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Authors

Ilfeld, Brian M
Enneking, F Kayser

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A Portable Mechanical Pump Providing Over Four Days of Patient-Controlled Analgesia by Perineural Infusion at Home

Brian M. Ilfeld, M.D., and F. Kayser Enneking, M.D.

Background and Objectives: Local anesthetics infused via perineural catheters postoperatively decrease opioid use and side effects while improving analgesia. However, the infusion pumps described for outpatients have been limited by several factors, including the following: limited local anesthetic reservoir volume, fixed infusion rate, and inability to provide patient-controlled doses of local anesthetic in combination with a continuous infusion. We describe a patient undergoing open rotator cuff repair who was discharged home with an interscalene perineural catheter and a mechanical infusion pump that allowed a variable rate of continuous infusion, as well as patient-controlled boluses of local anesthetic for over 4 days.

Case Report: A 77-year-old woman, who had previously required a 3-day hospital admission for acute postoperative pain following an open repair of her left rotator cuff, presented for an open repair of her contralateral rotator cuff. Preoperatively she received an interscalene block and perineural catheter. After the procedure she was discharged home with a portable pump that infused ropivacaine continuously at a rate of 6 mL/h and allowed a 2-mL patient-controlled bolus every 20 minutes (550-mL reservoir). The basal infusion was decreased, as tolerated, by having the patient reprogram the pump with instructions given over the telephone. Without the use of any oral opioids, the patient scored her surgical pain 0 to 1 (on a scale of 0 to 10) while at rest and 2 to 3 for 2 physical therapy sessions during which she used the bolus function to reinforce her analgesia. After 98 hours of infusion, the patient's husband removed the catheter with instructions given over the telephone, and her subsequent surgical pain was treated with oral opioids.

Conclusion: Continuous, perineural local anesthetic infusions are possible on an ambulatory basis for multiple days using a portable, programmable pump that provides a variable basal infusion rate, patient-controlled boluses, and a large anesthetic reservoir. *Reg Anesth Pain Med* 2002;27:100-104.

Key Words: Ambulatory surgery, Patient-controlled regional analgesia, Continuous nerve block, Interscalene nerve block, Perineural catheter, Postoperative analgesia.

The moderate to severe pain many patients experience following orthopedic procedures is often treated with oral and intravenous (IV) opioids, which are associated with undesirable side effects including nausea and vomiting, sedation, pruritus, and urinary retention.¹ Local anesthetics infused via perineural catheters have been shown to decrease opioid use and side effects,¹⁻³ improve pain control,^{1,3} and, in some cases, improve surgical outcome.^{2,4} Furthermore, patient-controlled local anesthetic administration, also called patient-

controlled regional analgesia (PCRA), provides equivalent or superior analgesia with lower local anesthetic consumption compared to continuous infusions alone with a variety of perineural techniques.^{2,5-7} With few exceptions, the infusion pumps that have been previously used are heavy, awkward to use, and technically sophisticated, requiring patients to remain in the hospital while the catheter is being used. This is both an inconvenience for patients and adds to the overall cost of their healthcare. Until now, the infusion pumps described for outpatients have been limited by several factors: limited local anesthetic reservoir volume, fixed infusion rate, and inability to provide PCRA doses in combination with a continuous infusion.^{3,8-10} We describe a patient undergoing open rotator cuff repair who was discharged home with an interscalene perineural catheter and a mechanical infusion pump which allowed a variable rate of continuous infusion, as well as patient-controlled boluses of local anesthetic for over 4 days.

From the Department of Anesthesiology, University of Florida, Gainesville, Florida.

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Reprint requests: Brian M. Ilfeld, M.D., Florida Surgical Center, University of Florida, 2001 SW 13th St, Gainesville, FL 32608. E-mail: ilfelbm@anest1.anest.ufl.edu

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Case Report

A 77-year-old woman presented for an open repair of her right rotator cuff. Past medical history was notable for only mild hypertension. The patient had previously (1993) undergone an uneventful open repair of her left rotator cuff under general anesthesia without a regional block. She was hospitalized postoperatively for 3 days to receive IV opioids for severe postoperative pain.

Physical exam revealed a blood pressure of 149/60 (weight, 55 kg; height, 161 cm). The patient was deemed a good candidate for ambulatory perineural infusion for multiple reasons: she appeared highly responsible and motivated, she clearly understood the responsibilities in caring for the pump and catheter system, she had few comorbidities and had never smoked, she had a competent caretaker (her husband) who would be with her continuously throughout the infusion period, and she strongly desired to avoid a hospital admission for postoperative analgesia as had been required for her previous surgery. After being presented with various options for surgical anesthesia and postoperative pain control, the patient decided in favor of the technique described below.

