J Nepal Health Res Counc 2011 Oct;9(19):145-49

Nerve Stimulation Under Ultrasound Guidance Expedites Onset of Axillary Brachial Plexus Block

Shrestha BR[1]

[1]Department of Anaesthesiology and ICU, Kathmandu Medical College Teaching hospital, Sinamangal, Nepal.

ABSTRACT

Background: Axillary block is popular technique in upper extremity surgery. Nerve stimulation is used for location of nerves to provide effective blockade. The advent of ultrasound imaging technique in regional anaesthesia has increased the accuracy of needle placement and local anaesthetic deposition around the nerve. The aim of this study is to find out if the nerve stimulation technique with ultrasound guidance has advantages over sole nerve stimulation technique. The outcome measures studied were onset of sensory and motor block, procedure time, number of skin puncture, vascular puncture and paresthesia during nerve stimulation.

Methods: This is a prospective randomized comparative study conducted in KMCTH from June 2009 to March 2010 on patients of American Society of Anaesthesiologist I and II requiring upper arm surgery under axillary block. The study comprised of two groups: ultrasound with nerve stimulation group (n=35) and nerve stimulation group (n=35). 24 ml of Bupivacaine 0.5% with injection Dexamethasone 4 mg was used to block the individual four nerves with 6 ml of the local anaesthetic solution per nerve namely ulnar, radial, median and musculocutaneous. The data were recorded by blinded observer. In case of partial block or block failure, the patients were supplemented with Fentanyl or subjected to laryngeal mask placement.

Results: Demographic characteristics (age, weight) in either group were similar (p>0.05). The male and female ratio (M: F) in ultrasound with nerve stimulation group was 12:16. The ratio was 18:17 in nerve stimulation group. The onset of complete sensory block was earlier and the onset of motor block was faster in ultrasound with nerve stimulation group than in sole nerve stimulation group (p=0.001). Ultrasound guidance decreased the number of skin puncture during the nerve stimulation, p= 0.02. The incidence of paresthesia was encountered during nerve location (14%), which could be minimized using ultrasound (7%). The success rate of the block was 93% with ultrasound assistance. The procedure time was not different in both techniques. The surgery duration was not significant statistically in either of the group, p=0.715.

Conclusions: This study showed that the onset of sensory and motor block was faster with ultrasound assistance nerve stimulation. Complications can be decreased with the use of ultrasound in axillary block.

Keywords: axillary nerves, block, motor, sensory, ultrasound.

INTRODUCTION

Delivering the right dose of local anaesthetic to the target nerve without causing any damage to the nerve and surrounding structures is the key in the practice of regional anaesthesia. With the knowledge of topographical anatomy nerve stimulation technique helps us to approach the needle towards the nerve to be

Correspondence: Dr. Babu Raja Shrestha, Department of Anaesthesiology and ICU, Kathmandu Medical College Teaching hospital, Kathmandu, Nepal. Email: barashrestha@yahoo.co.in, Phone: 9851044526.

blocked. Yet this technique itself remains the blind one. Ultrasound guided nerve blocks have been described in the literatures since 1978. With availability of high resolution portable ultrasound, it has become an integral component in present day practice of anaesthesia. There are different methods of brachial plexus block from blind parasthesia technique to ultrasound guidance. Nerve stimulation is used for localization of nerves during the block.

There are different methods like single, double or multiple injection techniques for block. Handoll et al came to conclusion that multiple injection technique using nerve stimulation produces effective blockade.[1]

Ultrasound in regional anaesthesia has revolutionalized the practice of nerve block for better outcomes. Studies have reported significant improvement in onset and blockade with ultrasound compared to transarterial technique.[2] Casaeti et al conducted a prospective randomized study comparing ultrasound technique and nerve stimulation technique.[3]

This present study was conducted to compare the two techniques of axillary block using ultrasound with concomitant nerve stimulation versus sole nerve stimulation technique.

METHODS

A prospective randomized comparative study was conducted in Kathmandu Medical College Teaching Hospital (KMCTH) from June 2009 to March 2010 on patients of American Society of Anaesthesiologist (ASA) I and II requiring upper arm surgery (wrist, forearm and hand) under axillary block. The study comprised of two groups: ultrasound with nerve stimulation (USNS) group (n=35) and nerve stimulation group (NS) (n=35). Patients were randomly allocated using lottery method to either of the study groups. 24 ml of Bupivacaine 0.5% with injection Dexamethasone 4 mg was used to block the individual four nerves with 6 ml of the local anaesthetic solution per nerve namely ulnar, radial, median and musculocutaneous. The data were recorded by blinded observer. In case of partial block or block failure, the patients were supplemented with Fentanyl or subjected to laryngeal mask placement.

