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A Comparative Analysis of Supraclavicular Nerve Block Techniques in Upper Limb Surgery: Nerve Stimulator vs. Ultrasound Guidance

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KEYWORDS

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Abstract: Background: The traditional method of employing a Peripheral Nerve Stimulator (PNS) has long been considered the benchmark for peripheral nerve blocks when ensuring precise needle positioning for regional anesthesia and pain relief [1]. In contrast, contemporary ultrasound (US) technology offers a safer alternative for guiding the injection needle, reducing the likelihood of harming nearby structures. The primary aim of this study was to evaluate and compare the efficacy of two techniques: one using a nerve stimulator as a guide and the other relying on ultrasound guidance for performing a supraclavicular brachial plexus block in upper limb surgical procedures. **Methods:** A prospective, randomized, single-blind comparative study was undertaken involving a total of one hundred patients who underwent a supraclavicular brachial plexus block using 0.5 Ropivacaine at Department of Anesthesia, KIMS, Karad. The study received approval from the ethical committee [2], [3]. The patients were allocated randomly into two groups: group PNS (n = 50) and group US (n = 50). The study assessed and compared procedure time, onset and duration of sensory and motor blockade, as well as any associated complications within both groups. **Results:** In group PNS, the procedure took an average of 9.0 ± 1.50 minutes, whereas in group US, it was notably shorter at 6.07 ± 1.20 minutes (p < 0.0001). The onset of sensory and motor blocks in group PNS occurred at 7.48 ± 1.23 minutes and 9.64 ± 1.08 minutes, respectively, while in group US, these onsets were quicker at

6.26 ± 1.02 minutes and 8.20 ± 1.02 minutes, respectively (p < 0.0001). Group US also demonstrated a shorter time to achieve

complete block, with an average of 13.64 ± 1.11 minutes, compared to 16.21 ± 1.54 minutes in group PNS (p < 0.0001). Regarding the duration of sensory and motor block, group PNS had blocks that lasted 6 hours for sensory and 5 hours for motor, whereas in group US, these durations were longer, lasting 7 hours for sensory and 6 hours for motor [4]. Additionally, the success rate was 90% in group PNS and notably higher at 97.5% in group US. **Conclusion:** The study demonstrated a significant superiority of the ultrasound-guided technique over the peripheral nerve stimulator (PNS) for performing the supraclavicular brachial plexus block.

I. INTRODUCTION

Various anesthetic techniques have been employed in up- per limb surgeries over time, each carrying its own set of advantages and drawbacks. While modern general anesthe- sia is considered reliable, safe, swift, and widely accepted, regional anesthesia offers distinct benefits such as reduced disruption to the body's normal metabolic processes and vital functions when compared to general anesthesia. It's worth noting that Kulenkampff was the first to describe the classical supraclavicular approach to the brachial plexus, a significant milestone in the field of anesthesia [5], [6]. Subsequently, various alternative approaches were introduced, including the axillary, interscalene,

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posterior, and infraclavicular ap- proaches. Nevertheless, the supraclavicular brachial plexus block has proven to be a consistently reliable method for providing effective regional anesthesia to the upper extrem- ity. A range of technical modalities are employed to identify and locate the brachial plexus in the supraclavicular region. Conventional methods involve the use of electric stimulation and patient-reported paresthesia, which rely on surface land- marks for identification in a semi-blind manner. In addition to accounting for individual and anatomical variations, the success rate in this context is contingent upon the precision of the equipment used. The practice of using electrical stim- ulation to pinpoint peripheral nerves was first introduced in 1962, and this method offers several advantages [7]. These advantages include an elevated success rate, the prevention of vascular injury, and the avoidance of paresthesia and the associated risk of neurological injury. Modern ultrasound machines have advanced capabilities that enable the imaging of individual nerve roots down to their cords in the infra-clavicular region. This sonographic imaging can serve as a precise guide for the injection needle, effectively reducing the risk of injuring adjacent structures. The use of ultrasound for nerve blocks dates back to 1978 when La Grange P et al. ini- tially reported performing a supraclavicular brachial plexus block with the assistance of a Doppler ultrasound blood- flow detector, aiding in the identification of the subclavian artery and vein. Subsequently, in 1981, Abramowitz HB et al. utilized Doppler ultrasound to identify and mark the location of the axillary artery for brachial plexus blocks, particularly in cases where the axillary artery was impalpable.

