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Original Article

Comparison of the Efficacy of Infraclavicular Block: Land Mark Technique versus Nerve Stimulator versus Ultrasound Technique through Coracoid Approach for Upper-Limb Surgeries

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Abstract

Introduction: Regional anesthesia for upper-limb surgeries has minimal side effects and complications and is cost effective. In upper-limb surgeries, infraclavicular block (ICB) is a good alternative to axillary and supraclavicular block as it prevents the side effects and complications such as vessel puncture and pneumothorax because of consistent bony landmarks.

Purpose: The present study aims to compare the efficacy of ICB using ultrasound, nerve stimulator, and landmark techniques through coracoid approach in patients undergoing upper-limb surgeries.

Materials and Methods: In a prospective, randomized study, 90 patients of either sex belonging to ASA Grades I and II, 20–60-year old undergoing forearm, elbow, wrist, and hand surgeries under ICB were randomly divided into three groups using computer-generated software in ultrasound-guided Group U, nerve stimulator guided Group N, and landmark technique Group L. 30 patients in each group were selected randomly.

Aims: Procedural time, Onset and time for peak effect of sensory and motor block, VAS Score, Number of doses of rescue analgesia.

Results: Compared with the landmark and nerve stimulator-guided block, the ultrasound-guided ICB had lesser procedural time (3.35 ± 1.05 min), early onset of sensory and motor block (6.02 ± 2.47 min, 7.93 ± 3.73 min, respectively), less time to achieve peak sensory and motor effect (14.66 ± 2.47 min, 19.62 ± 3.43 min, respectively), and more rate of a successful blockade (96.67%).

Conclusion: The use of ultrasound guidance for ICB decreases the procedural time, time for onset of sensory, motor block as well as time for peak effect of sensory, motor block and has better success rates.

Key words: Infraclavicular brachial plexus block, Nerve stimulator guidance, Onset of sensory and motor block, Procedural time, Success rate, Ultrasound guidance

INTRODUCTION

Brachial plexus block is a well-accepted technique for anesthesia and post-operative analgesia for upper-limb orthopedic surgeries. Surgeries of hand and forearm can be taken up under infraclavicular brachial plexus block (ICBPB). ICBPB is gaining support because of its consistent bony landmarks, lower probability of Vessel puncture, intense block and lesser incidence of pneumothorx.[1] ICBPB reduces tourniquet pain, prevents the side effects of general anesthesia, and requires shorter duration of hospital stay.[2-4] Among various approaches of ICBPB, the coracoid approach is the most popular[5] because of the presence of a consistent bony landmark, lesser chances of vascular puncture, and adequate neural blockage.[6] Historically, ICBPB was performed through

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blind technique using anatomical landmarks, Later on, nerve stimulator was used which ensures somewhat better blockade but both of these can cause neurovascular and pleural injuries, leading to permanent nerve damage and pneumothorax, respectively.[7-9] In recent years, with the ultrasound guidance (USG), we can know the exact location of nerves plexus and vessels. With USG, complete blocks have been demonstrated with a prolonged analgesic effect even exceeding the sensory block,[10] with higher success rates and fewer complications, lesser time to perform the block, and volume of the local anesthetic drugs.[11] Ultrasound guidance is the gold standard for peripheral regional anesthesia.[12-14]

Therefore, the present study is designed to compare the efficacy of ICBPB: Landmark technique versus nerve stimulator versus ultrasound technique through coracoid approach for upper-limb surgeries. Such a study had never been conducted in our institute with a very few studies done in the past comparing these.

