e-ISSN: 0975-5160, p-ISSN: 2820-2651

Available online on www.ijtpr.com

International Journal of Toxicological and Pharmacological Research 2024; 14(5); 47-54

Original Research Article

Comparison between Conventional Block and Nerve Locator Techniques for Supraclavicular Brachial Plexus Block in Upper Limb Surgeries

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Received: 21-03-2024 / Revised: 18-04-2024 / Accepted: 11-05-2024

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Conflict of interest: Nil

Abstract

Background: The supraclavicular block provides effective anesthesia for the brachial plexus for surgical procedures at or below the elbow level. Traditionally, the landmark technique has been used, but this blind method often necessitates multiple needle attempts through trial and error, leading to prolonged procedure times, associated pain, discomfort, and potentially severe complications. Peripheral nerve locator, a newer technique, offers advantages such as reduced procedure time, less pain, and discomfort, and fewer complications. This study aimed to compare two techniques in terms of the time required for the procedure, the onset and duration of sensory and motor blockade, and the overall effectiveness of the block.

Methods: Surgeries involving upper limbs. Patients belonging to the American Society of Anesthesiologists Grade I & II. Patients of either sex, aged between 15-70 years. In one group (Group C, n=30), the conventional subclavian perivascular technique was employed, while in the other group (Group NS, n=30), the supraclavicular nerve block was administered under peripheral nerve locator guidance. In both groups, the block consisted of 15 ml of 0.5% bupivacaine and 15 ml of 2% lignocaine with 1:200,000 adrenaline.

Results: The nerve locator technique was quicker (average time: 5.66 minutes) than the conventional method (8.7 minutes), potentially due to simpler procedures in the latter. The nerve locator approach significantly accelerated the onset of both sensory and motor blocks ($p<0.005$), likely because of direct nerve stimulation and more precise injections. It also prolonged the duration of these blocks ($p<0.005$) and achieved a higher success rate, with 97% complete block compared to 73% in the conventional group. Both methods exhibited low complication rates, which might be attributed to the use of short needles and correct techniques.

Conclusion: Our study reveals that among the available anesthesia techniques to be utilized for the supraclavicular blocks during upper limb surgeries, locating a nerve with a nerve locator results in an early onset of both sensory and motor blockade and a prolonged blockade duration and a decreased need of analgesics both during and after surgery. Furthermore, this technique is seen to have a relatively higher success rate and fewercomplications.

Keywords: Brachial Plexus Block, Peripheral-guided nerve locator, Conventional Block, upper limb surgeries

Introduction

Pain relief during surgery is the primary cause of anesthesia. Regional nerve blocks prevent the unwanted stress of laryngoscopy and tracheal intubation and the adverse effects of general anesthetic drugs [1, 2]. It provides better intraoperative and prolonged post-operative pain relief. Minimizing the stress response and anesthetic drug requirements is beneficial to patients, especially those with various cardiorespiratory comorbidities. Regional anesthesia (RA) is associated with reduced surgical and nonsurgical operative times [2, 3] fewer unanticipated postoperative hospital admissions [4], and greater patient satisfaction. In addition, the complete sensory blockade produced by RA techniques may reduce central sensitization and have a preventive analgesic benefit [5, 6]. However, modern analgesic techniques have several advantages over general anesthesia (GA). [7] Newer RA techniques, such as ultrasound-guided techniques and peripheral nerve locator techniques, produce significantly fewer adverse effects, shorter recovery time, reduced hospital costs, and improved patient satisfaction compared with conventional block and GA [8].

