Original Research Article

Indian Journal of Anesthesia and Analgesia
2018; 5 (2): 265-271
DOI: http://dx.doi.org/10.21088/ijaa.2349.8471.5218.19

Single Injection versus Double Injection Ultrasound Guided Supraclavicular Brachial Plexus Block: A Randomised Comparative Study

Renuka Guragol[1], Yatish Bevinaguddaiah[2], Sadasivan S. Iyer[3], Vinayak S. Pujari[4]

[1]Senior Resident, ESIC Medical College, Bengaluru, Karnataka 560010, India. [2,4]Associate Professor [3]Assistant Professor, M.S. Ramaiah Medical College, Bengaluru, Karnataka 560054, India.

Abstract

Background: Ultrasound guided (USG) supraclavicular brachial plexus (SPB) block can be performed either by a single injection (SI) technique, injecting the entire volume of drug in the corner pocket or by a double injection (DI) technique, whereby half the volume of the drug is injected in the corner pocket and remaining half directly into the neural cluster. We conducted this study to compare thesuccess rates of the two techniques. *Methods:* A comparative two group study was carried out in 120 patients who underwent elective upper limbsurgeries (excluding the shoulder) under USG guided SPB in M.S. Ramaiah Hospital, Bangalore. Patients were randomly allocated in two groups (SI & DI). Both the groups received 30 ml 0.5% ropivacaine. SI group received the entire volume in the corner pocket, whereas DIgroup received 15 ml in corner pocket and the remaining 15 ml in the neural cluster. The blocks were assessed every 5 mins upto 30 mins forboth sensory and motor blockade using cold test and motor movements respectively, in the musculocutaneous, median, radial and ulnar nerves distribution. Each nerve was allocated a maximum of 2 points for complete blockade. Hence a maximum composite score of 16 could be achieved. To label a block successful a minimum of 14 points were required. We compared the success rate of blockade and total anaesthesia related time between the two groups. *Results:* The success rate of the blockade in the SI and DI group was 96.7% and 91.7% respectively at 30 min of performing the block which was not statistically significant. All the seven patients who had failure in both the groups had ulnar nerve sparing. The mean total anaesthesia related times in the two groups were 21.42±3.29 and25.17±2.45 in DI and SI groups respectively with P<0.001. During the first 25 minutes, the DI group displayed a higher proportion of patients with minimal composite score of 14 points. Fifty eight patients(96.7%) in DI achieved a composite score of 14 points and above within the first 25 minutes. The mean onset times were 17.25±2.83 and 22.72±2.47 in DI and SI group respectively. No adverse events were seen in both the groups. *Conclusions:* The success rates in both the SI and DI techniques were comparable. The DI technique results in a faster onset and hence a shorter total anaesthesia related time, which however may not be clinically relevant.

Keywords: Corner Pocket; Supraclavicular; Ultrasound.

Introduction

The Supraclavicular block (SCB) provides a complete and reliable blockade for upper limb surgeries [1]. A precise needle position and proper delivery of the local anaesthetic (LA) solution ensures successful blockade. Without the use of ultrasound (USG), it is difficult to verify the precise location of the needle tip in relation to the nerve bundles as well as the distribution of the local anaesthetic.[2] Use of real time USG has improved block success rates, shortened the latency time for onset, and has reduced the volume of the local anaesthetic required for the successful block [1].

Ultrasound guided SCB can be performed either by the single injection (SI) technique, whereby the entire volume of the drug is injected at the corner pocket [3] (intersection of the first rib and the subclavian artery) or by the double injection (DI) technique, whereby half the volume is deposited at

Corresponding Author: Yatish Bevinaguddaiah, Associate Professor, Dept of Anaesthesiology, M.S. Ramaiah Medical College, Bengaluru, Karnataka 560054, India.
E-mail: yatishseeni@yahoo.co.in

Received on 24.10.2017, **Accepted on** 23.11.2017

the corner pocket and half is injected inside the neural cluster [4,5,6,7].

Intraneural injection while performing peripheral nerve blocks is a dreaded complication and hence many practitioners are conservative while performing such blocks [8]. Ultrasound has shown to reduce such intraneural injections but it depends on the practitioners' skill and the imaging characteristics of the needle and the tissues [9].

Reducing the needle maneuvering inside the neural cluster decreases the incidence of neural injury and this has been the goal of many practitioners. This forms the rationale behind single rather than multiple injections.

However, cadaver and patient studies using dye have shown that a single location injection does not ensure the spread of the dye into all the compartments [10].

