Original Article

Single-point versus double-point injection technique of ultrasound-guided supraclavicular block: A randomized controlled study

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Abstract

Background and Aims: This study aims to compare the single-point injection and double-point injection technique of ultrasound-guided supraclavicular block with regard to the success rate, time taken to perform the procedure, onset and duration of sensory and motor block, and complications.

Material and Methods: A total of 60 American Society of Anesthesiologists physical status I and II patients between 20 and 50 years of age, with body mass index ≤30 kg/m^2 posted for forearm surgeries, with anticipated surgical duration more than 1 h were randomly divided into two groups: group S (single-point injection) and group D (double-point injection technique). After locating the brachial plexus with ultrasound, needle was inserted from lateral to medial direction to reach the plexus. In group D, 20 ml of inj. bupivacaine 0.5% was deposited as 10 ml each in superior (in the cluster) and inferior pocket (corner pocket) between the plexus and subclavian artery with the help of hydrodissection while in group S the total 20 ml was deposited in the superior (in the cluster) pocket. The onset of sensory and motor block was assessed using pin prick method and modified Bromage scale. Adequacy of block was ensured by assessing the ulnar, radial, and median nerve distribution. Procedural time was defined from the point of scanning the plexus till the drug was injected completely. Total sensory, motor duration, and complications if any were noted.

Results: Group D had higher success rate compared to group S (96.7 vs. 83.3%; $P < 0.0001$). The total procedural time was significantly more in group D compared to group S (14.6 ± 2.7 vs. 10.1 ± 1.7 min; $P < 0.0001$). The onset of sensory and motor block was faster and the duration of sensory and motor block was significantly longer in group D.

Conclusion: The adequacy of block, sensory, and motor duration was significantly high in newer double-point injection technique. However, it requires longer procedural time compared to single-point injection technique.

Keywords: Brachial plexus block, bupivacaine, subclavian artery, ulnar nerve, ultrasonography

Introduction

Supraclavicular block is the most commonly performed brachial plexus block to provide surgical anesthesia in a majority of upper limb surgeries. Brachial plexus is tightly organized as a cluster at the point of administration of supraclavicular approach that results in faster onset and dense block.[1,2]

While performing the regional nerve blocks under ultrasonography (USG), the operator has the advantage of real-time visualization of the trajectory of the needle, avoiding

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injury to adjacent vital structures, ensuring site of deposition of drug and its spread, and avoiding intraneural injection.[3] It is hoped that USG will reduce the failure rate of supraclavicular block. The conventional one-point injection technique required deposition of local anesthetic near the plexus, but it mostly ended up in ulnar sparing, thus resulting in an incomplete block. "Eight ball corner pocket technique"[4] involving the deposition of local anesthetic solution in the pocket formed by subclavian artery laterally and first rib inferiorly resulted in faster onset. However, this technique also achieved successful blockade of ulnar nerve in only 85% of the cases.[5] In supraclavicular block, the target structures are trunks which are organized as a cluster posteromedial to subclavian artery. The ulnar nerve is commonly spared as the inferior trunk lies medially, and medially-directed needle carries a high risk of pneumothorax.[6,7]

Therefore, we hypothesized that double-point injection technique of supraclavicular block incorporating the "eight ball corner technique" along with hydrolocation/hydrodissection using lower volumes of local anesthetic solution will increase the success and safety of the block compared to single-point injection.

Material and Methods

This prospective randomized control led study was carried out in a tertiary care teaching institution after obtaining approval from the Institutional Ethics Committee. Written informed consent was obtained from all the patients after explaining the objective of the study, the two techniques of the procedure and the complications related of each technique.

Sixty American Society of Anesthesiologists (ASA) physical status I and II patients between 20 and 50 years of age of either sex, body mass index (BMI) ≤30 kg/m^2, posted for elective forearm orthopedic surgery in supine position of more than 1 h duration were included in the study.

We excluded patients with psychological disorders, coagulopathies, known allergy to local anesthetics, infection at the puncture site, neuropathy, nerve injury, and opioid dependence from our study.

The patients were divided into two groups, groups D (double-point injection technique) and S (single-point injection technique) with the help of computer-generated random number table. Subsequently, the number slips were placed in opaque sealed envelopes. The final group allocation was performed just before the procedure by opening the envelope by the staff nurse present. The anesthetist who assesses and records the study parameters is blinded to group allocation.

