Original Article

Feasibility and safety of ultrasound-guided nerve block for management of limb injuries by emergency care physicians

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ABSTRACT

Background: Patients require procedural sedation and analgesia (PSA) for the treatment of acute traumatic injuries. PSA has complications. Ultrasound (US) guided peripheral nerve block is a safe alternative. **Aim:** Ultrasound guided nerve blocks for management of traumatic limb emergencies in Emergency Department (ED). **Setting and Design:** Prospective observational study conducted in ED. **Materials and Methods:** Patients above five years requiring analgesia for management of limb emergencies were recruited. Emergency Physicians trained in US guided nerve blocks performed the procedure. **Statistical analysis:** Effectiveness of pain control, using visual analogue scale was assessed at baseline and at 15 and 60 minutes after the procedure. Paired *t* test was used for comparison. **Results:** Fifty US guided nerve blocks were sciatic- 4 (8%), femoral-7 (14%), brachial- 29 (58%), median -6 (12%), and radial 2 (4%) nerves. No patients required rescue PSA. Initial median VAS score was 9 (Inter Quartile Range [IQR] 7-10) and at 1 hour was 2(IQR 0-4). Median reduction in VAS score was 7.44 (IQR 8-10(75%), 1-2(25%) (P=0.0001). Median procedure time was 9 minutes (IQR 3, 12 minutes) and median time to reduction of pain was 5 minutes (IQR 1,15 minutes). No immediate or late complications noticed at 3 months. **Conclusion:** Ultrasound-guided nerve blocks can be safely and effectively performed for upper and lower limb emergencies by emergency physicians with adequate training.

Key Words: Emergency department, nerve block, ultrasound

INTRODUCTION

Emergency physicians often encounter patients, who require procedural sedation and analgesia (PSA) for the treatment of acute traumatic injuries like fracture reduction, joint dislocation reduction, wound care, and pain relief. PSA has its own complications such as airway or circulatory compromise. Such patients require close monitoring during and after the procedure for several hours before emergency department (ED) disposal.[1] Ultrasound (US)-guided peripheral nerve block is a safe alternative that utilizes minimal amounts of local anesthetic and minimum monitoring is essential for any procedure requiring regional block. US-guided nerve blocks have been reported extensively in the anesthesiology literature[2-5] and have proven effective than the traditional landmark techniques.[6,7] There are anecdotal reports of successful use of US-guided nerve blocks in academic ED setting. Liebmann *et al.* and Stone *et al.* reported feasibility of US-guided nerve blocks for upper limb emergencies[8,9] and Beaudoin *et al* reported a case series of US-guided femoral nerve block for hip fracture in ED.[10] The present study highlights the feasibility of US-guided nerve block for treatment of both upper and lower limb emergencies in ED.

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MATERIALS AND METHODS

Prospective observational study was conducted in a non-

Figure 1: In-plane approach, the needle is placed in-line with and parallel to the transducer

Figure 2: In-plane approach showing both the needle shaft and tip in an example of femoral nerve block

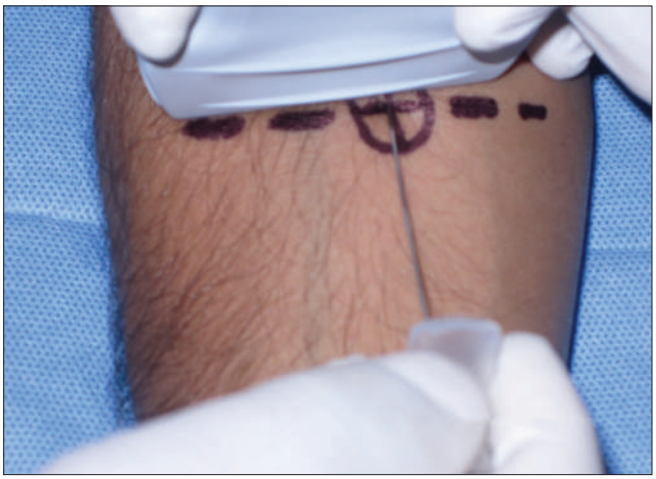

Figure 3: Out of plane approach: needle is placed perpendicular to the transducer

