

A Observational Study Between Ultrasound Guided (USG), Peripheral Nerve Stimulator (PNS) And Combined Technique (PNS+USG) For Supraclavicular Brachial Plexus Block in Patients Undergoing Elbow and Below Elbow Surgeries

Sayyada Sameera Mahveen¹, Syed Nasiruddin²

¹Consultant Anaesthesiologist, Dept. of Anaesthesia, Manur Multi-speciality Hospital, Kalaburagi

²Assistant Professor, Dept of General Surgery, GIMS, Kalaburagi

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Corresponding Author: Dr. Syed Nasiruddin

Conflict of interest: Nil

Abstract:

Background: The aim of this study is to assess and compare between ultrasound guided, peripheral nerve stimulator and combined technique for supraclavicular brachial plexus block in patients undergoing elbow and below elbow surgeries with respect to ease of administration, success rate and quality of block.

Materials and Methods: 75 patients belonging to ASA I and II grades and presenting for elective upper limb surgeries in the age group of 20-60 years were included in the study. They were randomly divided into one of the following three groups. Patients who received supraclavicular block through PNS technique were labelled as Group A. Patients who received supraclavicular block through USG technique were labelled as Group B. Patients received supraclavicular block through combined method were labelled as Group

C. We used 20-35 ml of local anaesthetics for all 3 groups which was a mixture of Lignocaine, Bupivacaine, Hyalase, Dexta with distilled water. In all 3 groups we noted block execution time, time taken for achieving complete nerve block, onset of sensory block, onset of motor block, duration of sensory block, duration of motor block, need for supplementation, safety profile, success and failure.

Observation and Results: There were no significant changes noted in all 3 groups with respect to demographic parameters. Mean time required for performing block was significantly lesser in combined group (6.32 +/- 1.60 min). Similarly, onset of sensory block was minimum in combined technique (5.56 +/- 2.56min). Mean duration of sensory block was observed to be more in combined technique (8.54 +/- 2.79 hours).

Conclusion: We observed shorter procedure time, faster onset time of sensory and motor block with combined USG and PNS guided supraclavicular block. There was no incidence of complications such as arterial puncture, nerve injury and pneumothorax with any of the techniques

Keywords: Brachial Plexus Block, Peripheral Nerve Stimulator, Ultrasound, Combined Technique.

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Introduction

Regional anaesthesia has much to offer for patients, surgeons and anaesthesiologists because of its inherent simplicity, preservation of consciousness, avoidance of airway instrumentation, rapid recovery and significant postoperative analgesia. Brachial plexus block has been widely used for upper limb surgeries. The various routes described for brachial plexus approach are interscalene, supraclavicular, infraclavicular and axillary [1].

The supraclavicular block is one of the several techniques used to accomplish anaesthesia of the brachial plexus. This supraclavicular block is performed at the level of the brachial nerve plexus trunks where majority of the sensory, motor and sympathetic innervation of the upper extremity is carried in just three nerve structures confined to a small surface area. Conse-

quently, typical features of this block include rapid onset, predictable and dense anaesthesia[1].

Kulenkampff in Germany in 1911 performed the first percutaneous supraclavicular approach, reportedly on himself, a few months after Hirschel described a definite surgical approach to the nerve plexus in the axilla [2]. The technique was later published in 1928 by Kulenkampff and Persky [2]. The brachial plexus block is also very much helpful in emergency cases where general anaesthesia is contraindicated. The technique provides most homogeneous block. There is a minimal possibility of missing peripheral or proximal nerve branches. Due to prolonged duration of analgesia, immediate post-operative analgesics can be avoided for pain relief.

Thus regional blockade at the brachial plexus provides effective and reliable anaesthesia and analgesia for upper extremity surgeries. However, success is highly dependent upon the precise localization of neural structures. Historically, this was accomplished through the elicitation of one or more paresthesia. The exclamation,

—No paresthesia, no anaesthesia became the mantra of many (though not all) of our founding fathers [3]. Clinicians in opposition to paresthesia techniques often cite an increased risk of neurologic complications postoperatively by proclaiming —more the paresthesia, more the dysesthesia. Although the intentional elicitation of a paresthesia may represent direct needle trauma and theoretically increase the risk of neurological injury, there are no prospective, randomized clinical studies that are able to definitively support this hypothesis. Paresthesia can indicate that the needle is in close proximity to the nerve and is a warning sign of impending mechanical contact and if the needle should be further advanced.