Septae and muscular membranes found between the scalene muscles might prevent the spread of the local anaesthetic [11]. Several studies have been conducted comparing single injection versus multiple injection techniques with the conclusion that the latter is more successful, with faster onset times and no increased complications. However, consistent results regarding the onset of the block or the nerves blocked were not demonstrated.

Hence, the aim of this study was to compare the block success rate of SI and DItechnique, USG guided SCB for upper limb surgery.

Methods

After obtaining ethics committee approval and written informed consent, this prospective randomized studywas undertaken in M.S. Ramaiah medicalcollege, Bangalore, in 120 patients undergoing upper limb surgeries not involving shoulder. The sample size was calculated based on the study done by Amr M.A. Sayed et al [7] using a power of 80%, alpha error 5% and confidence interval of 95%.

Inclusion criteria were age between 18 and 70 years, body mass index between 20 and 35 kg/m2 and ASA physical status I to III. Exclusion criteria were preexisting neuropathy, coagulopathy, hepatic or renal failure, allergy to LA, pregnancy and previous surgery in the supraclavicular fossa.

Patients undergoing upper limb surgeries not involving shoulder surgeries receivedultrasound-guided supraclavicular block with 0.5% ropivacaine. Patients were monitored byECG, pulse oximetry and NIBP. Intravenous midazolam (1-2 mg) was given to all the patients before the surgery. All blocks were performed by using an ultrasound machine (GE Logitech Venue 40) with an 8-12 MHz linear type probe. The surface of the ultrasound probe was covered with sterile coupling gel and covered with sterile transparent film.

The patients were randomised into two groups of 60 each, using computer generated randomisation numbers. The patients were placed in supine position with head turned to the opposite side. The ultrasound probe was placed in the supraclavicular fossa and a transverse view of the subclavian artery and the brachial plexus was obtained. The brachial plexus lie superolateral to the subclavian artery and appear as a 'bunch of grapes'. A skin wheal was raised with lidocaine 2%. Once the artery, rib, pleura and plexus were simultaneously in view, theneedle was guided, using an in-plane technique, towards the "corner pocket" [3] between the firstrib inferiorly, the subclavian artery medially and the nerves superiorly. Confirming that thelocation of the needle tip is not in hypo echoic nodules (in nerves), 0.5 ml of LA was injectedas a test dose to avoid intra neural injection. If the patients did not complain of paresthesia orpain or there was no excessive resistance to injection, the LA was injected. A total volume of 30 ml of local anesthetic was injected. This volume was derived from a study conducted byAmr M.A. Sayed [7].

In group SI the entire 30 ml was injected in the corner pocket (image 1). In group DI the volume wasdivided, where 15 ml was deposited in the corner pocket and during withdrawal of the needlethe remaining 15 ml was injected superior and lateral to the subclavian artery in the centre ofbrachial plexus (image 2).

Data was collected by an assessor blinded to the patient's volumeassignments. For both techniques, the following were recorded:

Imaging time: The time interval between contact of the ultrasound probe with thepatient and obtaining of a satisfactory picture.

The needling time: The temporal interval between the start of the skin wheal andthe end of local anaesthetic injection.

Performance time: The sum of imaging and needling times. The extent of sensory and motor blockade was tested by a blinded observer, every 5 minutesuntil 30 minutes.

Sensory blockade of the musculocutaneous (lateral part of forearm), median (palmar surface of

2nd finger), radial (dorsal surface of the hand between thumb and 2nd fingers), and ulnar nerves (5th finger) was gradedaccording to a 3-point scale using a cold test. GRADE 0 = no block, 1 = analgesia (patient can feel touch, not cold), 2 = anesthesia (patient cannot feel touch) [6].

Motor blockade was also graded on a 3-point scale. GRADE 0 = no block,1 = paresis, 2 = paralysis [6]. Motor blockade of the musculocutaneous, radial, median, and ulnar nerves were evaluatedby elbow flexion, thumb abduction, thumb opposition and thumb adduction, respectively [6].

Overall, the maximal composite score were 16 points. The block was considered successfulwhen a composite score of 14 was achieved. Composite score less than 14 was considered asfailure of blockade and was converted to general anaesthesia and excluded from the study. Onset time was defined as thetime required to obtain 14 points [6].

The primary outcome was to compare the success rate of blockade in SI versus DI groups.The secondary outcome was to measure the total anesthesia related time.

Total anesthesia related time was defined as the sum of performance time plus time for onset ofblock.Patients with Horner's syndrome, voice change and chest discomfort (dyspnea) were noted. The patients with failed blockades and those with severe complications such as arrhythmias, hypotension, and desaturation received general anesthesia.If in case surgery was unduly prolonged and the effect of the block wore off, rescue analgesiawas given in the form of intravenous Fentanyl 1 mcg/kg and infusion of Propofol 50-100mcg/kg/min.

