

# A RANDOMISED COMPARATIVE STUDY BETWEEN SINGLE INJECTION AND SINGLE NEEDLE PASS DOUBLE INJECTION TECHNIQUE IN ULTRASOUND GUIDED SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK

PRATAP R MAHANTY,<sup>1</sup> BHANU P SWAIN,<sup>2</sup>  
MANEESHA MRIGANK<sup>2</sup> AND AMLAN SWAIN<sup>3</sup>

## Abstract

**Background:** Consensus is lacking regarding the finer points of drug injection in ultrasound guided supraclavicular brachial plexus block. Single and multiple injection techniques have been investigated and they have demonstrated their own set of advantages and disadvantages.

**Objective:** This prospective observer blinded study compared the single corner pocket injection technique with single needle pass 2-injection technique.

**Methodology:** Hundred patients planned for upper limb surgery were randomly allocated in to one of two groups (Group S and group D). In group S, 30 ml of the drug (0.5% ropivacaine) was injected in the corner pocket formed by the junction of 1st rib and subclavian artery. In group D 10 ml of drug was injected in corner pocket and remaining 20 ml in the centre of the plexus. The primary objective was to find out the block onset time. The secondary objectives were percentage of surgical anesthesia, procedure time, duration of block, incidence of procedure related paraesthesia and Horner's syndrome. Fisher Exact test and Z-test were used for statistical analysis.

**Results:** In group D, block onset was quicker ( $18.5 \pm 5.08$  vs.  $25.33 \pm 3.27$  min;  $p < 0.001$ ) and procedure time was longer ( $9.12 \pm 1.92$  vs.  $8.36 \pm 1.86$  min;  $p = 0.047$ ). All patients in group D achieved surgical anesthesia, compared to 94% in group S. There was no difference in the incidence of paraesthesia and Horner's syndrome.

**Conclusion:** This single needle pass 2-injection technique ensures faster onset and more successful block as compared to single injection technique in ultrasound guided supraclavicular brachial plexus block.

**Clinical trial number:** Clinical Trial Registry-India-CTRI/2018/01/011076

**Keywords:** Ultrasound, Block, Brachial plexus, Paraesthesia, Horner's syndrome.

1 MD, Department of Anesthesia Tata Main Hospital.

2 DNB, Department of Anesthesia Tata Main Hospital.

3 DM, Department of Anesthesia Tata Main Hospital.

Corresponding Author: Dr Bhanu Pratap Swain, Address: Department of Anesthesia, Tata Main Hospital C Road West, Northern Town, Bistupur, Jamshedpur, Jharkhand 831001. Phone number: 06576641166, Facsimile number: +916572224559. E-mail address: bhanu.swain@tatasteel.com

## Introduction

Ultrasound has radically improved accuracy, effectiveness and patient safety in supraclavicular brachial plexus block (SCBPB) by allowing real time visualisation of nerve plexus, needle position, and the surrounding structures.<sup>1</sup> However, there is lack of consensus regarding injection technique and needle placement in ultrasound guided SCBPB despite a significant quantum of research in this field. Single as well as multiple injection techniques have been described. Available evidence suggests that single injection of local anesthetics in the corner pocket formed by the intersection between subclavian artery and the first rib results in effective surgical anesthesia.<sup>2,3,4</sup> Studies comparing multiple injection techniques with the single injection technique in ultrasound guided SCBPB have reported similar efficacy.<sup>5,6,7</sup> It is pertinent to note that each of these techniques have their own advantages and disadvantages. The single injection technique requires less needle manipulation, has an acceptable success rate but may result in delayed onsets and occasionally incomplete block.<sup>8</sup> Multiple injection techniques provide faster onset of block; however, they necessitate multiple needle manipulations, resulting in increased procedure time and patient discomfort.<sup>9</sup>

In our centre, whereas the single injection modality is more commonly practiced, regional anesthesia practitioners have always felt the need of a technique that would combine the benefits of single as well as multiple injections with the aim of ensuring a quicker onset and complete block with minimal needle manipulation. We devised a ultrasound guided SCBPB injection technique wherein drug was administered at two locations in the brachial plexus whilst employing a single needle pass. We hypothesised that our 2-injection technique would enable faster onsets and complete block of brachial plexus in comparison to the single injection technique.

