Print ISSN: 2321-6379
Online ISSN: 2321-595X

Original Article

Comparative Evaluation of Normal Saline and Dextrose as Diluent of Local Anesthetic in Ultrasonography-Guided Supraclavicular Brachial Plexus Block

Rishi Kumar Gupta[1], Inder Dev Ashahiya[2], Mayank Chansoriya[3], Neeraj Narang[2]

[1]Post-Graduate Student, Department of Anesthesiology, Netaji Subash Chandra Bose Medical College and Hospital, Jabalpur, Madhya Pradesh, India, [2]Associate Professor, Department of Anesthesiology, Netaji Subash Chandra Bose Medical College and Hospital, Jabalpur, Madhya Pradesh, India, [3]Professor, Department of Anesthesiology, Netaji Subash Chandra Bose Medical College and Hospital, Jabalpur, Madhya Pradesh, India

Abstract

Background: Ultrasonography has revolutionized the field of regional anesthesia due to its various advantages over peripheral nerve stimulation techniques.

Materials and Methods: This prospective blinded controlled study was carried out in 60 patients of American Society of Anesthesiologists grade I and II undergoing elective upper limb surgery randomly allocated into 30 patients in each group. Each group received supraclavicular block. Group NS patients received 21 ml 0.5% Ropivacaine (Prepared by diluting 14 ml 0.75% Ropivacaine with 7 ml of normal saline) and group D5% patients received 21 ml 0.5% Ropivacaine (Prepared by diluting 14 ml 0.75% Ropivacaine with 7 ml of dextrose). The time to onset of sensory block and motor block, duration of sensory and motor block and duration of post-operative analgesia and any side effects were recorded for each patient.

Results: In this study, the meantime for onset of analgesia with normal saline group was 41.00 ± 2.74 min and 28.33 ± 2.42 min for the dextrose group. The $P = 0.0001$, which shows that there was clinical evidence that dilution with dextrose results in a faster onset time of analgesia compared to dilution with normal saline.

Conclusion: Our study suggests that decrease in onset time of analgesia when dextrose was used as a diluent instead of normal saline for ultrasound-guided supraclavicular brachial plexus block.

Key words: Dextrose, Normal saline, Ropivacaine, Ultrasonography

INTRODUCTION

Regional anesthesia has many advantages over general anesthesia such as decreased chances of aspiration, decreased chances of nausea vomiting, maintenance of patient's consciousness and protective airway reflexes, less chance of post-operative hypoxia and respiratory complications (bronchospasm, aspirations, hypoxia post-operative residual paralysis etc.).[1]

The modern history of regional anesthesia and local anesthesia begins with Carl Koller who demonstrated topical anesthesia of the eye with cocaine in 1884. Later in 1884, William Halsted used cocaine for intradermal infiltration and for peripheral nerve blocks using the open surgical technique, applying cocaine directly onto the nerve plexus. The landmark-based percutaneous approach of the supraclavicular block (SCB) was introduced into clinical practice in Germany by Diedrich Kulenkampff in 1911.[2,3]

In 1880 French physicists Pierre Curie and Paul Jacques Curie discovered the piezoelectric effect in certain

Access this article online

www.ijss-sn.com

Month of Submission : 09-2021
Month of Peer Review : 10-2021
Month of Acceptance : 11-2021
Month of Publishing : 11-2021

Corresponding Author: Dr. Inder Dev Ashahiya, D-503 Acropolis, Near Gulati Petrol Pump, Madan Mahal, Jabalpur - 482 002, Madhya Pradesh, India.

crystals. Paul Langevin, a student of Pierre Curie, developed piezoelectric materials, which can generate and receive mechanical vibrations with high frequency (therefore ultrasound). During World War I, ultrasound was introduced in the navy as a means to detect enemy submarines. Diagnostic applications of ultrasound began through the collaboration of physicians and sonar (sound navigation ranging) engineers. In 1942 Karl Dussik, a neuropsychiatrist and his brother Friederich Dussik, a physicist described ultrasound as a medical diagnostic tool to visualize neoplastic tissues in the brain. The real-time B scanner was developed in 1965 and was first introduced in obstetrics. In 1976 the first ultrasound machines coupled with Doppler measurements were commercially available. With regard to regional anesthesia as early as 1978 La Grange *et al.* were the first anaesthesiologists to publish a case series report of ultrasound application for peripheral nerve blockade (PNB). With the advancement of technology in 1994 "Kapral *et al.*" first described ultrasound imaging of brachial plexus in supraclavicular position and needle insertion under ultrasound guidance.[4,5]

