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RESEARCH ARTICLE

Ultrasound Guided Axillary Brachial Plexus Block Versus Supraclavicular Block In Emergency Crushed Hand Patients : A Comparative Study

Rania Maher Hussien* and Dalia Ahmed Ibrahim

Department of Anesthesia and ICU, Ain Shams University, Cairo, Egypt

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Abstract:

Background:

The current study focusses on ultrasound guided Brachial Plexus Block (BPB) which plays an important role in patients with hand trauma either in pain control or for surgical intervention. The brachial plexus can be blocked by several techniques but the most commonly used are the Supraclavicular (SCB) and Axillary (AXB) blocks.

Objective:

To compare the two techniques with regards to the performance time, needling time, anesthesia-related time, block-related complications, number of needle pass and block related pain.

Methods:

After approval of the ethical committee and obtaining a written informed consent from patients, this prospective, randomized, interventional double-blinded study was done to patients undergoing emergency crushed hand surgery. 80 patients were allocated randomly into two equal groups. Under ultrasound guidance, the SCB and AXB were done for the two groups, respectively. The needling time, performance time, anesthesia-related time, onset time, number of 1st needle pass in each group and block related complications were noted.

Statistical Analysis:

Data were analysed using the Statistical Package for Social Science (IBM SPSS) version 23 SPSS.

Results:

Longer needling, performance, anesthesia-related time in the AXB group than SCB and less complications have occurred with AXB than SCB group.

Conclusion:

Axillary block of brachial plexus is a good alternative to Supraclavicular block in emergency crushed hand surgery and the choice is made according to the requirement of each case.

Keywords: Axillary brachial plexus, Supraclavicular Blocks (SCB), Axillary Blocks (AXB), Statistical Package for Social Science (IBM SPSS), Anesthesia-related time, Hand trauma.

* Address correspondence to this author at the Department of Anesthesia and ICU, Ain Shams University, Cairo, Egypt, Tel: 01000544520; E-mail: raniamhm@yahoo.com

1. INTRODUCTION

Injuries to the hand consistently hold a high place in the incidence of bodily trauma. They often need to be repaired immediately. Unfortunately, the stomach is often full of food, drinks or there may be multiple injuries which renders providing general anesthesia, a dangerous procedure. Moreover, most patients need a good perioperative analgesia which can be achieved through regional anesthesia (*e.g.* brachial plexus block).

Although the use of regional anesthesia for upper limb surgery has greatly increased, there is a lack of readily available information on the potential benefits of regional anesthesia as well as the choice of the block for the upper limb trauma [1].

Since ultrasound introduction to the clinical practice, it has become a valuable adjunct for peripheral nerve blocks. Initially used in conjunction with nerve stimulation, ultrasound guidance has now increasingly been used as a sole modality to locate and anesthetize brachial plexus by allowing the operator to visualize in real time the nerve, needle and local anesthetic spread. This resulted in success rates equal or superior to 95% for the supraclavicular, infraclavicular and axillary approaches.

This prospective, randomized, and the interventional double-blinded trial was conducted to compare the 2 commonly used ultrasound-guided approaches (supraclavicular and axillary) for brachial plexus block in emergency crushed hand surgery.

2. SUBJECTS AND METHODS

This study was done after the approval of the ethics committee and obtaining written informed consent from the patients. The study included 80 patients with ASA physical status II and III, and body mass index (BMI) between 20 and 35, aged 40-70, undergoing emergency crushed hand surgery from January 2016 to December 2016.

Patients with significant coagulopathy, infection or trauma at the site of local anesthetics injection, patients who are allergic to local anesthetics, or suffering from chronic obstructive airway disease, or neuropathies, patients who are mentally retarded, severely trauma patients who required general anesthesia from the start, patients who are shocked or unconscious due to the accident and those who refuse to participate were all excluded from the study.