## Methods

After obtaining institutional ethics committee approval we conducted this study in 100 consenting patients of ASA grade 1-3 of either sex, between the age of 17-70 years. Patients scheduled for elective

surgery on upper extremity below mid-humerus were selected. Uncooperative patients, patients with known neurological disorder or pre-existing neurological deficits in the operative limb, patients having history of allergy to ropivacaine, presence of infection at the site of injection, obese patients (BMI >35 kg/m<sup>2</sup>), patients having severe coagulopathy and patients with severe pulmonary disease or having poor respiratory reserve were excluded from the study.

Randomization was carried out by a computerized random number generator and group allocation of patients was done by a person not involved in the study via sealed opaque envelope. There were two groups: a single needle pass two injections group (Group D; n = 50) and a single corner pocket injection group (S; n = 50). In the operation theatre after attachment of standard ASA monitors and securing of intravenous cannula, all patients were positioned supine with head resting on a ring, taking care to keep their ipsilateral arm adducted and shoulder depressed. A roller pack was placed in between the scapulae and the patients were instructed to turn the head slightly towards contralateral side of injection for better exposure of neck. In all patients, full asepsis at the site of injection was achieved. This was followed by placement of linear high frequency ultrasound probe covered with a sterile transparent cover (SIEMENS ACUSON X 300 ultrasound machine) in the supraclavicular fossa with subsequent manipulation to obtain an optimal ultrasound image of the subclavian artery in the rounded transverse view superficial to the 1st rib and the brachial plexus just cephalad and posterolaterally to the subclavian artery. Locoplex (Vygon) 50 mm nerve block needle and peripheral nerve stimulator (Plexygon, Vygon) was used for all the procedures.

In both groups the needle was introduced from lateral to medial in plane with the ultrasound probe after infiltrating the skin with 1 ml of 2% of lignocaine. In Group D, the needle was initially positioned in the corner pocket formed by the junction of subclavian artery and 1st rib (Imaginary 5 O' clock or 7 O' clock position of artery) by passing through the neural cluster and 10 ml of 0.5% ropivacaine was injected after excluding intravascular needle placement by negative aspiration of blood. The needle was then withdrawn and 20 ml of 0.5% ropivacaine was injected in the

centre of the neural cluster. In group S, a total of 30 ml of Ropivacaine 0.5% was injected in the corner pocket. To prevent intraneural injection, drug injection was avoided when evoked motor response was obtained at current <0.2 mA or there was severe pain or high pressure (subjective) during injection. All the blocks were performed by a single anesthesiologist (BPS) well versed in ultrasound guided regional anesthesia. A 2nd anesthesiologist (PRM), monitored the total procedure related time, which includes both imaging and block performance time. The imaging time was defined as the time taken for getting an acceptable image of brachial plexus after placing the ultrasound probe on the patient. The performance time was defined as the time of insertion of needle through the skin till the needle was taken out after deposition of drug. Procedure related paraesthesia, complications like vascular puncture, hematoma formation, pneumothorax, and Horner's syndrome were recorded.

After the performance of the block, a blinded observer (MM) evaluated the sensory and motor block every 5 minutes till 30 minutes. Sensory block was evaluated by observing reduction in perceiving cold sensation to alcohol swab on the fifth finger (ulnar nerve), palmar aspect of second finger (median nerve), dorsum of the hand between thumb and second finger (radial nerve), and lateral aspect of forearm (musculocutaneous nerve) according to a 3-point scale (0 = no block, 1 = no cold sensation but can feel touch, 2 = patient cannot feel touch). Similarly, motor block was assessed by a 3-point scale (0 = no block, 1 = paresis, 2 = paralysis). Motor block of musculocutaneous, radial, median and ulnar nerves were assessed by elbow flexion, thumb abduction, thumb opposition and thumb adduction respectively. Onset of sensory block in each nerve was defined as time required to achieve complete loss of sensation (score = 2) in the respective area innervated by the nerve. Onset of motor block in each nerve was defined as the time required to achieve complete loss of movement (score = 2) in the respective muscle groups innervated by the nerve. Onset time was defined as the time required in obtaining a score of 14 out of maximal composite score of 16 (complete sensory and motor block of all 4 nerves). In patients who did not achieve a score of 14 at the end of 30 min, the onset time was not recorded. If the surgery was successfully conducted without