II. MATERIAL AND METHODS

A prospective, randomized, single-blind comparative study was conducted over the course of one year, following approval from the institutional ethical committee. The study involved patients who were slated to undergo elective forearm and hand surgeries, and these procedures were performed using a supraclavicular brachial plexus block. Written informed consent was obtained from both the patients and their attendants. The study included patients of both sexes, aged between 20 and 60 years, with an ASA (American Society of Anesthesiologists) grade of I and II [8]. Patients falling under ASA grades III, IV, and V, those with known hypersensitivity to local anesthetics, individuals with opioid addiction, patients with systemic diseases, uncooperative individuals, those with bleeding disorders, anatomical abnormalities at the regional site, pregnant women, and individuals with neurological deficits affecting the brachial plexus were excluded from the study. Patients were randomly assigned to one of two groups using a computer-generated sequence of random numbers and the sealed envelope technique. Group PNS ($n = 50$) received supraclavicular brachial plexus block guided by nerve stimulation, while Group US ($n = 50$) received ultrasound-guided block. Before the procedure, following routine pre-anesthetic evaluation, all patients were premedicated with injection Midazolam at a dose of 0.03mg/kg, administered 5 minutes prior to the procedure. It's noteworthy that no analgesic drugs were administered during pre-medication. In both groups, the injection consisted of 20 ml of ropivacaine (0.75%) along with 10 ml of normal saline [9]. To facilitate the detection of any subtle finger movement resulting from nerve stimulation, a specific maneuver was carried out. The needle entry point was positioned approximately 1 inch (2.5 cm) lateral to the point where the sternocleidomastoid (SCM) attaches to the clavicle, roughly equivalent to the width of one thumb. The location of the subclavian artery was confirmed by palpation at this point, and the index finger used for palpation was then retained in this position. At the intended puncture site, a local infiltration of 1 ml of 2% lignocaine was administered. It's important to note that an insulated needle was utilized for this technique [10]. The needle was connected to a nerve

Parameters		Group PNS (n=50)	Group US (n=50)
Mean Age (in Years)		32.52±12.80	35.27±13.93
Mean weight (in Kg)		62.63±9.73	61.75±6.55
Gender	Male	30	30
	Female	10	10
ASA	Grade I	34	31
	Grade II	5	8
Duration of Surgery (in minutes)		57.97±18.52	66.05±16.66
Duration of procedure (in minutes)		8.0±1.53	6.27±1.10
Onset of sensory block (in minutes)		7.08±1.33	6.56±1.02
Onset of motor block (in minutes)		9.64±1.28	8.20±1.02

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Time to achieve complete block (in minutes)	16.11±1.54	13.74±1.11
Duration of sensory block (in hours)	6.14±2.36	8.13±1.63
Duration of motor block (in hours)	5.14±2.36	7.13±1.63

TABLE 1: Comparison of the both the study groups

locator via electrodes and was properly grounded using ECG leads. Stimulation was initiated at an intensity of 2.0 mA with a pulse width of 100 μs. Once the desired response was achieved, characterized by a visible muscle twitch in the fingers, the current was gradually reduced to 0.5 mA. If the desired response was still obtained at 0.4 mA, then 30 ml of the drug solution was injected. However, if the response was only achieved at 0.4 mA, the needle was repositioned to ensure a response at 0.5 mA but not at 0.4 mA. [11] In cases of an insufficient response, the needle was repositioned in the anteroposterior plane, either slightly more posterior or slightly more anterior, always maintaining parallel alignment with the midline.

III. RESULTS

The study found that the mean age, weight, gender distribu- tion, and ASA grade of patients in both groups were compa- rable, with a p-value greater than 0.05, signifying statistical insignificance. Additionally, the mean duration of surgery in group PNS and group US was 56.97±18.42 minutes and 60.05±16.46 minutes, respectively, with a p-value greater than 0.05, indicating no statistically significant difference between the two groups [12]. The study found that the mean duration of onset for both sensory and motor blocks differed between the two groups. In group PNS, the onset of sensory block was 7.48±1.33 minutes, and the onset of motor block was 9.04±1.28 minutes. In contrast, in group US, the onset of sensory block was 6.06±1.04 minutes, and the onset of motor block was 8.20±1.02 minutes. The p-value for both sensory and motor block onset in both groups was < 0.0001, indicating a statistically significant difference.