Brachial plexus blocks provide a wonderful alternative to general anesthesia for upper limb surgeries [7]. They achieve near-ideal operative conditions by providing complete and prolonged pain relief, muscle relaxation, maintenance of stable intraoperative hemodynamics, and adequate sympathetic stability. Sympathetic stability decreases postoperative pain, vasospasm, and edema. Among the various approaches to brachial plexus block, the supraclavicular approach is considered the easiest and most effective. It also provides the most complete and reliable anesthesia for upper limb surgery. It is carried out at the level of trunks of the brachial plexus, where it is more compact, that is, at the middle of the brachial plexus, resulting in homogenous spread of anesthetic solution throughout the plexus with a faster onset and complete block. The first brachial plexus block was performed by William Stewart, Halsted in 1882. The patient used cocaine to perform the block after directly exposing the brachial plexus to the neck [2. 5] In 1913, Kulenkampff introduced the classical supraclavicular approach to brachial plexus blocks [9]. In 1964, Winnie and Collins introduced the subclavian perivascular approach to brachial plexus blocks [6]. The conventional subclavian perivascular paresthesia technique, which is a blind technique, may be associated with a higher failure rate and injury to nerves and Vascular structures [9]. Various techniques and approaches have been proposed to minimize these drawbacks. Among them, the peripheral nerve locator offers ease of locating the anatomical structure. Optimal needle positioning offers a safe block with superior quality by optimal needle positioning [6]. Newer techniques, such as ultrasound-guided techniques and peripheral nerve locators, have improved success rates with excellent localization and improved safety margin [7]. However, most anesthesiologists prefer conventional techniques for supraclavicular brachial plexus block because it is cost-effective and faster to perform. This study was designed to compare the well-established conventional subclavian perivascular approach after eliciting paresthesia and the nerve locator technique for supraclavicular.

Brachial plexus block with regard to the time taken for the procedure, onset, and duration of the block, success rate, overall effectiveness of the block, and incidence of complications involved.

Material and Methods

This prospective comparative study was conducted in the Department of Anesthesiology, Kakatiya Medical College, MGM Hospital and Research Centre, Warangal, Telangana State on patients undergoing elective surgeries of the upper limb under regional anesthesia. Approval was taken from the Institutional Ethical Committee before commencing the study. The participants were informed regarding the purpose, procedures, risks, and benefits of the study. Written and Informed Consent was obtained from all participants**.**

Sample Size: The present study was conducted with a total of 60 patients, randomly allocated into two groups; Group C & NL (30 patients each). Group

– C: Patients with supraclavicular brachial plexus block given with conventional paresthesia technique. Group – NL: Patients with supraclavicular brachial plexus block given with peripheral nerve locator technique.

Inclusion Criteria

1. Patients willing to participate in the study
2. Patients belonging to the American Society of Anesthesiologists GradeI & II
3. Patients of either sex, aged between 15-70 years.
4. Elective surgeries
5. Surgeries involving upper limbs.

Exclusion Criteria:

1. Patients are not willing for the procedure.
2. Patients with significant coagulopathies and other contra-indicationsfor
3. supraclavicular brachial plexus block.
4. Patients with psychiatric history.
5. Patient allergic to amide local anesthetics.
6. Preexisting neurological deficit in the upper limb

7. Patients refusing for RA.

Block was performed with 15 ml of 0.5% bupivacaine and 15 ml of 2% lignocaine with adrenaline 1:200000 in both groups. All the patients underwent thorough pre-anesthetic evaluation and ASA risk was stratified. Basic investigations such as Haemoglobin (Hb)%, bleeding time, clotting time, serum urea, serum creatinine, blood sugar, blood grouping, and crossmatching, Urine: albumin, sugar and microscopy, Electrocardiography (ECG) and chest X-ray PA view were done.

All the patients were kept nil per oral as per the fasting guidelines. Inj. midazolam and inj. ranitidine 150 mg, Inj. oldensetrone 4mg was given to all patients 30 minutes before surgery.

Operating Room: A peripheral intravenous line was accessed using an 18G intravenous cannula. All the patients were premedicated with an injection of glycopyrrolate 8µg/kg intramuscularly (IM) 45 minutes before starting the procedure. Intravenous fluid was started for all patients and was shifted tothe operating room.