All patients underwent a thorough preoperative examination and were kept nil per oral as per the standard ASA guidelines. The night before surgery, anxiolysis was done with alprazolam 0.5 mg orally. On the day of surgery, written anesthesia consent was obtained and the patient was explained the method of assessment of sensory (pin prick method) and motor (modified Bromage scale) blockade. In the preoperative area after documenting the baseline vitals, an intravenous cannula was secured in the nonoperating hand and ringer lactate/normal saline was started. The patient was shifted to the operating room, placed supine, and standard ASA monitors (electrocardiography, pulse oximeter, noninvasive blood pressure) were applied. Oxygen was administered via facemask. All patients were premedicated with intravenous midazolam 0.02–0.04 mg/kg and fentanyl 1–2 μg/kg, titrated to ensure that the patient remained calm but responsive to verbal commands before the procedure. All precautions were taken to ensure proper asepsis. All essential materials and equipments were arranged on a sterile trolley.

For performing the block, the USG screen, transducer, and the sterile trolley were arranged on the side to be blocked so that all were in the view of the operator. A single experienced anesthesiologist routinely performing USG-guided upper limb blocks in the operation theatre performed all the blocks. Optimization of the USG variables such as scanning mode, depth of field, and gain were done before the start of the procedure. At the time of block the patient was asked to turn the head slightly (45°) away from the side to be blocked. The arm to be blocked was kept adducted and the hand was rested upon the abdomen for the comfort of the patient. Sterile painting and draping were done. Sterile sheath was applied over USG transducer (7–10 MHz) and sterile gel was used as a medium between the transducer and the skin. The transducer was moved from cephalic to caudal direction toward the supraclavicular fossa to bring subclavian vessels to the center of the screen and then moved laterally to the point where the plexus can be located lateral to the artery. All other anatomical landmarks such as the first rib and pleura were identified [Figure 1]. A 20G 90 mm spinal needle was inserted 1–2 cm lateral to the transducer and directed in plane (lateral to medial) toward the plexus while visualizing the needle on USG in real-time.

In group S, when the needle reached the plexus, i.e., 11 o'clock position with respect to the subclavian artery, 20 ml of 0.5% bupivacaine was injected after piercing the nerve sheath following repeated aspiration and the spread of drug was noted around the plexus.

In group D, initially the needle was passed between the artery and plexus. To avoid injury to these structure,

hydrolocation/hydrodissection[5] with 0.5–1 ml of normal saline was done, which not only provided space for the needle but also increased the acoustic mismatch which resulted in better visualization of the needle tip. Once the needle reached the corner pocket formed by the subclavian artery and first rib, 10 ml of 0.5% bupivacaine was injected with repeated aspiration [Figure 2]. The needle was then slowly withdrawn and remaining 10 ml of 0.5% bupivacaine was deposited as in group S.

The primary outcome of our study was the rate of successful block using the two techniques. The secondary outcomes were the total procedural time, onset and duration of motor and sensory block, and incidence of complications.

The block was considered successful if analgesia was attained in the dermatomes supplied by the radial, ulnar, median, and musculocutaneous nerves. The block was incomplete if any of these dermatomes did not have analgesia after 30 min of drug injection. In such a situation, the patient was administered sedation with intravenous midazolam 0.02 mg/kg and fentanyl 1 μg/kg. If more than two nerves were spared from the action of local anesthetic, it was considered to be a failed block and general anesthesia was administered to the patient and the patient was excluded from the statistical analysis. The surgery was started after achieving successful block or waiting for 30 min, whichever was early.

The time to perform the block was defined as the total time taken from imaging the brachial plexus till the removal of needle after deposition of drug. The sensory block was evaluated by pin prick (23G needle) in the dermatomes innervated by median, ulnar, radial, and axillary nerves. every 30 s for the first 3 min, every 1 minute till the first 10 min and then every 2 min till 30 min or the required effect was attained, whichever was early. The onset of sensory block was defined as decreased sensation to pin prick (grade 1) in dermatome supplied by any of the nerves. Sensory block was graded as:

- Grade 0: Sharp sensation to pin prick
- Grade 1: Analgesia, dull sensation to pin prick
- Grade 2: Anesthesia, no sensation to pin prick.

Total duration of sensory block was the time from which the patient attained numerical rating scale (NRS) of 0/10 or sensory block of grade 2 up to recovery of NRS to 3/10 postoperatively.

The motor block was evaluated every 30 s using modified Bromage scale.[8]
The onset of the motor block was defined as the time from the drug injection to attainment of Bromage scale 1.