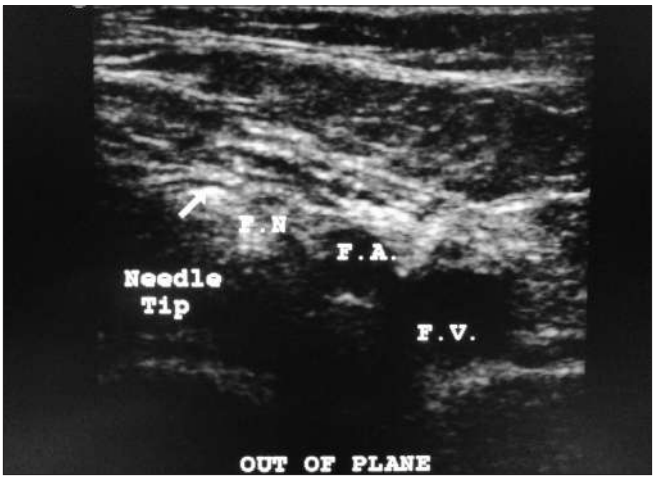

Figure 4: Out of plane approach showing the needle shaft and tip as a hyper-echoic dot in an example of femoral nerve block

academic ED of a level one trauma centre with an annual visit of 50,000 patients. Convenient sample of age group more than five years requiring PSA for the management of upper and lower limb emergencies were recruited. The indications of the procedure were reduction of fracture,joint dislocations with or without soft tissue debridement and pain relief. Those patients who had already received analgesia were excluded.The study was approved by the institutional ethical committee and written informed consent was taken from all patients. Sonographers were: faculty of emergency medicine (one) and residents of surgery (two), medicine (three) and orthopedics (two) posted in the ED as emergency physicians (EPs).They had completed standardized training in techniques for identifying upper limb nerves (brachial plexus, ulnar, radial, and median nerves) and lower limb nerves (femoral and sciatic). The method of training involved one hour of didactic session and demonstration of different upper and lower limb nerves by trained sonographers on live model. After the demonstration; the performers were asked to identify various nerves under supervision of trained sonographers for a period of one week for upper limb nerves and one week for lower limb nerves. Each of them had practiced a minimum of five US-guided nerve block procedures (In-plane and out of plane approach) on a commercially available nerve model (Blue phantom). In-plane approach, the needle is placed in-line with and parallel to the transducer (ultrasound beam) [Figure 1]. Both the needle shaft and tip are visualized [Figure 2]. In out of plane approach; needle is placed perpendicular to the transducer[Figure 3]**.**The needle shaft and tip are visualized as a hyper-echoic dot on ultrasound [Figure 4].None of the emergency physicians were credited in the emergency sonography; however some of them had previous exposure to emergency sonography because of their participation in the three-day workshop.

METHOD OF NERVE BLOCK

A systematic approach to ultrasonography of the forearm was developed by the authors to identify the nerve(s) innervating the injured region of the hand. Portable ultrasound machine with linear probe of thickness 13-6 MHz 25 mm broadband linear array probe and 5-2 MHz 60 mm broadband curved array probe

were used for the study. The radial nerve was identified using a 2-step procedure. First, the probe was placed over the radial artery at the wrist so that the artery was seen in cross-section.

Second, the probe was moved proximally to the midforearm, keeping the radial artery in the middle of the screen. The radial nerve was visualized lateral to the radial artery. The ulnar nerve was identified using the same 2-step procedure, starting at the distal ulnar artery. The ulnar nerve was visualized medial to the ulnar artery. The median nerve does not have an associated median artery, except in rare anatomic variants. Therefore, in the first step, the probe was centered over the volar wrist, between the ulnar and radialarteries, and moved proximally. The median nerve was visualized in the midforearm among the flexor digitorum muscle bundles.

The supraclavicular fossa was prepared and draped in sterile fashion. A sonographic view of the brachial plexus was obtained with a 10 to 7.0 MHz linear transducer oriented transversely in the supraclavicular fossa, just above the clavicle. In this view, the brachial plexus is superficial and lateral to the subclavian artery and is visualized as a group of hypoechoic nodules. Arterial flow was confirmed by pulsed wave Doppler flow to ensure the correct identification of the subclavian artery. The other approach was interscalene. The scanning technique ofInterscalene brachial plexusis done by turning patients head to the contralateral side by 45 degree and placing a linear 38 mm thickness,high frequency probe of 10 to 7.0 MHz. Optimize machine imaging capability by selecting the appropriate depth of field (within 2-3 cm), focus range, and gain. Visualize the nerve roots or trunks in the transverse view (short axis). Nerves in the interscalene groove appear hypoechoic, distinctly round or oval. Femoral nerve was visualized lateral to femoral artery in the inguinal canal and sciatic nerve was located by posterior approach between the greater trochanter and ischial tuberosity using a curvilinear probe of 2-5 MHz. All the blocks were performed after preparation of skin and under real time US guidance by the EPs with or without assistance for injecting the local anesthetic agent. In-plane or out of plane method were used where ever feasible.