the need of general anesthesia, rescue blocks or local infiltration, it was recorded under surgical anesthesia. The block was labelled as failure where the patient required supplemental anesthesia.

After the end of the surgery when patient arrived in the postoperative ward, offset of sensory and motor blocks were assessed every 30 min in the same manner as done in the preoperative period. Duration of sensory block was defined as the time elapsed from onset of sensory block to complete recovery of sensation to touch in distribution of all four nerves (score 0). Similarly, duration of motor block was defined as the time elapsed from onset of motor block to complete recovery of motor movement in all muscle groups (score 0). In the post-operative period, the VAS was monitored every hour and rescue analgesia in the form of injection of fentanyl 1mcg/kg intravenously was administered once VAS was observed to be more than 3 or patient complained of pain. Duration of analgesia was defined as the time from the onset of complete block till the patient requires rescue analgesia for the first time.

The primary outcome of our study was the block onset time. The secondary outcome measures were the procedure time, percentage of surgical anesthesia, incidence of paraesthesia, Horner's syndrome and duration of block.

### *Statistical analysis*

Block onset time was used to calculate sample size. In a pilot study done on 10 subjects we found the average block onset time in single corner pocket injection technique to be  $28.4 \pm 7.6$  minutes. As per the hypothesis of the study, we considered a decrease of 30% (8.52 minutes) in the onset time using 2-injection technique to be clinically significant. Thus, considering alpha error of 2.5% and power of study as 90%, a total sample size calculated as 80 with 40 in each group. Since block onset time can only be calculated in patients who would achieve the composite score of 14 in 30 minutes and we expected approximately 80% of patients (based on pilot study) to get this score, we increased the sample size to 100 patients with 50 in each group to accommodate patients who wouldn't achieve the score of 14 in 30 minutes.

Table 1  
Patient Demographics

Parameters	Single Injection (n = 50)	Two Injection (n = 50)	P value
Age in years (Mean ± SD)	40.56 ± 15.56	42.62 ± 17.30	0.53
Sex (F/M)	21/29	17/33	0.41
BMI (mean ± SD)	28.63 ± 3.60	28.41 ± 3.55	0.76
Surgical site (Elbow/Forearm/Wrist/Hand)	21/24/0/5	13/24/4/19	0.135
ASA (I/II/III)	29/21/0	28/17/5	0.066

The collected data was organised, tabulated and statistically analysed using “MedClac software version 17.2” (MedCalc Software bvba, Ostend, Belgium). Numerical data and categorical data were expressed as mean ± standard deviation, and relative frequency or percentage respectively. The “Fisher Exact test” was used to compare categorical data while the “Z-test” was used to test the significance for difference of proportions between the two groups of patients. P value <0.05 was considered statistically significant.

## Results

There were no differences in demographic

parameters and surgical procedures between the two groups (Table 1). The 2-injection technique achieved significantly a shorter onset time ( $18.5 \pm 5.08$  min vs.  $25.33 \pm 3.27$  min;  $P < 0.001$ ) (Table 2). At 20 minutes of block performance, 80% of patients in the 2-injection group achieved the target minimal composite score of 14 points (block onset) as compared to 16% in single injection group (Figure 1). At 30 minutes, all patients in the 2-injection group achieved a score of 14 as compared to 90% patients in single injection group (Figure 1). The performance of 2-injection technique took relatively longer time ( $8.36 \pm 1.86$  min vs.  $9.12 \pm 1.92$  min;  $p = 0.047$ ). In the 2-injection group a 100% block success was achieved, whereas 6% cases in