An 18-gauge intravenous cannula was placed at the forearm contralateral to the operated arm, standard monitoring was used (non-invasive arterial blood pressure, ECG, pulse oximetry) while performing the block and throughout the surgical procedure. Premedication was given intravenously in the form of 0.03 mg/kg midazolam (midazolam Halmen 5 mg/1ml by Sunny pharmaceutical-Egypt under license of Hameln Pharmaceutical-Germany for Sunny Medical Group).

Patients were randomly allocated to receive either upper limb regional anesthesia by axillary block technique (group AXB, No. = 40) or by supraclavicular block technique (group SCB, No. 40) using a computer-generated sequence of random numbers and sealed envelope technique.

A standard regional anesthesia tray was prepared containing sterile towels, gauze and packs, bupivacaine 0.5% (Sunny bupivacaine, 20 ml vial contains Bupivacaine HCL monohydrate 115.5 mg eq to 100 mg bupivacaine HCL, sunny pharmaceutical, Badr city cairo-Egypt), 5, 20 ml syringes, 1% Lidocaine vial (lidocaine Hydrochloride-pharco B international 50 mg/ 5 ml) for skin infiltration, 25-gauge needle. Sterile gloves, marking pen and emergency drugs (epinephrine, atropine, and ephedrine) were prepared.

Patients in the axillary group were placed in the supine position with the arm to be blocked abducted and externally rotated. After sterilization of the axilla, the Ultrasound probe (S-nerve ultrasound system, Fuji film sonosite inc., Bothell, WA) with a linear high frequency (8-12 MHZ) transducer was placed parallel to the anterior axillary fold at the axilla to identify the axillary artery and to identify lateral, medial and posterior cords of the brachial plexus in relation to the axillary artery. Lidocaine 1% was infiltrated subcutaneously 1 cm lateral to the probe then 7-10 ml of bupivacaine 0.5% was injected around each cord of the brachial plexus. The musculocutaneous nerve which supplies the skin of the lateral side of the forearm had to be blocked also. It is found between the biceps brachii and coracobrachialis muscles. It is either blocked by 5 mL bupivacaine 0.5% from the same site of injection of the axillary block or through another puncture site that is lower than that of the axillary block.

In the supraclavicular group, patients were placed in the supine position with the head of the bed elevated 30 degrees and patient's head turned away from the side to be blocked. After skin disinfection, an ultrasound device, the same as mentioned before, was placed transversely parallel to and above the middle third of the clavicle, the probe was

tilted till identification of the subclavian artery, 1st rib, pleura and brachial plexus which lies lateral to the subclavian artery and above the 1st rib. Lidocaine 1% was infiltrated subcutaneously 1 cm lateral to the lateral side of the probe. A needle inserted in plane 1 cm lateral to the probe and when adjacent to the brachial plexus, 25 ml of bupivacaine 0.5% was injected around the brachial plexus.

Injection of lidocaine 1% was also used in all patients to eliminate tourniquet pain and pain in the area of distribution of intercostobrachial (Th_2) and medial cutaneous branch (Th_1, Th_2) nerves.

Proper local anesthetics spread around the considered nerves was continuously evaluated under sonographic vision. Also, the position of the needle′s tip was continuously adjusted under sonographic vision with minimum movement during injection to optimize the impregnation of nerves structures.

This study was performed by 3 anaesthetists; one anaesthetist who is experienced in performing the blocks was allocated to perform either the axillary or subclavian according to a computer-generated sequence of random numbers and sealed envelope, and the other two anesthetists were blinded to the technique performed, and they monitored the patients intra and postoperatively. Assessment of brachial plexus blockade was carried out every 10 mins until 30 min by one of these two blinded observers. The supraclavicular and axillary areas were covered to maintain blinding of investigators.

Sensory blockade of the musculocutaneous, median, radial and ulnar nerves was graded according to the previously validated 3point scale using a cold test: 0= no block, 1= analgesia (patient can feel touch and not cold) and 2= anesthesia (patient cannot feel touch). Motor blockade was also graded on a validated 3point scale: 0=no block, 1 = paresis, 2= paralysis, motor blockade of musculocutaneous was evaluated by elbow flexion. Whereas, ulnar “by thumb adduction”, radial” by thumb abduction” and lastly median “by the thumb opposition” were difficult to be assessed due to the crushed hand and damaged nerves.