After IV placement, the patient was brought to the preoperative holding area where standard non-invasive monitors were applied, and oxygen was administered via a facemask. IV sedation included midazolam (1 mg) and fentanyl (75 μ g) titrated for patient comfort in divided doses. After sterile preparation and draping, a nerve stimulator and 38-mm insulated stimulating needle (Contiplex; B. Braun Medical, Bethlehem, PA) were used to place an interscalene block and 20-gauge perineural catheter. With gentle, continuous aspiration and the nerve stimulator initially set at 1.0 mA and 2 Hz, the needle was inserted using the same landmarks as described by Klein et al.³ Once the brachial plexus was identified with biceps motion, which ceased at 0.52 mA, the 38 mL of solution used for the initial block was injected in divided doses through the needle with negative aspiration every 2 mL. This solution contained mepivacaine, 1.5%; clonidine, 100 μ g; fresh epinephrine, 1:400,000; and 4 mEq NaHCO₃. Without moving the needle, the catheter was inserted and advanced 10 cm past the tip of the needle, and then the needle withdrawn over the catheter. Liquid adhesive was applied to the site of catheter entry, sterile tape (Steri-Strips; 3M Corp, St Paul, MN) were used to secure the catheter, and occlusive dressings (Tegaderm; 3M Corp) were placed over the entire site to retain sterility. In an effort to ensure catheter patency, 1 mL of this solution was administered via the cath-

eter after it was secured with a sterile occlusive dressing.

The patient was taken to the operating room where general anesthesia was induced with propofol and maintained solely with propofol and nitrous oxide, using a laryngeal mask airway. The open repair was completed without complications, and the patient emerged from anesthesia pain-free with a dense, unilateral sensory and motor block of her right shoulder and upper extremity. After negative aspiration of the catheter, a 3-mL test dose of mepivacaine, 1.5%, and epinephrine, 15 μ g, was injected via the catheter without a change in heart rate or signs/symptoms of epidural/subdural spread. A mechanical infusion pump (Microject PCA Pump; Sorenson Medical, West Jordan, UT) was attached to the catheter with a reservoir of 550 mL of plain ropivacaine, 0.2%. A continuous infusion of 6 mL/h was begun, with a 2-mL PCRA bolus allowed every 20 minutes.

Before discharge, the patient and her husband were given verbal and written instructions on the use of the pump, as well as warning signs and symptoms of local anesthetic toxicity, catheter site infection, nerve injury, and catheter migration. She was given standard, postoperative, outpatient instructions, including the importance of keeping her arm in a sling (except during physical therapy), and not driving during the infusion period. We recommended that she have someone with her for the duration of the infusion. The telephone and pager numbers of a physician available 24 hours per day, as well as prescriptions for an oral opioid, antiemetic, and nonsteroidal anti-inflammatory drug (naproxen, 250 mg orally twice daily, scheduled, $\times 3$ days) were also provided.

The patient was called by one of the authors the night of surgery and each night thereafter until the day after catheter removal. Information obtained included the patient's pain level, satisfaction with the pump/catheter system, symptoms related to local anesthetic toxicity, catheter migration, catheter site infection, the number of local anesthetic boluses attempted, and oral opioids used. The patient used the bolus function of the pump to supplement her block 0 to 4 times per day for breakthrough pain, as well as before and during physical therapy (PT) sessions, which she underwent on postoperative days (POD) 1 and 3. The patient remained comfortable, with pain scores of 0 to 1 (on a scale of 0 to 10, 10 = worst pain patient could imagine) during rest and scores of 2 to 3 during her PT sessions. The infusion was decreased twice because of minimal pain and PCRA bolus usage: from 6 to 5 mL/h on POD 1, and to 4 mL/h on POD 3. This was achieved by having the patient reprogram the infu-

sion pump, with instructions given over the telephone. Throughout the period of infusion, the patient reported her only sensory changes as a “tingly feeling” in her shoulder, but no decreased motor function in her hand.

On POD 4, after over 98 hours of infusion, the ropivacaine supply was exhausted. The patient’s husband was instructed on removal of the catheter and its blue tip confirmed with the physician in telephone contact throughout. The patient discarded the empty bag of ropivacaine, connection tubing, and catheter, and mailed the infusion pump to the surgical center in a preaddressed/stamped envelope. Until the catheter was removed, the patient did not require any oral opioids, and denied experiencing any nausea, sedation, pruritus, or urinary retention. The patient was again contacted by telephone 1 day and 1 week later, and she remained comfortable using oral opioids when necessary. There were no apparent complications, and the patient was very satisfied with her postoperative analgesia.