Rising popularity of ultrasound guidance for PNB is due to its various advantages over peripheral nerve stimulation (PNS) techniques. Principle benefit of ultrasound is its inherent ability to directly visualize anatomical structures such as peripheral nerves and tissue planes in real-time and additional benefit is the ability to reposition one's needle while assessing for adequate local anesthetic spread.[6,7]

The overall idea of pre-emptively scanning patient anatomy with Ultrasonography (USG) for neurovascular variations or abnormalities has been suggested as a means of improving patient safety by preventing block complications. So when compared to PNS guided nerve blocks, USG guided nerve blocks have been shown to require less time to perform, possess more rapid onset, longer duration of anesthesia and less risk of block failure, decrease risk of vascular puncture and improved quality of sensory block.[8-10]

The utilization of ultrasound in modern medicine is well established. This study evaluates and compare the quality of anesthesia and analgesia in patients undergoing upper limb surgeries under ultrasound-guided supraclavicular brachial plexus block (SCBPB) using inj. Ropivacaine with NS and inj. Ropivacaine with D5%.

MATERIALS AND METHODS

This prospective randomized casecontrol study was conducted at Netaji Subhash Chandra Bose Medical College and Hospital Jabalpur (Madhya Pradesh). After obtaining the Ethics Committee's approval, proper consent and thorough pre-anesthetic check-up of all 60 patients of either gender aged between 18–60 years and of American Society of Anesthesiologists (ASA) Class I and II, scheduled for elective upper-limb surgeries (arm, forearm, and hand). Patient was excluded from the study, who refused for surgery for trial, ASA physical status >III and have any medical problem such as history of allergy to local anesthetics, cardiac dysrhythmias, liver and renal dysfunctions, bleeding disorders, convulsions and have sensory neuropathy and motor deficit in the limb on which surgery was to be performed. Patient with or history of Diabetes Mellitus I and II and have severe systemic diseases such as asthma, chronic obstructive pulmonary disease and coronary artery diseases also be excluded from the study. Using computer-generated table of random numbers, patients were allocated into two groups of 30 each. Group NS- Patients received 14 mL of 0.75% inj. Ropivacaine and 7 ml of inj. Normal saline 0.9%. Group D5- Patients received 14 mL of 0.75% inj. Ropivacaine and 7ml of inj. dextrose 5%. Final volume and concentrations of local anesthetic solution in both groups were 0.5%, 21 ml Ropivacaine. After all standard preparations, patient entered the operating room placed them into a supine position in trolley/couch and routine monitoring devices was installed, i.e., Electrocardiography, Spo2, Non-invasive Blood Pressure and a patent I/V line. Preoperative antibiotic was given. I/V Midazolam 1mg was given to all patients before procedure as a premedication to reduce to relieve anxiety. Under all aseptic precaution, SCBPB was performed using a Sonoscape USG machine and a 13-6 MHz linear probe. In group NS and group D5%, drug were injected through 50 mm long, 22G insulated, short bevel needle (B Braun).

Patient Positioning

The patient is placed in a supine position with the head rotated away from the site to be blocked and the shoulder pulled down. The arm rests comfortably on the side while the wrist, if possible, is supinated [Figure 1]. The main landmarks for this USG guided block are behind the midpoint of the clavicle in the supraclavicular fossa region. Light premedication, for example., inj. Midazolam 1 mg is beneficial for patient comfort.

USG Guided Technique

Place a linear probe in the coronal oblique plane behind the midpoint of the clavicle in the supraclavicular fossa region [Figure 2]. Scan supraclavicular fossa to identify the subclavian artery and brachial plexus in short-axis view. The Brachial plexus will be visualized as a hypoechoic group of nerves, i.e., "Bunch of grape" appearance, located laterally and caudally to the prominent subclavian artery. Deep to the artery, the hyperechoic first rib is typically seen; however, the pleura is obscured by the rib's acoustic shadow [Figure 3]. After scanning and identifying the structures,

insert a 22 gauge 50 mm needle is in "In-plane" with USG beam toward the plexus and posterior to anterior direction, once at appropriate location local anesthetic solution will be administered slowly, incrementally using intermittent aspiration technique after negative aspiration ensuring expansion and adequate spread around the three sites of brachial plexus, a total of 21 ml LA is injected in three divided doses, i.e., 7 ml of 0.5% Ropivacaine injected in following three areas:-

