Ultrasound Guided Continuous Brachial Plexus Catheters

Sanjay K. Sinha[1]

Abstract

Continuous brachial plexus nerve blocks are an established technique for providing prolonged analgesia in patients having upper extremity surgeries. This narrative discusses continuous interscalene and infraclavicular nerve blocks. The catheter insertion techniques using ultrasound guidance alone or in combination with nerve stimulator is reviewed. The risks and complications of continuous nerve blocks are highlighted. Practical tips on successfully managing continuous blocks with peri-neural catheters for postoperative pain is reviewed. Introduction of long acting local anesthetic for peripheral nerve blocks, like liposomal bupivacaine, may offer an alternative to continuous catheter block technique in the future.

Keywords: Continuous brachial plexus nerve blocks, technique, catheter

Introduction

Brachial plexus blocks are very useful in providing surgical anesthesia and postoperative analgesia after upper extremity surgeries. Single shot brachial plexus blocks typically last 16 - 18 hours when long acting local anesthetic solutions are used. Addition of adjuvants may extend the duration of the block up to twenty-four hours, however, if a block lasting a few days is desired, then a continuous peri-nerual catheter block technique is the only method currently available to achieve this objective.

Continuous brachial plexus blocks can facilitate early rehabilitation and discharge from hospital and increase patient satisfaction. The other advantages of continuous brachial plexus block is that the depth of the block can be titrated by changing the concentration or rate of infusion of local anesthetic solution. In some circumstances, where surgeons want to assess nerve function after the surgery, a brachial plexus catheter can be placed pre-surgically and the block initiated in recovery room after confirming nerve function. This a review will focus on continuous interscalene and infra-clavicular blocks.

[1]St. Francis Hospital and Medical Center
Hartford, Connecticut, USA

Address of Correspondence
Dr. Sanjay K. Sinha MBBS
St. Francis Hospital and Medical Center
Hartford, Connecticut, USA
Email: sanjaysinha@comcast.net

Dr. Sanjay K. Sinha

Continuous Inter-scalene block

A continuous inter-scalene block is indicated for providing prolonged analgesia after surgeries of the shoulder and upper humerus. For placing an interscalene catheter, an insulated Touhy needle is advanced, under ultrasound guidance, to position the needle tip between C 5-6 nerve roots or upper and middle trunks of the brachial plexus between the anterior and middle scalene muscles.

The 18g Tuohy needle (Fig. 1) is placed close to the brachial plexus elements. After identifying the tip a small aliquote of local anesthetic is injected to demonstrate the spread.

After eliciting appropriate muscle twitch, local anesthetic solution or normal saline or 5% dextrose is injected through the needle to hydro-dissect a tissue plane (Fig. 2). Once it is an ideal spread is identified arrangements are made to insert the catheter. The catheter is then threaded 2-3 beyond the needle tip and the needle is withdrawn.

The placement of the catheter is observed over the monitor as it skirts the brachial plexus elements (Fig. 3). The tip of the catheter is positioned depending on the need of extent of analgesia.

Once positioned the catheter tip is flushed with a small volume of local anesthetic and the spread is identified (Fig. 4).

Normally for proximal humerus the catheter tip is positioned close to the superior trunk (Fig.5). This helps is adequate soaking of the superior trunk and a site specific analgesia.

The inplane catheter placement depicts the tip close to the superior trunk (Fig. 5). This an ideal placement in the interscalene groove for upper arm surgeries.

Postoperatively before infusing with 0.1% ropivacaine, a test dose identifies the tip of the catheter.

Alternatively, if a stimulating catheter (Fig. 6) is used, the catheter is attached to a nerve stimulator and advanced adjacent to the nerves so as to maintain a constant twitch as the catheter tip is positioned 2-3 cm beyond the needle. When using a stimulating catheter, usually no local anesthetic solution or normal saline is injected through the needle as it will abolish the muscle twitch (Fig. 7).

If hydrodissection is preferred before catheter insertion, dextrose 5% solution, which maintains muscle twitch, may be injected through the needle prior to inserting the catheter. The block is then induced by injecting local anesthetic solution through the catheter. It is purported that using a stimulating catheter will decrease the incidence of secondary block failures when compared to non-stimulating catheters.

