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"A COMPARATIVE STUDY OF ULTRASOUND GUIDED TECHNIQUE VERSUS PERIPHERAL NERVE STIMULATOR GUIDED TECHNIQUE IN INFRA-CLAVICULAR BRACHIAL PLEXUS BLOCK FOR UPPER LIMB SURGERIES."

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ABSTRACT **Background:** Extensive use of ultrasonography for block execution has increased the success of procedure due to direct visualization of anatomical structures. Infra-clavicular brachial plexus block can be an attractive alternative to supra-clavicular nerve block for upper limb surgeries. The objective of our study was to assess and compare the efficacy and success rate of USG guided technique versus PNS technique in Infra-clavicular brachial plexus block.

Material And Methods: 70 adult patients with age in the range of 18-60 years, weight 50-80 Kg, ASA Grade I & II posted for elective upper limb surgeries of hand, wrist, forearm and distal arm under infra-clavicular brachial plexus block.

Group P (PNS)– Nerve stimulator guided Infraclavicular brachial plexus block.

Group U (USG)– Ultrasound guided Infraclavicular brachial plexus block.

Block execution time, sensory blockade, motor blockade and success rate were assessed. Assessment of sensory blockade was done by Hollmen scale whereas motor block assessment was done by Bromage Scale.

Results: There was statistically significant difference between the groups for block execution time, onset of sensory and motor blockade, time for complete sensory and motor block and success rate($p<0.05$).

Conclusion: We conclude that, Ultrasound guided infraclavicular nerve block has shorter block execution time, faster sensory and motor block onset, significantly earlier complete sensory and motor blockade, higher success rate with lesser pricks and minimal complications and should be preferred over PNS technique.

KEYWORDS : Ultrasound guided Technique, Nerve stimulator guided Technique, Infraclavicular brachial plexus block.

INTRODUCTION:

Brachial plexus block remains the promising practical alternative to general anaesthesia for various surgeries on the upper limb. For more complex major procedures, continuous catheter techniques allow prolongation of analgesic block with earlier mobilization, improved rehabilitation, and the potential to reduce hospital stay and improve functional outcome[1]. **Halsted and Hall (1895)** performed the first regional anaesthetic procedure and indeed performed the first operation under brachial plexus block when he freed the cords and nerves of the brachial plexus after blocking cervical roots in neck with cocaine solution[2,3]. The first percutaneous supraclavicular block was performed in 1911 by German surgeon. **Bazy** was first to describe the infraclavicular block in 1914[4]. In 1967, **Speigel** described the infra-clavicular trans-pectoral perivascular technique[4]. **P. Prithvi Raj** modified the technique and reported a new approach with higher success rates using a nerve stimulator in 1973[4]. **Sims** developed the lateral infraclavicular block in 1976 to present a more consistent performance with a constant landmark: the coracoid process[5]. The infraclavicular block is a safer regional anesthetic technique developed to avoid the side effects and complications of supraclavicular block, particularly pneumothorax[6]. The success rate for infraclavicular brachial plexus block using nerve stimulation reportedly ranges from 60 to 80% [6]. Usage of peripheral nerve stimulator provides better localization of the nerves and plexus. The Ultrasound application for Infraclavicular brachial plexus block has improved the success rate of block with excellent localization and improved safety margin[7] specially in patients with variations in anatomical structures.

MATERIAL AND METHODS:

This prospective, observational study was conducted in the Department of Anaesthesiology, at a tertiary care center after approval from the Institutional ethics committee. The study was carried out in 70 adult patients admitted in the department of Orthopaedics, with age in the range of 18-60 years, weight 50-80 Kg, ASA Grade I & II posted for elective upper limb surgeries of hand, wrist, forearm and distal arm under infra-clavicular brachial plexus block. They were included in the study only after obtaining a written informed consent.

Inclusion Criterias:

Age between 18-60 years, body weight between 50-80 kg. American Society of Anesthesiologists Grade I & II, willing to undergo surgeries under regional anesthesia. Patients who had contraindications to peripheral nerve blocks like bleeding diathesis, local infections, neurological issues, cardiovascular and respiratory diseases were excluded from the study.