1. Corner pocket area
2. Intercluster region
3. Supracluster area.

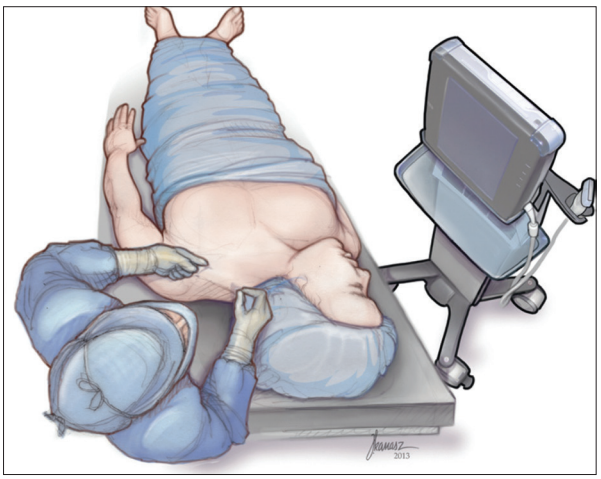


Figure 1: Patient position with the ultrasound machine for the supraclavicular block

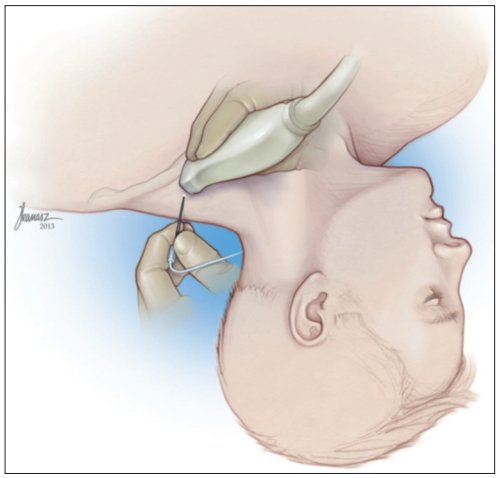


Figure 2: The probe is in the coronal oblique plane. Note the in-plane position of the needle with the direction of the needle from posterior to anterior

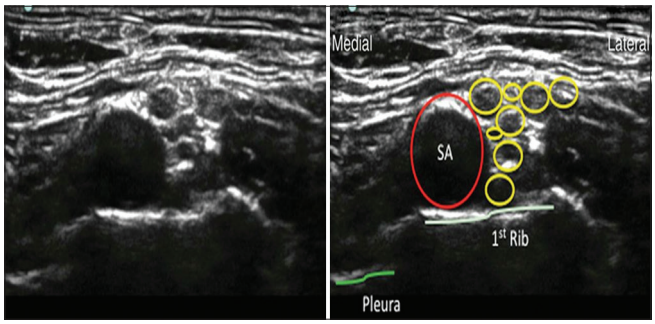


Figure 3: Ultrasonographic view of brachial plexus in supraclavicular approach

For abolishing tourniquet-related pain and discomfort in the upper-arm region, 5–7 ml 1% Lignocaine with adrenaline will be infiltrated subcutaneously in the medial aspect of arm at level of axillary fossa to block inter-costo-brachial nerve (T2 Block).

Parameters of Comparison

All patients were evaluated for the following parameters from the time of induction to 12 h. post induction-

1. The time to onset of sensory loss (Analgesia) and duration of sensory loss.
2. Evaluation of sensory and motor blockade up to 60 min or total block.
3. Post-operative analgesia.

Evaluation of Block

Assessment scales

- The sensory block was evaluated by a three-point scale for sensory block.
- The motor block was evaluated by three-point scale for motor block.
- Post-operative analgesia was evaluated by VAS score for pain at rest and at the movement of the limb at the proper interval in ward or post-op care unit.
- Result was noted and analyzed.

