Acta Anaesthesiol Scand 2005; **49**: 1562–1565
Printed in UK. All rights reserved

ACTA ANAESTHESIOLOGICA SCANDINAVICA
doi: 10.1111/j.1399-6576.2005.00736.x

Case Report

Dextrose 5% in water: fluid medium for maintaining electrical stimulation of peripheral nerves during stimulating catheter placement

B. C. H. Tsui[1], B. Kropelin[1], S. Ganapathy[2] and B. Finucane[1]
[1]*Department of Anesthesiology and Pain Medicine, University of Alberta Hospital, Edmonton, Alberta, and* [2]*Department of Anesthesia, University of Western Ontario, London, Ontario, Canada*

It is well documented that a higher electrical current is required to elicit a motor response following a normal saline (NS) injection during the placement of stimulating catheters for peripheral nerve block. We present three cases of continuous brachial plexus catheter placement in which Dextrose 5% in water (D5W) was used to dilate the perineural space instead of NS. Three brachial plexus blocks (two interscalene and one axillary) were performed in three different patients for pain relief. In each case, an insulated needle was advanced towards the brachial plexus. A corresponding motor response was elicited with a current less than 0.5 mA after needle repositioning. A stimulating catheter was advanced with ease after 3–5 ml of D5W was injected to dilate the perineural space. A corresponding motor response was maintained when the current applied to the stimulating catheter was less than 0.5 mA. Local anesthetic was then injected and the motor response immediately ceased. All blocks were successful and provided excellent pain relief with the continuous infusion of local anesthetics.

Accepted for publication 6 February 2005

Key words: Brachial plexus block; minimum amperage; nerve stimulation; stimulating catheters.

Case report

Continuous peripheral nerve blocks offer the potential benefits of accelerated functional recovery and extended optimal postoperative analgesia with minimal side-effects (1). However, a recent editorial noted that secondary analgesia is required in up to 40% of cases in which continuous peripheral nerve catheters are used, due to block failure, and this occurs even in experienced hands (2). Traditionally, continuous blocks are performed by first identifying the correct motor nerve with a stimulating needle, followed by the blind insertion of a peripheral catheter beyond the needle tip. Correct catheter placement is usually confirmed by observing the clinical effect of satisfactory analgesia and/or through sensory testing. Stimulating catheters were recently introduced to facilitate optimal catheter positioning during advancement (3–6). The ability to continuously stimulate a nerve during catheter advancement is advantageous, as it adds greatly to the predictability of this procedure. Occasionally, normal saline (NS) was injected to dilate the perineural space to facilitate advancement of the stimulating catheter. However, the ability to elicit a motor response with a low current (<0.5 mA) is completely lost after dilating the perineural space with even a small amount of normal saline or local anesthetic (7). In this report, we present three cases in which dextrose 5% in water (D5W) was used to facilitate optimal peripheral catheter placement by (1) dilating the perineural space to ease catheter advancement, and (2) allowing continuous monitoring of the elicited motor response during advancement of the catheter.

Case 1

A 76-year-old female (weight 60 kg) was scheduled for left total shoulder arthroplasty. Her past medical history included hypertension and osteoarthritis. Her medications included antihypertensive drugs (enalapril and hydrochlorothazide). General anesthesia combined with a continuous interscalene catheter was selected as her anesthetic plan.

Following sedation with fentanyl 50 µg and midazolam 1 mg, the patient was placed in the right lateral decubitus position. Using a sterile technique, 3 ml of 20 mg ml^{-1} lidocaine was used to infiltrate the skin and a left posterior paracervical interscalene brachial plexus block was performed with a stimulating catheter (Stimulong plus Kit with insulated Tuohy needle, Pajunk, GmbH, Geisingen, Germany). Using a technique similar to that described by Boezaart et al. (3), an 18-G insulated Tuohy needle (Pajunk, GmbH, Geisingen, Germany) was carefully inserted towards the left brachial plexus until a deltoid motor response was elicited with an initial current of 0.8 mA (0.1 msec; 1 Hz). The minimal threshold current required for a deltoid motor response was reduced to 0.4 mA after needle repositioning. A stimulating catheter was then introduced through the needle. Initially, there was some difficulty advancing the catheter. However, following the injection of 5 ml of D5W, the catheter passed 3 cm beyond the needle tip without difficulty. In addition, the deltoid motor response was maintained at a current of 0.4 mA; via the needle and stimulating catheter. The block was established using 20 ml of 20 mg ml^{-1} lidocaine with 5.0 µg ml^{-1} of epinephrine. The motor response immediately disappeared after the injection of local anesthetic. The patient had full motor and sensory block in her left upper extremity within 10 min.

