Subclavian Perivascular Block: Is it really the spinal of the arm?

J. Balavenkatasubramanian¹, Kartik Sonawane¹, Sandeep Diwan²

Abstract

Subclavian Perivascular Blocks are now being increasingly used by anaesthetists due to improved precision possible by use of peripheral nerve stimulator. The frequency of use is almost similar to spinal anaesthesia and has much similarity to it in anatomical and physiological premises. In this review we present an overview of subclavian perivascular blocks with special focus on the technique and technical aspects.

Keywords: Subclavian Perivascular Block, Paraesthesia , Neurostimulation, Ultrasound Brachial Plexus Blocks.

Introduction:
The upper extremities receive its innervations from the brachial plexus formed by the ventral primary rami of the lower cervical and upper thoracic nerve roots i.e. C5, C6, C7, C8, and T1. Brachial Plexus block is one of the most commonly performed blocks by anaesthesiologists and it is also one of the most discussed blocks in the Regional Anaesthesia literature. The ability to administer this block with precision has become possible with the advent of Peripheral Nerve Stimulator, Ultrasound, and Echogenic Stimulating needles. Depending upon the requirement for surgical anaesthesia/analgiesia, the brachial plexus can be approached at various levels starting from the roots to terminal branches.

Approaches to the Brachial Plexus.
The brachial plexus can be approached at various levels (Fig. 1); the interscalene at the level of the cervical roots, the supravacular at the level of the trunk-divisions, the infraclavicular at the level of the cords and the axillary at the level of the terminal nerves.

The various approaches of brachial plexus blocks are based on the site of the surgery. Thus an interscalene block at the level of the cervical roots is preferred for the shoulder surgeries (Table 1). The subclavian perivascular block is preferred for surgeries below the mid third of arm. Certain adjunct supplementary blocks are required for providing surgical anaesthesia for specific surgical procedures. The following table summarises the supplementary blocks.

Supravacular Block:
The supravacular percutaneous method was used for the first time by German surgeon Kulenkampff in 1911. The classical supravacular approach has certain limitations. This would include the prescribed needle insertion of 1 cm above the midpoint of clavicle and now we know that it does not exactly coincide with brachial plexus always. Also, the suggested needle direction “medial, caudal and dorsal” might miss the narrow space in which the brachial plexus is located in the supraclavicular area.

The advocacy that the needle tip should hit the first rib and then to walk over it after eliciting paraesthesia before depositing local anesthetic agent looks far from truth after our learnings from Ultrasound images. In fact Adriani [2] wrote, “we use supravacular block with great fear and trepidation”.

After redefining the supravacular anatomy, Winnie and Collins described the existence of a continuous fascia - the perineural and the perivascular space surrounding the brachial plexus from its origin at the cervical transverse processes to its terminal distribution in the upper third of arm. One of the methods to reach the subclavian space is to first identify the apex of the interscalene groove, which is usually palpable 1.5 cm lateral to the clavicular head of sternocleidomastoid at the level of C6. From the apex one should walk down the interscalene groove until its base. At the base of the interscalene groove the pulsations of the subclavian artery are palpated. The brachial plexus is in close relation posterolateral to the artery. The plexus is very superficial at this place approximately within 1 cm from the skin. This block is also called as “subclavian perivascular block” described by Winnie and Collins [3] in 1964. Subclavian perivascular block is performed where the brachial plexus is presented most compactly at the distal trunk level and hence it is also termed as “Spinal of arm” [4]. As just a single point injection in this compact area, the block provides short latency and complete, reliable anaesthesia for upper extremity surgery.
**Cadaveric Supraclavicular Anatomy**

The cervical roots form the trunks which then divide in the supraclavicular area close to the clavicle. The DSA is transected and usually travels through the lower cervical roots (Fig.2). Clavicle cut open.

A further cadaveric dissection depicts the formation of the divisions in the supraclavicular area (Fig. 3). Note that the superior trunk divisions are placed laterally (dark yellow), the divisions of middle trunk (green) travel in the mid area while the divisions of the inferior trunk (blue) are deep seated and behind the subclavian artery.

This is the reason of inadequate inferior trunk – divisions block as local anesthetics do not reach the inner most area of the brachial plexus.

The cadaveric brachial plexus is displayed as the patient lies in supine position (Fig. 4). The superior trunk divides lower down into divisions while the suprascapular nerve takes it path outwards.