The above dictums summarize the opposing views regarding the risks and benefits of the paresthesia versus non-paresthesia techniques used to perform peripheral nerve blockade.

To avoid some of the mentioned problems, the use of peripheral nerve stimulator was started to allow better localization of the brachial nerve plexus. The nerve stimulation technique rely on the use of electric current to elicit motor stimulation of nerves and confirm the proximity of the needle to the nerve [4]. In addition to a good success rate, there are other advantages in this method. Patients need not be discomforted to paresthesia when the nerve is stimulated to produce a motor twitch, because motor fibers have lower electrical threshold compared to sensory fibers. Another point in favor of nerve localization by electrical stimulation is that a satisfactory block may be performed when the patient is uncooperative, or uncommunicative, as a result of a psychotic state, coma, or language barrier and it can be given in any position. Regional block with the aid of a nerve stimulator can also be performed under general anesthesia, especially in children [5].

However, this nerve stimulator method of giving block may not be foolproof with persistent risk of nerve/vessel/ injury to pleura leading to pneumothorax [5].

The use of ultrasound for exact localization of brachial nerves has revolutionized the field of regional anaesthesia wherein ultrasound probes with suitable frequencies have successfully been tried. Use of ultrasound helps in providing real-time view of the block needle, the brachial nerve plexus and its relationship to the neighboring vital structures, it has increased the success rates and also has brought down the complication rates [6].

Hence, present study was planned to assess and compare between ultrasound guided, peripheral nerve stimulator and combined technique for supraclavicular brachial plexus block with respect to the ease of administration, success rate and quality of block in patients undergoing elbow and below elbow surgeries.

Material and Methods

This observational study was carried out in the Manur multi-speciality hospital, Kalaburagi.

Inclusion Criteria

1. Patients who will be posted for elbow and below elbow surgeries and anaesthetised by supraclavicular brachial block
2. Patients of either sex
3. Patients of age group between 20-60 years
4. Patients with informed written consent
5. ASA I and II

Exclusion Criteria

1. Infection at the site of block
2. Neuropathy (diabetic neuropathy)
3. Allergic to Local anaesthetics
4. Neurological deficits
5. Severe diabetics
6. Old pulmonary pathology