METHODOLOGY

Detailed pre-anaesthetic evaluation of the patients was performed by an experienced anaesthesiologist, a day before the surgery. Preliminary Investigations in the form of CBC, Blood grouping, HIV, HBsAg, Blood sugar, BTCT, Coagulation profile, LFT, KFT, ECG and Chest x ray were noted. Special investigations were also noted according to the patients for further evaluation, if required.

All patients were kept NBM for 8 hours before surgery. Patients were well explained about the procedure, technique, risk of procedure, pain score and informed written consent were obtained from them. Patients were also assured that any pain, anxiety or discomfort during surgery would be treated effectively. All patients were given Tab. Pantoprazole 40 mg and Tab. Alprazolam 0.5 mg orally a day prior to surgery and on the day of surgery in the morning. In operation theatre, multipara monitoring device with ECG, pulse rate, non-invasive blood pressure, SpO_2 was attached to the patient and baseline parameters were noted. Ringer lactate was started after establishing intravenous line with 18G cannula in unaffected limb, before the block. Patients also received Inj. Pantoprazole 40 mg and Inj. Ondansetron 4 mg IV. The Patients were allocated to one of the two groups of 35 patients each.

Group P (PNS)– Nerve stimulator guided Infraclavicular brachial plexus block with a standardized local anesthetic admixture containing 15 ml of 2% lidocaine with adrenaline 1:200000 and 15 ml of 0.5% bupivacaine (total volume 30 mL).

Group U (USG)– Ultrasound guided Infraclavicular brachial plexus block with a standardized local anesthetic admixture containing 15 ml of 2% lidocaine with adrenaline 1:200000 and 15 ml of 0.5% bupivacaine (total volume 30 mL).

Positioning of patient: The patients were positioned supine with the operative-side elbow flexed to 90° and the palm of the hand lying comfortably across the abdomen. The proposed site of block was aseptically prepared and draped. The site of needle puncture was infiltrated with 1% lignocaine 3 ml.

Group P (Peripheral nerve Stimulation group)

In Group P (PNS), the infraclavicular brachial plexus block was given by Coracoid approach, guided with peripheral nerve stimulator. A

sterile 22G, 50 mm insulated needle (Stimuplex, B. Braun Medical, Bethlehem, PA, USA) connected to a grounded nerve stimulator. Under all aseptic precautions, after local infiltration at the puncture site, the needle was inserted medially to the tip of the coracoid process and angled 15 degree to the coronal plane. In order to elicit the motor responses, the needle was redirected 0.5–1 cm superiorly or inferiorly (while maintaining posterior–inferior needle angulation) as needed.

Two of the following three motor endpoints were sought:

(1) lateral cord stimulation (elbow flexion, finger flexion, or thumb opposition);
(2) posterior cord stimulation (wrist extension);
(3) medial cord stimulation (finger flexion, thumb or wrist adduction).

At a minimum threshold current of 0.3–0.5 mA for each endpoint, a standardized local anesthetic admixture injected incrementally at each position.

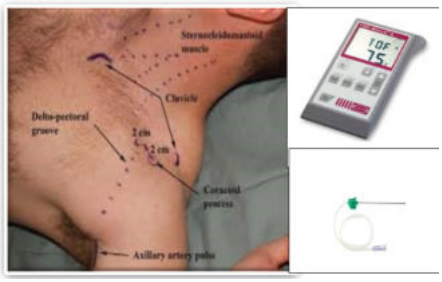


Fig 1:surface anatomy of Infra-clavicular brachial plexus block with coracoid approach

Group U (Ultrasound group)