The supraclavicular divisions (encircled light violet) receive contributions from the C5-T1 (C5,6 – dark yellow, C7 – green and C8 – blue) of which notice the inferior trunk contributions is deep seated (Fig. 4). It is difficult to negotiate the needle tip to gain access towards the inferior trunk – divisions (orange dotted). Unmonitored manipulation of needle tip in this area will lead to penetration of unwanted structures i.e. subclavian artery (red) and the pleura.

**Indications:**

All the surgeries including humerus (proximal, shaft and distal), elbow, forearm, and hand.

Closed reduction of Shoulder/elbow dislocation.

**Paraesthesia technique.**

A hypodermic needle is introduced 1 cm above the mid point of the clavicle to

---

**Figure 1:** Various Approaches of Brachial Plexus

<table>
<thead>
<tr>
<th>Brachial Plexus Level</th>
<th>Approaches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roots</td>
<td>Interscalene Block</td>
</tr>
<tr>
<td>Trunks/Divisions</td>
<td>Supraclavicular/Subclavian Perivascular Block</td>
</tr>
<tr>
<td>Cords</td>
<td>Infraclavicular Block</td>
</tr>
<tr>
<td>Terminal Branches</td>
<td>Axillary Approach of BP Block</td>
</tr>
</tbody>
</table>

---

**Figure 2:** Cadaveric dissection depicting the outlay of left brachial plexus. SSN – Suprascapular nerve; DSA – Dorsal Scapular Artery.

**Figure 3:** The right supraclavicular divisions of brachial plexus

**Figure 4:** Note the Inferior trunk is lifted from behind the subclavian artery.

---
obtain paraesthesia in the middle two fingers. The needle is then stabilised with the nondominant hand and injection was performed in small aliquots and frequent aspirations. 40ml of LA is flooded in the supraclavicular brachial plexus to provide nearly adequate anesthesia.

**Neurostimulation guided technique:**
Position of Patient: Supine/ semi-sitting (most preferred), or slight oblique position. Head facing away from the site to be blocked. Chin corresponding to the mid-clavicular line of the opposite site. Slight elevation of the head of the bed is often more comfortable for the patient and allows for better drainage and less prominence of the neck veins. The Anatomical Landmarks are: The base of the interscalene groove.

The Subclavian artery. 
Procedure: First palpate the cricoid cartilage and draw a line laterally up to the lateral margin of the clavicular head of sternocleidomastoid muscle. Around 1-1.5cm lateral to the clavicular head of sternocleidomastoid, the apex of interscalene triangle can be felt formed by scalenus anterior and scalenus medius muscle. By moving the finger from apex to base of interscalene triangle first we would palpate omohyoid muscle, it is felt as a cord like structure and on further moving down. Just below the omohyoid muscle, the subclavian artery pulsations are palpated at the base of interscalene groove. The thumb of non-dominant hand is placed upon the pulsations. Under all aseptic precautions, the skin wheal is raised with local anaesthetic.

Needle: A 22-25G, 5 cms, Stimuplex Needle direction: The needle is best inserted directing the needle tip posterolateral to the artery. Kindly remember the plexus is very superficial and you would get to the plexus within a depth of 1 cm. Target response: Flexion/extension of the fingers at current setting 0.3-0.5 mA. Total volume: A 30 ml (0.5 ml/kg) slowly for single shot block. Troubleshooting:
- Biceps contractions – needle too lateral (close to the divisions from the superior trunk)
- Pectoralis major contractions-needle too anterior
- Scapular movement-needle is too posterior to the plexus

Table 1: Various Approaches of Brachial Plexus

<table>
<thead>
<tr>
<th>Technique</th>
<th>Surgical Site</th>
<th>Supplementation required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interscalene</td>
<td>Shoulder, proximal arm</td>
<td>Intercostobrachial N, Superficial Cervical Plexus, Suprascapular N.</td>
</tr>
<tr>
<td>Supraclavicular</td>
<td>Distal to the shoulder</td>
<td>Ulnar N., Intercostobrachial N., Posterior cutaneous nerve of arm</td>
</tr>
<tr>
<td>Infraclavicular</td>
<td>Distal to the shoulder</td>
<td>Axillary/musculocutaneous N.</td>
</tr>
<tr>
<td>Axillary</td>
<td>Distal to the Elbow</td>
<td>Musculocutaneous N.</td>
</tr>
</tbody>
</table>

Figure 5. The Paraesthesia technique for supraclavicular block.