Three-point scale for sensory block

Score	Observation
2	Normal Sensation of pin prick
1	Analgesia (Less than normal pain to Pin Prick)
0	Anesthesia (Loss of Pin Prick sensation)

Sensory block evaluation site

Nerves	Sensory distribution for evaluation
Radial nerve	1st dorsal web space
Ulnar nerve	Median margin of the little finger
Median nerve	Lateral margin of the index finger
Musculocutaneous nerve	Lateral margin of the forearm

Three-point scale for motor block

Score	Observation
2	Full strength, normal movements
1	Some movements possible (Paresis)
0	Absence of movements (Total paresis)

Motor block evaluation sites

Nerves	Motor evaluation
Radial nerve	Loss of thumb abduction, finger, and wrist extension
Ulnar nerve	Loss of thumb adduction
Median nerve	Loss of thumb opposition
Musculocutaneous nerve	Loss of elbow flexion

Analgesia

Postoperative pain was assessed by verbal numeric rating scale (visual analog scale [VAS]) at 2 h, 4 h, 6 h, 8 h, 10 h, 12 h, 14h, 16, 20 h, and 24 h after surgery [Figure 4].

VAS score[11]

- 0 - no pain
- 1–3 - mild pain
- 4–7- moderate pain
- 8–10 - severe pain.

Data Analysis

Patients were monitored intra-operatively and all findings and observations were recorded on the patient proforma. The data of the present study was recorded/fed into the computers and after its proper validation, check for error, coding, and decoding was compiled. Appropriate univariate and bivariate analysis and use of Student's *t*-test. The VAS scores in two groups were analyzed using a non-parametric test. For the onset time of sensory blockade, the independent-t test was used. Individual nerve block times, total duration of block, total procedure time, and onset time for total paresis were also analyzed using the independent *t*-test. Data analysis was done using SPSS version 20 (SPSS Inc, Chicago, Illinois, USA). All means are expressed as mean ± standard deviation and the proportion as in percentage (%). The critical value for the significance of the results will be considered at 0.05 levels.

RESULTS

Mean age ± standard deviation of patients in group NS was 35.57 ± 11.98 years and in group D5 it was 39.37 ± 12.78 years. Mean age in both groups was comparable statistically. (P = 0.24). Mean weight (kg) of the patients in group NS and D5 was 68.73 ± 6.03 and 65.67 ± 6.48 respectively. Mean weight in both groups was statistically comparable (P= 0.063).

Table 1 shows the meantime for onset of analgesia in both the group. Normal saline group was 41.00 ± 2.74 min and 28.33 ± 2.42 min for the dextrose group. The P = 0.0001, which means difference between both the groups was statistically highly significant [Graph 1].

Tables 2-5 show the mean onset time of sensory block for median nerve, ulnar nerve, musculocutaneous nerve % radial nerve, respectively. The comparison between both groups was not statistically significant (P > 0.05) [Graphs 2-5].

Table 6 shows the duration of the sensory block (386.31 ± 4.78 min in NS group, 389.30 ± 8.27 min in D5 group, P = 0.096). The comparison between both groups was not statistically significant [Graph 6].

Table 7 shows post-operative mean vas score at different time intervals in both groups. The difference in mean vas

Table 1: Onset time of sensory block (in minutes)

Group	NS		D5		*P*
	Mean	SD	Mean	SD	
Time	41.00	2.74	28.33	2.42	0.0001

Table 2: Onset time of sensory block for median nerve (in minutes)

Group	NS		D5		*P*
	Mean	SD	Mean	SD	
Time	30.88	2.99	29.50	2.47	0.057

Table 3: Onset time of sensory block for ulnar nerve (in minutes)

Group	NS		D5		*P*
	Mean	SD	Mean	SD	
Time	34.00	2.55	32.77	2.54	0.0659

Table 4: Onset time of sensory block for musculocutaneous nerve (in minutes)

Group	NS		D5		*P*
	Mean	SD	Mean	SD	
Time	20.53	1.22	19.90	1.56	0.0859

Table 5: Onset time of sensory block for radial nerve (in minutes)

Group	NS		D5		*P*
	Mean	SD	Mean	SD	
Time	29.83	2.42	28.82	1.85	0.067

Table 6: Duration of sensory block (in minutes)

Group	NS		D5		*P*
	Mean	SD	Mean	SD	
Time	386.31	4.78	389.30	8.27	0.096

score in both groups was non-significant from 2 to 12 h post-operative period [Graph 7].

DISCUSSION

USG has revolutionized the field of regional anesthesia. The effective application of this technology requires understanding of two-dimensional anatomy, optimal imaging of the nerves and anatomical structures, accurate real-time needle guidance, and precise local anesthetic delivery. Principle benefit of ultrasound is inherent ability to directly visualization of anatomical structures like peripheral nerves and tissue planes in real-time and additional benefit is the ability to reposition one's needle in assessing for adequate local anesthetic spread. The overall idea of pre-emptively scanning patient anatomy with USG for neurovascular variations or abnormalities has been suggested as a means of improving patient safety by preventing block complications. So when compared to PNS guided nerve blocks, USG guided nerve blocks has been shown to require less time to perform, possess more rapid onset, longer duration of anesthesia and less risk of block failure, decrease risk of vascular puncture and improved quality of sensory block.[2-6] In our study block procedure time in both groups was not different between two groups.