Institutional ethical committee approval and informed consent were obtained to conduct the study. For group USNS, ultrasound and nerve locator were used for nerve imaging and identification. Exclusion criteria adopted in the study were: history of coagulopathy, allergy to drug, diabetes, local infection at the site of block, patients requiring bilateral hand surgery, patients' denial, cases that needed conversion to general anesthesia, surgery lasting more than three and half hours and patients beyond age of 20-65 years and body weight of 45-65 kg.

Once the patients arrived in the operation theatre intravenous line was secured. Monitors (electrocardiogram, noninvasive blood pressure, pulse oximetry) were applied. Patients were positioned supine with the arm to be blocked abducted perpendicular to the body. All blocks were performed with 24 ml of 0.5% bupivacaine with 4mg of Dexamethasone added as adjuvant to local anaesthetic.

Under aseptic precautions local infiltration with 1% lidocaine was made in the area prior to skin puncture. The individual four nerves ulnar, medial, radial and musculoskeletal nerves were blocked. The nerve stimulator used in the study was innervator 272, Fisher and Paykel health Care Ltd. The nerve location was aided with a short-beveled Teflon coated insulating needle 22 G (Stimulpex, B Braun).

The nerve stimulator was set with pulse duration of 0.2 ms, a current intensity of 1 mA and a frequency of 2 Hz. The nerves were fixed on the basis of the twitches generated on the hand in the corresponding areas during the stimulation.

The current from 1mA intensity was gradually reduced to 0.6 mA once the twitch was observed following nerve stimulation. Then 1 ml of local anaesthetic was injected to see if the twitches disappeared. The disappearance of the muscle twitch confirms the nerve location and the remaining 5 ml of local anaesthetic deposited in to the same place. The paresthesia upon seeking the nerves was recorded. The needle was then withdrawn up to the skin and redirected to other nerves. The number of skin punctures was recorded.

In USNS group, the nerve location was facilitated by using portable ultrasound scanner with superficial linear probe of 6.5 cm length and frequency of 8 MHz (Toshiba, PLG-805 S). The needle was advanced towards nerves under real time sonographic vision of the needle using long axis view (Figure 3). The location of the nerve was further confirmed by concomitant nerve stimulation and local anaesthetic deposited under ultrasound guidance. Intermittent aspiration through the syringe reconfirmed intravascular placement. The incidents of vascular punctures were recorded. The blocks were performed by the same person. The person performing block assessment was blinded to the nature of block technique.

Sensory block was assessed by loss of ice-cold sensation in different parts of the arm comparing the sensation at the corresponding area of the contralateral arm. Normal sensation of coldness meant no block, whereas total loss of sensation was taken as complete sensory block.

Motor block was evaluated using 3 P (Pinch, Pull and Push) techniques and asking to flex the arm at the elbow against gravity. Complete motor block was considered

when the arm was unable to overcome against the gravity. Surgery was allowed to proceed when there was complete sensory and motor block. The block was taken as "success" when surgery could be performed without any further rescue blocks or drug supplements beyond the allowed limits. In case of pain during surgery inj. Fentanyl (to 100 mcg) were given and recorded .Despite the supplement if surgery were not possible to proceed ,the case was subjected to general anaesthesia with LMA. The total duration of surgery in both groups were recorded.

Statistical package for social sciences (SPSS) version 14.0 for windows was used for statistical analysis. The means of continuous variables were compared using the student's 't'-test and categorical variables were compared using ANOVA test. p value < 0.05 was considered statistically significant.

RESULTS

Demographic values were similar in the two groups (Table 1). The mean onset of sensory block in USNS and NS are 12 min and 17 min respectively, p=0.01. The faster onset of sensory block was observed in USNS group.

Table 1. Patient demographics.

	USNS Group	NS Group	p- Value
Sex (M:F)	M:F = 12:16	M:F= 18:17	-
Age (yr), mean ± SD	37.71 ± 11.46	41.0 ± 13.57	0.283
Weight ,kg	58.42 ± 6.4	57.14 ± 6.8	0.89

Table 2. Outcome measures, the values are mean or number (SD) or (%).