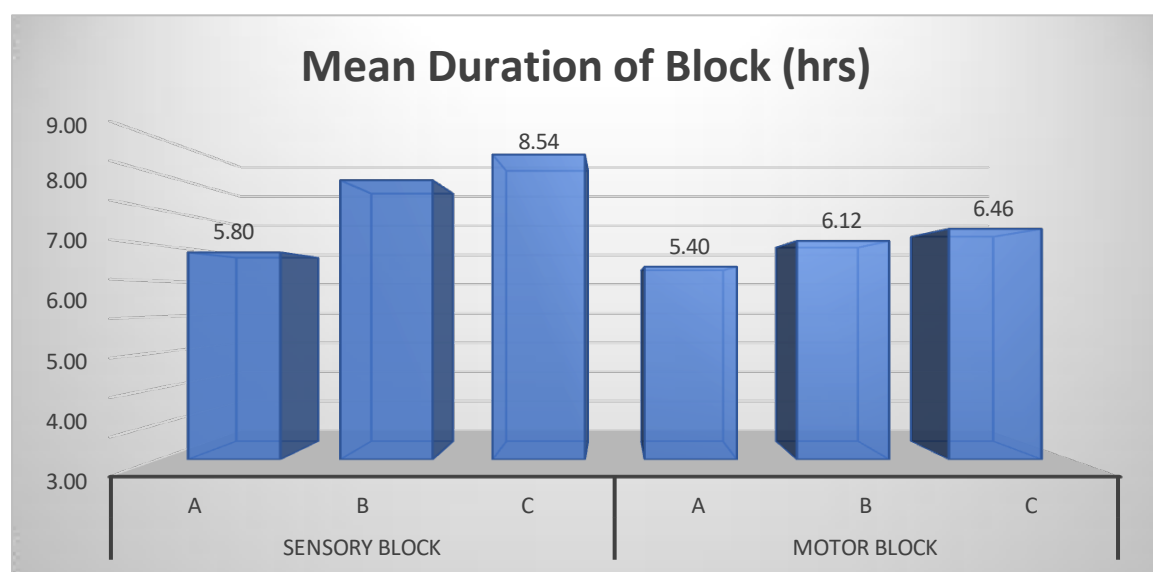
Results

Table 1: Mean comparison of duration of motor and sensory block

Duration (mins)	Group	N	Mean	SD	p- value
Sensory Block	A	25	5.80	2.67	<0.05 (A vs B & C)
	B	25	7.82	1.93	
	C	25	8.54	2.79	
Motor Block	A	25	5.40	2.46	0.16
	B	25	6.12	1.91	
	C	25	6.46	1.49	

Mean duration of sensory and motor block was observed to be more combined PNS and USG technique (8.54 and 6.46 hrs) followed by USG technique alone (7.82 vs 6.12) and lowest in PNS technique (5.80 and

5.40 hrs). The difference was however statistically significant in sensory block duration across three groups ($p < 0.05$).

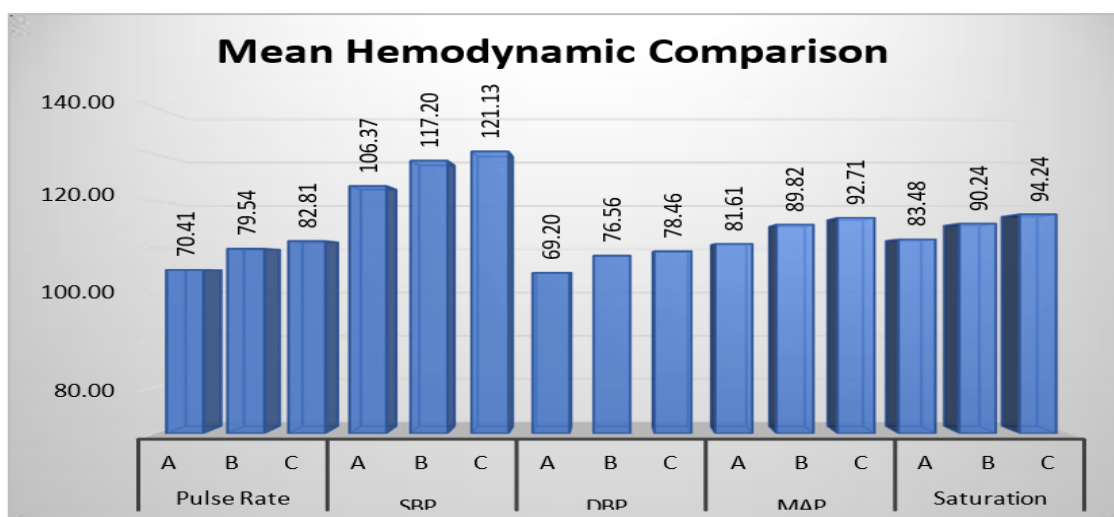


Graph 1: Mean comparison of duration of motor and sensory block

Table 2: Mean comparison of baseline hemodynamic parameters

Hemodynamic Parameters	Group	N	Mean	SD	p- value
Pulse Rate	A	25	70.41	33.99	0.26
	B	25	79.54	26.93	
	C	25	82.81	20.51	
SBP	A	25	106.37	48.32	0.37
	B	25	117.20	36.61	
	C	25	121.13	27.17	
DBP	A	25	69.20	31.73	0.4
	B	25	76.56	24.33	
	C	25	78.46	18.21	
MAP	A	25	81.61	37.24	0.39
	B	25	89.82	28.37	
	C	25	92.71	21.16	
Saturation	A	25	83.48	37.20	0.41
	B	25	90.24	27.20	
	C	25	94.24	19.69	

All the three groups were comparable with respect to baseline hemodynamic parameters ($p > 0.05$).