In Group U (USG guided), the infraclavicular brachial plexus block was given under the guidance of Ultrasonography. A Sonosite Micromax-HFL linear probe (6-13 MHz) with PCPNDT no. MH INGC/0473 was used for conducting the block in every case. It is available in the Department. The ultrasound probe was positioned medially to the coracoid process and caudally to the clavicle to allow visualization of the axillary artery in the parasagittal plane. Slight rotational movements of the probe was made until a short-axis view of the cords of the brachial plexus was obtained and identified as round hypoechoic nodules located around the second part of the axillary artery. A sterile 22G, 50–80 mm insulated needle (Stimuplex, B. Braun Medical, Bethlehem, PA, USA) was advanced using an in-plane needle approach under ultrasound guidance. In one needle pass, the needle tip was positioned under direct vision adjacent to the lateral cord (9 o'clock position relative to the second part of the axillary artery). In another needle pass, the needle tip was positioned adjacent to the posterior cord (6 o'clock position relative to the second part of the axillary artery). At each of these positions, a standardized local anesthetic admixture was injected incrementally.

The occurrences of adverse events or potential block-related complications were recorded in both the groups, including vessel puncture, nerve injury, pneumothorax, anaphylaxis, local anaesthetic toxicity and were treated accordingly.

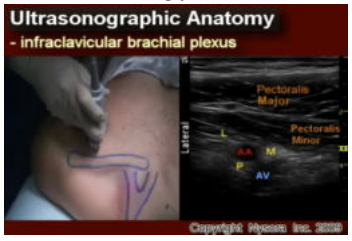


Figure 2: showing ultrasonographic anatomy of infraclavicular brachial plexus.

Intra-operatively all patients were monitored for vitals, Sensory and motor block characteristics.: onset, complete and total duration of sensory block, Motor block: onset, density of block by using Modified Bromage scale and total duration of motor block, Visual Analogue Scale score for pain assessment.

Cardiorespiratory parameters were recorded in every 5 minutes till 1 hour, then in 2nd hour for every 10 minutes and in every 20 minutes thereafter till the completion of surgery.

Block execution time:

Group P (PNS) - From the time of insertion of the needle to its removal.

Group U (USG) - From the time of keeping the USG probe for scanning till the removal of the needle.

Sensory Block Assessment – Sensory block was evaluated by **Hollmen scale**[8] and findings were recorded at an interval of every 2 min from time-0(Time of injection of local anaesthetic) till complete sensory block was achieved i.e. Hollmen Score = 4.

Hollmen Scale[8]**:**

Score 1 = Normal sensation of pinprick.
Score 2 = Pin prick felt as sharp pointed but weaker compared with same area in the other upper limb.
Score 3 = Pin prick recognized as touch with blunt object.
Score 4 = No perception of pin prick.

Time for Onset of Sensory Block (TFOSB): was taken as the time interval in minutes from time-0(Time of injection of local anaesthetic) till sensory block started appearing i.e. Hollmen score = 2.

Time for Complete Sensory Block (TFCSB): was taken as the duration of time in minutes from time-0 till complete sensory block was achieved i.e. Hollmen Score=4. Thereafter effect of block was tested every 30 minutes.

Total Duration of Sensory Block (TDSB): was taken as the duration of time from the time-0 till the time when patient came back to Hollmen score 1.

Assessment Of Motor Block:

Motor block was evaluated by using **Bromage Scale (BS)**[8] for upper extremity and findings were recorded at an interval of every 2 min from time-0 till complete loss of motor power was achieved i.e. BS Score=3

Bromage scale for upper extremity[8]**:**

0: Able to raise the extended arm to 90° for full 2 seconds.
1: Able to flex the elbow and move the fingers but unable to raise the extended arm.
2: Unable to flex the elbow but able to move the fingers.
3: Unable to move the arm, elbow and fingers.

Time for Onset of Motor Block (TFOMB): was taken as the time interval in minutes from time-0 till motor block started appearing i.e. BS score ≥1.

Time for Complete Motor Block (TFCMB): was taken as the duration of time in minutes from time-0 till complete motor block was achieved i.e. BS score=3. Thereafter effect of block was tested every 30 minutes.

Total Duration of Motor Block (TDMB): was taken as the duration of time from time-0 till the time when BS score 0 with complete recovery of motor functions in the postoperative period.

Success:

Block was considered to be successful when the patient had a full block of all the sensory dermatomes and had no power to move above-mentioned joints i.e. Shoulder, elbow, and wrist.