	USNS Group	NS Group	p-value
Onset of sensory block, min	12.21 ± 3.5	17.31 ± 3.5	0.01
Onset of motor block, min	16.10 ± 1.66	20.80 ± 3.35	0.001
No of skin puncture	2.46 ± 0.63	3.62 ± 1.0	0.026
Paresthesia	2/28 (7%)	5/35 (14.28 %)	-
Success rate	93% (26/28)	86% (30/35)	-
Vascular puncture	1.0 ± 0 (7%)	1.12 ± 0.35 (23%)	0.297
Procedure time, min	6.75 ± 1.37	6.88 ± 1.85	0.08
Surgery time, min	98.17 ± 34.67	92.85 ± 38.49	0.715

The complete motor block was found to occur in 16 min in USNS group which was 21 min in NS group, p=0.001 .Thus faster motor block was seen in USNS group. Ultrasound guidance decreased the number of skin puncture during the nerve stimulation, p= 0.02. The incidence of paresthesia was encountered during nerve location (14%), which could be minimized using ultrasound (7%). The success rate of the block was 93% with ultrasound with nerve stimulation technique which was higher than in nerve stimulation group (86%).The inadvertent vascular puncture was 7% in ultrasound with nerve stimulation group which increased to 23% in nerve stimulation technique. Duration of surgery in either of the groups was statistically not significant, p=0.75. The mean time spent to block the nerves in both groups was also not different, p=0.08.

DISCUSSION

In the present study ultrasound aided nerve stimulation speeded up the axillary block. The onset of sensory block was 12 min in USNS group and 17 min in NS group. This finding is statistically significant (p= 0.01) (Figure 1).

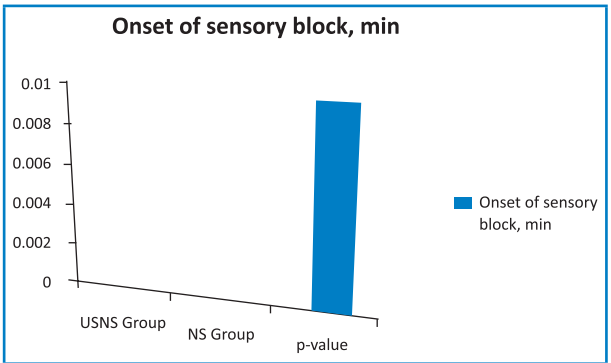

Figure 1. Onset of sensory block in two groups.

In a study conducted by Casati A et al the onset of sensory block was 14 min in US group without concomitant nerve stimulation where as the onset of sensory block was 18 min in nerve stimulation group.[3]

In a study in pediatric patients, Marhofer et al reported shorter mean onset time of 9 min in Ultrasound technique than in nerve stimulation group (15 min) in infraclavicular blocks.[4]

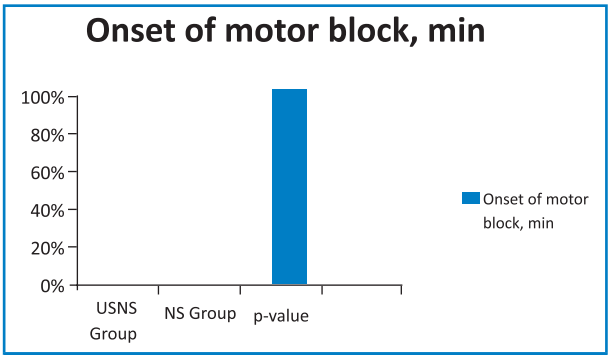

Figure 2. Onset of motor block.

The onset of motor block in the present study was 16 min in USNS group, which increased to 20 min in NS group. The difference in motor block onset is statistically significant between the groups (p=0.001) (Figure 2).

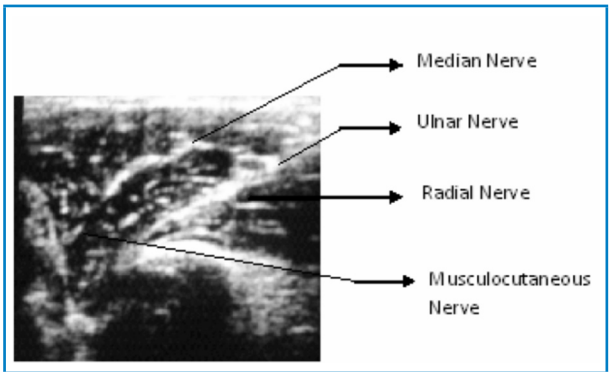

Figure 3. Ultrasound showing axillary nerves.