Figure 6: Position and anatomical landmarks for Subclavian Perivascular Block. Sternocleidomastoid – Orange; Blue –Interscalene groove; Red – Subclavian Artery; Yellow –Needle Insertion Site for SPVB; Green –Clavicle.

Figure 7: Note the linear contrast spread after obtaining a radial nerve response in the SPVB. (Contrast study by Sandeep Diwan )

Figure 8: The needle direction in the Subclavian Perivascular Brachial Plexus Block.
Complications:
Pneumothorax: The possibility of creating a pneumothorax is a concern when attempting supraclavicular block. The published incidence of pneumothorax by De Jong RH et al [5] varies between 1% and 4% using the classical supraclavicular approach and paraesthesia for nerve localization. Several alternative supraclavicular approaches have been described. One of them by Fortin G and Tremblay [6] using a short needle for brachial plexus block in an attempt to minimize the incidence of pneumothorax.
The subclavian perivascular approach has been shown in a large series by Fanelli G et al [7] to have an incidence of clinically significant pneumothorax less than the classical approach.
Cadaveric and volunteer MRI studies with modified approach to supraclavicular area showed that in no instance there was contact pleura and subclavian artery [8]. This is the famous plumc bob technique. Phrenic nerve block: This incidence is around 50% - 60% [9]. It causes hemiparalysis of the diaphragm. In patients without baseline pathologies of the respiratory system, this is not a significant problem. But in patients with potentially reduced function of the respiratory system, this block could be clinically dangerous. Hence it is suggested to administer low volumes of local anesthetic in SPVB [10].
The other associated possible complications are:
- Recurrent laryngeal nerve block.
- Horner's syndrome.
- Subclavian artery puncture.
- Haemothorax.

Clinical pearls:
Palpating the subclavian artery in its entirety in the base of the scalene groove and inserting the needle tip posterolateral to the artery brings the best results. It is a very superficial block and the needle should not be inserted more than 1 inch (2.5 cm) if plexus is not found.
The subclavian artery and the transverse cervical artery are the primary vascular puncture risks of this approach. Hence as a dictum we should aspirate after injecting 3ml aliquots.
Stimulation of the middle trunk indicated by the flexion of fingers is associated with higher success rates for hand surgery.

Is Subclavian Perivascular the “Spinal of Arm”?
An appropriate spinal anaesthesia with adequate volume of local anesthetic will provide a desired complete surgical anaesthesia. The subclavian perivascular block is also termed as “Spinal of Arm”. This is because a single injection in the compact supraclavicular area and subsequent deposition of local anaesthesia is claimed to provide a complete and reliable anaesthesia of upper extremity.
The extent of anaesthesia will depend on the volume and spread of anaesthetic solution.
To claim as a spinal anesthetic of the arm, a small volume of local anesthetic in the brachial plexus should have blocked all the elements of brachial plexus. Indeed as much as 30ml of local anesthetic is necessary in the supraclavicular area to produce an adequate brachial block. This can be compared more to an epidural anaesthesia as is also rightly mentioned by Winnie and Collins: “Henceforth, brachial plexus anaesthesia can be likened to peridural anesthesia, the axillary approach analogous to caudal and subclavian approach to lumbar epidural. Thus, as with peridural techniques a single injection is necessary and the extent of anesthesia depends on the volume of anesthetic solution” [3].
Just as the epidural has its missed segments so do the brachial plexus blocks. As suggested in the table 1 supplementation of few nerves are required which are inadequately blocked with subclavian perivascular approach (SPVB). Before comparing subclavian perivascular with spinal anaesthesia we need to know what is blocked and what is spared in this block also we should know the solutions to avoid sparing.
Harley and Gjessing [11] performed paraesthesia guided classical supraclavicular block with 25ml of LA. They assessed the following cutaneous nerves:
- Posterior cutaneous nerve of arm and circumflex - C5
- Musculocutaneous nerve - C6
- Posterior cutaneous nerve of forearm - C6

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>C6</td>
<td>Superficial radial nerve - C6,7</td>
</tr>
<tr>
<td></td>
<td>Median nerve - C7</td>
</tr>
<tr>
<td></td>
<td>Ulnar nerve - C8 T1</td>
</tr>
<tr>
<td></td>
<td>Medial cutaneous nerve of forearm - T1</td>
</tr>
<tr>
<td></td>
<td>Intercostobrachial nerve - T1,T2</td>
</tr>
</tbody>
</table>

Surprisingly the analysis of block revealed the sparing of dermatomes of the middle trunk (C 7), in the distribution of the median nerve.