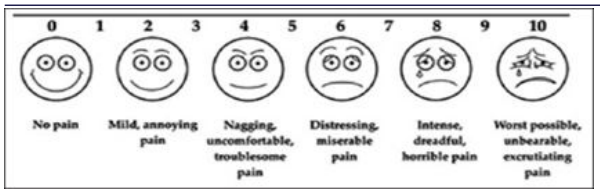
Failure:

Failure was defined as the absence of full sensory block in at least one dermatome, even after 30 mins failed block was converted to GA and these patient were excluded from the study.

Postoperatively, Patients were monitored till the complete recession of sensory as well as motor block and till the patient demands any analgesic or visual analogue scale (VAS) score more than equal to 4 along with hemodynamics.

Visual Analogue Scale[9]

0 = no pain.
10 = maximum pain.



For pain relief patient was given systemic analgesia inj. diclofenac 1.5 mg/kg I.V. slowly or as per individual requirement.

Subsequently analgesia was given with inj. diclofenac 1.5mg/kg I.V. slowly along with inj. Pantoprazole 40 mg BD.

Parameters along with vitals were recorded in the postoperative period every 6 hourly till 24 hours. The surgical teams were requested to give feedback for any neurological deficit or any delayed complications.

Statistical Analysis

Data were collected, tabulated, code then analyzed using SPSS computer software version 20.0 and Microsoft word and Excel have been used to generate graphs and table etc.

Numerical variable were presented as mean & standard deviation (SD). Test applied – student unpaired t- test, Student paired t- test, chi-square test. Analysis of quantitative data between the two groups was done using Student unpaired t- test. Analysis of quantitative data in a single group was done using student paired test. Quantitative data was represented in form of frequency and percentage. Association between quantitative variables was assessed by Chi-square test.

p value >0.05- Non-Significant, <0.05 – Significant, <0.001- Highly Significant.

RESULTS:

70 adult patients included in the study were comparable in demographic characteristics such as age, weight and duration of surgery.

The mean (±SD) **number of pricks** in Group P was 1.25(±0.44) and in Group U was 1.05(±0.23) respectively. Number of pricks required in Group U were less as compared to Group P (p= 0.0213) (S).

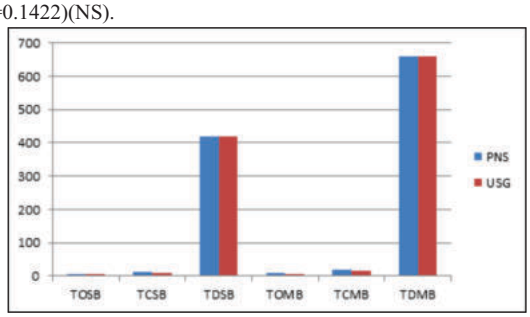
The mean block execution time was earlier in USG Group (3.39 ±0.45 minutes) as compared to PNS Group (6.3±0.49 minutes) (p=0.0001)(HS).

Sensory Block Characteristics:

The mean(±SD) onset time of sensory block was achieved significantly earlier in Group U (5.05±0.93 minutes) than in Group P (5.6±0.88 minutes) (p=0.0150). The mean(±SD) time for complete sensory block was earlier in Group U (9.68±1.64 minutes) as compared to Group P(10.8±1.34 minutes) (p=0.0028)(HS). The Mean(±SD) total duration of sensory blockade in Group P (7.65±0.48 hours) was comparable to Group U (7.54±0.56 hours) (p=0.3635).

Motor Block Characteristics:

The mean(±SD) time for onset of motor block in Group U (6.8±1.34 minutes) was significantly earlier as compared to Group P (8.68±1.25 minutes) (p<0.0001)(HS). The mean(±SD) time for complete motor block was significantly earlier in Group U (15.28 ±2.95 minutes) as compared to Group P (17.34±2.30 minutes) (p=0.0018)(HS). The Mean(±SD) total duration of motor block in Group P (11.40±0.60 hours) was comparable with Group U(11.14±0.82 hours) (p=0.1422)(NS).