The number of needle passes was recorded. The initial needle insertion was counted as the first pass. Any subsequent needle advancement was considered an additional pass. Furthermore, the incidence of vascular punctual or patient′s discomfort was also recorded.

All patients in SCB were warned about the symptoms and signs of pneumothorax (pain, dyspnea and cyanosis) because it was an ambulatory setting.

We considered the block successful if it provided surgical anesthesia, which is defined as the ability to proceed with surgery without the need for intravenous narcotics or general anesthesia or even local infiltration by the surgeon and it was recorded by the same blinded investigators. Duration of the block also was recorded, defined as the time from completing injection of the local anesthetic till complete recovery of sensory function, *i.e.*, patient feels cold sensation.

Imaging time was measured and defined as the time interval between the contact of ultrasound probe with the patient and acquisition of the satisfactory image.

Needling time, defined as time interval between the start of skin wheal and the end of local anesthetic injection through the needle, was recorded.

Performance time is the sum of needling time and imaging time.

The onset time is defined as the time required to obtain surgical anesthesia.

Therefore, anesthesia-related time was equal to the sum of performance time and the onset time.

Block related complications were recorded *e.g.* failed block (still included in the study), motor weakness 24 h after the block, vascular puncture, Horner syndrome (is due to the proximity of the cervical sympathetic chain to the brachial plexus in the supraclavicular area), paresthesia and pneumothorax (manifested by dyspnea due to injury of the apex of the lung during SCB).

The blinded observer also recorded patients′ characteristics as well as the level of procedural pain (pain due to the performance of block) immediately after performing the block, using a 10 cm visual analog scale (0 cm= no pain, 10 cm= the worst imaginable pain). Signs and symptoms suggestive of local anesthetic toxicity were also recorded.

Postoperatively pain was managed by nalbuphine. One week after surgery, patients were contacted by blinded investigators to inquire about complications as a motor deficit or persistent paresthesia.

Our primary outcomes were block-related complications, and anesthesia-related times (which include imaging time,

performance time needling and onset time). The secondary outcomes were a number of first needle pass, success rates, block related pain, patient's characteristics, motor weakness 24 h after the block and persistent paresthesia.

3. STATISTICAL ANALYSIS

Data were collected, revised, coded and entered into the statistical package for Social Science (IBM SPSS) version 23. The quantitative data were presented as mean, standard deviations and ranges when their distribution found parametric, while qualitative data were presented as number and percentage. The comparison between two independent groups with qualitative data was done by using the *Chi-square test*. The comparison between two independent groups with quantitative data and parametric distribution was done by using the *Independent t-test*. The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the P-value was considered significant at the level of <0.05.

4. RESULTS

A total of 80 patients were included in the study. Patients were randomized into two groups: SCB and AXB. The two groups were similar in demographic data. M: F proportion, preoperative diagnosis and type of surgery was also similar on comparing the two groups (Table **1**).

Table 1. Demographic Data.

Variable	SCB (n = 40)	AXB (n = 40)	Test Value	P-Value
Age (years)	45.5 (19.4)	42.7(18.9)	-0.462	0.647
Gender (M/F)	20/20	21/19	0.100	0.752
BMI (Kgm^{-2})	25.1(3.4)	26.3(5.9)	0.788	0.436
ASA (I, II, III)	22/17/1	22/18/0	1.067	0.587

Continuous variables are presented as mean (SD); categorical variables are presented as counts ASA= American society of Anaesthesiologists

There were no significant differences between the two groups as regard the onset time and the imaging time. The needling time, performance time and anesthesia-related time were significantly shorter in SCB group than AXB group. The number of needle pass was significantly less in SCB group than AXB group. The success rate was high in the two groups without a significant difference between them. Regarding complications related to each block, the frequency of Horner syndrome and pneumothorax was significantly higher in SCB group than AXB group. However, there was no significant difference between the two groups as regard paresthesia and vascular puncture (Table **2**).