MATERIALS AND METHODS

After obtaining the approval from Institutional Ethics and Thesis Committee along with the written and informed consent, this prospective, observational clinical study was conducted on 90 patients of either sex belonging to ASA Grade I and II, 18–60 years of age, admitted in tertiary hospital undergoing forearm, elbow, wrist, and hand surgeries under ICBPB. The ICBPB was attained with the injection ropivacaine 0.5% + injection butorphanol 1 mg using landmark, nerve stimulator, and ultrasound-guided techniques. Patients were randomly divided using computer-generated software into three groups of 30 each as Group L: Landmark technique, Group N: Nerve stimulator, and Group U: USG. A detailed pre-anesthetic check-up of the patients was carried out a day before surgery. General physical examination and systemic examination were done. Routine investigations were reviewed. The procedure to be performed was explained in detail; written informed written consent was obtained from each patient before the procedure. All patients were reassessed in the pre-operative room and vitals were noted. Then, the patients were shifted to the operation theater. An IV line using 18/20G IV line was secured. An infusion of ringer lactate solution was started. Patients' monitoring was started using the multipara monitors (NIBP, ECG, and SpO_2) which were attached and baseline readings were recorded. All patients were given tablet alprazolam 0.25 mg orally night before surgery and in morning with a sip of water, injection midazolam 0.04 mg/kg, injection butorphanol 1 mg, and injection ondansetron 0.1 mg/kg before the start of the surgery. Patients were made to lie in the supine position with arms by side and the head is turned away from the side to be blocked. The area was cleaned with povidone iodine solution and draped properly.

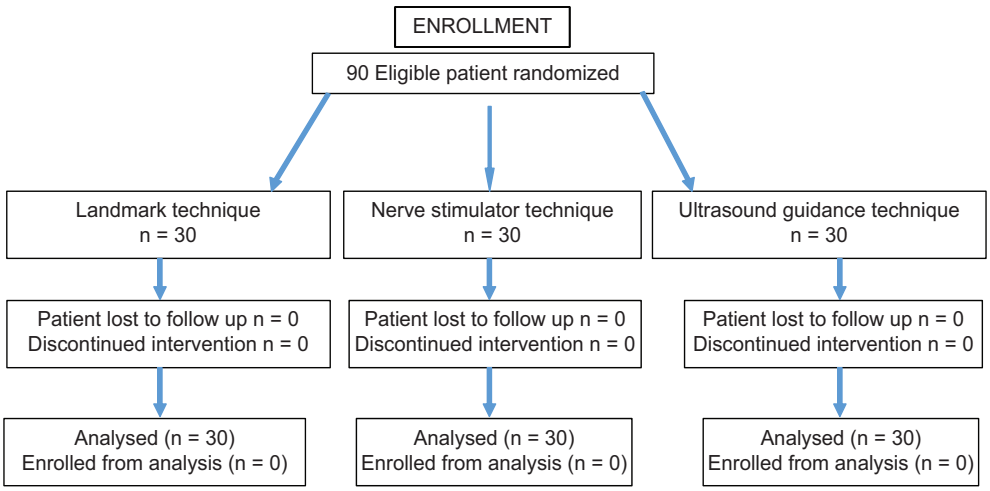
Group L: Received 30 mL of 0.5% ropivacaine + injection butorphanol 1 mg by ICBPB using landmark technique.

Group N: Received 30 mL of 0.5% ropivacaine + injection butorphanol 1 mg by ICBPB using nerve stimulator.

Group U: Received 30 mL of 0.5% ropivacaine + injection butorphanol 1 mg by ICBPB using USG.

Exclusion criteria patients who refused to take part in the procedure or to enlist in study, ASA Grade III and IV, clinically significant pulmonary pathology, coagulation disorders, anticoagulation therapy, having history of allergy to local anesthetic and known neuropathies involving forearm and hand, uncooperative patients, and pregnant patients were excluded from the study.

Study Design



Analysis: Required sample size calculated	
Input	Effect size f=0.34
	α err prob=0.41
	Power (1-β err prob) = 0.95
	Numerator df=10
	Number of groups=3
	Number of covariates=1
Output	Noncentrality parameter λ = 9.9416000
	Critical F=1.0502587
	Total sample size=84
	Actual power=0.95006

Thus, sample size taken for the ease of distribution into three groups was 90.

Block Assessment

The attainment of a successful block was determined by the following methods –

1. Procedural time taken to complete the block in each technique was noted. It was defined as the time after cleaning and draping of site, till the injection of local anesthetic drug
2. Sensory block was assessed by Hollmen scale

Onset of sensory block was defined when the patient achieved a score of Grade II (pin prick felt as a sharp pointed but weaker compared with the same area in other limbs).