Bar Diagram 1 : Sensory And Motor Block Characteristics

Block Success Rate:

In Group P, 8(22.86%) patients required supplementation whereas, 1 (2.86%) patient required supplementation in Group U. 27(77.14%) patients in Group P and 34(97.14%) patients in Group U underwent surgery without supplementation. The number of patients requiring supplementation were significantly less in Group U than in Group P (p=0.012) (S). In our study 2(5.71%) patients from Group P(PNS) and 1(2.86%) patient from group U(USG) had failed block. Hence, they were given general anesthesia and were excluded from the study group.

Incidence of complications

In our study, vessel puncture was observed in 3(8.57%) patients in PNS Group and 1(2.86%) patient in US Group. Nerve injury was seen in 1(2.86%) patient in PNS Group and none in US Group. Nausea was observed in 4 (11.43%) patients in PNS Group and in 1(2.86%) patient in US Group. Vomiting was observed in 1(2.86%) patient each in both the groups. The complications were more in Peripheral nerve stimulator group than in Ultrasound group(p=0.031)(S).

Discussion:

The infra-clavicular brachial plexus block is a safer regional anesthetic technique developed to avoid the side effects and complications of supraclavicular block, particularly pneumothorax[4]. Peripheral nerve stimulator allows better localization of the nerves and plexuses, but it is a blind technique having persistent risk of injury to the surrounding structures. Ultrasound provides a real time imaging for needle tip placement and drug injection resulting in more consistent and accurate results for peripheral nerve blocks and can be applied to many regional anesthesia procedures.

Number Of Pricks:

In our study, number of pricks required in Group U (1.05±0.23) were significantly less as compared to Group P(1.25±0.44) (p= 0.0213) (S).

Chan Vincent W. S. et al (2003)[10] suggested that ultrasound minimizes the number of needle attempts as real-time ultrasound imaging can help to guide the block needle to reach target nerves with fewer attempts (p<0.05).

Block Execution Time:

In our study, the mean(±SD) block execution time in Group U (3.39±0.45 minutes) was significantly earlier than Group P (6.3±0.49 minutes) (p<0.0001)(HS).

Dingemans E et al **(2007)**[11] found that the mean block execution time was significantly shorter in group U(3min) compared to Group P (5.2min)(p =0.006). **Brull R et al (2009)**[6] **observed that** the block performance time was significantly shorter in Ultrasound group(5min) as compared to the nerve stimulation group(10min)(p<0.001). **Taboada Manuel et al (2009)**[12] observed that the block execution time was shorter in ultrasound group(3min) as compared to nerve stimulation group(6min) (p<0.0001). **Dhir. S et al (2016)**[13] observed that the block execution time required was shorter in ultrasound group(7.2 ± 2.5 minutes) compared with nerve stimulation group(9.6 ± 3.6 minutes)(p<0.001).

SENSORY block characteristics

Onset of sensory block

In our study, the mean (±SD) onset time for sensory block in USG Group (5.05±0.93 minutes) was significantly earlier than PNS Group (5.6±0.88 minutes) (p=0.0150)(S).

Marhofer P.et al (2004)[14] observed that the median Onset time of sensory block was significantly earlier in ultrasound group (9 (5-15) minutes) than nerve stimulation group (15 (5-25) minutes) (p<0.001). **Abrahams M.S et al (2009)**[15] observed that blocks performed using ultrasound guidance had faster onset (29% shorter onset time with 95% CI) than nerve stimulation (p=0.001). **Trabelsi Walid et al (2013)**[16], they observed that there was significantly faster onset of sensory block with ultrasound guidance compared to nerve stimulation (p<0.05).

Time for complete sensory block :

In our study, the mean (±SD) time for complete sensory block was earlier in Group U (9.68±1.64 minutes) as compared to Group P (10.8±1.34minutes) (p=0.0028) (HS).