Soeding et al compared conventional landmark technique to ultrasound approach in the axillary block and found that ultrasound guidance significantly speeds up the sensory and motor block.[5]

Ultrasound with or without concomitant nerve stimulation has been shown to improve the success rate of axillary block. The findings in terms of block onset from this study are comparable to reports from different studies.[4-6] It was noticed that earlier onset of sensory and motor block in USNS in the study. The speed of onset seems to be enhanced by ultrasound assistance which enables the local anaesthetic to be deposited close proximity around the nerve under direct vision. Moreover the use of Dexamethasone as an adjuvant in the present study might have played a role to hasten the onset.[7] The minimum effective dose of local anaesthetic agent required to achieve axillary block under ultrasound guidance is unknown.[8] The usual recommended volume used in axillary nerve block is 30-44 ml of local anaesthetic in conventional technique. In this study the volume used was fixed (28 ml) which was thought to be within normal limits for our population in common weight basis. There has been a report of effective block using total of 4 ml of lidocaine in ultrasound guided axillary block.[8]

The number of skin punctures was less in USNS group than in NS group (2 vs 3). In nerve stimulation technique one has to seek the nerves keeping the anatomic pictures in mind which increases the chance of multiple punctures. Ultrasound gives real time vision of the structures and the needle which helps us to lessen the multiple pricks. In the study by Urebaugh et al Ultrasound guided nerve stimulation technique was reported to have less needle insertions when compared to nerve stimulation method (2 times versus 6, p<0.001).[9]

Chan VW and Perlas A also reported a less incidence of axillary bruising and punctures in USNS technique in their study.[6]

Though safe and commonly used, axillary block has a surprisingly poor success rate if used as a single-injection technique due to presence of septae within the sheath restricting free spread of local anaesthetic.[10] Multiple injections or repositioning of needle is required in nerve stimulation to block nerves in different compartments in axillary plexus. Ultrasound minimizes the trauma to the skin. The presence of septae within the brachial plexus sheath becomes a non issue with the emergence of Ultrasound as individual nerve can be blocked using this technique.[11]

This study reports vascular injury in USNS group (7%) and in NS group (23%) which was statistically not different (p=0.29). Ability to visualize the needle tip, intermittent aspiration is always a rule whatever technique is employed. Studies have shown that statistically significant fewer blood vessel punctures occur with the use of ultrasound in axillary plexus block than when it is not used with nerve stimulation.[9,12] Doppler ultrasound has been employed to identify and mark the location of the axillary artery for brachial plexus block in patients whose axillary artery was impalpable.[13] Ultrasound speeds up the block completion time, unlike the sole nerve stimulation technique in which more time will be spent in seeking the nerves. The block execution time in the present study was mean 6-7 min for both groups and that was not significant statistically, unlike the findings of Williams SR et al who completed the block under Ultrasound in 5 min whereas it took 10 min for them to accomplish the procedure in nerve stimulation technique.[14] The block performance time for axillary block was 1.7 to 6 min in the study by Brian D.O and Gabrielle I.[8] Increased time consumption for the block and slower block onset may cause delayed start of surgery and increases unnecessary cancellation of the list .

Paresthesia was encountered in 2 (7%) patients of USNS group and 5 (14.28%) patients of NS group in this study. Sole paresthesia method of nerve block is too blind to cause patient discomfort. Hu et al recommend to prefer the use of nerve stimulation technique over the paresthesia technique to decrease pain and discomfort during the block.[15] Studies have stressed the benefits of ultrasound over the nerve stimulation to avoid uncomfortable muscle twitches during blocks.[16,17]

In USNS group the number of patients enrolled was 28 before initiation of the block. Three patients denied use of ultrasound, two patients had uncontrolled hypertension and two patients were found to have increased blood sugar. Thus seven patients were not included in the study due to factors not related to the procedure. The success rate was 26 (93%) and 30 (86%) in USNS group and NS group, respectively in this study. Data from large observational studies document 90%-98 % success rates when skilled operators utilize peripheral nerve stimulator techniques.[18] The success rate which

is high in Ultrasound guided block in different studies could not be reproduced in the present study.[3-4] The similar success rate between the groups and failure to show the superiority of USNS over NS in this study could be related to skill, learning curve of the performer. One accepted fact by now after numerous studies is ultrasound enhances the block success rate.[2-6]

Two patients in USNS group underwent laryngeal mask insertion once more than 100 mcg of fentanyl consumed. Five patients received general anaesthesia due to inadequacy of surgical anaesthesia in NS group.

The established methods of nerve location were based on either paresthesia technique or visualization of proper motor response on nerve stimulation. Both these methods have been found to have a low sensitivity for detection of needle to nerve contact.[19] Ultrasound has been introduced as a valuable tool to identify peripheral nerves and view the spread of local anaesthetic solution around the nerves under sonographic vision.[20-23]

The demographic characteristics were similar in two groups (Table 1). The operative time in two groups was also not different statistically.

The limitation of this study was it did not study the effective minimum volume of local anaesthetic necessary to block the nerve successfully. This study fixed the volume of local anaesthetic to all patients and equal volume was used to block the all four individual nerves. Another shortcoming was this study did not study regression of sensory and motor block.