In this study, the mean time for onset of analgesia with normal saline group was 41.00 ± 2.74 min and 28.33 ± 2.42 min for dextrose group. The $P = 0.0001$, these finding is similar to another study by Dhir *et al.*[12] They prospectively compared and evaluate block characteristics when local anesthetics drug was diluted with D5W and NS.

Table 7: Post-operative vas score

VAS score (at h)	NS group		D5 group		*P*
	Mean	SD	Mean	SD	
2	0.23	0.97	0.34	1.17	0.692
4	1.93	1.33	1.21	1.80	0.083
6	2.90	0.71	2.66	1.31	0.376
8	4.43	0.72	4.31	1.00	0.591
10	5.47	0.62	5.00	1.28	0.079
12	6.23	0.50	6.07	1.28	0.516

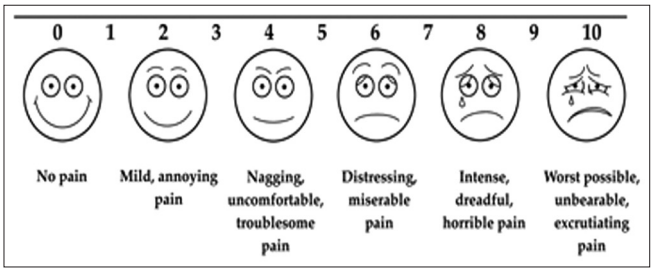
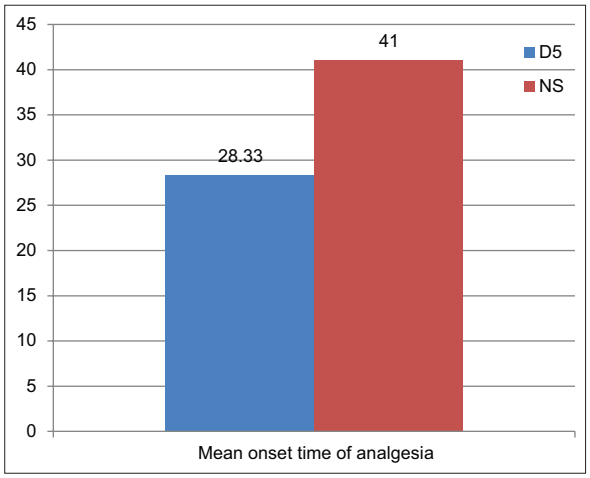
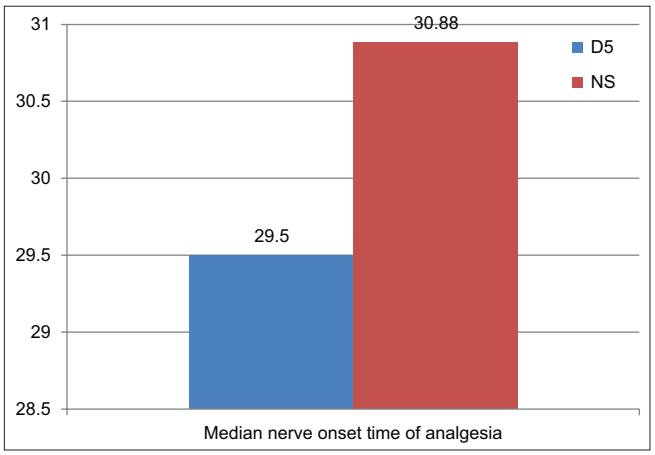


