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

Available online on www.ijtpr.com

International Journal of Toxicological and Pharmacological Research 2023; 13(8); 76-81

Original Research Article

Clinical Study of Effectiveness of Peripheral Nerve Stimulator Guided Multiple Injection in Axillary Brachial Plexus Block

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Received: 28-05-2023 / Revised: 29-06-2023 / Accepted: 26-07-2023

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Conflict of interest: Nil

Abstract:

Background and Aim: Axillary brachial plexus block is one of the most widely used regional anesthesia technique for surgical procedures involving forearm, wrist, and hand. Peripheral nerve stimulator (PNS) was considered as the gold standard technique for nerve location. Present study was done with an aim to Study Effectiveness of Peripheral nerve stimulator guided multiple injection technique of axillary brachial plexus block.

Material and Methods: Forty patients with physical status ASA grade I and II aged between 18 - 60 years, scheduled for elective hand, wrist and forearm surgeries were included in this study. Under all aseptic precautions, all patient were given peripheral nerve stimulator-guided axillary brachial plexus block with multiple injection technique was using 20 ml of 0.5% inj Bupivacaine and 20 ml of 2% inj Lignocaine with Adrenaline. All patients were observed for following parameters: Onset of sensory and motor block, Duration of sensory and motor block, Duration of analgesia, Hemodynamic changes, adverse effect/ complications.

Results: Mean onset of sensory and motor block was 9.48 ± 1.28 min and 12.60 ± 0.98 min respectively. Mean Duration of sensory and motor block was 432.00 ± 78.61 min and 399.00 ± 76.49 min. Patients remained hemodynamically stable throughout the surgery and postoperatively. Mean duration of analgesia was 470.62 ± 81.65 min. VAS was increased with time. VAS at 1 hour was 0.07 ± 0.2667, VAS at 6 hours was 3.38 ± 0.69, and VAS at 8 hours was 4.00 ± 0.00. So, Rescue analgesic required mostly after 8 hrs post operatively.

Conclusion: The peripheral nerve stimulator guided axillary brachial plexus block with multiple injection technique using 20 ml of 0.5% inj Bupivacaine and 20 ml of 2% inj Lignocaine with Adrenaline shorten the onset of sensory and motor block, prolong the duration of sensory and motor block and better postoperative analgesia without any major significant complications.

Keywords: Axillary brachial plexus block, Bupivacaine, Lignocaine, and Peripheral Nerve Stimulator.

Introduction

Pain is "an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of damage". Pain is mainly protective phenomenon and complex perpetual experience. [1]

Adequate pain relief can modify surgical stress response (endocrine, metabolic and inflammatory) which contributes to reduced incidence of perioperative organ dysfunction. [2] Anaesthetist has a key role to play in perioperative pain management. The major goal in the management of perioperative pain is minimizing the dose of medication to lessen side effect while still providing adequate analgesia. Management of perioperative pain relieves suffering and increases patient's satisfaction, shortens hospital stay and reduces hospital cost and leads to early mobilization. [3]

Peripheral nerve block offers many advantages that contribute to both improved patient outcome & lower healthcare costs. Peripheral nerve block provides excellent anaesthesia & postoperative analgesia with fewer side effects, when compared to general anaesthesia. The use of nerve block also

leads to prolonged post- operative analgesia, reduced use of post-operative opioids, post-operative complications & early discharge.

Peripheral nerve blocks (PNB) are frequently used techniques in upper extremity surgery. PNB provides optimal surgical conditions while providing prolonged post-operative analgesia. [4] For upper extremity surgery brachial plexus block is preferred due to easy approach & lower complication rate. [5] There are several approaches of brachial plexus block that is interscalene, supraclavicular, infraclavicular, and axillary.

Axillary brachial plexus block is one of the most widely used regional anaesthesia technique for surgical procedures involving forearm, wrist, and hand. Ease of performance, presence of clear vascular landmark, and absence of major complications makes it a preferred block. In contrast to interscalene, supraclavicular and infraclavicular brachial plexus blockade, an axillary block has the advantage of minimum risk to intervertebral, intrathecal, or epidural injection, as well as reduced incidence of phrenic nerve paralysis or stellate ganglion block & pneumothorax. [6,7]

There are three techniques to block the brachial plexus, first one is anatomical, Second one is peripheral nerve stimulator and third one is ultrasound.