None of the patients suffered from procedure-related pain, persistent paresthesia nor motor weakness one week after surgery (Table **2**).

Table 2. Block performance data.

Parameters	SCB (n = 40)	AXB (n = 40)	Test	P-Value
Imaging time, mean (SD), sec	58.99 (35.6)	65.8 (41.6)	0.787	0.433
Needling time, mean (SD), sec	292 (117.0)	477.5 (145.5)	6.278	<0.001*
Performance time, mean (SD), min	6.1 (2.4)	9.5 (3.2)	5.376	<0.001*
Onset time, mean (SD), min	19.3 (7.3)	18.9 (5.8)	0.271	0.786
Total anesthesia-related time, min	24.2 (6.2)	27.6 (5.5)	2.595	0.011*
Surgical anesthesia, % (Success rate)	38 (95.0%)	39 (97.5%)	0.346	0.556
No. of passes	2.15 (1.35)	6.19 (2.24)	9.770	<0.001*
Paresthesia, n (%)	3 (10)	4 (15)	0.157	0.692
Vascular puncture, n (%)	2 (2.5)	2 (2.5)	0.000	1.000
Horner syndrome, n (%)	13 (32.5)	0 (0.0%)	15.522	<0.001*
Pneumothorax	4 (10.0%)	0 (0.0%)	4.211	0.040*
Motor weakness	0 (0.0%)	0 (0.0%)	NA	NA
Procedural related pain	0 (0.0%)	0 (0.0%)	NA	NA

NA: Not applicable Data are expressed as Mean (±SD) and No (%) *: significant at P < 0.05

5. DISCUSSION

In the current study, supraclavicular and axillary block for brachial plexus (the most commonly used two techniques) were compared. It was found that both blocks were suitable to anesthetize patients undergoing emergency crushed hand surgery. They have the same success rate (surgical anesthesia), onset time and procedural related pain. Yet axillary block was considered safer due to lower incidence of complications, in spite of requiring a longer performance and anesthesia-related time and requiring a separate block of musculocutaneous nerve. While the supraclavicular block was considered efficient from first needle pass when compared to the axillary block.

Due to the long anatomical journey of the brachial plexus, there are several techniques for blocking the nerves of the brachial plexus. These techniques are classified by the level at the needle inserted for injecting the local anesthetic, interscalene block in the neck, supraclavicular block immediately above the clavicle, an infraclavicular block below the clavicle and axillary block in the axilla [2].

Although general anesthesia is a popular method for surgical anesthesia especially in small hospitals, Regional Anesthesia (RA) and especially peripheral nerve blocks provide superior pain control during the surgery and the postoperative period as well [3].

The ultrasound-guidance of the peripheral nerve block renders it safe [4], highly effective, minimally invasive [5] and a cost-effective method of anesthesia as reported by Sandhu *et al*. [6]. However, that was not measured in the current study.

In this prospective, interventional blinded, randomized trial, we compared the supraclavicular with axillary approaches for brachial plexus block anesthesia using ultrasound guidance in emergency crushed hand patients.

Both approaches for Brachial Plexus Block (BPB) were safe and can be used in a patient with emergency crushed hand surgery [7].

For the current study, we decided to use a Single Injection technique for (SCB), whereas a multiple injection techniques were performed for the Axillary Block (AXB). This decision was taken to reflect our practice as well as the state of the published studies concerned to US (ultrasound) guided BPB [8, 9].

In the present study, similar high success rate (surgical anesthesia) was achieved in both groups. This high rate of surgical anesthesia mirrors the finding of previous studies. Where the success rates were 95% [8] for SCB and (95-100%) [10] for axillary block, these results were also consistent with that reached by Arnuntasupakul *et al.* who also compared both techniques on elective hand surgery [11] that may be because the ultrasonography offers a clear endpoints for performance of these two approaches. In the current study, the use of US did not only help to identify the anatomical structures but also allowed complete identification of the needle passage till local anesthetic was injected. This agrees with previous studies′ findings [3, 12, 13].