CONCLUSIONS

This study shows the onset of sensory and motor block is faster with ultrasound guided nerve stimulation. Complications can be decreased with ultrasound guidance in axillary block.

REFERENCES

1. Handoll HH, Koscielniak-Nielsen ZJ. Single or multiple injection techniques for axillary brachial plexus block for hand, wrist or forearm surgery. Cochrane Database Syst Rev. 2006;25:CD003842.
2. Sites BD, Beach ML, Spence BC, Wiley CW, Shifrfrin J, Hartman GS, et al. Ultrasound guidance improves the success rate of perivascular axillary plexus block. Acta Anaesthesiol Scand. 2006;50:678-84.
3. Casati A, Danelli G, Baciarello M, Corradi M, Leone S, Di cianni S, et al. A prospective, randomized comparison between ultrasound and nerve stimulation guidance for multiple injection axillary brachial plexus block. Anaesthesiology. 2007;106:992-6.
4. Marhofer P, Sitzwohl C, Greher M, Kapral S. Ultrasound guidance for infraclavicular brachial plexus anaesthesia in children. Anaesthesia 2004;59:642-46.
5. Soeding PE, Sha S, Royse CE, Marks P, Hoy G, Royse AG. A randomized trial of ultrasound-guided brachial plexus anaesthesia in upper limb surgery. Anaesth Intensive Care. 2005;33:719-25.
6. Chan VW, Perlas A, McCartney CJ, Brull R, Xu D, Abbas S. Ultrasound guidance improves success rate of axillary brachial plexus block. Can J Anaesth. 2007;54:176-82.
7. Shrestha BR, Maharjan SK, Shrestha S, Gautam B, Thapa C, Thapa PB, et al. Comparative study between tramadol and dexamethasone as an admixture to bupivacaine in supraclavicular brachial plexus block. J Nepal Med Assoc. 2007;46(168):158-64.
8. Brian DO, Gabrielle I. An estimation of the minimum effective anaesthetic volume of 2% lidocaine in ultrasound-guided axillary brachial plexus block. Anaesthesiology. 2009;111:25-9.
9. Orebaugh SL, Williams BA, Kentor ML. Ultrasound guidance with nerve stimulation reduces the time necessary for resident peripheral nerve blockade. Reg Anesth Pain Med. 2007;32:448-54.
10. Thompson GE, Rorie DK. Functional anatomy of the brachial plexus sheaths. Anaesthesiology. 1983;59:117-22.
11. Anthony RB. Ultrasound versus peripheral nerve stimulator for peripheral nerve blockade: Pros and cons. Revista Mexicana de Anaesthesiologica. 2008;31:79-84.
12. Lo N, Brull R, Perlas A, Chan VW, McCartney CJ, Raffaele S, et al. Evolution of ultrasound guided axillary brachial plexus blockade: retrospective analysis of 662 blocks. Can J Anaesth. 2008;55(7):408-13.
13. Abramowitz HB, Cohen CH. Use of Doppler for difficult axillary block. Anaesthesiology. 1981; 55: 965-7.
14. 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 . Anaesth Analg. 2003;97:1518-23.
15. Hu P, Harmon D, Frizelle H. Patient comfort during regional anaesthesia. J Clin Anaesth. 2007;19:67-74.
16. Marohfer P, Greher M, Karpral S. Ultrasound guidance in regional anaesthesia. Br J Anaesth. 2005;94:7-17.
17. O' Sullivan MJ. Patient comfort in regional anaesthesia. Anaesth Analg. 2008;106:348-50.
18. Perris TM, Watt JM. The road to success: a review of 1000 axillary brachial plexus blocks. Aneasthesia. 2003 ;58:1220-4
19. Perlas A, Niazi A, McCartney C, Chan V, Xu D, Abbas S. The sensitivity of motor response to nerve stimulation and paresthesia for nerve location as evaluated by ultrasound. Reg Anaesth Pain Med. 2006;31:445-50.
20. Grau T. Ultrasonography in the current practice of regional anaesthesia. Best Pract Res Clin Anaesthesiol. 2005;19:175-200.
21. Sandhu NS, Capan LM. Ultrasound-guided supraclavicular brachial plexus block. Br J Anaesth. 2002;89:254-9.
22. Schafhalter-Zoppoth I, McCulloch CE, Gray AT. Ultrasound visibility of needles used for regional nerve block: an invitro study. Reg Anesth Pain Med. 2004;29:480-8.
23. Denny NM, Harrop-Griffiths W. Ultrasound imagining in regional anaesthesia. Br J Anaesth. 2005;94:1-3.