Group C underwent a conventional subclavian perivascular nerve block. Patients were positioned supine with aseptic preparation of the supraclavicular area. The subclavian artery was palpated, and a 23G needle was inserted with real-time needle manipulation based on paresthesia (tingling) elicited in the arm. Following negative aspiration for blood, 30 ml of local anesthetic was injected. A three-minute massage facilitated distribution. If paresthesia wasn't achieved within 20 minutes, the patient received alternative anesthesia and was excluded from the study.

Group NL: Nerve Locator Technique: This group used a nerve locator. After locating the brachial plexus by feel (around 2.5cm lateral to the sternocleidomastoid muscle), a stimulating needle was inserted and adjusted until a specific muscle twitch response was achieved. This guided the needle toward the lower trunk (fingers). Once a finger twitch was elicited at a low current (0.5mA), the local anesthetic (25ml) was injected. The success of the block depends on reaching the lower trunk (motor response of the fingers) is the most important factor in accomplishing a successful supraclavicular brachial plexus block. As soon as paraesthesia was elicited, the needle was fixed in position, and 25ml of the respective drug was injected depending on whether the patient was allotted to The Quality of sensory and motor block was studied and graded as per whether the blocks were complete, incomplete, or absent. The patients were watched for bradycardia, convulsions, drowsiness, and other complications.

A: showing positioning of patient and site preparation; B: Conventional method of supraclavicular approach; C: Brachial block- Supraclavicular approach; D: Supraclavicular approach with Nerve locator

Statistical analysis: All the available data was uploaded to an MS Excel spreadsheet and analyzed by SPSS version 21 in Windows format. The continuous variables were represented as mean, standard deviation, and percentages. The categorical variables were calculated by using students' unpaired t-test, and Yate's chi-square test. The values of p (<0.05) wereconsidered as significant.

Results

This prospective single-blinded randomized controlled study was done in 60 ASA I and II patients of either sex aged from 15 to 70 years, posted for upper limb surgeries under supraclavicular brachial plexus block. The study was undertaken to evaluate the time taken for the procedure, onset, and duration of blockade, success rate, and overall effectiveness of block and complications of the conventional subclavian perivascular approach of supraclavicular brachial plexus block performed versus peripheral nerve locator technique.

Table 1: Age-Wise Distribution of study groups

Age groupin years	Group C		Group NL		T value	P value
	N	%	N	%		
15 – 30	11	36.7	12	40.0	0.13	0.891
31 – 45	10	33.3	10	33.3		
46 – 70	9	30.0	8	26.7		
Total	30	100.0	30	100.0		

In Group C, the number of patients in the age group 15–30 years is 11, while in Group NL, it is 12. The total number of patients in Group C in theage group 31–45 years is 10, and in Group NL also, it is 10. The total number of persons in Group C in the age group 46–70 years is 9, while in Group NL, it is 8. Samples are age-matched with a p-value of 0.89 ($p > 0.05$), hence statistically not significant. So, the age distribution between the two groups is comparable. The gender distribution (male: female ratio) in group C was 19:11, while in group NL, it was 11:8. The P value was 0.428 ($p > 0.5$). Hence, it is not significant, and the groups were comparable.

Table 2: Comparison of conventional and peripheral nerve locator-guidedblock based on the mean body weight of the patients:

Study Group	Mean ± SD (kgs)	Mean Difference	t Value	P value
Group C	61.3 ± 7.77	1.53	0.471	0.319
Group NL	60.47 ± 7.56			

As shown in Table 2 the mean weight of the patient in group NL was 60.47±7.56 kilograms and in group C, it was 61.3±7.77 kilograms and it is not statistically significant (p=0.319).