Figure 1: In Plane Ultrasound guided needle placement

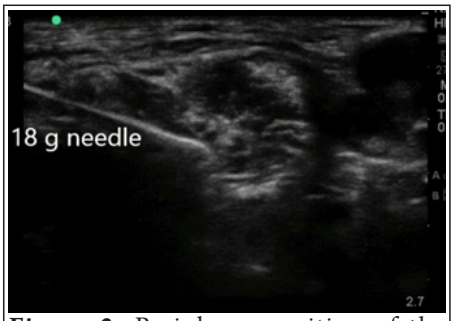

Figure 2: Periplexus position of the insulated 18g needle.

Figure 3: 18g catheter observed in vicinity of the brachial plexus Orange arrows – depicting the catheter placement. (Sandeep diwan)

Since the brachial plexus is in a very superficial tissue plane in the interscalene space, these catheters are very prone to dislodgment. One of the methods used to keep the catheter in place is to tunnel these catheters through subcutaneous tissue. To reduce the back leak of local anesthetic at the catheter insertion site, dermabond is use by many anesthesiologists to seal the insertion site. Catheter–over-needle systems may also be used to decrease the risk of leaks. The risk of diaphragmatic hemiparesis from a continuous interscalene block exists even when using low volume or concentration of local anesthetic solution. Placing the catheter tip extra-facially compared to within the brachial plexus fascia has been shown to decrease the risk of hemi-diaphragmatic paresis without affecting the analgesic efficacy of the block.

The block is initiated by a bolus of local anesthetic solution through the needle or catheter. This is followed by a continuous infusion of dilute local anesthetic solution at 4-6 mL/h to maintain the block.

A patient controlled bolus can be can be programmed in addition to the continuous infusion giving patients greater control in supplementing the block for breakthrough pain. Typically, we use ropivacaine 0.5% 10-20 mL is to induce the block followed by an infusion of ropivacaine 0.2% at 4-6 mL/h and a 5mL bolus of ropivacaine 0.2% self-administered every 30 minutes at the discretion of the patient.

Continuous Infra-clavicular Block

A continuous infra-clavicular block is indicated the surgeries below the arm including the elbow, forearm wrist and hand. The block is performed at the level of the cords of the brachial plexus and is an excellent location to place a peri-neural catheter because it is less likely to be dislodged as it is held in place by the pectoral muscles and can secured in place on the flat surface of the anterior chest wall. As the cords of the brachial plexus are arranged around the axillary artery (Fig. 9) and not close to each other, a larger volume local anesthetic solution bolus is required to initiate the block and a higher rate of infusion is necessary to maintain the block.

To place a catheter, an insulated Touhy needle tip is positioned, under ultrasound guidance, in close proximity to the cords of the brachial plexus to elicit a muscle twitch. A posterior cord twitch should is sought as it results in higher success rate. Subsequently, 10-25 mL of local anesthetic solution or normal saline or 5% dextrose is injected through the needle to create a pocket. A non-stimulating catheter is then inserted through the needle with the catheter tip placed 2 to 4 cm beyond the needle (Fig. 10).

High resolution of ultrasound detects the nerves , surrounding structures , needle tip and the placement of the local anesthetic agent. Catheter tip verification is challenging particularly in the infraclavicular area. Anecdotal description of the catheter tip placement with fluid agitation (Fig. 11) is described. Echogenic contrast also aids in the placement of the peripheral nerve catheters.

White – Color Doppler tissue agitation ;
Green – Arterial Doppler

If a stimulating catheter is used, it is attached to a nerve stimulator and advanced along side the nerve while maintaining a muscle twitch (Fig. 12). The block is typically induced by injecting ropivacaine 0.5% 20-30 mL a

Figure 4: Local anesthetic solution close to the brachial trunks – divisions.
Bluish discoloration is the LA spread after catheter placement. (Sandeep diwan)

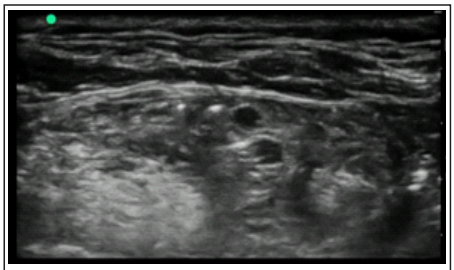

Figure 5: Hyperechoic (blue arrow) end on view of the interscalene brachial catheter. (Sandeep diwan)

Figure 6: Insertion of stimulating catheter.