Total duration of motor block was considered from attainment of Bromage scale 2 till the return of Bromage scale 0.

All patients were observed for any complication (paresthesia, pneumothorax, arterial puncture, local anesthetic toxicity) in the intraoperative and postoperative period.

Statistical analysis

The primary outcome of our study was the success rate of double-point injection compared to single-point injection technique of ultrasound-guided supraclavicular block. In the previous study conducted by Choi *et al.*,[9] double-point injection technique of ultrasound-guided supraclavicular block increased the rate of success to 94% compared to 67% by single-point injection technique. In our study, we used

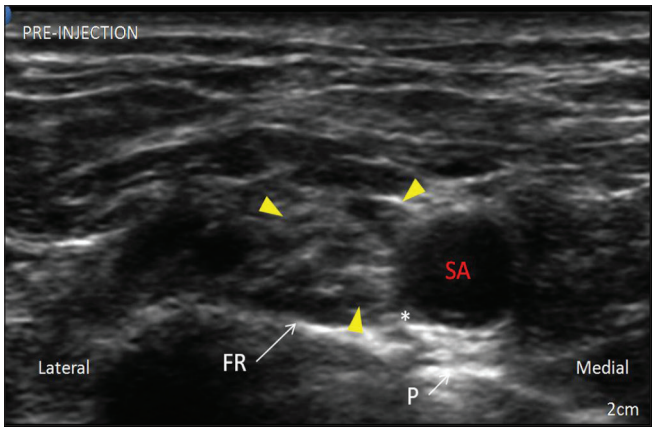


Figure 1: View on the USG screen before injection of local anesthetic drug. Brachial plexus = *yellow arrows*. FR = first rib, SA = subclavian artery, *P* = pleura, * = corner pocket

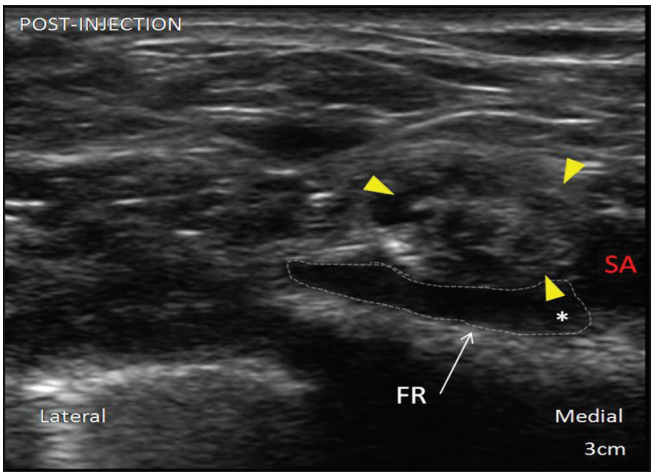


Figure 2: Postanesthetic injection: Right supraclavicular brachial plexus (*yellow arrows*). Local anesthetic (*dashed lines*) had been deposited in corner pocket (*). Note the nerves now appeared to be floating on the injected anesthetic drug. FR = first rib, SA = subclavian artery

a lower drug volume and a combination of corner pocket technique and hydrodissection. We assumed that these two changes in our study design would have significant effect on the success rate of the block. Based on this, in order to have power of study of 80% and type 1 error < 0.05 in our study, 26 patients would be required in each study group. Considering the probability of loss of some patients during follow-up, we took 30 patients in each study group. The data were analyzed using Statistical Package for Social Sciences, version 20. Quantitative data (procedural time, onset and duration of sensory and motor block, and complications) were compared using Wilcoxon rank-sum test, and qualitative data (success rate of block) were compared using Fisher's exact test. Significance level was taken as P value <0.05.

Results

The flow of the patients enrolled in the study is represented in the CONSORT-flow diagram [Figure 3]. A total of 60 patients fulfilling the inclusion criteria participated in the study. The demographic profile (age, sex, weight, height, BMI) of the two groups was compared [Table 1]. The time taken to perform the block was longer in group D, $P < 0.0001$ [Graph 1]. The success rate of block was significantly high in group D than in group S (96.6% vs. 83.3%), $P < 0.0001$ [Graph 2]. One patient in group D and five in group S had incomplete block because of ulnar sparing. There was no failed block in either of the two groups. The onset of sensory block was faster in group D with a significantly longer duration of sensory block compared to group S, $P < 0.0001$ [Table 2]. The onset of motor block was significantly faster in group D with prolonged motor block duration compared to group S, $P < 0.0001$ [Table 3].

