third that were fixed either by (a) Open Reduction and Internal Fixation with a clavicular anatomical plate or (b) Closed reduction and internal fixation with Titanium elastic nailing system (TENS) (c) Acromioclavicular joint dislocation (d) infected clavicle implant (plate) removal. ASA: American Society of Anesthesiologists; BMI: Body mass index; SD: Standard deviation; RT: Right; LT: Left

sensory and motor function at the end of 24 hours. None of the patients reported any persistent sensory or motor symptoms at the 1-week follow-up.

DISCUSSION

In this prospective study, we observed that the SCUT block was selective and efficacious as a sole anaesthetic technique for clavicle surgery in 96% of patients. When 8 ml LA was injected at the target nerves, 3 ml at the SCN and 5 ml at the UT, there was CCB of the target nerves in all patients prior to incision. The methodology employed for assessment of conduction blockade in both plexus territories enabled us to describe the selectiveness of the SCUT block. Following 3-ml injection for the SCN, we observed sensory blockade similar to that described in previous studies.[4,9] However, 20% of patients had an additional involvement of the transverse cervical branch [Table 1, which we attribute to a medial and proximal spread of LA within the same fascial plane. UT block with 5-ml revealed CCB in territories of suprascapular, axillary, and musculocutaneous nerves in all patients, grade 1 sensory block in radial nerve territory of the forearm in 20% of patients and sparing of median and ulnar nerves in all patients. We believe that to establish a selective block and avoid LA spread, between closely organised BP elements within the interscalene and supraclavicular area, it becomes of paramount importance to deposit minimum required LA volume to the targets with precise needling techniques, and the volume of LA, should strike a balance between selectivity and efficacy. As the minimum effective LA volume that achieves these objectives has not been defined, we chose 3 ml for the SCN block and 5 ml for UT block from published studies and the authors' experience.[4,7]

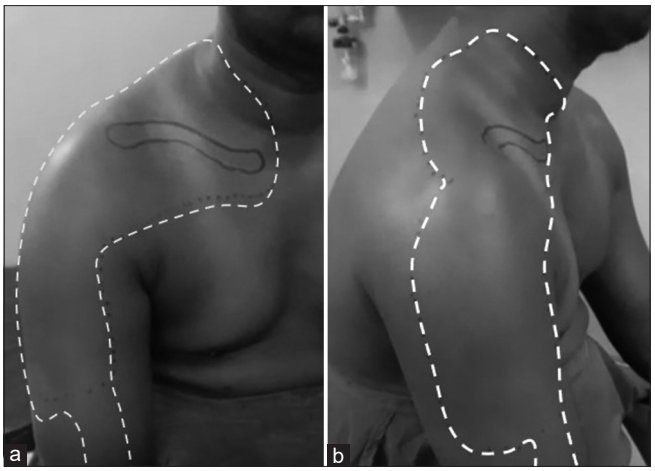

Figure 4: Image showing the extent of the sensory blockade of the SCUT block. The white dotted line shows the boundary of the sensory blockade, in a patient about to undergo implant exit surgery from the clavicle. (a) Anterior aspect (b) Posterior aspect

In our study, three patients required rescue analgesic interventions during the intraoperative period, despite CCB of targeted nerves prior to starting the surgery. We attribute the strategy failures either to an incomplete blockade of the branches of the SCN (medial, intermediate or lateral branch) which might have been overlooked during assessment, or possible nociceptive impulses conducted from neighbouring structures during surgical manipulation of muscle attachments to the clavicle, like the trapezius via spinal accessory nerve, or the pectoralis major through medial pectoral nerves, which were not blocked. However, among these three patients, only one required GA to complete the surgery, which we attributed to relatively increased stimulus during osteotomy and manipulation of malunited 6-month-old clavicle fracture. Even though anatomical literature reports only four nerves are possible afferents from clavicle, we postulate that during surgical exposure, other nerves may be responsible for noxious impulse transmission, which can only be identified by selectively blocking the contemplated four nerves while sparing other branches. The studies describing the UT or interscalene injections for shoulder anaesthesia and analgesia, used 10–15 ml of LA volume, but did not state the selectiveness of the block with individual nerve assessment, instead collectively noted a difference in sustained hand grip or reported as a failed block.[11-13] One of the authors recently explored the selective C5 nerve root injection with SCN block as a sole anaesthetic technique for clavicle surgery in 20 patients.[4] Even though the strategy was more site-specific with the sparing of musculocutaneous nerve in 100% of the patients and axillary nerve in 60% patients, there was inadequate

blockade in four out of 20 patients (i.e. 20% failure) especially at the lateral end of clavicle. On the contrary, following SCUT block the failure rate was 4%, but the axillary and musculocutaneous nerves were blocked in 100% of patients. This improved strategy success of the SCUT block could be due to axillary nerve blockade, causing deltoid muscle paralysis, which may contribute to surgical anaesthesia involving lateral end of the clavicle and acromioclavicular joint. The role of radial or musculocutaneous nerve blockade however may be redundant and out of site-specific anaesthesia requirement. Thus, future randomised controlled trials (RCTs) must explore the balance of site specificity and efficacy between these two strategies. Efficacy of clavipectoral fascia block towards sole regional anaesthetic technique for surgical anaesthesia cannot be commented on due to coadministration of GA.[6]

The limitation of our study was that a majority of the surgeries were open reduction and internal fixation with plates and screws for acute fractures. Clavicular surgeries with intramedullary nailing or involving the medial end may require additional subcutaneous skin infiltration at the midline to block the nerve fibres crossing over from the opposite side. Another limitation is that even though none of the patients exhibited any apparent features suggestive of phrenic involvement, we have not objectively analysed the diaphragmatic movement to comment upon the incidence of phrenic nerve paresis.

Further prospective RCTs should aim to shed light on relative efficacy, site specificity and complication profiles of different regional anaesthesia strategies described.

CONCLUSION

From our findings we conclude that the SCUT block was effective in providing site-specific regional anaesthesia for clavicle surgeries and can be used as a sole anaesthetic technique.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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