Figure 4: Visual analogue scale

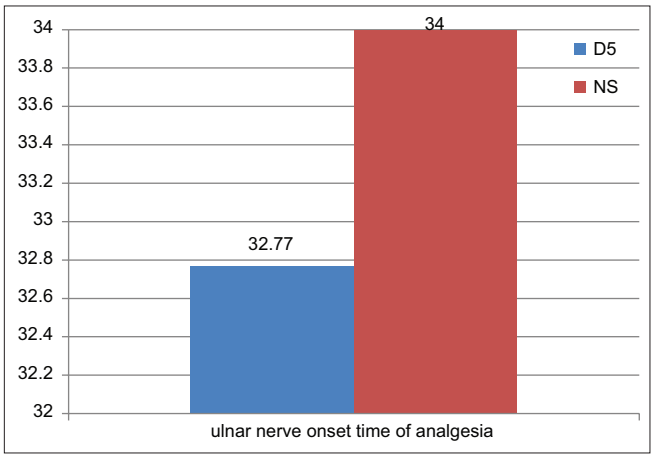
The mean time to complete the sensory block was 18.3 ± 6.1 min in the dextrose group and 22.5 ± 6.4 min in the saline group ($P < 0.001$, 95% confidence interval for mean difference 3.0-5.4 min). In their study, they concluded that dilution with 5% dextrose provides earlier onset of axillary brachial plexus block with Ropivacaine.



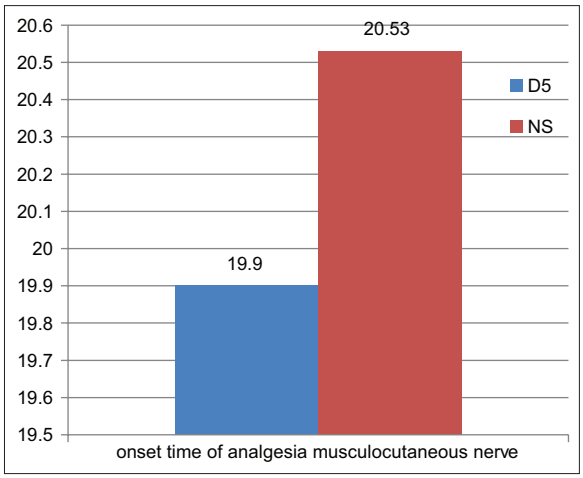
Graph 1: Mean onset time of analgesia



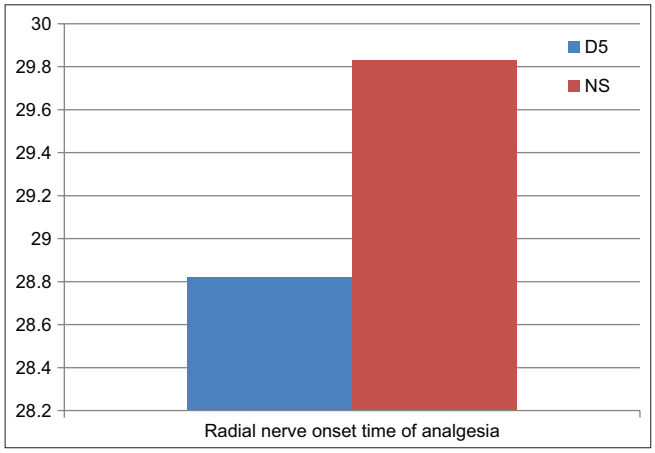
Graph 2: Median nerve onset time of analgesia



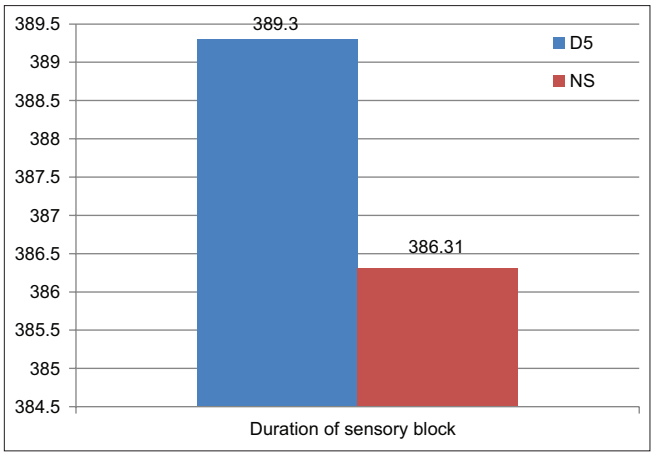
Graph 3: Ulnar nerve onset time of analgesia