No complications were observed in either of the two groups.

Discussion

We found double-point injection technique to have higher rate of success compared to single-point injection technique of ultrasound-guided brachial plexus block. The major advantage of ultrasound is the real-time visualization of the exact site of deposition of local anesthetic agent that increases the possibility of successful block.[3] However, in spite of USG guidance, the rate of success of blocks is not 100%. Other than expertise of the operator, there are certain anatomical factors which may result in unsuccessful or failed block.[10] Ulnar sparing is the most common problem faced during supraclavicular block that results in incomplete or partial block.[11] Subramanyam *et al.*[12] found slower rate of onset of ulnar blockade, and ulnar sparing remains a concern with supraclavicular block. This may result from apprehension of the operator in correct placement of needle tip for the anticipated complication of pneumothorax. This newer double-point injection technique of supraclavicular block aims to prevent ulnar sparing and increases the success rate of the block.

There have been studies[13-15] where double-point injection technique has been used for ultrasound-guided supraclavicular block. However they studied limited parameters in the two approaches, unlike our study where we tried to include all the relevant parameters. Moreover, previous studies had certain

Table 1: Demographic profile

Parameter	Group S	Group D	*P*
Age	40.2±12.7	43.7±13.0	0.132
Sex (M:F)	15/15	15/15	1.000
Height	161±48.4	163±50.2	0.823
Weight	56.43±8.7	59.02±9.2	0.152
BMI	22.73±5.7	23.17±6.2	0.682

Table 2: Sensory characteristics

Parameter	Group S	Group D	*P*
Onset of sensory block (mins)	10.6±2.7	7.0±1.5	<0.0001
Duration of sensory block (mins)	134.4±31.2	171.4±40.1	

Table 3: Motor characteristics

Parameter	Group S	Group D	*P*
Onset of motor block (mins)	14.9±3.1	11.1±2.8	<0.0001
Duration of motor block (mins)	101.4±27.6	134.1±36.7	

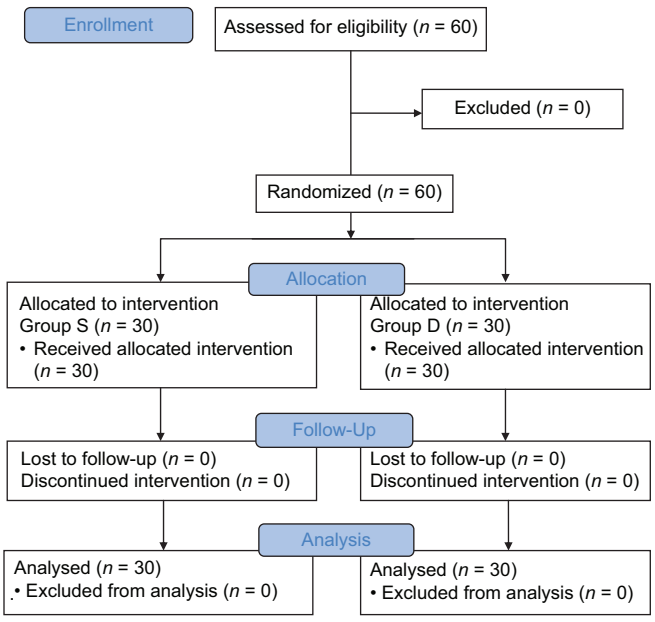
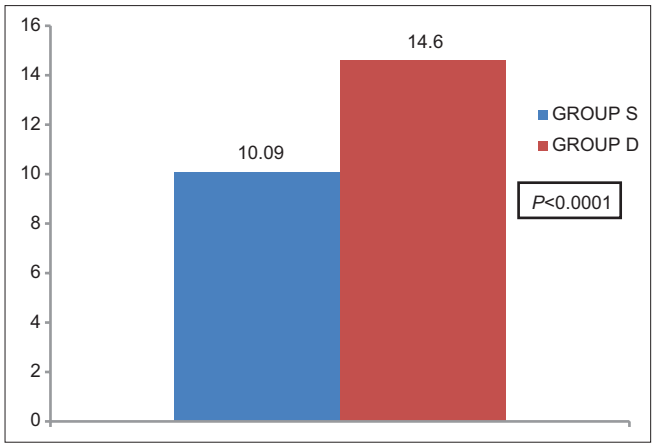
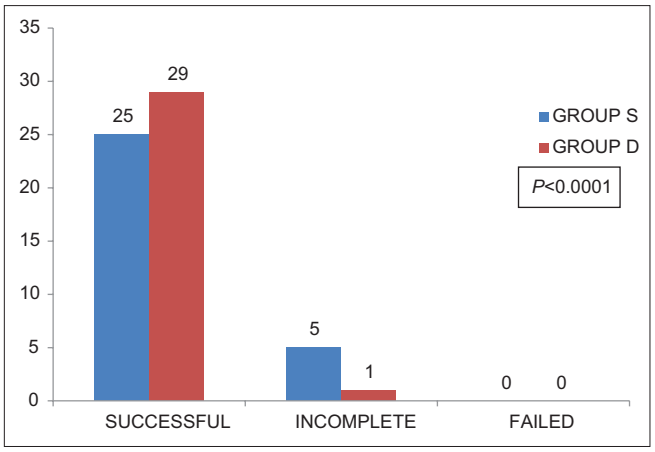