Drug Used

We used 1% lidocaine for analgesia, 2% lidocaine for reductions, debridement, and 2% lidocaine with 0.5% bupivacaine for immediate and prolonged analgesia was used along with 8.4% sodium bicarbonate in 9:1 ratio in recommended volume pertaining to nerve being infiltrated.

Intravenous (IV) fentanyl (1mcg/Kg) as a titration dose with Propafol (1mg/Kg) and Propafol (0.5mg/Kg), if needed, for reductions and Ketamine (1.5-2mg/Kg) IV for debridement was kept ready in case of failed USG-guided nerve block.

Data Collection and Processing

Research assistants recorded all data on a data collection sheet developed for this study. Physicians were asked to answer binary questions after completion of the procedure [Table 1].

Table1: Questionnaires for emergency physicians performing USG guided nerve blocks

Question	Answer
To perform the procedure in the anesthetized region, was additional anesthesia/ analgesia required after the nerve block?	Yes/No
The need for additional anesthesia was based on patient request during the procedure.	Yes/No
If the patient requested additional anesthesia, a research assistant subsequently reviewed the medical record, and the time and dose of the medication were recorded.	Yes/No

Participants were asked to mark their pain level on a standardized horizontal linear 100-mm visual analog scale (VAS) before the procedure. Fifteen and sixty minutes after completion of the nerve-block injection, the patients were again asked to rate their pain on a VAS. Patients were blinded to the results of their initial score. A research assistant recorded the time from initiation of ultrasonography to the completion of anesthetic injection for each nerve blocked in minutes and seconds by using a digital stopwatch and then rounded the time to the nearest minute. Aspiration of blood before injection of the anesthetic was recorded as a puncture of a vessel. Sharp pain radiating to the distribution of the nerve being blocked was recorded as a puncture of the nerve. Patients were asked to follow up in the outpatient department three months after their ED visit to identify long-term complications of the procedure. Research assistants also recorded patient demographic information and wound description. The primary outcome measures were the percentage of cases completed without rescue anesthesia/ analgesia and the median reduction in pain after the nerve block, using a VAS. There were four secondary outcome measures: (1) median time from initiation of ultrasonography to completion of the nerve blocks for each subject; (2) immediate complications, including vascular, (3) nerve puncture; and (4) complications or complaints within the 3-month follow-up period.

Statistical method

Medians and interquartile ranges were calculated for visual analog scale and time data. Data were analysed using Stata v 10 (Stata Corporation, College Station, TX). Paired *t*-test was used for statistical evaluation and comparison.

RESULTS

Fifty patients were enrolled for the study. The median age was 27.5 years (range 7 to 80 years). Five patients were in pediatric age group (7-16 yrs). Forty-two were males (M) and 8 females (F) with M:F ratio of 5.2:1. Fifty US-guided nerve blocks were performed [Table 2]. The US-guided nerve blocks were sciatic - 4(8%), femoral - 7(14%), brachial - 29(58%), median - 6(12%), and radial 2 (4%) nerves. Two patients underwent more than one nerve block, which was clubbed as one [Table 3].

Out of 24 brachial plexus block, 13 were used to reduce shoulder joint dislocation, 3 for elbow joint dislocation, and 8 for fracture dislocations of upper limb long bones. The median amount

Table 2: Demographic details

Age in years	Males (*n*)	Females (*n*)
0-15	3	1
16-25	13	1
26-40	13	4
41-60	9	2
61-80	4	0
Total	42	8

Table 3: Indication for upper limb and lower limb nerve blocks (figures depicting the number of patients)

Type of nerve blocks	Reduction	Debridement	Reduction with debridement	Pain relief
Brachial plexus	24	1	3	1
Radial nerve	2	0	0	0
Median nerve	3	2	0	1
Femoral nerve	5	2	0	0
Sciatic nerve	3	1	0	0