Table 3: Comparison of conventional and peripheral nerve locator guided block based on time taken for the procedure

Study Group	Mean ± SD (mins)	Mean Difference	t value	p-value
Group C	5.66 ± 1.7	3.03	4.17	0.000*
Group NL	8.7 ± 2.36			

*Significant

As shown in Table 3 the mean duration taken to perform a conventional block was 5.66 ± 1.7 minutes and in group NL, it was 8.70 ± 2.36 minutes. The statistical analysis by student's unpaired 't' test showed that the conventional technique was significantly faster to perform when compared to the peripheral nerve locator-guided technique ($p<0.001$).

Table 4: Comparison of conventional and peripheral nerve locator-guided block based on the time taken for the onset of sensory and motor blockade

Study group	Mean ± SD (min)	Mean Difference	T value	P value
Sensory Blockade				
Group C	10.89 ± 8.11	2.77	3.16	0.003*
Group NL	8.11 ± 2.67			
Motor Blockade				
Group C	13.00 ± 3.7	2.77	2.58	0.007*
Group NL	10.42 ± 3.16			

As shown in Table 4, the mean time for the onset of sensory block in group C was 10.89 ± 8.11 minutes, and in group NL, it was 8.11 ± 2.67 minutes. The statistical analysis by the student's unpaired 't' test showed that the time taken for the onset of sensory block in group C was significantly faster when compared to group C (p = 0.003). The mean time for the onset of motor block in group C was 13 ± 3.7 minutes, and in group NL, it was 10.42 ± 3.16 minutes. The statistical analysis by the student's unpaired 't' test showed that the time for onset of motor block in group NL was significantly faster when compared to group C (p = 0.007).

Table 5: Comparison of conventional and peripheral nerve locator-guidedblock on the basis duration of sensory and motor blockade

Study group	Mean ± SD (min)	Mean Difference	T value	P value
Sensory Blockade				
Group C	5.41 ± 1.1	0.91	3.34	0.001*
Group NL	6.32 ± 0.97			
Motor Blockade				
Group C	5.04 ± 1.08	0.77	3.08	0.001*
Group NL	5.82 ± 0.83			

*Significant

Table 5 shows the mean duration of sensory block in group NL was 6.32 ± 0.97 hours and in group C was 5.41 ± 1.1 hours. The statistical analysis by students unpaired 't' test showed that the duration of sensory block in groupNL was significantly longer when compared to group C, with a 'p' value of 0.001 (p < 0.01). Similarly, the mean duration of the motor block in group NL was 5.82 ± 0.83 hours, and in group C was 5.04 ± 1.08 hours. The statistical analysis by students' unpaired 't' test showed that group NL has some moreduration of motor blockade when compared to group C, and it is statisticallysignificant (p < 0.01).

Table 6: Comparison of intraoperative analgesic supplementation, overalleffectiveness, and success rate of the blocks

Intraoperative Analgesic supplementation					
	Supplementation required	Supplementation Not required		Chi-Square	P value
Group C	9	21		7.86	0.006*
Group NL	1	29			
Overall Effectiveness of the Block					
	Totally Effective	Partially effective	Converted to GA	Chi-Square	P value
Group C	21	7	2	6.53	0.038*
Group NL	29	1	0		
	Success rate			Chi-Square	P value
	Number	Percentage			
Group C	21	93.33		2.069	0.006*
Group NL	29	98.33			

*Significant

Table 6 shows that in Group NL, 1 out of 30 patients required analgesic supplementation during surgery, and in the conventional group, it was 9 outof 30 patients. The chi-square value is 7.68. The requirement for analgesics was significantly reduced in the peripheral nerve locator group than in the conventional group. (p = 0.006). For the comparison of the effectiveness of the blockade in group NL, 29 patients (99.67%) had an effective blockade, and in 1 patient the block was partially effective (1.33%), and there was no conversion to general anesthesia in the NL group. Whereas in group C, only 21 patients had an effective block; in 7 patients, the block was partially effective; and in 2 patients, the block failed and required conversion to general anesthesia. This difference is statistically significant (p< 0.05). For the overall success of the block, we found in group C, 21 out of 30 cases had a successful block (93.33% success rate). In group NL, all 29 cases had a successful block (98.33% success rate). The record of complications revealed that 4 among 30 patients in Group C had vessel puncture (13%) and 1 among 30 patients in Group NL (3%). No other Complication was elicited in either of the groups.