Statistical Analysis

Statistical Methods

Descriptive and inferential statistical analysis has been carried out inthe present study. Results on continuous measurements are presented on Mean±SD (Min-Max) and results on categorical measurements are presented in Number (%). Significance was assessed at 5% level of significance.

The following assumptions on data were made,

1. Dependent variables should be normally distributed.
2. Samples drawn from the population should be random, cases of the samples should beindependent.

Student 't ' test (two tailed, independent) has been used to find the significance of study parameters on continuous scale between the two groups (inter group analysis) on metric parameters. Chi-square/ Fisher Exact test has been used to find the significance of study parameters oncategorical scale between two or more groups and non-parametric setting for qualitative dataanalysis.

Significant Figures

+ Suggestive significance (P value: 0.05<P<0.10)

* Moderately significant (P value:0.01<P ? 0.05)

** Strongly significant (P value: P?0.01)

Statistical Software

The Statistical software namely SAS 9.2, SPSS 15.0, Stata 10.1, MedCalc 9.0.1, Systat 12.0 and R environment ver. 2.11.1 were used for the analysis of the data and Microsoft word and Excel have been used to generate graphs, tables etc.

Results

The study was carried out on a total of 120 patients operated under USG guided supraclavicular brachial plexus block. Demographic data, success rate, imaging time, needling time, performance time, onset time, total anaesthesia related time, adverse perioperative events and complications werecompared between Group SI and Group DI.There were no significant differences in the patient characteristics including age, gender, weight, height, BMI and ASA grade (Table 1).

Our primary endpoint was the success rate of blockade (composite score>14). In all, 113 patients had successful blockade. Five patients in SI and 2 patients in DI failed to achieve a composite score of 14 and hence were labelled as failure and excluded from the study. All the 7 patients who had failure of block couldn't achieve a composite score of 14 due to ulnar nerve sparing. The success rate of blockade in both the SI and DI groups were 91.7% and 96.7% respectively at 30 minutes of performing the block which was not statistically significant (Tables 2-5).

Our secondary endpoint was to compare the total anaesthesia related time between the two groups.The total anaesthesia related time was less than 20 mins in 24.1% of patients in DI and none of the patients in DI grouptook more than 30 minutes. The mean total anaesthesia related times in the two groups were 21.42±3.29 and25.17±2.45 in DI and SI

groups respectively with P<0.001. There was no difference in the imaging time between the two groups. However, the needling time was significantly longer in the DI group and consequently the performance time was also significantly longer in the DI group (Tables 6 & 8).

During the first 25 minutes, the DI group displayed a higher proportion of patients with minimal composite score of 14 points. Fifty eight patients (96.7%) in DI achieved a composite score of 14 points and above within the first 25 minutes. In comparison, 6 patients in SI group had onset time of more than 25 minutes. Eleven patients in DI had

Table 1: Demographics

	DI (Mean ± SD)n=60	SI (Mean ± SD) n=60	P value
Age(Yrs)	49.37±16.79	45.35±16.25	0.186
Gender(F/M)	20/40	20/40	1.000
Weight(kgs)	67.90±10.23	68.4±8.57	0.757
Height(cms)	166.15±6.72	164.20±13.53	0.319
BMI(kg/m^2)	24.79±3.31	24.85±3.30	0.920
ASA grade 1/2/3	27/13/20	31/15/14	0.478

Table 2: Comparison of sensory blockade in group DI and SI

Sensory blockade	Group DI (n=60)	Group SI (n=60)
Musculocutaneous		
0	0(0%)	0(0%)
1	3(5%)	6(10%)
2	57(95%)	54(90%)
Median		
0	0(0%)	0(0%)
1	0(0%)	1(1.7%)
2	60(100%)	59(98.3%)
Radial		
0	0(0%)	0(0%)
1	2(3.3%)	0(0%)
2	58(96.7%)	60(100%)
Ulnar		
0	2(3.3%)	5(8.3%)
1	3(5%)	0(0%)
2	55(91.7%)	55(91.7%)

Table 3: Comparison of motor blockade in both groups

Motor blockade	Group DI (n=60)	Group SI(n=60)
Musculocutaneous		
0	0(0%)	0(0%)
1	3(5%)	6(10%)
2	57(95%)	54(90%)
Median		
0	0(0%)	0(0%)
1	0(0%)	1(1.7%)
2	60(100%)	59(98.3%)
Radial		
0	0(0%)	0(0%)
1	2(3.3%)	0(0%)
2	58(96.7%)	60(100%)
Ulnar		
0	2(3.3%)	5(8.3%)
1	3(5%)	0(0%)
2	55(91.7%)	55(91.7%)