Figure 7: Assessing the neurostimulation evoked responses through the stimulating catheter.

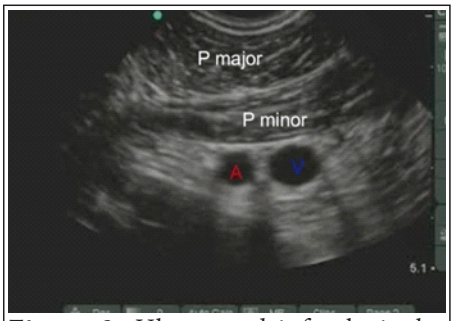

Figure 8: Ultrasound infraclavicular depicting the sonoanatomy with a curvilinear probe.

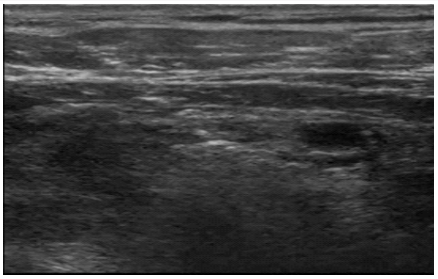

Figure 10: Ultrasound placement of catheter posterior to the axillary artery Orange arrows is the course of the catheter in the infraclavicular area (Sandeep diwan)

local anesthetic solution through the needle or a catheter and then a continuous infusion of ropivacaine 0.2% at 8-10 mL/h infusion (Fig. 13). A patient controlled bolus of 5 – 10 mL of ropivacaine 0.2% every 30 minutes can also be set for breakthrough pain.

General Considerations

It is important use sterile technique during catheter insertion to minimize the risk of infection. These catheters can be inserted successfully, by experienced Anesthesiologists, using ultrasound guidance only without the assistance of nerve stimulators.

These patients should be monitored very closely by daily rounds or by phone calls if the patients are sent home with catheters. The pain scores and extent of the block should be determined. The catheter insertion site should be inspected for signs of infection. In addition, signs of local anesthetic toxicity should be ruled out. When a patient complains of pain, it is important to give a bolus of local anesthetic solution before increasing the infusion rate. When a bolus, of a higher concentration of local anesthetic solution, fails to produce an analgesic effect, the catheter tip is assumed to have migrated and it should be removed. Color Doppler function on ultrasound machines has been used to determine spread of local solution around the cords in the infraclavicular region. Catheter tip migration will result in block failure, local anesthetic systemic toxicity if catheter enters a blood vessel.

If patients are going home with catheters, they and their caregivers should have very clear instructions if they experience pain or develop early warning signs of local anesthetic toxicity. They should have the ability to contact an Anesthesiologist anytime as long as the catheter is in place. Patients should also be prescribed analgesics for block failure or breakthrough pain. For home catheters, the patient or their caregivers can remove the catheter safely with proper instructions or return to the hospital for removal by an Anesthesiologist.

In the future, long acting local anesthetic solution, like liposomal bupivacaine may replace catheters in providing prolonged analgesia. The advantage of such long acting local solution is that long acting blocks will become more available and accessible to patients because the higher skill level required for inserting catheters will not be necessary. In addition, the cost of catheters, infusion pumps and personnel cost in running a catheter program will be reduced. These advantages will have to weighed against the cost of using newer and more expensive long acting local anesthetic preparations.

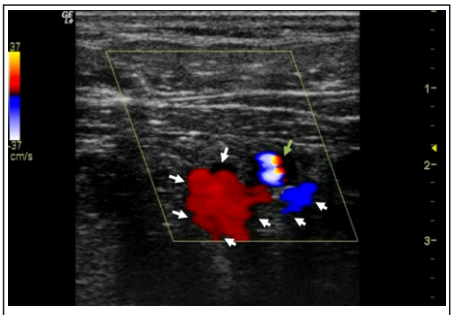

Figure 11: Note the color Doppler tissue agitation. (Sandeep diwan)

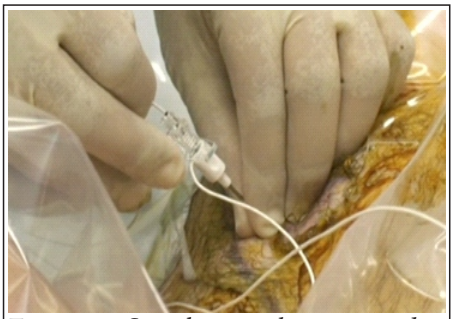

Figure 12: Stimulating catheter inserted in the infraclavicular perineural sheath after a posterior cord stimulation

Figure 13: The catheter fixed on the anterior chest wall.