Discussion

The success of peripheral nerve blocks is based on the ability to correctly identify nerves involved in surgery and put an adequate dose of local anesthetic around them, to achieve a complete impregnation of all nerves involved in surgery. Brachial plexus block has been proven to be a valuable method of providing anesthesia for surgery of the forearm and hand. The mostcommon technique is the supraclavicular approach of the brachial plexus because of its ease of performance and increased extent of blockade. The patients in our study did not vary much with respect to age, sex, and weight.

The p-value was 0.896 for age-wise distribution among the groups and 0.319 for weight. Distribution ($p > 0.05$) and are not significant. The mean age group for conventional in the study was 37.9 ± 14.08 years old, and in. the nerve locator, it was 37.43±13.44 years. The mean weight of the patients in the conventional group was 61.3 ± 7.77 kg and in the nerve locator, it was 60.47 ± 7.56 kg. Hence, both groups are comparable.

We have used a 30 ml, 1:1 ratio of 0.5% Inj. Bupivacaine and 2% Inj. Lignocaine with adrenaline for both groups. In a study by Duggan et al. [11] to determine the minimum effective volume of a lignocaine-bupivacaine mixture for Nerve locator guided supraclavicular block, It is concluded that ED50 is 23 ml (i.e., the effective dose for 50 patients is 23 ml) and ED95 is 42 mL without any major complications. They found no difference in the volume of drugs needed in Nerve locator-guided techniques when compared to conventional techniques. Several research studies have focused on the selection of a 30 mL local anesthetic volume for supraclavicular blocks. Tranet al. [12] have reported the efficiency of the use of Nerve locator in the supraclavicular block for 90% of patients through a volume of 32 ml. Jeon et al. [13] determined that ED90 of 30 mL, without side effects, was applicable. Hickey et al. [14] and Raizada et al. [15] used 30 ml for conventional subclavian perivascular blocks. Therefore, we decided to use a volume of 30 ml for both the nerve locator and conventional subclavicular perivascular techniques in this study.

Our study found the conventional subclavian block mean time to be: The scan completion time of the new system (mean: 28.62 seconds) was 43% faster ($p<0.005$) than the nerve locator technique (average time: 8.7 minutes). These findings are similar to previous studies that reported faster times with a familiar approach compared to ultrasound-guided and nerve stimulation practices [16, 17]. The reason behind the difference in our study is probably because of such factors as the weak battery and/or the inability to pick out the nerve bundle in the nerve locator group. However, Duncan et al. [18] and Williams et al. [19] noticed the same time for the locator of the nerves and ultrasound, but Stephan et al. state that faster time for the use of ultrasound than the nerve stimulator, which might be due to the identification of the anatomy being different between the techniques used in their study. Our study found that the conventional subclavicular block procedure, which relies on feeling for a tingling sensation (paresthesia), was significantly faster (average time: 5.66 minutes) compared to the nerve locator technique (average time: 8.7 minutes) ($p<0.005$). This aligns with previous research by Singh et al. [16] and Veeresham et al. [17] who reported faster times for conventional approaches. The nerve locator technique may have been slowed down by weakbatteries or other technical difficulties. The conventional technique relies ona simpler approach for identifying the target area, potentially leading to a quicker setup time compared to the nerve locator method. While some studies have shown similar times for nerve locator and ultrasound-guided techniques, others suggest ultrasound might be faster than nerve stimulation. [15-19] This variation highlights potential differences in how these techniques are used in various studies. Our study found a statistically significant faster onset of sensory block (average time: 8.11 minutes) in the nerve locator group compared to the conventional technique (average time: 10.89 minutes) ($p<0.005$). This finding suggests potential advantages of the nerve locatormethod. The nerve locator allows for a more targeted injection within the fascia, which some studies suggest might lead to a faster onset of the block compared to the extra fascial approach used in the conventional technique. Studies by Gajendra Singh et al. [16] and Veeresham et al. [17] reported similar sensory block onset times between nerve locator/ultrasound and conventional techniques. Duncan et al. [18] and Chan et al. [20] observed a faster onset time with ultrasound-guided techniques compared to nerve stimulation, suggesting potential differences in how these techniques are implemented.