Table 4: Comparison of the composite point in each group

Composite point	Group DI (n=60)	Group SI(n=60)
12	2(3.3%)	5(8.3%)
14	7(11.7%)	7(11.7%)
15	2(3.3%)	0(0%)
16	49(81.7%)	48(80%)
Total	60(100%)	60(100%)

P= 0.382, not significant, Fischer exact test

Table 5: Blockade failure in both the SI and DI groups

Blockade Failure	Group DI (n=60)	Group SI(n=60)	Total (n=120)
No	58(96.7%)	55(91.7%)	113(94.2%)
GA	2(3.3%)	5(8.3%)	7(5.8%)
Total	60(100%)	60(100%)	120(100%)

P=0.439, not significant, Fischer exact test

Table 6: Performance Time

	Group DI (n=60)	Group SI(n=60)	Total	P value
Imaging time(min)	1.83±1.17	1.67±5.65	1.75±4.10	0.84
Needling time(min)	2.36±1.15	1.43±0.71	1.89±1.06	<0.001**
Performance time(min)	4.25±2.28	2.40±0.99	3.32±1.99	<0.001**

student t test

Table 7: Onset time

Onset time	Group DI (n=58)	Group SI(n=55)	Total (n+113)
<15 min	11(19%)	0(0%)	11(9%)
15-25 min	47(81%)	49(89%)	96(85.5%)
>25 min	0(0%)	6(11%)	6(5.5%)
Total	58(100%)	55(100%)	113(100%)
Mean±SD	17.25±2.83	22.72±2.47	19.91±3.81

P<0.001**, significant, student t test

Table 8: Total anaesthesia related time

Total anaesthesia related time	Group DI (n=58)	Group SI(n=55)	Total (n+113)
<20 min	14(24.1%)	0(0%)	14(12.4%)
20-30 min	44(77.5%)	53(96.4%)	97(85.8%)
>30 min	0(0%)	2(3.6%)	2(1.7%)
total	58(100%)	55(100%)	113(100%)
Mean±SD	21.42±3.29	25.17±2.45	23.24±3.47

P<0.001**, significant, student t test

Table 9: Adverse Perioperative event

Adverse preoperative event	Group DI (n=60)	Group SI(n=60)
None	60	60
Yes	0	0
Total	60	60

onset time of <15 minutes. The mean onset times were 17.25±2.83 and 22.72±2.47 in DI and SI group respectively (Table 7). The DI group hada significantly faster onset with a p value <0.001. None of the patients in both the groups developed any perioperative adverse events (Table 9).

Discussion

In this prospective randomized trial we compared the DI technique with the SI technique forperforming USG guided supraclavicular brachial

plexus block.In ourstudy we found thatboth the techniques provided similar success rates of surgical anaesthesia. The performancetime was longer in group DI in comparison with group SI probably because group DI requiredmore needle maneuvering. However, the additional needle maneuvering did not lead to anincrease in the incidence of vascular puncture, paraesthesia or post operative neurologicdeficits.

In comparison with a study done by Amr M.A. Sayed, Amr Sobhy [7], our current studydemonstrated a shorter total anaesthesia related time in DI technique, despite having a longerperformance time in view of a shorter onset time.The results of our present study are in agreement with a study conducted by Techasuk W et al [12]. They compared the DI technique with TII and concluded that the total anesthesia relatedtime was shorter with TII group. The two methods achieved comparable rates of surgical anesthesia and the DI group required fewer needle passes as well as shorter needling andperformance time.

Injection of the drug directly into the brachial plexus could lead to the formation of smallersatellite clusters, resulting in the increase in the surface area of exposure of the nerves to the local anaesthetics [12]. This could explain the faster onset of the blockade in the DI group observed in thestudy.

However, safety regarding the direct placement of the needle in the brachial plexus cluster isnot established. In an observational study conducted by Bigeleisen et al, it was opined that60the positioning of the needle tip in the cluster was equivalent to intra neural placement [13]. Thus they concluded that DI technique posed a larger risk of adverse neurological deficits. Inanother contrasting study done by Franco it was opined that intra cluster injection of LA didnot amount to true intra neuronal injection [14]. Irrespective of the fact whether LA injected intothe neural cluster amounts to true intra neuronal injection, recent evidence supports the safetyof DI technique [15]. There was no incidence of paraesthesia or any other adverse neurological outcome in our study, thus confirming the safety of DI technique.