Table 2  
Procedure related Data

	Single Injection (n = 50)	Two injection (n = 50)	p-value
Onset time (minutes) (Mean ± SD)	25.33 ± 3.27	18.5 ± 5.08	<0.001
Performance time (minutes) (Mean ± SD)	8.36 ± 1.86	9.12 ± 1.92	0.047
% of patients achieving composite score of 14	45 (90)	50 (100)	0.056
Surgical anesthesia, n (%)	47 (94)	50 (100)	0.242
Failure rate, n (%)	3 (6)	0	0.242
Incidence of paresthesia, n (%)	12 (24)	14 (28)	0.648
Incidence of Horner's syndrome, n (%)	2 (4)	4 (8)	0.678
Duration of sensory (minutes) (Mean ± SD)	541.49 ± 137.67	554.80 ± 88.98	0.576
Duration of motors (minutes) (Mean ± SD)	490.64 ± 139.22	495.40 ± 87.91	0.842
Duration of Analgesia (minutes) (Mean ± SD)	602.98 ± 144.95	625.50 ± 91.53	0.366

Fig. 1  
Percentage of patients with composite score of 14 according to time; \*  $p < 0.05$

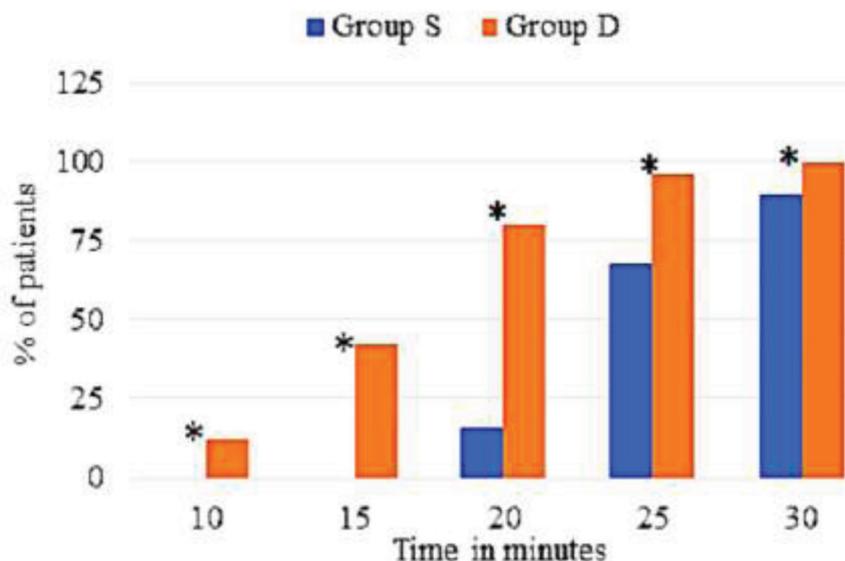


Fig. 2  
Percentage of patients with sensory block (score of 2) in cutaneous distribution of different nerves according to time. \*  $p < 0.05$