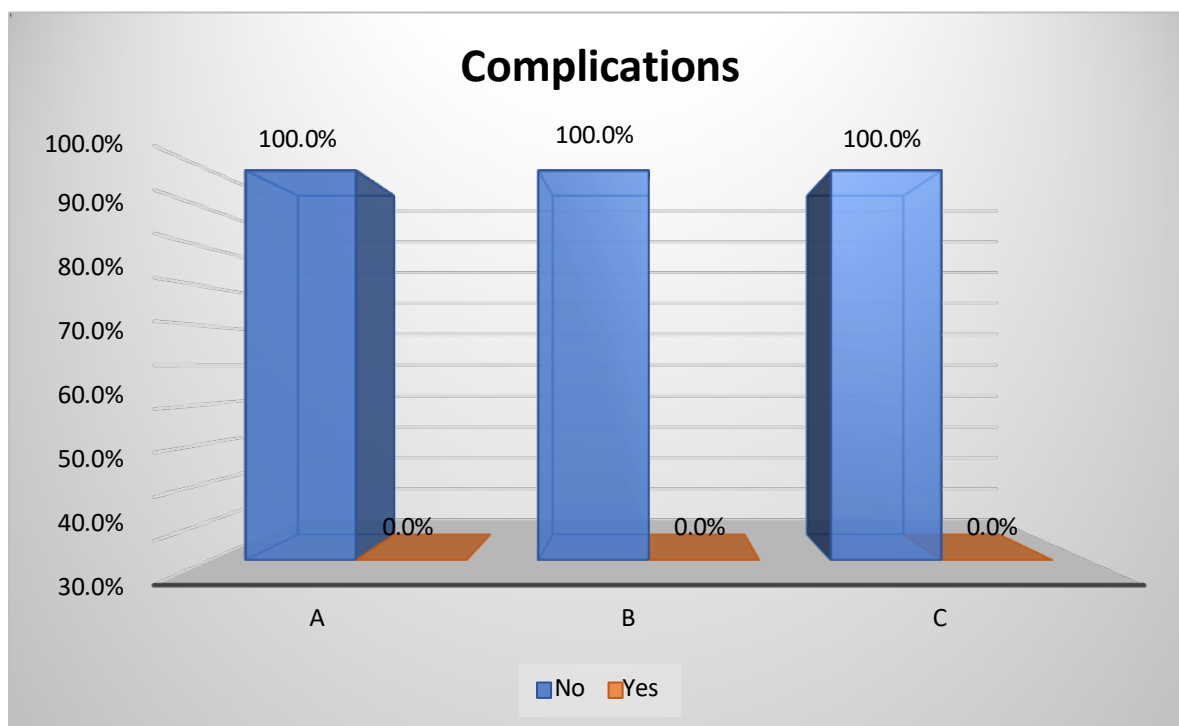


Graph 2: Mean comparison of baseline hemodynamic parameters

Table 3: Comparison of associated complications among group

Group	Complications		Total
	No	Yes	
A	25	0	25
	100.0%	0.0%	100.0%
B	25	0	25
	100.0%	0.0%	100.0%
C	25	0	25
	100.0%	0.0%	100.0%
Total	75	0	75
	100.0%	0.0%	100.0%
p- value - NA			

No Complication was observed in any of the study groups.