In view to understand the extent of various approaches to brachial plexus the supraclavicular technique according to Kulenkampff and the subclavian perivascular technique according to Winnie result in almost identical extents of blockade [12]. They used 50ml of 0.5 % bupivacaine , almost twice the volume administered currently. Both techniques result in an even sensory and motor blockade of all nerves of the brachial plexus. The reasons for this pattern are the compact topography in which the trunks and cords are bundled closely together at the site of injection [12].

In the SPVB the trunks of the plexus, especially upper and middle and the sympathetic nerve supply to the upper limb are blocked adequately. The lower trunk may be missed in 5% of blocks. There is an ulnar sparing and needs a supplementation usually provided by a specific block in the axillary area.

Thus probably the subclavian perivascular block does not fulfill the qualities of a spinal anaesthesia due to sparing observed during single injection of LA.

Further to add to the inadequacies of the SPVB the following nerves are spared to some or the other extent:

- Intercostobrachial nerve: It arises from T2 and carries cutaneous sensations from the inner aspect of the arm. Separate infiltration is required to block this nerve for the shoulder and proximal arm surgery. It is blocked by depositing local anaesthetic solution subcutaneously in an inverted U shaped manner on either side of the axillary fold for about 2 inches.
- Posterior Cutaneous Nerve of Arm: It is the branch of radial nerve arising in axilla and giving sensory innervation to the posterior arm. There is overlapping dermatomal innervation over the posterior aspect of the arm by posterior
cutaneous nerve of arm, cutaneous branch of axillary nerve, and branches from T1 and T2. The surgery involving distal humerus or elbow requires an additional infiltration “T” shaped manner starting from tip of elbow to mid arm.

Supraventricular nerves: These are branches of superficial cervical plexus which are needed to be blocked especially when SPVB is administered for the surgeries involving shoulder, proximal humerus, clavicle or the supraventricular area.

Suprascapular Nerve: It is branch of upper trunk of brachial plexus which supplies posterior aspect of shoulder joint. As depicted in the image (Fig. 2) it leaves the brachial plexus sheath at much higher level and will be missed during a SPVB. A separate injection is required to block this nerve in surgeries involving posterior aspect of shoulder.

SPVB reported a 85% success rate with supplementation in 8 patients in a total of 160 cases posted for various hand plastic surgeries. The SPVB was administered by paraesthesia technique without complications and the authors claimed it is the choice for upper limb surgeries [13]. The paraesthesia technique should be obsolete now with the availability of the nerve stimulation and ultrasound units.

For several years and even now many believe that the only way to find a nerve was to contact the nerve and produce paraesthesia. This paved the famous apomorphism “No paraesthesia, No Anesthesia [14].”

Subsequently animal studies by Selander [15] raised the possibility of paraesthesia techniques leading to nerve damage. With neurostimulation a mixed nerve is stimulated by an electrical current, the motor fibers are depolarized by a lower current than the sensory fibers, which allows the anesthesiologist to obtain a visible muscle contraction without eliciting a paraesthesia [16].

Carlo Franco and Zairo EG [17] demonstrated in 1001 patients the effectiveness of the neurostimulation guided SPVB. They employed the Winnies technique. Of the 1001 SPVB, 97.2% were completely successful; 1.6% were incomplete and needed supplementation; and 12 blocks 1.2% failed and required general anesthesia, giving a success rate for regional anesthesia of 98.8%. The authors claim that the SPVB provides adequate surgical anesthesia defined as “those blocks in which all dermatomes (C5 to T1) had been anesthetized, regardless of the surgical site.” Thus they excluded the spared dermatomes which did not require supplementation. Carlo Franco attribute their success to the topographical arrangement of the supraventricular area where the brachial plexus is reduced to the smallest component requiring a low volume LA.