Similarly, the mean duration of time required to achieve complete block also differed between the groups. In group PNS, it took an average of 16.11±1.54 minutes, while in group US, it took an average of 13.44±1.11 minutes. The *p*- value for the time to achieve complete block in both groups was <0.0001, demonstrating a statistically significant differ- ence. [13]

IV. DISCUSSION

In recent times, there has been a growing interest in the use of peripheral nerve blocks (PNB) due to their association with several advantages. [14] These blocks offer effective regional anesthesia, have a lower complication rate, and provide su- perior postoperative pain management. The supraclavicular block, in particular, stands out as a technique that delivers rapid, dense, and highly predictable anesthesia to the entire upper extremity, surpassing other brachial plexus methods in terms of consistency. Continuous efforts have been made to enhance the precision and reliability of nerve blocks. [15] Mechanical and electrical nerve stimulation were notable advancements in this direction. However, with the advent of improved imaging technology and its increased availability, ultrasound guidance (USG) has emerged as a valuable tool for PNBs. USG enables real-time visualization and precise guidance during nerve blocks. It is a portable, cost-effective, and radiation-free modality that can be readily taught and learned, making it an increasingly popular choice in the field of regional anesthesia. In our study, it's important to note that both groups exhibited comparability in terms of patient age, gender, weight, and ASA grade. No statistically significant differences were observed between the two groups. As a result, these clinically insignificant variations in age allowed us to mitigate potential confounding factors related to drug distribution, metabolism, excretion, and action. This unifor- mity in patient characteristics enhances the reliability and validity of our study's findings [16]. The clinically insignif- icant variations in weight played a crucial role in addressing a potential point of controversy, as both obesity and cachexia can significantly impact the clinical action of drugs. Similar demographic findings were consistent with a previous study. It's worth noting that there was a male preponderance in both study groups [17]. This could be attributed to a higher number of male patients undergoing surgery in our institution

Groups	Successful block	Failed block
PNS group (n=50)	38 (90%)	4 (10%)
US group (n=50)	39 (97.5%)	1 (2.5%)

TABLE 2: Success and failure of block in both the groups

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during the study period. Nevertheless, this male preponder- ance had no clinical relevance in influencing the study's results. The probable reason for the shorter procedure time and faster onset of both sensory and motor blockade in the ultrasound-guided group may be attributed to the capabilities of ultrasound technology. Ultrasound allows for the precise determination of the size, depth, and precise location of the brachial plexus and its adjacent structures. Moreover, with ultrasound guidance, the positioning and, if necessary, repositioning of the needle can be carried out under direct visualization and in real time. This stands in contrast to the blind redirection and repositioning of the needle in the peripheral nerve stimulator (PNS) group. These advantages of ultrasound technology likely contributed to the observed differences in procedure efficiency and block onset between the two groups. [18] It's notable that in both study groups, there were no reported incidents of nerve injury or pneumoth- orax. This aligns with the findings of similar studies where the use of ultrasound (US) technique demonstrated a low or nonexistent incidence of complications. The improved safety profile associated with ultrasound-guided techniques can be attributed to their ability to identify and avoid vital structures accurately [19]. Additionally, the direct visualization of local anesthetic spread offered by ultrasound may lead to more precise dosages and selective blocks, ultimately resulting in higher accuracy and fewer complications, as supported by previous research.

V. CONCLUSION

The study's findings reveal several noteworthy differences between the ultrasound (US) and peripheral nerve stimulator (PNS) groups. In the US group, the procedure time, onset of sensory and motor block, and time required to achieve complete block were all significantly shorter compared to the PNS group. Moreover, the US group exhibited a longer duration of sensory and motor block, a higher success rate of block, and a lower incidence of complications such as artery puncture, respiratory distress, and nausea compared to the PNS group [20]. In light of these results, the ultrasound- guided technique was established as significantly superior to the peripheral nerve stimulator-guided technique for supra- clavicular brachial plexus block in this study

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AUTHORS CONTRIBUTION

Authors are equally contributed

CONFLICT OF INTERESTS

Author declared that there is no conflict of interest.

REFERENCES

[1] Kulenkampff D, Persy MA. Brachial plexus anesthesia: its indications, technique and dangers. Ann Surg. 1928;87:883-91.