General anesthesia was induced and the surgery was completed uneventfully. Thirty minutes before the end of surgery, 10 ml of 5 mg ml^{-1} bupivacaine was administrated via the catheter. At the end of the procedure, the patient rapidly emerged from general anesthesia and was extubated uneventfully. The patient was then transferred to the postoperative recovery room in a stable condition. In the recovery room, the patient had no pain (VAS = 0) and did not require additional analgesics. Complete sensory and motor blockade of the left arm was noted. The patient was then transferred to the surgical ward with a continuous infusion of 1 mg ml^{-1} plain bupivacaine at 6 ml h^{-1} through the interscalene catheter. Motor function of the upper extremity returned after 6 h. The patient experienced no pain in her left upper extremity while the continuous catheter was *in situ*, and she had normal sensory and motor function. Oral hydromorphone 2 mg was given 2 h prior to removal of the catheter on postoperative day 2. The patient was discharged without complications following removal of the catheter.

Case 2

A 50-year-old female (weight 56.2 kg) was scheduled to undergo right shoulder arthrolysis. Her medical problems included insulin-dependent diabetes mellitus, dyspepsia, atypical chest pain, which was determined to be non-cardiac and due to extreme anxiety. She was a heavy smoker. Her medications included ramipril, ranitidine, lorazepam and insulin.

Other relevant history included severe postoperative nausea secondary to opioids. A continuous interscalene block was planned for intra and postoperative analgesia. Following sedation with fentanyl 150 µg and midazolam 2 mg, a continuous interscalene block was performed using a modified classical approach similar to that described by Boezaart et al. (4, 8) After sterile preparation and lidocaine local anesthetic infiltration in the interscalene groove (thyroid cartilage level), a 19.5-G short bevel needle (Stimulong plus Kit with insulated short bevel needle, Pajunk, GmbH, Geisingen, Germany) was inserted to a depth of 1.5 cm. A motor response was observed in the biceps and deltoid muscles using a current of 0.5 mA (0.1 msec; 2 Hz). At this point, 3 ml of D5W was injected via the needle, which augmented the motor response in the deltoid and biceps muscles. The stimulating catheter was then advanced easily to a distance of 9 cm into the interscalene region while maintaining a motor response with 0.5 mA. A test dose of 1 ml of 5 mg ml^{-1} ropivacaine with 2.5 µg ml^{-1} of epinephrine abolished the motor response. An additional bolus of 20 ml of ropivacaine was injected via the catheter. The catheter was tunneled and secured with Steristrips® (3M, London, ON, Canada) and an occlusive bandage. An additional 10 ml of 5 mg ml^{-1} ropivacaine was injected via the catheter. A dense block of the brachial plexus occurred and general anesthesia was induced. The surgery was uneventful. Postoperatively, 12 ml of 2.5 mg ml^{-1} bupivacaine was injected and a local anesthetic infusion of 1.25 mg ml^{-1} bupivacaine was started at a rate of 6 ml h^{-1} with patient-controlled boluses of 3 ml every 30 min. The patient was discharged home the following day with the infusion in place, which continued for 72 h. The patient also received multimodal analgesia with oral rofecoxib and acetaminophen. The patient had excellent pain relief and had no nausea and did not require any opioid.

Case 3

A 16-year-old female (weight 52 kg) developed complex regional pain syndrome after she injured her left wrist from a fall on an outstretched hand. Despite oral medication with nortryptilline, meloxicam, gabapentin and acetaminophen with codeine, the patient suffered excruciating pain in her forearm and hand. The patient was referred for a continuous brachial plexus block. There was diffuse allodynia and hyperalgesia of all the fingers although the sensation remained intact. The patient could not move her fingers but could passively extend them with the other hand, which resulted in severe pain. The fingers were puffy and sweaty with loss of hair. The forearm had some disuse atrophy.