Previous studies have shown a higher success rate of the block and lesser complications when using a nerve stimulator compared to the trans arterial injection or by paresthesia technique. [8,9] Many recent studies have demonstrated that ultrasound-guided axillary block provided similar success and less complication rates then with nerve stimulation method. [10,11]

Ultrasound-guided regional anaesthesia requires the mastering of different skills: knowledge of physics, use of the ultrasound machine, improved manual dexterity, and extensive knowledge of sonographic anatomy. On the other hand the use of a nerve stimulator to detect vicinity of the needle to a nerve also requires knowledge of physics as well as knowledge of anatomy, physiology and pathophysiology. The correct use of a nerve stimulator also deserves an adequate teaching. Thus, equal efficacy and absence for the need of expensive ultrasound machine makes nerve stimulator still an attractive method for axillary block.

Peripheral nerve stimulator (PNS) was considered as the gold standard technique for nerve location. Other methods of the location of brachial plexus (axillary approach) include loss of resistance, trans-arterial (TA) injections, elicitation of paraesthesia and ultrasonographic guided techniques. [12,13,14] PNS with double injection technique has a success rate of 85 to 95% when musculocutaneous nerve is blocked separately. For a successful block local anaesthetic solution should be injected into the nerve sheath. [15] According to De Jong, [5] the estimated volume of brachial plexus sheath is 42 ml. Forearm and hand get their innervation from four nerves, namely, ulnar, median, radial nerve, and musculocutaneous nerves. The techniques described for axillary block using nerve stimulator are identification of one, two, three, or all the four nerves and corresponding number of separate injections. Many studies suggest higher success with the identification of more nerves individually, but identification of all the four nerves is more difficult and time-consuming. However, a similar study has shown no significant difference in block success rate between three and four injections technique which implies that identification of ulnar nerve is not always essential. Therefore, a simplified technique with a reduced number of injections might be desirable.[16]

Present study was done with an aim to Study Effectiveness of Peripheral nerve stimulator guided multiple injection technique of axillary brachial plexus block.

Material and Methods

After obtaining approval from hospital International Review Board, 40 patients with physical status ASA grade I and II aged between 18 - 60 years, scheduled for elective hand, wrist and forearm surgeries were included in this study. Study was conducted at AMC MET Medical College, Sheth L. G. Hospital, and Ahmedabad during the year of 2019-2021.

Inclusion Criteria

- ASA grade 1 & 2
- Both sex, between 18 to 60 yr age
- Posted for elective hand, wrist and forearm surgery

Exclusion Criteria

- ASA grade ≥ 3
- Unwillingness of patients
- Allergic To local anaesthetics
- Local infection
- Bleeding disorders & altered coagulation(coagulopathy)
- Neurological deficite involving brachial plexus

After obtaining written, informed consent and IRB approval, 40 patients of ASA grade1 & 2 posted for elective hand, wrist & forearm surgery were included in study. All patients were examined thoroughly and investigated. On the day before surgery, patients were explained about the procedure along with its benefits and risks. All patients were explained about visual analogue scale

(VAS) and made well conversant with it. An intravenous line was secured with an intravenous 20G cannula. Pulse oximeter, non-invasive blood pressure cuff and ECG electrodes were applied and baseline pulse, blood pressure, oxygen saturation and respiratory rate were recorded.

Details of Procedure

- Position – Supine with arm abducted at 90°& Head turns to opposite side, Side
  - Right / Left
- Technique – Axillary brachial plexus block
- Approach – PNS guided
- Needle size – 23G ,100mm
- Method of localization of plexus – Peripheral nerve stimulator with multiple injection technique

Under all aseptic prequation, Patient was positioned for block in supine position with arm abducted 90° and forearm placed in supine position. A 23G, 100 mm long, short bevelled insulated needle connected to negative lead of nerve stimulator. The needle was inserted perpendicular in the neurovascular sheath above axillary artery to localise the median, musculocutaneous nerve & study drug were injected. The needle was withdrawn & reinserted at same level below artery to localise the radial & ulnar nerve & study drug were injected. Nerves stimulating current was started with 1.5 mA till 0.5 mA at frequency of 2Hz. Local anesthetic solution was prepared with 20 ml inj. Bupivacaine (0.5%) and 20 ml of inj. Lignocaine with Adrenaline (2%). Local anaesthetic solution was prepared with 20 ml inj. Bupivacaine (0.5%) and 20 ml of inj. Lignocaine with Adrenaline (2%). The sensory block was assessed by pinprick and cold application every 2 min until the onset of sensory block. Motor block was graded according to Modified Bromage Scale. After gaining adequate surgical anesthesia inj. Fentanyl 100 mcg & Midazolam 1mg were given. Then continuous monitoring of vitals done intraoperatively and postoperatively for 24 hours.