Figure 3: CONSORT diagram showing the division of patients at every stage of randomized control trial



Graph 1: Time taken to perform the block (min)



Graph 2: Adequacy of block

shortcomings in their study design which we tried to overcome in our study by incorporating all the techniques which can improve the success rate of the block.

In our present study we incorporated the "eight ball corner pocket"[4] in two-point injection technique using the hydrodissection for safe and correct placement of needle using lower volume of anesthetic solution, which was not used in the previous studies.

There are septate barriers around the plexus that prevent the uniform spread of the drug and may also result in an incomplete block.[10] The injected local anesthetic preferentially spreads to areas of low resistance and may not necessarily reach all the nerves of the brachial plexus in a sufficient quantity to produce effective blockade. In the study by Roy *et al.*,[16] the complete sensory block after 15 min of drug deposition was 49 and 53%, and the overall success rate was 76 and 90% by single- and double-point injection technique, respectively, which was not statistically significant. Tran *et al.*[13] and Wallaya *et al.*[17] also found similar success rates between the two techniques which may be attributed to the higher volume (30–35 ml) of local anesthetics used in their study.

Tran *et al.*[18] concluded that 32 ml of 1.5% lidocaine with 5 μg/ml epinephrine was the minimum volume of local anesthetic required for successful ultrasound-guided supraclavicular block. We can suggest that one should take the full advantage of site-specific deposition of local anesthetic solution with the use of ultrasound, thus reducing the overall dose of the drugs and its overall adverse effects. We limited the dose to only 20 ml of 0.5% bupivacaine, which is less than the minimum effective dose suggested by Tran *et al.*[18] and obtained favorable results emphasizing the role of correct deposition of local anesthetic solution in a successful block. We limited our drug volume to 20 ml based on the study by Vazen *et al.*[19]

Our total procedural time was significantly longer in double injection technique. However it was not clinically significant. There were two reasons for longer procedural time in group D. First, more needle manipulation and redirection were required. Secondly, in some patients, we had to use the hydrodissection technique to construct the path between the plexus for reaching the corner pocket. These results were comparable to previous studies.[13,17]

In our study, the onset of sensory and motor block was significantly faster in the double-point injection technique. Tran *et al.*[13] had similar results, while Sayed *et al.*[14] and Choi *et al.*[8] did not find any difference. In addition, the double-point injection technique significantly prolonged the total duration of sensory and motor block. The reason for longer duration of block could be an even distribution and systemic absorption of the local anesthetic solution. Sayed *et al.*[14] found no difference in the total duration of sensory and motor block.

There was no complication in either of the two groups. Sayed *et al.*[14] and Roy *et al.*[16] found higher incidence of paresthesia with double-point injection technique. In our methodology we included the technique of hydrodissection that prevents the needle tip from injuring either the plexus or vessel. Also the increased acoustic mismatch that helps in better visualization of needle to prevent any complication.

The major limitation in our study was the small sample size. Also, the double-point injection and hydrodissection techniques had its own learning curve which may have affected the procedural time taken in the said group.

Conclusion

Double-point injection with integration of corner pocket technique of ultrasound-guided supraclavicular block increases

the success rate with faster onset and longer duration of sensory and motor blockade compared to single-point injection technique. Furthermore, the art of skillful hydrodissection in double-point injection technique helps in needle maneuvering with decreased rate of complications. Hence further studies on ultrasound-guided double-point injection technique may establish it as the gold standard for optimal block.

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Nil.

Conflicts of interest
There are no conflicts of interest.

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