Discussion

Regional nerve blocks are generally limited to providing postoperative analgesia of 24 hours or less.¹¹ The use of perineural catheters to infuse local anesthetic allows for postoperative analgesia after the initial regional block has resolved. To use this technique in the ambulatory setting, several requirements must be fulfilled: appropriate patient selection and education, close physician follow-up, and appropriate equipment. The portable infusion pump we used was developed specifically for ambulatory use. To date, only a few reports of ambulatory perineural infusion have been published, and all have involved elastomeric balloon pumps, which are limited in their local anesthetic reservoir volume, infusion rate flexibility, and ability to provide patient-controlled doses.

Rawal et al.⁸ first reported using intraarticular, surgical wound, and axillary perineural catheters for postoperative pain control at home using a 50- or 100-mL elastomeric balloon pump delivering bu-

Fig 1. A portable, programmable infusion pump, weighing 98 g without and 147 g with “AA” batteries; and measuring $13.2 \times 6.1 \times 2.4$ cm. (A) The front of the pump with basal flow and bolus controls. (B) The back of the pump with the removable, disposable cassette attached.

pivacaine. The tubing between the balloon and catheter was clamped and did not provide a basal infusion. Patients were instructed to unclamp the tubing for 6 minutes when they experienced pain. This provided roughly 10 doses of anesthetic before the reservoir was exhausted. Ganapathy et al.⁹ used a similar system for interscalene and popliteal perineural catheters, as well as fascia iliaca and epidural catheters.

Klein et al.^{3,10} used an elastomeric balloon pump to infuse ropivacaine via interscalene and popliteal perineural catheters. The 270-mL maximum volume of these pumps and a manufacturer-determined fixed infusion rate of 10 mL/h allowed for 27 hours of infusion. PCRA boluses of local anesthetic were not possible with this system, and breakthrough pain was treated with IV³ or oral¹⁰ opioids.

As with catheters in other locations, interscalene perineural catheters require a basal infusion for optimal pain relief.¹² A rate of 5 mL/h plus PCRA boluses has been shown to maximize patient comfort and satisfaction, while minimizing the total volume of anesthetic required.¹² The duration of postoperative pain usually extends beyond the first 24 hours, but decreases with time, allowing for a decrease in the rate of local anesthetic infusion. Furthermore, by providing PCRA boluses of local anesthetic for breakthrough pain, oral opioids, with their frequent undesirable side effects, may be avoided. A system that provides for all of these variables will optimize postoperative analgesia and minimize the risk of local anesthetic toxicity.¹³

The infusion pump used for the patient described above is a small, lightweight, battery-powered infusion pump, which is easily carried in a small pouch (Figs 1 and 2). The reusable, mechanical pump attaches to a disposable cassette that infuses local anesthetic from a reservoir bag to the perineural catheter. The reservoir volume limit is 1 L, set by the manufacturer. The pump is easily programmed to deliver a basal infusion rate of 0.1 to 9.9 mL/h in intervals of 0.1 mL/h; a bolus dose of 0 to 2 mL (intervals of 0.1 mL from 0 to 1 mL, and a 2-mL option), which is triggered with a button on the pump; and a lockout period for the bolus function of 6 to 60 minutes. The pump is easily reprogrammed, allowing a healthcare provider to talk a patient through the process over the telephone. The authors have done this with more than 50 patients without incident or difficulty (unpublished data, December 2000). However, a lockable cover is available to prevent a change in the programming if desired. Finally, the pump will report the total volume infused, as well as the number of PCRA requests and doses delivered.

In the case presented above, the patient's basal

Fig 2. A 550-mL local anesthetic reservoir connected to the infusion pump with its carrying case.

infusion rate was progressively decreased as her pain resolved. This not only decreased the risk of local anesthetic toxicity, but allowed for a longer infusion of anesthetic without refilling the reservoir. The PCRA bolus doses of 2 mL allowed the patient to treat her breakthrough pain without oral opioids, and allowed a lower basal infusion rate to control her pain. Furthermore, her block could be reinforced for potentially painful PT sessions. The exceptional analgesia and flexibility provided by a programmable pump and perineural catheter combination may be an excellent alternative to oral opioids alone for many painful ambulatory procedures.

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