After informed consent, the patient was sedated with intravenous fentanyl 150 μg and midazolam 2 mg. A continuous brachial plexus block was performed using the axillary approach. After sterile preparation and local anesthetic skin infiltration in the left axilla, a 2-inch 19.5-G short bevel insulated needle with a stimulating catheter (Stimulong plus Kit with insulated short bevel needle, Pajunk, GmbH, Geisingen, Germany) was inserted. A motor response in the distribution of the median nerve was obtained initially with 0.4 mA (0.1 msec; 2 Hz) of current. Further adjustment resulted in a motor response in the distribution of the radial nerve at 0.4 mA. At this point 3 ml of D5W was injected via the needle, which augmented the motor response. A stimulating catheter was then advanced via the needle using the same current (0.4 mA). Motor responses were observed in the distribution of median, radial, and pectoral nerves as the stimulating catheter was advanced and the current required was 0.38 mA. Reducing the current to 0.2 mA resulted in barely perceptible twitches. The current was again increased to 0.38 mA and a test dose of 1 ml of 5 mg ml^{-1} ropivacaine abolished the twitch. An additional bolus of 10 ml of 5 mg ml^{-1} ropivacaine with 2.5 μg ml^{-1} of epinephrine resulted in pain relief within minutes and the patient had improved movement in her fingers. The catheter was tunneled for 1 inch and secured with tissue glue, Steristrips® (3M) and an occlusive bandage (Tegaderm® 3M). An additional 10 ml of ropivacaine was injected while the infraclavicular area was imaged using ultrasound. A hyperechoic shadow was seen posterior to the axillary artery and the local anesthetic was seen distending the area posterior to the artery. The patient was sent home on a disposable infusion device delivering 2 mg ml^{-1} ropivacaine at a rate of 5 ml h^{-1} with patient-controlled boluses of 5 ml every 60 min when needed. The patient experienced excellent pain relief at rest and with physiotherapy. The block was discontinued without complications 8 days later and the allodynia and hyperalgesia had completely resolved.

Discussion

This is the first case series describing the use of D5W to dilate the perineural space and maintain an electrically induced motor response via a stimulating catheter during continuous brachial plexus block placement. The ability to maintain a motor response with a stimulating catheter after dilating the perineural space with fluid allows 'real time' monitoring of the catheter position upon advancement and facilitates optimal catheter placement.

Theoretically, stimulating catheters allow one to advance and position catheters in an optimal position in real time in perineural spaces. Prior to the introduction of the stimulating catheters, continuous peripheral nerve blocks were performed with catheters blindly placed in perineural spaces and the success rates were unacceptably low. The ability to a elicit a motor response with a stimulating catheter is a great advantage, as it allows 'real-time' observation of motor responses as the catheter is advanced along the axis of the target nerve. In practice, however, this real-time stimulation is lost if one uses a saline flush or local anesthetic to distend the perineural space to facilitate catheter insertion (7). This limitation was identified and demonstrated in a recent clinical study which compared motor responses to electrical stimulation using insulated needles and catheters. This study found that the mean current required to stimulate motor nerves was significantly higher using stimulating catheters (1.6 mA) following the injection of saline compared to that required when using insulated needles alone (0.5 mA) (7). Furthermore, the package insert provided with the Pajunk kit suggested that at least 1 mA would be required after dilation with normal saline. On the other hand, reports in which stimulating catheters were threaded, without the use of saline, did not demonstrate such discrepancies between the threshold currents of the needle and the catheter (4, 6). These clinical observations indicate that when saline is used to dilate the perineural space during a continuous peripheral nerve block, the loss of motor response could encourage unwarranted efforts to optimize stimulating catheter placement. However, the use of fluid to distend the space can be occasionally useful to facilitate the insertion of these catheters. Since there is an expected increase in the clinical use of continuous peripheral blocks, we need a reliable method to verify that the advancing catheter remains close to the target nerve.

Previously, the cause of this muscle twitch dissipation after the injection of normal saline was thought to be a result of physical displacement of the nerve from the stimulating needle tip by the injected fluid (9). This is the basis for the 'Raj Test'. This is, however, incorrect. We recently demonstrated that normal saline increases the conductive area surrounding the stimulating needle tip resulting in an insufficient current density to stimulate the desired nerve (10). We have also demonstrated that the injection of a non-conducting solution (D5W) restores the motor response by decreasing the conductive surface area and increasing the current density at the needle tip (10). We therefore speculate that one may potentially use a non-conducting solution (such as D5W) instead of saline to dilate the perineural space to avoid misinterpretation of the catheter position. These points were well illustrated in these three cases. In the first case, the catheter was initially difficult to thread prior to the injection of fluid to dilate the perineural space. However, after 5 ml of D5W was injected the catheter advanced with ease. In the other cases, the two catheters were easily inserted into the perineural space after the 3-ml injection of D5W. More importantly, the elicited corresponding motor response observed via the stimulating catheter was maintained at a low current (<0.5mA) similar to that obtained with the needle prior to the injection of the D5W. Thus, these cases support our previous hypothesis that the use of D5W to dilate the perineural space not only facilitates catheter advancement, but ensures accurate placement of these catheters by minimizing electrical interference from other conductive fluids (e.g. saline, interstitial fluid, or blood). In this study, D5W was selected as the non-conducting solution because its osmolality is similar to that of normal saline and the injection of D5W around neurological tissue (intrathecal or epidural) is not known to cause any long-term sequelae in animals or humans (11–14). It is also painless on injection compared to sterile water (15–17).