References

1. Albrecht, E., I. Bathory, N. Fournier, A. Jacot-Guillarmod, A. Farron, and R. Brull. "Reduced Hemidiaphragmatic Paresis with Extrafascial Compared with Conventional Intrafascial Tip Placement for Continuous Interscalene Brachial Plexus Block: A Randomized, Controlled, Double-Blind Trial." British Journal of Anaesthesia 118, no. 4 (April 1, 2017): 586–92.
2. Auyong, David B., David Asher Cantor, Cynthia Green, and Neil A. Hanson. "The Effect of Fixation Technique on Continuous Interscalene Nerve Block Catheter Success: A Randomized, Double-Blind Trial." Anesthesia and Analgesia 124, no. 3 (March 2017): 959–65.
3. Birnbaum, Juergen, Miriam Kip, Claudia D. Spies, Ortrud Vargas Hein, Karsten Labs, Gregor Moeckel, and Thomas Volk. "The Effect of Stimulating versus Nonstimulating Catheters for Continuous Interscalene Plexus Blocks in Short-Term Pain Management." Journal of Clinical Anesthesia 19, no. 6 (September 2007): 434–39.
4. Capdevila, Xavier, Samir Jaber, Pertti Pesonen, Alain Borgeat, and Jean-Jacques Eledjam. "Acute Neck Cellulitis and Mediastinitis Complicating a Continuous Interscalene Block." Anesthesia and Analgesia 107, no. 4 (October 2008): 1419–21.
5. Choromanski, Dominik W., Pranav S. Patel, Joel M. Frederick, Stephen E. Lemos, and Elie J. Chidiac. "The Effect of Continuous Interscalene Brachial Plexus Block with 0.125% Bupivacaine vs 0.2% Ropivacaine on Pain Relief, Diaphragmatic Motility, and Ventilatory Function." Journal of Clinical Anesthesia 27, no. 8 (December 2015): 619–26.
6. Ilfeld BM, Morey TE, Wright TW, Chidgey LK, Enneking FK. Continuous interscalene brachial plexus block for postoperative pain control at home: a randomized, double-blinded, placebo-controlled study. Anesth Analg. 2003 Apr;96(4):1089-95
7. Dhir, S., and S. Ganapathy. "Comparative Evaluation of Ultrasound-Guided Continuous Infraclavicular Brachial Plexus Block with Stimulating Catheter and Traditional Technique: A Prospective-Randomized Trial." Acta Anaesthesiologica Scandinavica 52, no. 8 (September 2008): 1158–66. doi:10.1111/j.1399-6576.2008.01736.x.
8. Fredrickson, M. J., P. Leightley, A. Wong, M. Chaddock, A. Abeysekera, and C. Frampton. "An Analysis of 1505 Consecutive Patients Receiving Continuous Interscalene Analgesia at Home: A Multicentre Prospective Safety Study." Anaesthesia 71, no. 4 (April 2016): 373–79. doi:10.1111/anae.13385.
9. Fredrickson, Michael J., Michel J. Fredrickson, Craig M. Ball, and Adam J. Dalgleish. "Analgesic Effectiveness of a Continuous versus Single-Injection Interscalene Block for Minor Arthroscopic Shoulder Surgery." Regional Anesthesia and Pain Medicine 35, no. 1 (February 2010): 28–33.
10. Hu, DeeDee, Erol Onel, Neil Singla, William G. Kramer, and Admir Hadzic. "Pharmacokinetic Profile of Liposome Bupivacaine Injection Following a Single Administration at the Surgical Site." Clinical Drug Investigation 33, no. 2 (February 1, 2013): 109–15.
11. Ilfeld, Brian M., Linda T. Le, Joanne Ramjohn, Vanessa J. Loland, Anupama N. Wadhwa, J. C. Gerancher, Elizabeth M. Renehan, et al. "The Effects of Local Anesthetic Concentration and Dose on Continuous Infraclavicular Nerve Blocks: A Multicenter, Randomized, Observer-Masked, Controlled Study." Anesthesia and Analgesia 108, no. 1 (January 2009): 345–50.