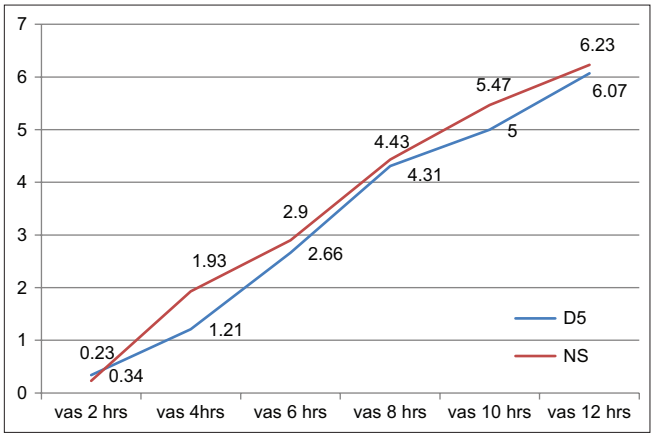
Graph 4: Onset time of analgesia musculocutaneous nerve



Graph 5: Radial nerve onset time of analgesia



Graph 6: Duration of sensory block



Graph 7: Post-operative vas score

In a study by Lim and Hasan,[13] a prospective, randomized comparison was made between 13.3 ml, 0.75% Ropivacaine diluted with either 6.7 ml normal saline or dextrose in upper extremity surgery via ultrasound-guided supraclavicular (SCB) nerve block. In their study, 50 patients scheduled for upper limb surgery were randomly assigned to receive supraclavicular plexus block with 0.75% Ropivacaine (diluted with either 5% dextrose or normal saline). They found meantime for onset of analgesia for the dextrose group was 37.6 ± 12.9 min while the meantime for the saline group was 45.2 ± 13.9 min with a $P = 0.05$.

The study of Shah *et al.*[14] also observed that the effect of 5% DW as diluent, in onset and duration of complete motor and sensory block as compared to normal saline, when given through supraclavicular approach of brachial plexus block. 5% Dextrose administered resulted in significant reduction in latency of onset of complete motor and sensory block with no significant increase in duration of block. Onset of complete sensory blockade for 5D and NS were 10.38 ± 3.14 and 18.10 ± 4.68 min respectively ($P < 0.0001$). Onset of complete motor blockade with 5DW and NS were 16.42 ± 4.23 and 22.36 ± 3.56, respectively ($P < 0.0001$). Duration of complete sensory block with 5D and NS groups was 193.12 ± 18.54 and 185.26 ± 19.89 respectively ($P = 0.1188$). Duration of complete motor block with 5D and NS was 217.32 ± 19.35 and 209.65 ± 21.48 ($P = 0.1516$). It is concluded that 5% DW produces a definite reduction in latency of complete sensory as well as motor blockade with no significant changes in the duration of motor and sensory block.

Perlas *et al.*[11] performed 510 USG guided SCB (50 inpatients, 460 outpatients) over 24 month period. Successful surgical anesthesia was achieved in 94.6% of patients after a single attempt, 2.8% required local anesthetic supplementation of a single peripheral nerve territory, and 2.6% received an unplanned general anesthetic. No cases of clinically symptomatic pneumothorax developed. Complications included symptomatic hemi-diaphragmatic paresis (1%), unintended vascular punctures (0.4%), and transient sensory deficits (0.4%). They concluded USG guided block is associated with a high rate of successful surgical anesthesia and a low rate of complications and thus may be a safe alternative for both inpatients and outpatients. Severe

underlying respiratory disease and coagulopathy should remain a contraindication for this brachial plexus approach.

Williams *et al.*[15] has done prospective study and assessed the quality, safety, and execution time of SCBPB using USG guided and neuro-stimulation guided combined and compared with anatomical landmarks guided neuro-stimulation. Eighty patients were randomized into two groups of 40, Group US (SCBPB guided in real-time by a 2D ultrasound image, with neuro-stimulator confirmation of correct needle position) and Group NS (SCBPB using the subclavian perivascular approach, also with neuro-stimulation). Blocks were performed using bupivacaine 0.5% and lidocaine2% (1:1 vol) with epinephrine (1:200,000) as the anaesthetic mixture. The onset of motor and sensory block for musculocutaneous, median, radial, and ulnar nerves was evaluated over a 30 min period. At 30 min 95% of patients in Group US and 85% of patients in Group NS had a partial or complete sensory block of all nerve territories ($P = 0.13$) and 55% of patients in Group US and 65% of patients in Group NS had a complete block of all nerve territories ($P = 0.25$). Surgical anesthesia without supplementation was achieved in 85% of patients in Group US and 78% of patients in Group NS ($P = 0.28$). No patient in Group US and 8% of patients in Group NS required general anesthesia ($P = 0.12$).