In conclusion, this initial clinical experience of using D5W to facilitate the placement of a stimulating catheter is encouraging. We speculate that the ability to dilate the space while maintaining a motor response with a stimulating catheter should allow real-time monitoring of the catheter and may lead to successful catheter placement. However, a properly conducted randomized, controlled trial is necessary to confirm the importance of this technique for continuous peripheral nerve block placement.

Acknowledgements

Supported in part by the Department of Anesthesiology and Pain Medicine, University of Alberta Hospital, and the Department of Anesthesia, University of Western Ontario. Dr Tsui was a recipient of the Clinical Investigatorship Award, Alberta Heritage Foundation for Medical Research, Alberta, Canada.

References

1. Liu SS, Salinas FV. Continuous plexus and peripheral nerve blocks for postoperative analgesia. *Anesth Analg* 2003; **96**: 263–72.
2. Salinas FV. Location, location, location: Continuous peripheral nerve blocks and stimulating catheters. *Reg Anesth Pain Med* 2003; **28**: 79–82.
3. Boezaart AP, De Beer JF, Nell ML. Early experience with continuous cervical paravertebral block using a stimulating catheter. *Reg Anesth Pain Med* 2003; **28**: 406–13.
4. Boezaart AP, De Beer JFTC, RK. A new technique of continuous interscalene nerve block. *Can J Anaesth* 1999; **46**: 275–81.
5. Copeland SJ, Laxton MA. A new stimulating catheter for continuous peripheral nerve blocks. *Reg Anesth Pain Med* 2001; **26**: 589–90.
6. Sutherland ID. Continuous sciatic nerve infusion: expanded case report describing a new approach. *Reg Anesth Pain Med* 1998; **23**: 496–501.
7. Pham-Dang C, Kick O, Collet T et al. Continuous peripheral nerve blocks with stimulating catheters. *Reg Anesth Pain Med* 2003; **28**: 83–8.
8. Winnie AP. Interscalene brachial plexus block. *Anesth Analg* 1970; **49**: 455–66.
9. Raj PP, de Andres J, Grossi P et al. Aids to localization of peripheral nerves. In: Raj PP, ed. *Clinical Practice of Regional Anesthesia*. New York: Churchill Livingstone, 1991: 251–84.
10. Tsui BC, Wagner A, Finucane B. Electrophysiologic effect of injectates on peripheral nerve stimulation. *Reg Anesth Pain Med* 2004; **29**: 189–93.
11. Hashimoto K, Sakura S, Bollen AW et al. Comparative toxicity of glucose and lidocaine administered intrathecally in the rat. *Reg Anesth Pain Med* 1998; **23**: 444–50.
12. Mphanza T. Inadvertent infusion of glucose saline into the extradural space. *Br J Anaesth* 1996; **76**: 332.
13. Sakura S, Chan VW, Ciriales R, Drasner K. The addition of 7.5% glucose does not alter the neurotoxicity of 5% lidocaine administered intrathecally in the rat. *Anesthesiology* 1995; **82**: 236–40.
14. Whiteley MH, Laurito CE. Neurologic symptoms after accidental administration of epidural glucose. *Anesth Analg* 1997; **84**: 216–7.
15. Cohn AI, Levesque PR. Saline versus water for epidural injection. *Anesth Analg* 1993; **76**: 455–6.
16. Fortuna A, Fortuna AO. Saline versus water for epidural injection. *Anesth Analg* 1993; **77**: 864–5.
17. Mayhew JF. Saline versus water for epidural injection. *Anesth Analg* 1993; **77**: 646.

Address:
Ban C.H. Tsui, MSC, MD, FRCP(C)
Department of Anesthesiology and Pain Medicine
8–120 Clinical Sciences Building
Edmonton
Alberta
Canada
T6G 2G3
e-mail: btsui@ualberta.ca