12. Ilfeld, Brian M., Timothy E. Morey, and F. Kayser Enneking. "Infraclavicular Perineural Local Anesthetic Infusion: A Comparison of Three Dosing Regimens for Postoperative Analgesia." Anesthesiology 100, no. 2 (February 2004): 395–402.
13. Vivian H. Y., Mark C. Rockley, and Ban C. H. Tsui. "The Catheter-over-Needle Assembly Offers Greater Stability and Less Leakage Compared with the Traditional Counterpart in Continuous Interscalene Nerve Blocks: A Randomized Patient-Blinded Study." Canadian Journal of Anaesthesia = Journal Canadien D'anesthesie 60, no. 12 (December 2013): 1272–73.
14. Marhofer, D., P. Marhofer, L. Triffterer, M. Leonhardt, M. Weber, and M. Zeitlinger. "Dislocation Rates of Perineural Catheters: A Volunteer Study." British Journal of Anaesthesia 111, no. 5 (November 2013): 800–806.
15. Mariano, Edward R., Vanessa J. Loland, Richard H. Bellars, NavParkash S. Sandhu, Michael L. Bishop, Reid A. Abrams, Matthew J. Meunier, Rosalita C. Maldonado, Eliza J. Ferguson, and Brian M. Ilfeld. "Ultrasound Guidance versus Electrical Stimulation for Infraclavicular Brachial Plexus Perineural Catheter Insertion." Journal of Ultrasound in Medicine: Official Journal of the American Institute of Ultrasound in Medicine 28, no. 9 (September 2009): 1211–18.
16. Mariano, Edward R., Vanessa J. Loland, NavParkash S. Sandhu, Michael L. Bishop, Matthew J. Meunier, Robert Afra, Eliza J. Ferguson, and Brian M. Ilfeld. "A Trainee-Based Randomized Comparison of Stimulating Interscalene Perineural Catheters with a New Technique Using Ultrasound Guidance Alone." Journal of Ultrasound in Medicine: Official Journal of the American Institute of Ultrasound in Medicine 29, no. 3 (March 2010): 329–36.
17. Morimoto, Yasuhiro. "Continuous Interscalene Brachial Plexus Block." Acta Anaesthesiologica Taiwanica 54, no. 2 (June 1, 2016): 75. doi:10.1016/j.aat.2016.02.002.
18. Morin, Astrid M., Peter Kranke, Hinnerk Wulf, Rudolf Stienstra, and Leopold H. J. Eberhart. "The Effect of Stimulating versus Nonstimulating Catheter Techniques for Continuous Regional Anesthesia: A Semiquantitative Systematic Review." Regional Anesthesia and Pain Medicine 35, no. 2 (April 2010): 194–99.
19. Pere, P., M. Pitkänen, P. H. Rosenberg, J.-M. Björkenheim, H. Linden, Y. Salorinne, and M. Tuominen. "Effect of Continuous Interscalene Brachial Plexus Block on Diaphragm Motion and on Ventilatory Function." Acta Anaesthesiologica Scandinavica 36, no. 1 (January 1, 1992): 53–57.
20. Yang CW, Jung SM, Kwon HU, Cho CK, Yi JW, Kim CW, Jung JK, An YM. A clinical comparison of continuous interscalene brachial plexus block with different basal infusion rates of 0.2% ropivacaine for shoulder surgery. Korean J Anesthesiol. 2010 Jul;59(1):27-33.
21. Yanovski, B., L. Gaitini, D. Volodarski, and B. Ben-David. "Catastrophic Complication of an Interscalene Catheter for Continuous Peripheral Nerve Block Analgesia." Anaesthesia 67, no. 10 (October 2012): 1166–69.
22. Swenson JD, Davis JJ, DeCou JA. A novel approach for assessing catheter position after ultrasound-guided placement of continuous interscalene block. Anesth Analg. 2008 Mar;106(3):1015-6

Conflict of Interest: Nil
Source of Support: None

How to Cite this Article

Sinha SK. Ultrasound Guided Continuous Brachial Plexus Catheters. International Journal of Regional Anaesthesia. Jan - April 2018; 1(1):42-45