In our study meantime for onset of motor block could not be calculated, as a large number of patients (approx. 95%) did not have complete motor paralysis at the point of total loss of sensation to pinprick. This was predictable, as the total dose of Ropivacaine used in the study was lesser than usual dose so total motor blockade was not achieved in approx. 95% patients.

In this study, no differences were observed in post-operative analgesia using VAS scale and in the duration of sensory block (386.31 ± 4.78 min in NS group, 389.30 ± 8.27 min in D5 group, $P = 0.096$).

CONCLUSION

Our study concluded that Ropivacaine when diluted with dextrose shows faster onset time of analgesia compared to dilution with normal saline. Further studies are required to ascertain if the results are similar for different concentrations of other local anesthetics, and for other ultrasound-guided nerve blocks.

REFERENCES

1. Barash PG. Clinical Anaesthesia. 8th ed., Ch. 1. United States: Wiley; 2017. p. 1-23.
2. Wasnick J, Butterworth J, Mackey D. Morgan and Mikhail's Clinical Anaesthesiology. 6th ed., Ch. 1. United States: McGraw Hill Education; 2013. p. 1-7.
3. Marhofer P, Schrogendofer K, Koinig H, Kapral S, Weinstabl C, Mayer N. Ultasonographic guidance improves sensory block and onset time of three-in-one blocks. Anesth Analg 1997;85:854-7.
4. Chan VW, Perlas A, McCartney CJ, Brull R, Xu D, Abbas S. Ultrasound guidance improves the success rate of axillary brachial plexus block. Can J Anaesth 2007;54:176-82.
5. Perlas A, Niazi A, McCartney C, Chan V, Xu D, Abbas S. The sensitivity of motor response to nerve stimulation and paresthesia for nerve localization as evaluated by ultrasound. Reg Anesth Pain Med 2006;31:445-50.
6. Sites BD, Brull R, Chan VW, Spence BC, Gallagher J, Beach ML, *et al*. Artifacts and pitfall errors associated with ultrasound-guided regional anesthesia. Reg Anesth Pain Med 2007;32:419-33.
7. Marhofer P, Schrogendofer K, Wallner T, Koinig H, Mayer N, Kapral S. Ultasonographic guidance reduces the amount of local anesthetic for 3-in-1 blocks. Reg Anesth Pain Med 1998;23:584-8.
8. Abrahams MS, Aziz MF, Fu RF, Horn JL. Ultrasound guidance compared with electrical neurostimulation for peripheral nerve block: A systematic review and meta-analysis of randomized controlled trials. Br J Anaesth 2009;102:408-17.
9. Beach ML, Sites BD, Gallagher JD. Use of a nerve stimulator does not improve the efficacy of ultrasound-guided supraclavicular block. J Clin Anesth 2006;18:580-4.
10. Sandberg W, Urman R, Ehrenfeld J. The MGH Textbook of Anesthetic Equipment. 1st ed., Ch. 11. p. 160-5. London: Churchill Livingstone; 2010.
11. Perlas A, Lobo G, Lo N, Brull R, Chan VW, Karkhanis R. Ultrasound-guided supraclavicular nerve block: Outcome of 510 consecutive cases. Reg Anesth Pain Med 2009;34:171-6.
12. Dhir S, Tureanu L, Bouzari A, Masood A, Francispragasam M, Ganapathy S. Reduction in sodium content of local anesthetics for peripheral nerve blocks: A comparative evaluation of saline with 5% dextrose--a randomized controlled double-blind study. Anesth Analg 2012;114:1359-64.
13. Lim HJ, Hasan MS, Chinna K. Faster onset time of supraclavicular brachial plexus block using local anesthetic diluted with dextrose. Braz J Anesthesiol 2016;66:341-5.
14. Shah B, Vyas AB. Comparative study between 5% dextrose and normal saline in brachial plexus block for onset and duration of complete sensory and motor block. Res J Pharm Biol Chem Sci 2014;5:50-7.
15. Williams SR, Chouinard P, Arcand G, Harris P, Ruel M, Boudreault D, *et al*. Ultrasound guidance speeds execution and improves the quality of supraclavicular block. Anesth Analg 2003;97:1518-23.

How to cite this article: Gupta RK, Ashahiya ID, Chansoriya M, Narang N. Comparative Evaluation of Normal Saline and Dextrose as Diluent of Local Anesthetic in Ultrasonography-Guided Supraclavicular Brachial Plexus Block. Int J Sci Stud 2021;9(8):100-106.

Source of Support: Nil, **Conflicts of Interest:** None declared.