Patients were observed for intra-operative vitals at the time of induction, at the time of incision then, then every 15 minutes thereafter. Duration of surgery were noted. Signs and symptoms of local anaesthetic toxicity were observed. Postoperative monitoring was done half an hourly till 1 hour, then every 1 hourly till 6 hours, then 2 hourly till 10 hours thereafter at 15 and 24 hrs. Post-operatively patients were assessed according to visual analogue score (VAS).

Statistical analysis

The recorded data was compiled and entered in a spreadsheet computer program (Microsoft Excel 2007) and then exported to data editor page of SPSS version 15 (SPSS Inc., Chicago, Illinois, USA). For all tests, confidence level and level of significance were set at 95% and 5% respectively.

Results

The present study was carried out on 40 patients with physical ASA I-II, posted for elective hand, wrist and forearm surgeries after taking written informed consent.

Table 1: Demographic Data

Variables	Mean ± SD (n = 40)
Gender	
Male	29(72.5%)
Female	11(27.5%)
Age (year)	36.35 ± 12.34
Duration of surgery (min)	97.25 ± 12.65

Table 1 shows comparison of demographic data like gender and age and surgical duration. In above table showed that the mean Age (mean ± SD) of patients was 36.35 ± 12.34 (year) in our study. In our study 29 male and 11 female patient out of 40. The mean Duration of surgery (Mean ± SD) of patients was 97.25 ± 12.65 min. In our study, 6 (15.0%) patients had Lt DER platting surgery, 2 (5.0%) patients had Lt Radius Tens nail ROI surgery, 4 (10.0%) patient had Rt 5th MC k wire surgery and 2 (5.0%) patients had Rt DER platting ROI surgery. In our study, 31 (77.5%) patients had ASA Grade 1 and 9 (22.5%) patients had ASA Grade 2.

Table 2: Distribution of Mean Time of Onset for Sensory Block and Time of Onset for Motor Block

Variable	Mean ± SD (n=40)
Time of onset for sensory block (min)	9.48 ± 1.28
Time of onset for motor block (min)	12.60 ± 0.98

In above table showed that the mean Time of onset for sensory block (mean ± SD) of patients was 9.48 ± 1.28 min. In above table showed that the mean Time of onset for motor block (mean ± SD) of patients was 12.60 ± 0.98 min. There were no significant changes in pulse rate intraoperatively

from preoperative pulse value. Minimal increase in SBP, DBP, and MAP at the time of block execution was observed, which was less than 5 % of preoperative value. After that throughout the surgery vitals remained stable. Throughout perioperative period spo2 remain unchanged.

Table 3: Distribution of Duration of Motor Block

Variable	Mean ± SD (n=40)
Duration of motor block (min)	399.00 ± 76.49

In above table showed that the mean Duration of motor block (min) (mean± SD) of patients was 399.00 ± 76.49.

Table 4: Distribution of Duration of Sensory Block

Variable	Mean ± SD (n=40)
Duration of sensory block (min)	432.00 ± 78.61

In above table showed that the mean Duration of sensory block (min) (mean ± SD) of patients was 432.00 ± 78.61. There were no significant changes in pulse rate from preoperative value till 24 hr of post-operative periods.

In our study, spo2 remained within normal limit with fluctuation of ≤ 3% from preoperative value, there were no significant variation in spo2 intraoperatively and post operatively till 24 hr. Minimal increase in SBP, DBP, and MAP at the time of recovery from block was observed post operatively between 6 to 8 hrs, which was < 5% of preoperative value. After that vitals remained stable for 24 hr post operatively.

Table 5: Distribution of VAS Immediate After Surgery and VAS All Time Intervals

Variable	Number	Mean ± SD
VAS immediate after surgery	40	0.00
VAS 30 min	40	0.00
VAS 1 hour (60 min)	40	0.07 ± 0.26
VAS 2 hours (120 min)	40	0.37 ± 0.70
VAS 3 hours (180 min)	40	1.15 ± 1.09
VAS 4 hours (240 min)	39	2.07 ± 1.10
VAS 5 hours (300 min)	34	2.76 ± 0.88
VAS 6 hours (360 min)	26	3.38 ± 0.69
VAS 8 hours (480 min)	13	4.00 ± 0.00
VAS 10 hours (600 min)	0	0.00
VAS 15 hours (900 min)	0	0.00
VAS 24 hours (1440 min)	0	0.00

We observed that VAS was increased with time. In above table VAS at 1 hour was 0.07 ± 0.26, VAS at 2 hours was 0.37 ± 0.70, VAS at 3 hours was 1.15 ± 1.09, VAS at 4 hours was 2.07 ± 1.10, VAS at 5 hours was 2.76 ± 0.88, VAS at 6 hours was 3.38 ± 0.69, and VAS at 8 hours was 4.00 ± 0. So, Rescue analgesic required mostly after 8 hrs post operatively.