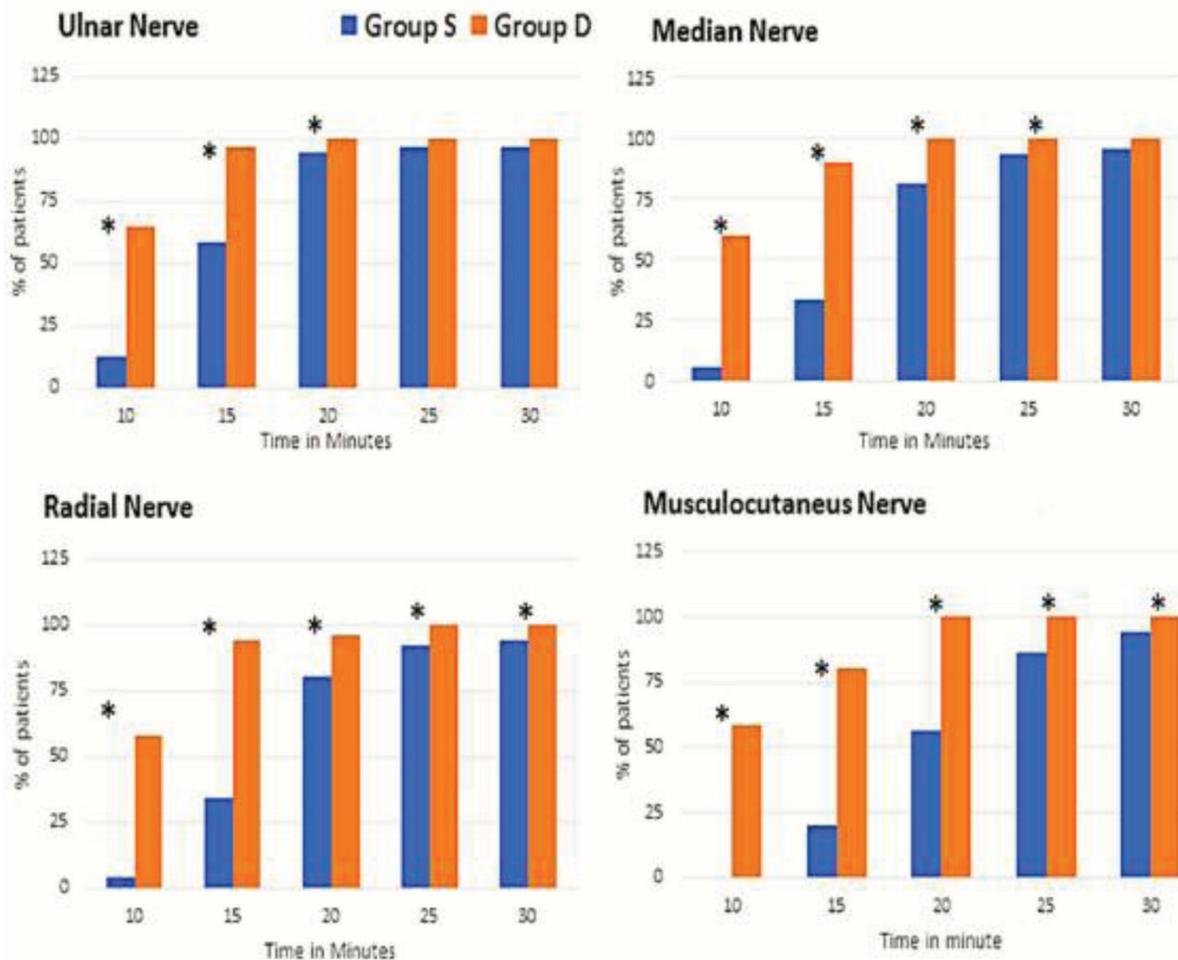