of local anesthetic drug (2% lidocaine: 3-5 mg/Kg) used for brachial plexus was 10 ml. About 15-20 ml of local anesthetic (2% lidocaine: 3-5 mg/Kg with or without 0.5% bupivacaine: 1-2 mg/Kg) was used for femoral and sciatic. Both in-plane and out of plane techniques for the nerve blocks were used. A total of 26% were done by in-plane and rest by out of plane approach. There was one case of failed block in a 13-year-old boy with supracondylar fracture in which additional propofol was used. The initial median VAS score was 9 (Inter Quartile Range [IQR] 7-10) and the VAS score after 1 hour was 2 (IQR 0-4). The median reduction in the visual analogue pain score after one hour was 7.44 (IQR 8-10(75%), 1-2(25%) [*P*=0.0001] [Figure 5]. There was significant reduction of pain in both males (7.428) (*P*=0.0001) and females (7.500), *P*=0.0001.There was no statistical significant difference in the VAS reduction in males when compared to females (*P*=0.889) and also among age <25 years (7.722) compared to >25 years (7.281) (*P*=0.258). The median time to completion of the entire procedure, from the beginning of the ultrasonography to the completion of injection of anesthetic drug was 9 minutes (IQR 3, 12 minutes). The median time to reduction of pain after the injection of drug for the nerve block was 5 minutes (IQR 1, 15 minutes). There were no immediate complications such as vascular puncture or direct nerve injection, pneumothorax, phrenic nerve palsy observed. None of the patients had any late complications of nerve block such as numbness, parathesia, or weakness of the limb, which was anesthetized on follow-up at 3 months.

DISCUSSION

The use of US-guided nerve blocks in the ED has been an exciting recent development. However, US assistance in regional anesthesia was first described in 1978.[11] The conventional methods of procedural analgesia are local wound infiltration, nerve blocks, hematoma blocks, intravenous regional blocks (bier blocks), parenteral pain medications, and procedural sedation.

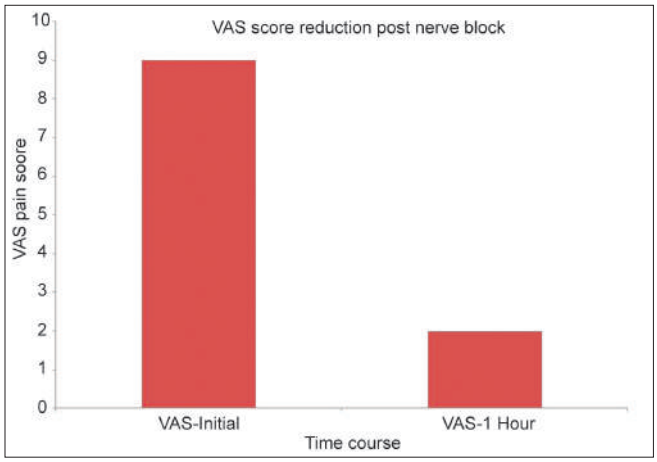

Figure 5: Score: Median VAS reduction was 7.44 Interquartile range (IQR), 8-10(75%), 1-2(25%) *P* = 0.0001

Procedural sedation involves prolonged fasting, multiple providers, a monitored bed in the ED, time for preparation, sedation and recovery, and risks of deep sedation. In addition, certain conditions such as head injury, hypotension, or underlying cardiopulmonary disease may make the use of procedural sedation unacceptable for some patients, given the risk of hypotension and the inability to closely monitor neurologic status during sedation.

Performing nerve blocks blindly using the landmark technique lead to complications such as arterial puncture, pneumothorax, parasthesias, recurrent laryngeal or phrenic nerve paralysis, compartment syndrome, and rarely permanent neurologic dysfunction. The rate of block success is increased from approximately 85% using the landmark technique to 95% using real-time US-guided nerve block. The ability to visualize directly the spread of local anesthetic solution and its relationship with the nerve allows for immediate adjustments to needle position and/or local anesthetic volume and spread resulting theoretically in improved block performance through faster onset, reduced local anesthetic volumes, and higher success rates.[12,13]

Michael *et al.* reported the ability of US-guided nerve blocks to achieve excellent analgesia for a wide range of painful upper extremity procedures and early disposal of patients in a busy and overcrowded ED.[9] Tantry *et al.* addressed the impact of US-guided nerve blocks in improving the patient safety issues in two cases of severe cardiac valvular lesions on anticoagulants; avoiding the use of general and regional anesthesia, which carry potential risk.[14] Marhofer *et al.* demonstrated a clear benefit of US guidance over nerve stimulator for nerve blocks.[15,16] US-guided peripheral nerve blocks also have their limitations. Saranteas *et al.* encountered difficulty in using ultrasound imaging for nerve block in 2 trauma patients due to edema and subcutaneous air.[17] In our study group, the efficacy of US-guided nerve blocks is adequately demonstrated as only one patient required additional anesthesia, achieved statistically significant pain reduction and none of them had early or late complications. Mean time taken (nine minutes) to complete the nerve blocks