Table 6: Distribution of Duration of Analgesia

Variable	Mean ± SD (n=40)
Duration of analgesia(min)	470.62 ± 81.65

Above table and graph showed that the mean Duration of analgesia (mean ± SD) of patients was 470.62 ± 81.65 min.

Discussion

The Axillary approach of brachial plexus block results in anaesthesia of upper limb below the shoulder. It is very safe and reliable approach for surgeries involving hands, wrist, and forearm. We studied 40 adult patients (ASA I/II) aged 18 to 60 years, of either sex undergoing elective hand, wrist and forearm surgeries under peripheral nerve stimulator guided Axillary brachial plexus block with multiple injection technique. Injection 0.5% Bupivacaine 20 ml and Injection 2% Lignocaine with Adrenaline 20 ml were used in all patients. Lavoie et al. compared single and multiple injections for the axillary block using a nerve stimulator and demonstrated the benefit of considering the musculocutaneous nerve as a separate, preliminary part of any axillary brachial plexus block. [17] In our study, we observed that mean onset of sensory block was 9.48 ± 1.28 mins and mean onset of motor block was 12.60 ± 0.98 mins. Badiger SV et al [18] (2017) compared onset, and duration of sensory and motor anesthesia of axillary block using nerve stimulator, either with single injection after identification of any one of the four nerves or four separate injections following identification of each of nerve. Four injection groups had a faster onset of sensory and motor block and prolonged duration of analgesia compared to single-injection group (P < 0.001). Handoll HH et al [21] (2006) showed that the time

for block performance was significantly shorter for single and double injections compared with multiple injections, but the requirement for supplementary blocks in these groups tended to increase the time to readiness for surgery.

In our study, total duration of analgesia in 470.62 ± 81.65 min. Badiger SV et al [18] (2017) in their study on axillary block using mixture of Bupivacaine 0.5% and Lignocaine 1.5% in single injection group and four injection group, they observed average duration of analgesia in single injection group was 167 mins and in other group it was 201 min. Duration of analgesia prolonged in our study, it might be due to using more volume of drug and higher concentration of Lignocaine with Adrenaline (2%) compared to above study. Thus duration of analgesia might be varies with volume and concentration of drug used.

We observed that VAS was increased with time. VAS at 1 hour was 0.07 ± 0.2667, VAS at 2 hours was 0.3750 ± .7048, VAS at 3 hours was 1.1500 ± 1.0990, VAS at 4 hours was 2.0769 ± 1.1094, VAS at 5 hours was 2.7647 ± 0.8896, VAS at 6 hours was 3.38 ± 0.69, and VAS at 8 hours was 4.00 ± 0.00. So, Rescue analgesic required mostly after 8 hrs post operatively. In our study, there were no significant changes in intra-operative hemodynamic parameters. Changes in mean heart rate, mean SBP, DBP, MAP and SpO2 were stable intraoperative and postoperative periods. All the patients were observed for following complications like, hematoma, cardiotoxicity, neurotoxicity, nausea and vomiting, LAST.

In our study, no complications or significant adverse effects were noted. Sahana TH et al [20] (2020) compared, "peripheral nerve stimulator (PNS) versus trans- arterial (TA) techniques for axillary brachial plexus block". In their study conclude that TA technique has the risk of hematoma formation and possible intravenous injection. The PNS techniques have the possibility of inadvertent neurovascular damage. Altun D et al [21] (2021) aimed to compare stimulator-guided (NS) peripheral nerve block with and without ultrasonography (US) techniques to investigate the sensory and motor block onset time, procedure-related preoperative and postoperative complications, and visual analog scale (VAS) scores were recorded.

In their study observed that complications was significantly higher in the NS group ($p<0.05$). Using US with the NS in the axillary approach to brachial plexus block improves the success rate with a lower incidence rate of complications.

The notable short comings of this study are:

1. The sample size was small. Only 40 cases are not sufficient for final conclusion.
2. The study has been done in a single centre.
3. The study was carried out in a tertiary care hospital, so hospital bias cannot be ruled out.

Conclusion

The pheripheral nerve stimulator guided axillary brachial plexus block with multiple injection technique using 20 ml of 0.5% inj Bupivacaine and 20 ml of 2% inj Lignocaine with Adrenaline shorten the onset of sensory and motor block, prolong the duration of sensory and motor block and better postoperative analgesia without any major significant complications.

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