Dingemans E et al (2007)[11] observed that sensory block was

significantly better and earlier in Group U at 30 mins. The proportion of complete blocks at 30 mins was significantly larger in group U (86%) than in group S (57%) (p=0.007). **Dhir S et al (2016)**[13] observed that the mean(±SD) time for complete sensory block was comparable in Ultrasound group (13.9 ±6.7 min) and nerve stimulation group (15.7 ±7.3 min) (p=0.10).

Total duration of sensory block :
In our study, the mean(±SD) total duration of sensory block in PNS Group (7.65±0.48 hours) and USG Group (7.54±0.56 hours) was statistically nonsignificant (p=0.3635).

Honnannavar KA, Mudakanagoudar MS (2017)[7] observed that, mean total duration of sensory blockade in Group C (393.2 ±95.33minutes) and Group U (444.16 ±116.27 minutes) was statistically nonsignificant (p=0.0994)(NS).

Motor Block Characteristics
Onset Time of Motor Block:
In our study, the mean (±SD) onset time for motor block in USG Group (6.8 ±1.34) minutes) was significantly earlier than PNS Group (8.68±1.25 minutes) (p<0.0001)(HS).

Trabelsi Walid et al (2013) [16], they observed a significantly faster onset of motor block with Ultrasound guidance compared to Nerve stimulation (p<0.05).

Time for complete motor block:
In our study, the mean(±SD) time for complete motor block in USG Group (15.28±2.95) minutes was significantly earlier than PNS Group (17.34+2.30) minutes (p=0.0018)(HS).

In a study conducted by Dhir S.et al (2016)[13]**,** the Mean(±SD) time for complete motor block success was 19 (±6.1) mins in Ultrasound group and 20.7(±5.9) mins in nerve stimulation group (p=0.10).

Total duration of motor block:
In our study, the Mean(±SD) total duration of motor blockade in Group P (11.40 ±0.60 hours) and Group U (11.14 ±0.82 hours) was comparable in both groups (p=0.1422)(NS).

Honnannavar A. K, Mudakanagoudar S.M. (2017)[7] observed that, the mean(±SD) total duration of motor blockade was comparable between Group C (409.16±86.49 minutes) and Group U (409.16±94.03 minutes) (p= 0.6338)(NS).

The findings regarding sensory block and motor block characteristics from our study were similar to the findings from the above mentioned studies.

Success rate
The number of patients requiring supplementation were significantly less in USG Group (2.86%) than in PNS Group (22.86%), implying that block success was more in Ultrasound Group than Peripheral nerve stimulator Group (p=0.012) (S).

Dingemans E et al (2007)[11]**,** they observed that, rate of complete infraclavicular brachial plexus block in Group U (USG alone) was significantly better than in Group S(USG with neurostimulation) (p=0.01). The block supplementation rates were 8% in group U versus 26% in group S. The block supplementation rates were significantly lower in Group U (p=0.049). **Brull R et al (2009)**[6]**,** they observed that, Success rate was 92% in the ultrasound group and 80% in the nerve stimulation group (p=0.18). The patients in stimulation group required more fentanyl supplementation for intraoperative analgesia than those in ultrasound group (p=0.001).

COMPLICATIONS
In our study, incidence of complications were more in PNS Group than USG Group (p=0.031) (S). They were managed efficiently. The patients were hemodynamically stable throughout the study period.

In a study conducted by **Sandu Navprakash. S, Charanjeet S, et al (2006)**[17]**,** no complications related to the Ultrasonography guided infraclavicular block were recorded.

In a study conducted by **Brull R et al (2009)**[6]**,** during block performance, 3 patients (6%) in the ultrasound group reported paresthesia compared to 22 patients (45%) in the stimulation group which was statistically significant (p<0.001). Vascular puncture occurred in 4 patients (8%) in stimulation group compared to none 0% in ultrasound group (p=0.11).

In our study, the complications were minimal and managed accordingly.

CONCLUSION
We conclude that, Ultrasound guided infraclavicular nerve block has shorter block execution time, faster sensory and motor block onset, significantly earlier complete sensory and motor blockade, higher success rate with lesser pricks and minimal complications and should be preferred over PNS technique.

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