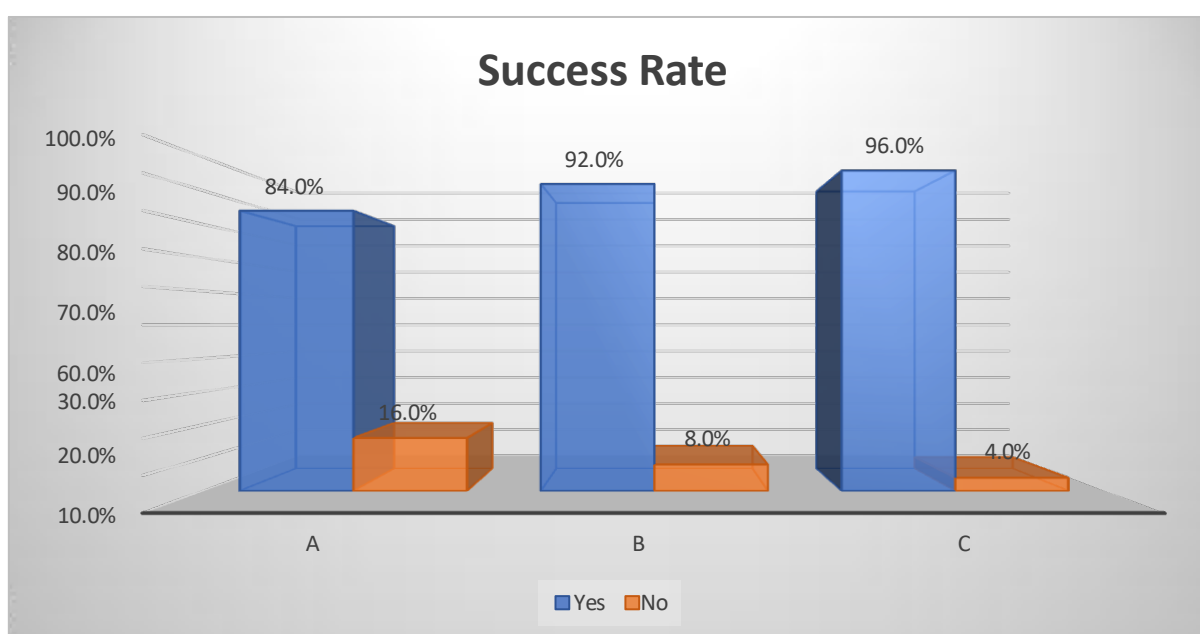


Graph 3: Comparison of associated complications among group

Table 4: Comparison of success rate among study groups

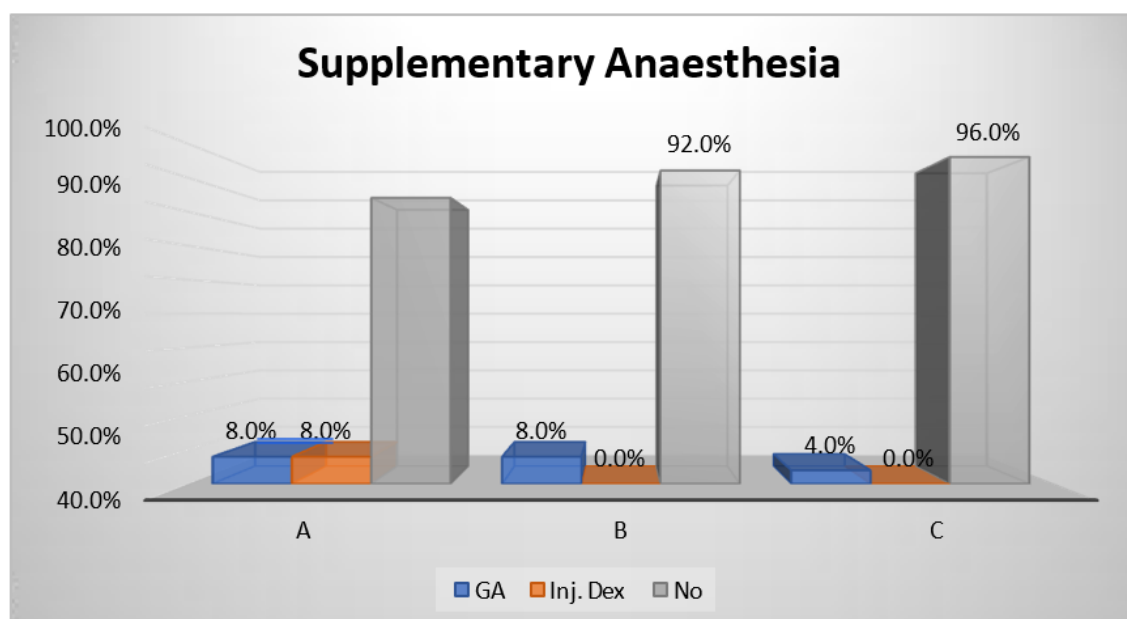
Group	Success Rate		Total
	Yes	No	
A	21	4	25
	84.0%	16.0%	100.0%
B	23	2	25
	92.0%	8.0%	100.0%
C	24	1	25
	96.0%	4.0%	100.0%
Total	68	7	75
	90.7%	9.3%	100.0%
p- value - 0.3			

Success rate was highest in combined PNS and USG technique alone (96%) as compared to either PNS (84%) or USG (92%) technique alone.