Time taken to achieve peak sensory block was defined when the patient achieved score of Grade IV (no perception of pin prick).

3. Motor block was assessed by modified Bromage scale

Onset of motor block was defined when the patient achieved a score of Grade II (decreased motor strength with ability to move fingers only).

Time taken to achieve peak motor block was defined when the patient achieved a score of Grade III (complete motor block with inability to move fingers).

4. Post-operative pain was assessed using VAS Score.

VAS was assessed post-operatively at every 1 h interval for the first 4 h and then 2 h for the next 8 h and then every 4 h till 24 h. Rescue analgesia was given if VAS was more than 3 in the form of i/v paracetamol infusion. If pain is not relieved by paracetamol, injection tramadol 100 mg i/v was given.

5. Success rate of each technique was noted.

A successful block was defined if surgery was done without patient discomfort or without the need for supplementation or sensory blockade of Grade IV and motor blockade of Grade III.

A failed block was defined if a sensory region involved in the surgery was not completely anesthetized and the block needed supplementation by injection propofol or any other drug or sensory and motor blockade was less than Grades IV and III, respectively.

6. Number of inadvertent vessel punctures were noted in each block
7. Number of pricks taken in each block were noted in each block
8. Hemodynamic changes, side effect, and complication were also noted in each block.

RESULTS

In the present study, we included 90 patients into the study $n = 30$ each. Patient's demographics were comparable ($P > 0.05$) in all the three groups. The duration of surgery was also comparable between the groups as shown in Table 1.

Procedure time (time after cleaning and draping of site, till the injection of local anesthetic drug) of Group L was 9.59 ± 4.63 min, Group N was 6.62 ± 2.49 min, and of Group U was 3.35 ± 1.05 min ($P < 0.01$) as shown in Table 2.

The mean onset of sensory block in Group L was 9.01 ± 4.13 min, Group N was 7.99 ± 3.69 min, and Group U was 6.02 ± 2.47 min. Onset of sensory block was nonsignificant between Group L/N ($P = 0.313$ NS) but was significant between Group N/U ($P = 0.023$ S) and was highly significant between Group L/U ($P = 0.001$ HS). Mean time for peak effect of sensory block of Group L was 19.61 ± 5.13 min, Group N was 17.58 ± 3.69 min, and Group U was 14.66 ± 2.47 min. Time for peak sensory block was nonsignificant between Group L/N ($P = 0.117$ NS), significantly between Group N/U ($P = 0.014$ S), and highly significant between Group L/U ($P = 0.001$ HS) as shown in Table 2.

The mean onset of motor block in Group L was 12.28 ± 6.02 min, Group N was 10.35 ± 5.27 min, and Group U was 7.93 ± 3.73 min. Onset of motor block was nonsignificant between Group L/N ($P = 0.191$ NS) but was significant between Group N/U ($P = 0.040$ S) and was highly significant between Group L/U ($P = 0.001$ HS). Mean time for peak effect of motor block of Group L was 23.28 ± 5.16 min, Group N was 22.35 ± 4.27 min, and Group U was 19.62 ± 3.43 min. Time for peak motor block was nonsignificant between Group L/N ($P = 0.450$ NS), significantly between Group N/U ($P = 0.008$ S), and Group L/U ($P = 0.004$ S) as shown in Table 2.

Success rate of Group L was 80%, Group N was 90%, and Group U was 96.67%. Success rate was non-significant between Group L/N and N/U ($P > 0.05$ NS) but was significant between Group L/U with $P = 0.044$(S).