Winnie et al [18] concluded the technical and mechanical factors utilized to improve the flow of the injected local anesthetic agent within the sheath in the desired direction have a profound effect upon the success achieved.

Thus separate injections are required to block the nerves mentioned above but the lower trunk sparing can be overcome by following techniques:

1) By increasing the volume of local anesthetic agent.
2) An ultrasound “Corner pocket injection” and a
3) 3-Quadrant injection

Sparing versus Volume of Drug:
Most of the time the sparing observed is volume dependent.

The possible explanations for the lower trunk or ulnar sparing are as follows:

It is commonly observed that the C8-T1 (lower trunk) lies below the Subclavian artery (SA) (Fig. 4). Thus the lower trunk –divisions are separated from middle and superior trunks. LA injected in the supraventricular fossa is unable to reach and soak the lower trunk due to physical barrier created by SA, which leads to patchy block or sparing of lower trunk.

A study [19] confirmed that the minimum volume required for US-guided supraventricular block in 50% of patients was 23 mL, and in 95% of patients was 42 mL. Thus the calculated volume of LA required for US-guided supraventricular block does not seem to differ from the conventionally recommended volume required for supraventricular blocks using non-US-based nerve localization techniques.

The Ultrasound SPVB:
Ultrasound guided SPVB [20] has rejuvenated and rekindled the lost hope in supraventricular blocks. The “Eight Ball Corner Pocket” Technique was popularised by Soares L G et al [22]. This technique involves local anaesthetic injection without concomitant nerve stimulation in the pocket bordered inferiorly by the first rib and medially by the subclavian artery. It has been observed that corner pocket injections produce a reliable, rapid onset block within minutes. Fredrickson M J [23] et al observed a complete sensory blockade in all four nerve territories at 30 min was achieved in 57% in group supraventricular and 70% in group infraclavicular blocks. In the supraventricular group, 9 / 11 failures were due to incomplete ulnar nerve territory anesthesia. Thus even an injection in the corner pocket fails to block the ulnar nerve!

The “3-Quadrant injection” Technique:
The ultrasound guidance provides visualization of the important structures like the subclavian artery and the pleura. The brachial plexus divisions are well delineated and if scanned from trunks to the divisions, it can be clearly visualised the superior, middle and the inferior trunks dividing into respective divisions. These authors perform the three quadrant technique on a daily basis.

Initially the corner pocket is targeted and after evoked responses of the inferior trunk 10ml LA is injected. This is followed by the intraplexus injection and lastly the superolateral aspect of the brachial plexus. A total 22-25ml of 0.5% bupivacaine is sufficient to soak the brachial plexus. As shown in ultrasound image (Fig. 8), for meticulously separation of plexus around the subclavian artery the drug should be injected in all quadrants like upper quadrant corresponds to upper trunk area, middle quadrant corresponds to middle trunk area and lower quadrant corresponds to lower trunk area which lies in the corner pocket as shown in ultrasound image (Fig 8).

This author
Figure 8: 3 Quadrants around the subclavian artery and the corner pocket.
Sandeep Diwan, Sancheti Hospital, Pune.
Corner Pocket – dark yellow; L.A – Light blue

Balvenkatsubramaniam et al observed that a single 3.75 mg/kg injection of ropivacaine 7.5 mg/ml injected in the supraclavicular approach produced higher peak plasma concentrations of local anaesthetic than the infraclavicular approach. They also make an important statement that on average, initial signs of systemic local anaesthetic toxicity may occur approximately 12 min earlier following a supraclavicular approach. Finally they caution to decrease the dose of local anaesthetic for the supraclavicular approaches.

Conclusion:
All the surgeries around shoulder, proximal and distal humerus require additional supplementation to block spared cutaneous area as discussed before. The SPVB was claimed to be the “Spinal of Arm”. But as mentioned earlier additional supplementation blocks are required depending upon the site of surgery. As many as 4 single nerves may need to be blocked depending on sparing in the related dermatomes, apart from the possible sparing of the lower trunk –divisions.
So instead of calling it as “Spinal of Arm”, the term “Epidural of the Arm” seems to be more appropriate.

References
13. Ravindra Bhat, S Raja Sabhapathy and Dinesh Kumar Shetty. Subclavian Perivascular Approach for Brachial Plexus Block in upper extremity surgery.


Conflict of Interest: Nil
Source of Support: None

How to Cite this Article