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Original Research Article

To Compare the Efficacy of Ultrasound Guided Costoclavicular versus Axillary Brachial Plexus Block for Forearm, Wrist and Hand Surgeries: A Prospective Randomized Comparative Study

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Abstract

Background: Ultrasound guided technique reduces the risk of vascular puncture and ensures targeted delivery of local anaesthetics to the nerve cords producing profound sensory and motor blockade. Levobupivacaine has been shown to produce effective sensory and motor block (MB) characteristics as comparable to Bupivacaine in various approaches of brachial plexus block (BPB). The aim of this research was to evaluate the efficacy of axillary versus costoclavicular approach for BPB under ultrasound guidance for forearm, wrist and hand surgeries.

Methodology: Axillary block was performed to group A and Costoclavicular block to Group C under Ultrasound guidance. A Volume of 19 ml of 0.5% Levobupivacaine and 1 ml of Fentanyl 50 ug, total volume of 20 ml was administered in both the groups. Performance time, onset and duration times of sensory and MB characteristics, time to first request analgesia and side effects were compared.

Results: The performance time and mean onset of sensory block were significantly less in group C. There were no statistical significant difference between the groups with respect to mean onset of MB, and mean duration of sensory and MBs. Time to first request analgesia is significantly high in group C (7.00 ± 1.7 hrs.') compared to group A (5.47 ± 1.8 hrs).

Conclusion: Costoclavicular Block is efficacious in providing prolonged post operative analgesia with shorter performance time when administered with Levobupivacaine and Fentanyl compared to Axillary plexus block.

Keywords: Costoclavicular Block, Axillary Brachial Plexus Block, Ultrasound Guided Block, Levobupivacaine, Fentanyl.

Introduction

Costoclavicular block (CB) is a proximal infraclavicular block technique administered between the cords of the brachial plexus [1]. Costoclavicular space is between the clavicle and the second rib, bounded by subclavius and the clavicular head of pectoralis major anteriorly and the anterior chest wall and the serratus muscle posteriorly. [2] It is continuous with the supraclavicular fossa and the medial infraclavicular space. The cords of the brachial plexus are clustered together lateral to the axillary artery, requiring potentially one needle pass through ultrasound guidance, and it has faster onset of block and reduced volume of local anaesthetic needed. Ultrasound guided technique reduces the risk of vascular puncture and ensures targeted delivery of local anaesthetics to the nerve cords producing profound sensory and motor blockade. [3] It also reduces complications like phrenic nerve palsy, pneumothorax which are commonly associated with some of the classical approaches like interscalene brachial plexus block (BPB), supraclavicular BPB and axillary BPB. [4]

BPB via the axillary approach targets terminal branches like median, radial, ulnar, and musculocutaneous nerves is used for surgical procedures on forearm, hand and wrist. [5] Axillary fossa is bounded laterally by biceps and coracobrachialis, medially by triceps, with the floor formed by conjoint tendon of teres major and latissimus dorsi. It is primarily associated with the risk of vascular puncture as it requires multiple needle trajectories to individually block each nerve due to their spread in the axillary fossa.

Levobupivacaine has been shown in various studies to produce effective sensory and MB characteristics as comparable to Bupivacaine in various approaches of BPB[6].Fentanyl is a potent opioid which has been proved to enhance the quality of blockade in different approaches of BPB [7]. The aim of the study was to compare the efficacy of axillary brachial plexus approach versus costoclavicular approach under ultrasound guidance with Levobupivacaine and Fentanyl for forearm, hand and wrist surgeries.

Methodology

It was a prospective research conducted in the department of Anaesthesiology, Siddhartha Medical College, Vijayawada. Study protocol was approved by the institutional ethical committee. Written and informed consent was collected. Study was conducted between January to April 2024. Individuals of either gender, 18 – 60 years, ASA grade I and II, undergoing forearm, wrist and hand surgeries with BMI ≤ 30 were included in the research. Non cooperative individuals, ASA grade III, IV, those with allergic history to local anesthetics were not considered. Randomly the study members were allocated into group A and group C. Sample size was calculated based on Nalini KB et al. [14] report. Considering the alpha value as 0.05 and the beta power as 80% and margin of error as 5%, the sample size was taken as 30 per group.

On the day of surgery, patients were transferred to the operating room, where baseline hemodynamic parameters—heart rate, non-invasive blood pressure (NIBP), and oxygen saturation (SpO2) were recorded. An 18G intravenous cannula was secured in the non-operative hand of each patient, who were continuously monitored using standard ASA parameters, including SpO2, NIBP, ECG, and respiratory rate. No premedication was administered prior to the procedure. An expert anesthetist performed the blocks using a high-frequency linear ultrasound probe (GE machine) with a 23G spinal needle (10 cm) attached to extension tubing and a three-way stopcock to facilitate the in-plane deposition of local anesthetic.

Patients in group A received an axillary block, while those in group C underwent a CB, both under ultrasound guidance. Group A patients were positioned supine with the operative arm abducted to 90^0 and externally rotated. Following axilla sterilization with Betadine, the ultrasound probe was positioned over the axillary crease to identify the axillary artery and surrounding structures. In group C, the ultrasound transducer was placed parallel to the middle third of the clavicle, with the operative arm abducted to 90° in supination, a position that opens the costoclavicular space. However, this position can be challenging in cases of arm and forearm fractures. A mixture of 19 ml of 0.5% Levobupivacaine and 1 ml of 50 mcg Fentanyl (20 ml total) was administered in both groups.