in our study is in accordance with other studies.[8] There are no studies published demonstrating the feasibility of nerve blocks in the pediatric age group. We effectively performed blocks in all age groups ranging from pediatrics to geriatrics for management of both upper and lower limb injuries. The impact of factors such as age and gender on for pain reduction score was not found to be statistically significant, which is lacking in other studies. We did both in-plane and out of plane blocks with significant reduction of pain in both groups as compared to available data; which has been done as either in-plane or out of plane.The volume of the anesthetic drug was lower than used in other studies. This may be due to the fact that the average Indian body mass index is lower than the average worldwide, thus reducing the dose requirement.[18] This study was carried out in a non- academic ED where residents from various specialties who work as emergency physicians. The training methodology adapted by our study is adequate for the performance of block. A formal training must be incorporated in the curriculum to improve the safety aspect of the ultrasound guided block and to manage patients with inadequate or failed block as 5% failure rate can still occur with ultrasound guided block. This study will encourage and serve as a prototype for other non-academic emergency department to perform ultrasound-guided nerve blocks for patients undergoing procedures for upper and lower limb emergencies and pain relief.

Limitation

It is an observational, convenience sample, no control group, no blinding. The study does not highlight the ED disposition time and patient satisfaction issues.

CONCLUSION

Ultrasound-guided nerve blocks can be safely and effectively performed for upper and lower limb emergencies by emergency physicians with adequate training.

REFERENCES

1. Green SM, Krauss B. Pulmonary aspiration risk during emergency department procedural sedation—an examination of the role of fasting and sedation depth. Acad Emerg Med 2002;9:35-42.
2. Chan VW. Applying ultrasound imaging to interscalene brachial plexus block. Reg Anesth Pain Med 2003;28:340-3.
3. Chan VW, Perlas A, Rawson R, Odukoya O. Ultrasound-guided supraclavicular brachial plexus block. Anesth Analg 2003;97:1514-7.
4. De Andres J, Sala-Blanch X. Ultrasound in the practice of brachial plexus anesthesia. Reg Anesth Pain Med 2002;27:77-89.
5. 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.
6. Williams SR, Chouinard P, Arcand G, Harris P, Ruel M, Boudreault D, *et al*. Ultrasound guidance speeds execution and improves the quality of supraclavicular block. Anesth Analg 2003;97:1518-23.
7. Marhofer P, GreherM, KapralS. Ultrasound guidance in regional anaesthesia. Br J Anaesth 2005;94:7-17.
8. Liebmann O, Price D, Mills C, Gardner R, Wang R, Wilson S, *et al*. Feasibility of forearm ultrasonography-guided nerve blocks of the radial, ulnar, and median nerves for hand procedures in the emergency department. Ann Emerg Med 2006;48:558-62.
9. Stone MB, Price DD, Wang R. Ultrasound-guided supraclavicular block for the treatment of upper extremity fractures, dislocations, and abscesses in the emergency department. Am J Emerg Med 2007;25:472-5.
10. Beaudoin FL, Nagdev A, Roland CM, Becker BM. Ultrasound-guided femoral nerve blocks in elderly patients with hip fractures. Am J Emerg Med 2010;28:76-81.
11. La Grange P, Foster PA, Pretorius LK. Application of the Doppler ultrasound blood flow detector in supraclavicular brachial plexus block. Br J Anaesth 1978;50:965-7.
12. Yang WT, Chui PT, Metreweli C. Anatomy of the normal brachial plexus revealed by sonography and the role of sonographic guidance in anesthesia of the brachial plexus. Am J Roentgenol 1998;171:1631-6.
13. Perlas A, Chan VW, Simons M. Brachial plexus examination and localization using ultrasound and electrical stimulation: Avolunteer study. Anesthesiology 2003;99:429-35.
14. Tantry T P, Kadam D, Shetty P, Bhandary S. Combined femoral and sciatic nerve blocks for lower limb anaesthesia in anticoagulated patients with severe cardiac valvular lesions. Indian J Anaesth 2010;54:235-8.
15. Marhofer P, Schrögendorfer K, Koinig H, Kapral S, Weinstabl C, Mayer N. Ultrasonographic guidance improves sensory block and onset time of three-in-one blocks. Anesth Analg 1997;85:854-7.
16. Marhofer P, Schrögendorfer K, Wallner T, Koinig H, Mayer N, Kapral S. Ultrasound guidance reduces the amount of local anesthetic for 3-in-1 blocks. Reg Anesth Pain Med 1998;23:584-8.
17. Saranteas T, Karakitsos D, Alevizou A, Poularas J, Kostopanagiotou G, Karabinis A. Limitations and technical considerations of ultrasound -guided peripheral nerve blocks: Edema and Subcutaneous air. Reg Anesth Pain Med 2008;33:353-6.
18. Venkaiah K, Damayanti K, Nayak MU, Vijayaraghavan K. Diet and nutritional status of rural adolescents in India. EurJClinNutr2002;56:1119-25.

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