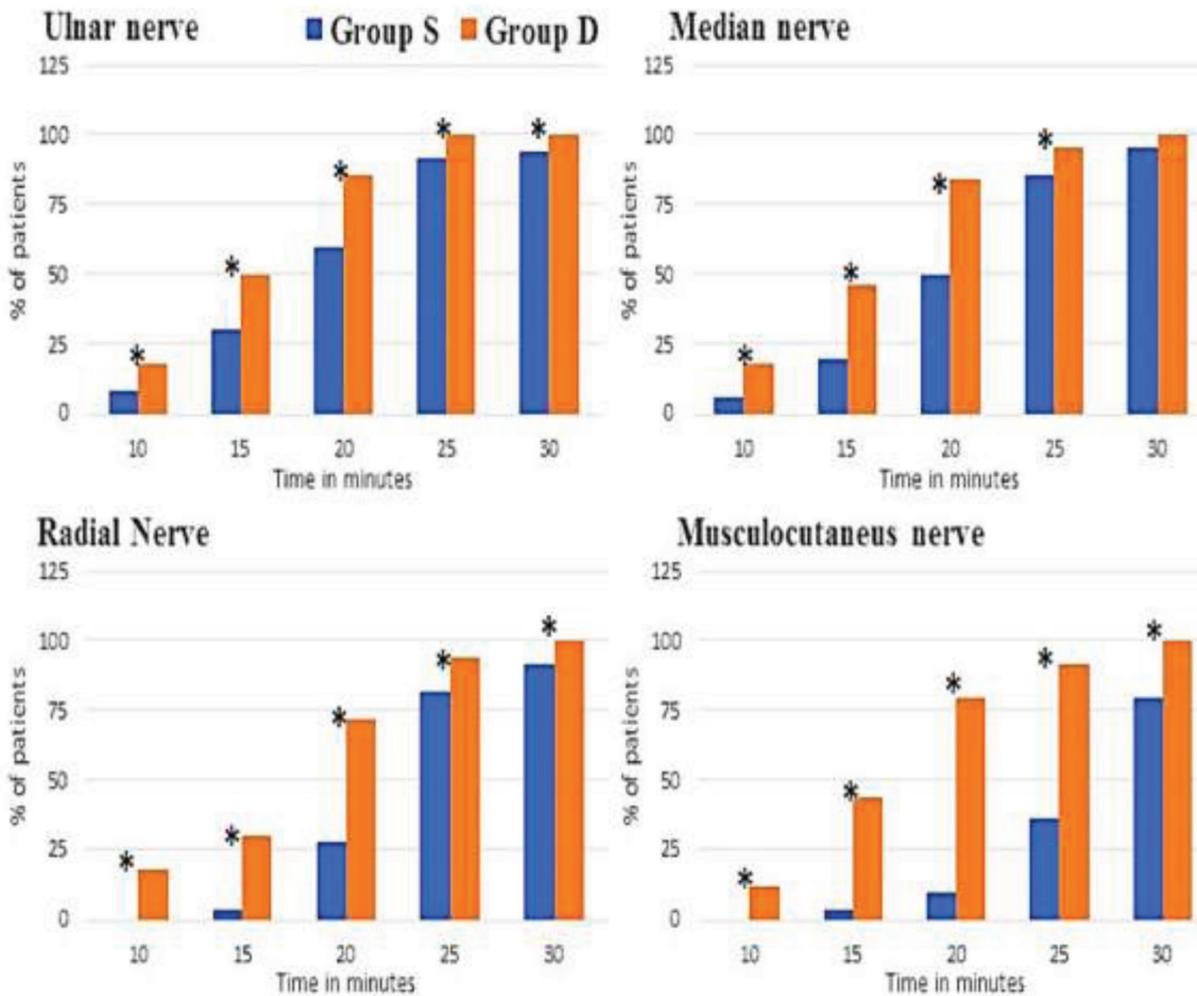