[2] Neal JM, Gerancher JC, Hebl JR, Ilfeld BM, McCartney CJ, Franco CD et al. Upper extremity regional anesthesia: essentials of our current understanding, 2008. Reg Anesth Pain Med. 2009;34:134-70.

[3] Greenblatt GM, Denson JS. Needle nerve stimulator- locator: nerve blocks with a new instrument for location of nerves. Anaesth Analg. 1962;41:599- 602.

[4] Sia S, Bartoli M, Lepri A, Marchini O, Ponsecchi P. Multiple- injection axillary brachial plexus block: a comparison of two methods of nerve localization- nerve stimulation versus paresthesia. Anaesth Analg. 2000;91:647-51.

[5] Winnie AP. Does the transarterial technique of axillary block provide a higher success rate and lower complication rate than a paresthesia technique? Reg Anaesth. 1995;20:482-5.

[6] Baranowski AP, Pither CE. A comparison of three methods of axillary brachial plexus anaesthesia.Anaesthesia. 1990;45:362-5.

[7] Chan VW, Brull R, McCartney CJ, Xu D, Abbas S, Shannon P. An ultrasonic and histologic study of intraneural injection and electrical stimulation in pigs. Anaesth Analg. 2007;104:1281-4.

[8] Schwemmer U, Schleppers A, Markus C, Kredel M, Kirschner S, Roewer

N. Operative management in axillary brachial plexus blocks: Comparison of ultrasound and nerve stimulation. Anaesthesist. 2006;55:451-6.

[9] La Grange P, Foster P, Pretorius L. Application of the doppler ultra- sound blood flow detector in supraclavicular brachial plexus block. BJA 1978;50:965-7.

[10] Abramowitz HB, Cohen C. Use of Doppler for difficult axillary block. Anaesthesiology. 1981;55:603.

Journal of Chemical Health Risks
www.jchr.org
JCHR (2023) 13(6), 3362-3366 | ISSN:2251-6727

[11] McCartney CJ, Brull R, Chan VW, Katz J, Abbas S, Graham B, et al. Early but no long term benefit of regional compared with general anaesthesia for ambulatory hand surgery. Anesthesiology. 2004;101:461-7.

[12] Aromaa U, Lahdensuu M, Cozanitis DA. Severe complications associated with epidural and spinal anaesthesia in Finland 1987-1993. A study based on patient insurance claims. Acta Anaesthesiol Scand. 1997;41:445-52.

[13] Moen V, Dahlgren N, Irestedt L. Severe neurological complications af- ter central neuroaxial blockades in Sweden 1990-1999. Anesthesiology. 2004;101:950- 9.

[14] Pathak RG, Anand PS, Rajendra NK. Supraclavicular brachial plexus block with and without Dexamethasone - A Comparative Study. Int J Sci Res Publ. 2012;12:1-7.

[15] Singh G, Mohammed YS. Comparison between conventional technique and ultrasound guided supraclavicular brachial plexus block in upper limb surgeries. IJSS. 2014;2(8):169-76.

[16] Rupera KB, Khara BN, Shah VR, Parikh BK. Supra- Clavicular Brachial Plexus Block: Ultra-Sonography Guided Technique Offer Advantage Over Peripheral Nerve Stimulator Guided Technique. Natl J Med Res. 2013;3(3):241-4.

[17] Williams SR, Couinard P, Arcand G, Harris P, Ruel M, Boudreault D, et al. Ultrasound guidance speeds execution and improves the quality of supraclavicuar block Anesth Analg. 2003;97:1518-23.

[18] Simpson G, Nicholls B. Use of ultrasound in chronic pain medicine. Part 1: neuraxial and sympathetic blocks. Contin Educ Anaesth Crit Care Pain. 2013;13:145-51.

[19] Yuan JM, Yang XH, FU SK, Yuan CQ, Chen K, LI Ji, et al. Ultrasound guidance for brachial plexus block decreases the incidence of complete hemi- diaphragmatic paresis or vascular punctures and improves success rate of brachial plexus nerve block compared with peripheral nerve stimu- lator in adults. Chin Med J. 2012;125:1811-6

[20] Kapral S, Krafft P, Eibenberger K, Fitzgerald R, Gosch M, Weinstabl C. Ultrasound-guided supraclavicular approach for regional anesthesia of the brachial plexus. Anesth Analg. 1994;78:507-13