Our study has some limitations. First, we found that the decrease in the total anaesthesia related time in the DI technique was approximately 4 mins. In a hospital with a busy set upwhere large number of upper limb surgeries are performed under regional anaesthesia, such areduction could result in a clinically relevant reduction in anaesthesia related time over the course of the day. However, we agree that such a difference may not be clinically relevant in acentre that performs lesser number of cases per day. Second, we did not restrict to a single type of surgical procedure. In a study done by Arab etal [16] they focused on a single type of surgical procedure to eliminate any confounding factorsarising from the surgical stimulus or location of the surgery. Third, the blocks were performed by both senior anaesthesiologists trained in USG andresidents. The DI technique required needle redirections thus increasing the level of difficulty among the residents and hence could have led to a longer performance time. There were no complications such as hypotension, arrhythmia and desaturation noted ineither of the groups. None of the surgical procedures in both the groups required rescueanalgesia.

Conclusion

In conclusion, this study demonstrated that the success rates in both the SI and DI techniques are comparable. The DI technique results in a faster onset and hence a shorter total anaesthesia related time, which however may not be clinically relevant.

References

1. Marohfer P, Greher M, Kapral S. Ultrasound guidance in regional anaesthesia. Br JAnaesthesiology 2005;94:7–17.
2. Marhofer P, Schrendorfer K, Wallner T, Koinig H, Mayer N, Kapral S.Ultrasonographic guidance reduces the amount of local anesthetic for 3-in-1 blocks. Regional Anesthesia Pain Medicine 1998; 23:584–8.
3. Soares LG, Brull R, Lai J, Chan VW. Eight ball, corner pocket: the optimal needleposition for ultrasound-guided supraclavicular block. Regional Anesthesia Pain Med 2007;32:94–5.
4. Tran DQH, Muz L, Zaouter C, Russo G, Finlayson RJ. A prospective, randomized comparison between single- and double-injection, ultrasound-guided supraclavicular brachial plexus block. Regional Anesthesia Pain Medicine 2009;34:420-4.
5. Tran DQH, Dugani S, Correa JA, Dyachenko A, Alsenosy N, Finlayson RJ. Minimum effective volume of lidocaine for ultrasound- guided supraclavicular block. Regional Anesthesia Pain Medicine 2011;36:466–9.
6. Roy M, Nadeau MJ, Cote D, Levesque S, Dion N, Nicole PC, Turgeon AF. Comparison of a single or double-injection technique for ultrasound-guidedsupraclavicular block: a prospective,

randomized, blinded controlled study. Regional Anesthesia Pain Medicine 2012;37:55–9.

7. Amr M.A. Sayed, Amr Sobhy. Levo bupivacaine in single-injection versusdualinjectionultrasound-guided supraclavicular brachial plexus block. Ain-Shams Journalof Anesthesiology 2014;07:182–186.
8. Sites BD, Neal JM, Chan V. Ultrasound in regional anesthesia: where should the focus be set? Regional Anesthesia Pain Med 2009;34:531–533.
9. Altermatt FR, Cummings TJ, Auten KM, Baldwin MF, Belknap SW, Reynolds JD. Ultrasonographic appearance of intraneural injections in the porcine model. Regional anaesthesia Pain Medicine 2010; 35:203–206.
10. Thompson GE, Rorie DK. Functional anatomy of the brachial plexus sheaths. Anesthesiology 1983;59: 117–22.
11. Chelly JE. Peripheral Nerve Blocks a Color Atlas, 3rd ed. Philadelphia, PA: Lippincott Williams & Wilkins, 2009.
12. Techasuk W, González AP, Bernucci F, Cupido T, Finlayson RJ, Tran de Q. Arandomized comparison between double-injection and targeted intra cluster-injectionultrasound-guided supraclavicular brachial plexus block. Anesthesia Analgesia. 2014 Jun;118(6): 1363-9.
13. Bigeleisen PE, Moayeri N, Groen GJ. Extraneural versus intraneuralstimulationthresholds during ultrasound-guided supraclavicular block. Anesthesiology 2009;110:1235–43.
14. Franco CD. Connective tissues associated with peripheral nerves. RegionalAnesthesia Pain Medicine. 2012;37:363–5.
15. Perlas A, Lobo G, Lo N, Brull R, Chan VW, Karkhanis R.Ultrasound-guidedsupraclavicular block: outcome of 510 consecutive cases. Regional Anesthesia Pain Medicine. 2009;34:171–6.
16. Arab SA, Alharbi MK, Nada EM, Alrefai DA, Mowafi HA. Ultrasound-guidedsupraclavicular brachial plexus block: single versus triple injection technique for upperlimb arteriovenous access surgery. Anesthesia Analgesia. 2014 May;118(5):1120-5.