Our study also revealed a statistically significant faster onset of motor block in the nerve locator group (average time: 10.42 minutes) compared to the conventional technique (average time: 13 minutes) ($p<0.005$). This aligns with findings from other studies. Singh et al. [16] reported a faster motor block onset with ultrasound-guided techniques compared to the conventional approach. Duncan et al. [18] Their study showed a faster motor block onset with ultrasound guidance compared to nerve stimulation. This study also observed a quicker motor block onset with ultrasound compared to the nerve stimulator technique. An interesting observation in our study, and potentially in others as well, is that the onset of motor block was slower than sensory block in both groups. This suggests that a numbness sensation might occur before complete motor function loss. Our study demonstrated a statistically significant difference (p<0.005) in the duration of sensory block. The nerve locator group achieved an average block duration of 6.32 hours, while the conventional technique only lasted 5.41 hours. This extended duration of numbness with the nerve locator technique is supported by previous research. Singh et al. [16] found a significantly longer sensory block duration with ultrasound and nerve stimulation techniques compared to conventional approaches. Veeresham et al. [17] observed a prolonged block duration in the nerve stimulation group compared to the conventional group. Stephen et al. [19] a longer duration of anesthesia with ultrasound guidance compared to nerve stimulation. Duncan et al. [18] While they observed a slight prolongation of sensory block in the ultrasound group, it wasn't statistically significant compared to the nerve stimulation group. The extended duration of the sensory block with the nerve locator technique suggests a potential benefit for pain management procedures.

Our study revealed a statistically significant advantage (p<0.005) for the nerve locator technique in terms of motor block duration. The nerve locator group achieved an average motor block duration of 5.82 hours, compared to 5.04 hours for the conventional technique. This extended motor block duration aligns with findings from Gajendra Singh et al. [16] reported a longer motor block duration with the nerve locator group compared to the conventional approach. Furthermore, our study suggests a significant difference (p<0.005) in block success rate between the two techniques. These results indicate a considerably higher success rate with the nerve locator

technique compared to the conventional method. This is statistically significant (p<0.05) based on the chi-square test. Overall, the findings favor the nerve locator technique for achieving a longer duration of both sensory and motor block, and a higher success rate for block achievement compared to the conventional subclavian perivascular paresthesia eliciting method. Studies reported a higher incidence of vascular puncture compared to our findings. [10, 16, 17] Other studies documented a higher rate of hematoma formation compared to our conventional group. Research suggests a lower risk of complications like vascular puncture and diaphragmatic paresis compared to conventional techniques. Our study likely benefited from using short needles and careful injection techniques in both groups. This highlights the importance of proper technique to minimize complications during any peripheral nerve block procedure.

Conclusion

Our study reveals that among the available anesthesia techniques to be utilized for the supraclavicular blocks during upper limb surgeries, locating a nerve with a nerve locator results in an early onset of both sensory and motor blockade and a prolonged blockade duration and a decreased need for analgesics both during and after surgery. Furthermore, this technique is seen to have a relatively higher success rate and fewer complications. The single drawback of the nerve locator technique is that it takes a little longer than the conventional way