Table 1: Demographic characteristic of patients in Groups L, N, and U

Demographics	Group L	Group N	Group U	*P*-value		
				L/N	N/U	L/U
Mean age	39.60±13.14	37.06±15.53	36.53±14.33	0.847 (NS)	0.988 (NS)	0.767 (NS)
Gender						
Male	20 (66)	23 (76)	21 (70)	0.389 (NS)	0.559 (NS)	0.781 (NS)
Female	10 (33)	7 (23)	9 (30)			
ASA Grade						
I	21 (70)	21 (70)	24 (80)	1.00 (NS)	0.371 (NS)	0.371 (NS)
II	9 (30)	9 (30)	6 (20)			
Mean duration of surgery (in hours)	1.65±0.64	1.58±0.59	1.61±0.74	0.661 (NS)	0.862 (NS)	0.823 (NS)

Table 2: Procedure time, sensory and motor block characteristics, and success rate among Groups L, N, and U

Parameters	Group L	Group N	Group U	*P*-value		
				L/N	N/U	L/U
Procedure time (minutes)	9.59±4.63	6.62±2.49	3.35±1.05	0.001 (HS)	0.001 (HS)	0.001 (HS)
Mean onset of sensory block (minutes)	9.01±4.13	7.99±3.69	6.02±2.47	0.313 (NS)	0.023 (S)	0.001 (HS)
Mean time to peak sensory block (minutes)	19.61±5.13	17.58±3.69	14.66±2.47	0.117 (NS)	0.014 (S)	0.001 (HS)
Mean onset of motor block (minutes)	12.28±6.02	10.35±5.27	7.93±3.73	0.191 (NS)	0.040 (S)	0.001 (HS)
Mean time to peak motor block (minutes)	23.28±5.16	22.35±4.27	19.62±3.43	0.450 (NS)	0.008 (S)	0.004 (S)
Success rate	24 (80)	27 (90)	29 (96.67)	0.687 (NS)	0.300 (NS)	0.044 (S)
Number of inadvertent vessel puncture	2 (6.6)	1 (3.3)	0	0.553 (NS)	0.523 (NS)	0.150 (NS)
Number of patients requiring multiple pricks	7 (23.3)	5 (16.6)	1 (3.3)	0.518 (NS)	0.085 (NS)	0.020 (S)

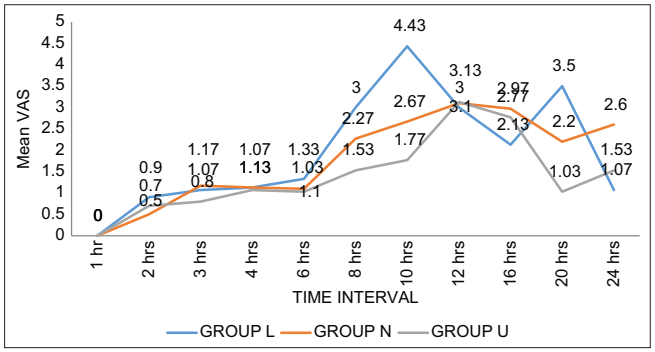
NS: Non significant (*P*>0.05); S: Significant (*P*<0.05); HS: Highly significant (*P*<0.001)

There were 6.67% vessel punctures in Group L, 3.3% vessel puncture in Group N, and no vessel puncture seen in Group U. However, no significant difference was seen among the 3 groups ($P > 0.05$). In these cases, the needle was withdrawn and redirected. The drug was then injected after negative aspiration. Thus, sign and symptoms associated with intravascular injection were not encountered in any of these patients as shown in Table 2.

Needle pricks were repeated twice in 7 patients in Group L, 5 patients in Group N, and 1 patient in Group U. However, the difference between the three groups was non-significant ($P > 0.05$) as shown in Table 2.

During post-operative period, patients were monitored for pain using VAS score at every 1 h interval for the first 4 h and then 2 h for the next 8 h and then every 4 h till 24 h. VAS scores were comparable among three groups for the first 8 h of the study. At 12th h, VAS was comparable between the three groups. At 16 h, VAS was significant between Group L/N ($P = 0.04$) and non-significant between Group N/U and L/U ($P > 0.05$). Latter on, VAS was comparable and statistically non-significant ($P > 0.05$) among all the groups till 24 h as shown in Graph 1. Rescue analgesia was given when VAS was more than three and total number of rescue analgesia given was maximum in Group L and minimum in Group U.