Fig. 3

Percentage of patients with motor block (score of 2) of muscle groups innervated by different nerves according to time. \*  $p < 0.05$



single injection group were deemed as block failure ( $P = 0.242$ ).

In the 2-injection group, onsets of complete sensory and motor blocks were faster in all the 4 nerves studied (Figure 2, Figure 3). After 25 minutes of institution of block, there were minimal differences between the two techniques. However, the percentage of patients with complete block of musculocutaneous nerve was significantly higher at all time intervals in the 2-injection group (Figures 2, 3).

Occurrences of paraesthesia during block institution and incidences of Horner's syndrome were comparable between both techniques. There were no differences in terms of duration of sensory block, motor block and analgesia between the two groups

(Table 2). There was no incidence of vascular puncture or pneumothorax in any of the groups.

## Discussion

The 2-injection technique of ultrasound guided brachial plexus block led to a faster onset of motor and sensory blocks. Though the procedure time was marginally higher in 2-injection group as compared to single injection technique, the logistic impact of such a difference is inconsequential. The fact that, this new technique reliably provided 100% surgical anesthesia in all the cases is more relevant.

Few previous studies explored similar hypothesis. De Tran et al, reported faster onset of block in their double injection technique ( $17.5 \pm 8.4$  min vs. 21.7

± 7.2 min) using 35 ml of 2% lignocaine.<sup>5</sup> However unlike our study, they didn't find any difference in the proportion of patients with complete block in both techniques at 30 minutes of block initiation. Roy et al also compared single injection with double injection technique with 30 ml of 1.5% mepivacaine and found no difference in the rate of sensory block at 15 minutes (49% vs. 50%).<sup>6</sup> They noticed significantly shorter procedure time in the single injection technique ( $179 \pm 104$  vs.  $275 \pm 137$  sec;  $P < 0.01$ ). In a recent study, Amr Sayed and colleague addressed similar research query and observed no difference in the percentage of patients progressing to sensory and motor block over time.<sup>7</sup>

Though the above-mentioned studies had similar research queries akin to ours, the outcome of our study was different, owing to the differences in the methodology. The protocol of double injection technique in the previous studies was to inject 50% or more of the drug in the corner pocket and then redirect the needle to the centre of the plexus to deposit the remaining fraction of the drug. In our study, we modified the double injection technique, wherein we deposited only one third of local anesthetics (10 ml of 0.5% Ropivacaine) in the corner pocket, targeting the lower trunk of brachial plexus. The remaining drug volume (20 ml) was injected in the centre of the plexus by merely withdrawing the needle, avoiding any further needle manipulations. We rationalised that this modification would prevent upward displacement of the plexus by injecting lesser volume of drugs in the corner pocket. We further surmised that the 10 ml of local anesthetic solution in the corner pocket would be sufficient to block the lower trunk, so that the remaining larger fraction of the drug could be utilised to be injected symmetrically in the central cluster. A large volume of drug in the corner pocket would have displace the plexus upward, making it difficult to inject the drug uniformly in the central cluster and which would have necessitated multiple needle passes. We hypothesized that our technique of drug administration would allow the drug to spread uniformly in the brachial plexus, hence leading to quicker onset and more successful block. The result of our study vindicated our scientific reasoning as all the patients achieved surgical anesthesia in 2-injection group, whereas 6% of patients in single injection

group were deemed block failures. The employment of the aforementioned technique in our study could be the reason of our results being different from De Tran et al. who reported equal percentage of surgical anesthesia in both single and double injection group (95.7%).<sup>5</sup>

In terms of individual nerves, though the onset of motor and sensory block was significantly quicker in the 2-injection group, there was negligible difference between the two groups after 25 minutes of block placement. However, motor block of the musculocutaneous nerve was significantly better in 2-injection group at all-time intervals. It is logical to assume that failure to block one nerve territory can result in failed anesthesia, especially when surgery is performed in the same area. Hence, our 2-injection technique performed better in terms of completeness of block and the probable reason could be the rapid distribution of local anesthetics in all three trunks of brachial plexus.

We used 30 ml of 0.5% ropivacaine as the available literature revealed it to be the most common volume of local anesthetic used in studies involving supraclavicular brachial plexus block.<sup>10, 11</sup>

We also studied duration of motor block and sensory block and duration of analgesia. We didn't find any difference between the groups, which is in agreement with the study by Amar Sayed and colleagues.

Procedure related paraesthesia is an unpleasant experience for the patients during nerve blocks caused by the needle manipulation in the neural plexus. Both the injection techniques in our study had comparable incidence of paraesthesia and it was similar to the incidence reported by De Tran et al (30.5% vs. 28.3%;  $P = 0.819$ ).<sup>[5]</sup> In comparison, Amr Sayed and colleagues reported a higher occurrence of paraesthesia in double injection group (52% in double injection group vs. 30% in single injection group) which they attributed to frequent redirection and maneuvering of needle in vicinity of neural tissue.<sup>[7]</sup> Our 2-injection technique avoided multiple needle redirections and hence accounted for a lesser incidence of paraesthesia. Furthermore, all incidences of paraesthesia in our study were transient and self-remitting and there were no instances of new onset neurological deficit within 48 hours of follow up after complete recovery from

block.