However, Vazin *et al.* in a study comparing axillary versus supraclavicular block for distal arm surgery concluded that supraclavicular block had a higher success rate than the axillary block [14], which doesn't match the results we reached, and this may be attributed to the multiple injection techniques they used for supraclavicular block while we performed the block through a single injection site.

The current study showed that AXB was associated with longer needling time (477.5 sec), and performance time (9.5 min), and these times were within the previously reported ranges introduced by Site *et al.* [12] and Chan *et al.* [10]. Despite single injection technique of SCB and multiple injection techniques of AXB, both blocks had comparable onset time and success rate that coincides with earlier studies [11, 15, 16], and this may be attributed to the compactly topographic arrangement of trunks, divisions, and cords of brachial plexus, respectively [17].

In relation to performance time, longer anesthesia-related time was noticed in AXB when compared to SCB, the same was reported by Anatoli *et al*. [3]. Arnuntasupakul *et al*. and Vazin *et al.* also found that SCB resulted in shorter anaesthesia related time which coincides with our results [11, 14].

Although patients in the AXB group had a significant increase in a number of 1st needle pass when compared to patients in SCB, yet, patients in AXB group did not report any increase in procedure-related pain. This finding was also reached by Finucane and Tsui and Chan *et al.* [7, 10]. This may be due to sedation that was given to all patients before the procedure. The same opinion was provided by Koscielniak-Nielsen *et al*. [18] who concluded that the electrostimulation and not the number of needles passes that constitute the main source of block-related pain.

In the current study, 32.5% of the patients in the SCB group and none of AXB developed Horner syndrome, all cases recovered completely within 24 hours.

These results were consistent with that reached by Antoli et al. who reported that 10% of their cases developed Horner syndrome [3]. Also, Russo *et al.* [2] reported that 37.5% of their patients had Horner syndrome.

Moreover, 4 cases of pneumothorax were reported in SCB group patients while none of the AXB group patients suffered from pneumothorax, this may be because the axilla is away from both lungs making it difficult to puncture the pleura. These cases were managed by intercostal chest tube insertion. None of the patients developed signs and symptoms of pneumothorax.

Roshid and others reported that the incidence of pneumothorax with SCB was about 6.1%. They concluded that the incidence of complications following brachial plexus block is low but it's much more common with SCB than AXB, this was also stated by Arnuntasupakul *et al*., and they advised to avoid SCB if there is pulmonary dysfunction [11, 19].

Finucane and Tsui [7] reported that AXB is simple to perform, easy, with lower risks of complications but still supraclavicular approach has lower performance time and needling time which mimics the results we reached in this study.

No significant difference between the two groups regarding paresthesia and vascular puncture, the same was reported by Tran *et al.* [17].

In the current study, it was observed that SCB was usually performed from the first needle pass, through the same puncture point of local anesthetic injection.

On the other hand, Axillary block, which has a success rate up to 100% due to ultrasound guidance, easier identification of the block in an obese patient, very safe, easy to be done and reported to be the least one of the brachial plexus approaches to have complications [19]. Although it needs more needling and performance time to be performed and subsequently more anesthesia-related time.

CONCLUSION

Axillary approach for brachial plexus block is an alternative to supraclavicular approach in patients with emergency crushed hand undergoing surgery because it's safer, easy to perform, with an excellent success rate under imaging techniques with less complication, yet, it needs more performance time, needling time, anesthesia-related time and number of needle pass but with no effect on the onset of the block and the choice of the block is made according to the requirement of each case for further researches.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was done after the approval of ethics committee of Research Ethics Committee (REC) FWA 000017585: FMASU R43/2017.

HUMAN AND ANIMAL RIGHTS

No Animals were used in this research. All human research procedures followed were in accordance with the ethical standards of the committee responsible for human experimentation (institutional and national), and with the Helsinki Declaration of 1975, as revised in 2013.

CONSENT FOR PUBLICATION

This study was done after obtaining written informed consent from the patients.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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