**Graph 4: Comparison of success rate among study groups****Table 5: Comparison of requirement of Supplementary Anaesthesia among study groups**

Group	Supplementary Anaesthesia			Total
	GA	Inj. Dex	No	
A	2	2	21	25
	8.0%	8.0%	84.0%	100.0%
B	2	0	23	25
	8.0%	0.0%	92.0%	100.0%
C	1	0	24	25
	4.0%	0.0%	96.0%	100.0%
Total	5	2	68	75
	6.7%	2.7%	90.7%	100.0%
p- value - 0.33				

Supplementary anaesthesia was required in 1 (4%) case of combined technique group while it was required in 2 (8%) and 4 (16%) cases respectively of USG and PNS group.



Graph 5: Comparison of requirement of Supplementary Anaesthesia among study groups

Discussion

The present study was planned to combine USG and PNS technique for supraclavicular brachial plexus block and compare it with USG and PNS technique with respect to the ease of administration, success rate and quality of block in patients undergoing elbow and below elbow surgeries.

The aim of the study was to assess and compare between ultrasound guided, peripheral nerve stimulator and combined technique for supraclavicular brachial plexus block with respect to the ease of administration, success rate and quality of block as measured by duration of analgesia in patients undergoing elbow and below elbow surgeries.

To the best of our knowledge, there are very few studies evaluating the combined use of USG and PNS technique for brachial plexus block. Study done by Casati et al. [7] compared the time to onset of an axillary block utilizing a multiple injection technique with USG and nerve stimulator technique. Study done by Soeding et al. [8] compared paraesthesia guided brachial block to ultrasound-guided approach in the performance of interscalene and axillary blocks. A randomized controlled trial was done by Vinu Mervick, Alfred et al. [9] to compare ultrasound with peripheral nerve stimulator-guided technique for supraclavicular block in upper limb surgeries.

These are few studies who have compared PNS and USG; but not combined PNS and USG. Paucity of studies to compare between ultrasound guided, peripheral nerve stimulator and combined technique for supraclavicular brachial plexus block with respect to the ease of administration, success rate and quality of block as measured by duration of analgesia in patients

undergoing elbow and below elbow surgeries prompted us to design present study.

Study included a total of 75 subjects posted for elbow and below elbow surgeries and anaesthetised by supraclavicular brachial plexus block. Patients who received supraclavicular block through PNS technique were labeled as group A; Patients who received supraclavicular block through USG technique were labeled as group B and patients who received supraclavicular block through combined method were labeled as group C.

Mean age of the study subjects was 37.62 years while mean weight was 60.21 Kg. No difference was observed among study groups with respect to age and weight distribution. Out of total 75 cases, 56 (74.7%) were males while 19 (25.3%) were females. No difference was observed between study groups with respect to gender distribution ($p=0.93$).

Time required for performing supraclavicular brachial plexus block was minimum in combined PNS and USG technique as compared to other two techniques (PNS: USG: Combined PNS & USG – 8.82 vs 7.02 vs 6.32 mins; $p<0.05$).

Orebaugh et al. [10] compared the time taken to perform various blocks (interscalene, axillary, femoral and popliteal) with either a PNS alone or a PNS aided by US. The authors reported that US-aided blocks were faster to perform (median = 1.6 min vs 6.5 min, $p<0.001$). This finding is consistent with the findings in our study, in our study time required for performing supraclavicular brachial plexus block was lesser in combined PNS and USG technique (6.32 min) as compared to other two techniques Sites et al. [11] compared the time to perform an axillary block utilizing a transarterial technique (TA) versus ultrasound (US).

The US group demonstrated a reduction in performance times vs transarterial group (7.9 ± 3.9 min vs 11.1 ± 5.7 min, $p < 0.05$). This finding is consistent with the findings in our study, in our study time required for performing supraclavicular brachial plexus block was lesser in USG technique as compared to PNS.