Horner's syndrome is another adverse effect seen commonly in previous studies investigating the brachial plexus block. In our study, we observed significantly lower incidence of Horner's syndrome with minimal difference between the groups. Our results were more in accordance with the study by Samer Arab et al, who reported 6.38% incidence of Horner's syndrome in triple injection group vs. 4.3% in single injection group.<sup>[8]</sup> De Tran et al reported a very high incidence in their study with single injection group (67.4% vs. 58.7%). A plausible explanation for such a high incidence of Horner's syndrome could be because of the use of higher volume and concentration of local anesthetic (35 ml of 2% lignocaine).<sup>5</sup>

There were few limitations in our study. We didn't assess the block of axillary nerve as we included patients requiring surgeries below the mid humerus level. We didn't record the number of manipulations, as it was difficult to define the transducer adjustments

and needle passes (movements) during block performance, though some previous authors had tried to do so. We used a drug volume of 30 ml and results could have been different if we used a different volume or concentration of the drug in question. Lastly all the blocks were performed by a single person with considerable experience in ultrasound guided regional anesthesia. The outcome of the study could have been different with less experienced operator.

## Conclusion

In conclusion, a single needle pass with 2-injection technique of ultrasound guided supraclavicular brachial plexus block resulted in faster onset of block and provided higher percentage of successful surgical anesthesia compared to single injection technique using 0.5% ropivacaine.

**Acknowledgments:** Department of Anesthesia, Tata Main Hospital.

## References

1. Hanumanthaiah D, Vaidyanathan S, Garstka M, Szucs S, Iohom G. Ultrasound guided supraclavicular block. *Med Ultrason.* 2013; 15 (3):224-9.
2. Soares LG, Brull R, Lai J, Chan VW. Eight ball, corner pocket: The optimal needle position for ultrasound-guided supraclavicular block. *Reg Anesth Pain Med* 2007; 32:94-95.
3. Macfarlane AJ, Perlas A, Chan V, Brull R. Eight ball, corner pocket ultrasound-guided supraclavicular block: avoiding a scratch. *Reg Anesth Pain Med.* 2008; 33(5):502-3; author reply 504.
4. Tran DQ, Munoz L, Russo G, Finlayson RJ. A trick shot to the corner pocket. *Reg Anesth Pain Med.* 2008; 33(5):503-4; author reply 504.
5. Tran DQ, Muñoz L, Zaouter C, Russo G, Finlayson RJ. A prospective, randomized comparison between single and double-injection, ultrasound-guided supraclavicular brachial plexus block. *Reg Anesth Pain Med* 2009; 34:420.
6. Roy M, Nadeau MJ, Côté D, Levesque S, Dion N, Nicole PC, et al. Comparison of a single or double-injection technique for ultrasound-guided supraclavicular block a prospective, randomized, blinded controlled study. *Reg Anesth Pain Med* 2012; 37:55–59.
7. Sayed AM, Sobhy A. Levobupivacaine in single injection versus dual injection ultrasound guided supraclavicular block. *Ain-Shams J Anaesthesiol* 2014; 7:182-6
8. Arab SA, Alharbi MK, Nada EM, Alrefai DA, Mowafi HA. Ultrasound-guided supraclavicular brachial plexus block: single versus triple injection technique for upper limb arteriovenous access surgery. *Anesth Analg.* 2014; 118(5):1120-5.
9. Techasuk W, González AP, Bernucci F, Cupido Tracy DO, Roderick JF, Tran DQ. A randomized comparison between double-Injection and targeted Intracluster-Injection ultrasound-guided supraclavicular brachial plexus block. *Anesth Analg:* 2014; 118 – (6):1363–9.
10. Venkatesh RR, Kumar P, Trissur R R, George S K; A Randomised Controlled Study of 0.5% Bupivacaine, 0.5% Ropivacaine and 0.75% Ropivacaine for Supraclavicular Brachial Plexus Block. *J Clin Diagn Res.* 2016; 10(12): UC09-UC12.
11. Ali QE, Manjunatha L, Amir SH, Jamil S, Quadir A. Efficacy of clonidine as an adjuvant to ropivacaine in supraclavicular brachial plexus block: A prospective study. *Indian J Anaesth* 2014; 58:709-13.