Sensory and MB onset and duration were assessed. Sensory block (SB) characteristics were evaluated with an alcohol swab, and MB characteristics were tested by observing responses in the ulnar, radial, median, and musculocutaneous nerves. The quality of the block was graded on a four-point scale (excellent, good, fair, poor) based on block adequacy and the need for additional analgesics. Intraoperative vitals were monitored throughout surgery, with patients observed postoperatively in the PACU for two hours and subsequently in the ward. Pain was assessed using a Visual Analogue Scale (VAS), and rescue analgesics were administered if VAS scores reached ≥4. Incidences of side effects, including nausea, vomiting, shivering, vascular puncture, pneumothorax, and block failures, were documented.

Statistical Analysis: Data were compiled, tabulated and analyzed using SSPS version 21. The quantitative data were presented as mean, standard deviations while qualitative data were represented as number and percentages. The comparison between two independent groups with quantitative data and parametric distribution was done by using the independent t –test. Demographic data was analyzed with Fischer exact test. P>0.05 considered significant.

Results

Sixty members were included in the study, 30 in each group. There was statistically comparable difference between groups in demographic parameters like height, weight, ASA physical status, age, gender and duration of surgery. The performance time and mean onset of SB were significantly less in group C. There were no statistically significant differences between the groups in the mean onset of MB, and mean duration of sensory and MBs; the time to first request analgesia is significantly high in Group C.

The adequacy of overall blockade was 76% in group C and 60% in group A; none of the patients in both the group had block failure and 3% in group A had radial nerve sparing and 10% in group C had ulnar nerve sparing. None of the patients in both the groups had technique related side effects as well as LA toxicity. The incidence of intraoperative shivering and postoperative nausea and vomiting (.PONV) were comparable between both groups. Perioperative haemodynamics were comparable between the groups and other side effects were not recorded in the groups.

Discussion

The CB, a newer regional technique for upper limb anesthesia, is gaining popularity due to its efficiency under ultrasound guidance. Unlike the axillary

block, which requires multiple needle insertions due to the dispersed nerve arrangement, the compact grouping of brachial plexus cords in the costoclavicular space allows for a more streamlined, effective block [8, 9]. As per the literature, CB and axillary block are efficacious in producing effective sensorimotor block [10] .Levobupivacaine is a potent local anaesthetic comparable to bupivacaine. Fentanyl is also a potent opioid which enhances the quality of block when administered with LA mixture and potentially safe in the doses administered perineurally [11].

In this study, mixture of 0.5 % Levobupivacaine (19 ml) and 50 mcg Fentanyl (1 ml), total 20ml was given. Karmakar MK et al. [12] also used 20 ml with effective blockade. In the present study also 20 ml LA mixture produced effective block without any block failures.

Shubha M Ramesh et al. compared costoclavicular versus supraclavicular BPB and concluded that costoclavicular BPB has shorter procedural time and rapid onset of sensory and motor blockade compared to supraclavicular BPB [13].These findings are similar to the current study where there was rapid onset of SB and short performance time in CB when compared to axillary block and mean onset of MB was similar in both the groups.

Nalini KB et al. compared ultrasound guided costoclavicular versus axillary block and concluded that both groups resulted in similar onset times; however the block performance time was longer in axillary group compared to costoclavicular group and these findings were similar to the current study [14]. In the current research intergroup differences was not found especially in the success rates.

Wong MH et al. [15] reported dose finding research on the minimum effective volume of 0.5% ropivacaine for ultrasound-guided costoclavicular BPB and concluded that the MEV 90 of 0.5% ropivacaine required to produce surgical anaesthesia with an ultrasound-guided Costoclavicular BPB was 20.9 ml [15]. Whereas in the current study 20 ml was used.

Zhu M and Sun W [16] reported that in their review on the Application and Research Progress of Ultrasound Guided BPB through Costoclavicular space approach in upper limb surgery and concluded that Ultrasound-guided BPB via the costoclavicular space approach was effective and safe in upper limb surgery. It provides good anesthesia and postoperative analgesia, making it a valuable technique for various upper limb surgeries.

Time to first request analgesia is significantly prolonged in the present study which is inconsistent with the findings of above-mentioned studies, where they had comparable durations of post operative analgesia. This could be attributed to the compactness of arrangement of three cords in costoclavicular space and administration of undiluted concentration of Levo-bupivacaine with fentanyl. This study has few limitations. Firstly, the sample size is small to translate the conclusions into practice. In this study 10 % of patients had ulnar nerve sparing which is also contrary to the cited studies which shows that ulnar nerve sparing is rare. This could be attributed to the expertise of the anaesthesiologist performing the block. In most of the studies block is performed with bupivacaine while in this study Levobupivacaine is used. Despite small variations in the methods used, most of the studies concluded that CB produced effective sensory and MB with short performance times and short onset times without any significant side effects [17, 18].

Conclusion

CB is efficacious in providing prolonged post operative analgesia with shorter performance time when administered with levobupivacaine and fentanyl compared to axillary plexus block. The adequacy of sensorimotor blockade for surgical anaesthesia is comparable between costoclavicular and axillary approaches. Future research with large scale and multicentre studies are required to translate observations into routine clinical care.

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