Baseline hemodynamic parameters were comparable in all the three groups at all measured intervals and remained stable. None of the patient developed pneumothorax, Horner's syndrome, hoarseness, arrhythmias, respiratory depression, and neuropathy in the post-operative period.



Graph 1: VAS score

DISCUSSION

Coracoid approach is better because of easy identification of coracoid process and there is no need for limb movement. ICBPB provides certain advantages over interscalene, supraclavicular, and axillary approaches, as the complications such as pneumothorax and vessel puncture are less, and the block is more consistent.[14] Using USG to identify nerves, further improves the success rate of block as the drug is deposited close to the nerve sheath, and chances of vascular and neurological injuries are less. In the present study, we compared landmark versus nerve stimulator versus ultrasound technique using coracoid

approach for ICBPB. Only two patients in Group L and one patient in Group N had vascular puncture while performing the block. None of the patients developed pneumothorax, Horner's syndrome, hoarseness, and neuropathy in the post-operative period. In the present study, the primary outcome was shorter procedure time, faster onset of the sensory and motor block, time to achieve peak sensory and motor effect was less, and the success rate achieved was more with the use of USG for the block.

Procedural time was shorter in USG (3.35 ± 1.05 min) in our study. This fact is supported by studies done by Taboada[15] *et al*. where they observed that time to perform the ICBPB was shorter using USG (3 ± 1 min) vs. 6 ± 2 min with nerve stimulator and Trabelsi[16] *et al*. who found the procedural time for ICBPB was 3.6 min ± 2.1 with ultrasound versus 4.6 ± 2.2 min with nerve stimulator.

The mean onset of sensory and motor block was significantly less in Group U (6.02 ± 2.47 and 7.93 ± 3.73 min) which was almost comparable with a study done by Dakshinamurthy[17] with USG supraclavicular BPB in where they found that the time for onset of sensory block with ropivacaine was 5.22 ± 1.28 min and motor block was 7.90 ± 1.68 min. Time for peak sensory onset with ropivacaine was in 14.93 ± 2.14 min and the peak motor onset was in 18.82 ± 3.01 min. Time to achieve peak sensory and motor effect were also significantly less in Group U (14.66 ± 2.47 and 19.62 ± 3.43 min, respectively) which is also comparable to above study. Similarly, Kyizom *et al*.[18] did a study with 30 mL of 0.5% ropivacaine for USG brachial plexus block and found the mean time to achieve peak sensory and motor effects of 14.37 ± 3.7 min and 19.63 ± 3.96 min, respectively.

In the present study, the success rate was significantly higher with Group U (96.67%) which was comparable with a study done by Desroches[19] in which they observed the success rate of 91% for ICBPB by coracoid approach using nerve stimulator and with a study done by Ootaki *et al*.[20] in which they found the success rate of 95% in ultrasound-guided ICBPB and they concluded that ICBPB using USG produced more accurate block with lesser discomfort of the patient when compared with landmark technique. Likewise, Taboada *et al*.[15] did a comparative study between ultrasound and nerve stimulator-guided ICBPB using coracoid approach and found 89% success with ultrasound versus 91% with nerve stimulator. However, the difference was statistically nonsignificant ($P = 0.881$).

Limitations

The anesthesiologist performing the block was also monitoring the block parameters. Hence, double blinding is not possible. As the sample size was small, the study had significantly important results, so future studies should be undertaken with a large population size. We used VAS score as a pain measurement method which is not an objective method and could have some variability in patient's ability to use that scale. To perform the USG-guided block techniques, trained and registered anesthesiologist is needed which may me not available in all the other centers.

CONCLUSION

Finally, it can be concluded that ultrasound-guided ICBPB is a better choice as compared to peripheral nerve stimulator-guided or landmark-guided technique as it provides better placement of drugs near the nerve plexus producing better results. It was observed that with the use of USG for ICBPB, the procedural time is shortened, time for onset of sensory, motor block as well as time for peak effect of sensory, motor block is reduced, better success rates are achieved, and number of inadvertent vessel punctures and number of pricks taken are also reduced.

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