In a prospective study, Williams et al. [12] assessed the quality, safety, and execution time of supraclavicular blocks of the brachial plexus using ultrasonic guidance and neurostimulation compared with a supraclavicular technique that used anatomical landmarks and neurostimulation. The block was performed in an average of 9.8 min in Group NS and 5.0 min in Group US ($P = 0.0001$). This finding is consistent with our study, where time required for performing supraclavicular brachial plexus block was lesser in combined PNS and USG technique (6.32 min) as compared to other two techniques ((PNS: USG: Combined PNS & USG – 8.82 vs 7.02 vs 6.32 mins;). The procedure time was greater in the nerve stimulator group because of the variability in the relationship between the surface anatomy and nerve location whereas use of USG may minimize this variation. Furthermore, PNS technique took a longer time since the initial response was seen at the shoulder and then the needle position had to be adjusted slightly posteriorly to get finger twitches. With USG guidance, positioning, and any repositioning of the needle is performed under direct vision whereas in the PNS technique, landmark technique is used to locate the plexus requiring repeated needle pricks and needle repositioning ultimately leading to longer procedure time.

Marhofer et al. [13] evaluated whether ultrasound facilitates the approach for blocks. Forty patients undergoing hip surgery after trauma were randomly assigned to either an ultrasound (US) or a nerve stimulator (NS) group. The onset of sensory blockade was significantly shorter in Group US compared with Group NS (US 16 ± 14 min, NS 27 ± 16 min, $P < 0.05$). This finding is consistent with the findings in our study

Time of onset of sensory block was minimum in combined PNS and USG technique as compared to other two techniques (PNS: USG: Combined PNS & USG – 7.32 vs 6.86 vs 5.56 mins; $p < 0.05$) while no difference was observed related to time of onset for motor block ($p = 0.24$). Mean duration of sensory and motor block was observed to be more in combined PNS and USG technique (8.54 and 6.46 hrs) followed by USG technique alone (7.82 vs 6.12) and lowest in PNS technique (5.80 and 5.40 hrs). The difference was however significant in sensory block duration across three groups ($p < 0.05$), reason being that the sonographic imaging-guided supraclavicular block helps in assessing the size, depth, and the exact location along with the anatomy of the adjacent structures. Ultrasound assists in the exact placement of the needle and helps in depositing the local anesthetic in the accurate site and also helps in visualizing the spread of the drug.

Soeding et al. [14] compared conventional —landmark-based— plexus anaesthesia to an ultrasound-guided approach in the performance of interscalene and axillary blocks. The use of ultrasound significantly improved the onset and completeness of sensory ($p = 0.011$) and motor ($p < 0.01$) block. This finding is consistent with the findings in our study, in our study the US group had faster onset and longer completeness of block compared to PNS group.

Casati et al. [7] compared the time to onset of an axillary block utilizing a multiple injection technique with either US or a PNS. The onset of sensory block was shorter in the US group (14 ± 6 min) than in the PNS group (18 ± 6 min) (P value = 0.01) whereas there were no differences observed in onset of motor block or readiness to surgery (28 ± 8 min in US group versus $28 \pm$ min in PNS group). This finding is consistent with the findings in our study, in our study time of onset of block was faster in USG guided block, compared to PNS alone. Time of onset of sensory block in our study is 5.56 min (combined), 6.86 min (USG) and 7.32 min (PNS)

Marhofer et al. [13] observed that onset of sensory blockade was significantly shorter in group US compared with Group NS (US 16 ± 14 min, NS 27 ± 16 min, $P < 0.05$). The quality of the sensory block after injection of the local anesthetic was also significantly better in Group US compared with Group NS (US $15\% \pm 10\%$ of initial value, NS $27\% \pm 14\%$ of initial value, $P < 0.05$). This finding is consistent with the findings in our study, in our study time of onset of block was faster in US and duration of block was longer in US group compared to PNS group. Time of onset of sensory block in our study is 5.56 min (combined), 6.86 min (USG) and 7.32 min (PNS)

Conclusion

We observed shorter procedure time, faster onset time of sensory and motor block with combined USG and PNS guided supraclavicular block. There was no incidence of complications such as arterial puncture, nerve injury and pneumothorax with any of the techniques

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