References

1. Folino TB, Mahboobi SK. Regional Anesthetic Blocks. [Updated 2023 Jan 29]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan. Available from: https://www.ncbi.nlm.nih.gov/books/NBK563238/
2. Raj Phulchand. Historical aspects of Regional Anaesthesia. 1st ed. Chapter 1. In: Textbook of Regional Anaesthesia; 2002 May. p. 3 - 15.
3. Vermeylen K, Engelen S, Sermeus L, Soetens F, Van de Velde M. Supraclavicular brachial plexus blocks: review and current practice. Acta anaesthesiologica Belgica 2012; 63:15-21.
4. Lee JA, Atkinson RS, Rushman GB. A Synopsis of Anesthesia. 10th ed. England: IOP Publishing Ltd. 1987; p. 618.
5. Kulenkampff D Anesthesia of the brachial plexus. Zentralbl Chir 1911; 38:1337- 50.
6. Winnie AP, Collins VJ. The Subclavian Perivascular Technique of Brachial Plexus Anesthesia. Anesthesiology. 1964 May-Jun; 25:353-63.
7. Kothari D. Supraclavicular Brachial Plexus Block: A New Approach. Indian J. Anaesth. 2003; 47 (4): 287-288
8. Armstrong KPJ, Cherry RA. Brachial plexus anesthesia compared to general anesthesia when a block room is available. Can J Anaesth 2004; 51:41–44.
9. D'Souza RS, Johnson RL. Supraclavicular Block. [Updated 2023 Jul 25]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK519056/
10. Carty Suzanne, Nicholls Barry. Ultrasound-guided regional anesthesia. Continuing Education in Anaesthesia, Critical Care & Pain 2007; 7:20- 24.
11. Duggan E, El Beheiry H, Perlas A, Lupu M, Nuica A, Chan VW, Brull R. Minimum effective volume of local anesthetic for ultrasound-

guided supraclavicular brachial plexus block. Reg Anesth Pain Med. 2009 May- Jun;34 (3): 215-18.
12. Tran DQ, Dugani S, Correa JA, Dyachenko A, Alsenosy N, Finlayson RJ. Minimum effective volume of lidocaine for ultrasound-guided supraclavicular block. Reg Anesth Pain Med. 2011 Sep-Oct;36(5):466- 69.
13. Jeon DG, Kim SK, Kang BJ, Kwon MA, Song JG, Jeon SM. Comparison of ultrasound-guided supraclavicular block according to the various volumes of local anesthetic. Korean J Anesthesiol. 2013 Jun;64(6):494- 9.
14. Hickey R, Garland TA, Ramamurthy S. Subclavian perivascular block: influence of location of paresthesia. Anesth Analg. 1989 Jun; 68(6):767- 71.
15. Raizada N, Chandralekha, Jain P. C, Kumar. Does compounding and an increase in the concentration of local anesthetic agents increase the success rate of brachial plexus block? Indian Journal of Anaesthesia. 2002; 46(3):193-196.
16. Gajendra Singh, Mohammed Younus Saleem. Comparison of the conventional technique from the ultrasound-guided supraclavicular block in upper limb surgeries. International Journal Scientific Study; Nov 2014; 2(8):169-176.
17. M. Veeresham, Upender Goud, P. Surender, Pavan Kumar. Comparison between Conventional Technique and Ultrasound-Guided Brachial Plexus Block in Upper Limb Surgeries. Journal of Evolution of Medical and Dental Sciences 2015; 4(37): 6465-76.
18. Duncan M, Shetti AN, Tripathy DK, Roshan Singh D, Krishnaveni N. A comparative study of nerve stimulator versus ultrasound-guided supraclavicular brachial plexus block. Anesth Essays Res. 2013 Sep- Dec;7(3):359-64.
19. Williams SR, Chouinard P, Arcand G, Harris P, Ruel M, Boudreault D, Girard F. Ultrasound guidance speeds execution and improves the quality of supraclavicular block. Anesth Analg. 2003 Nov;97(5):1518- 23.
20. Chan VWS, Perlas A, Rawson R, Odukoya O. Ultrasound-guided supraclavicular brachial plexus block. Anesth Analg. 2003 Nov;97(5): 1514-17.