Continuous Perineural Catheters for Postoperative Analgesia: An Update

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Recent evidence from randomized controlled trials (RCTs) are demonstrating that continuous perineural techniques offer the potential benefits of prolonged analgesia with fewer side effects. This refresher course will summarize pertinent anatomy, technical aspects, and current evidence from RCTs for the indications and efficacy of continuous perineural techniques for postoperative analgesia.

Surgery for Upper Extremities

Evidence for Potential Benefits

RCTs demonstrate that the use of continuous interscalene analgesia reduces opioid requirements compared with placebo for hospitalized patients (1,2). Compared with IV patient-controlled analgesia (PCA) for open shoulder surgery, RCTs consistently demonstrate that continuous interscalene analgesia not only reduces requirements for postoperative opioids (3–6) but also provides better analgesia, reduces opioid-related side effects, and provides better patient satisfaction for at least the first 48 h after inpatient surgery. Although a case series of 100 patients suggested enhanced physical rehabilitation after shoulder surgery with continuous interscalene analgesia (7), effects on success of physical rehabilitation or duration of hospitalization are unknown. Development of portable disposable and electronic pumps has increased interest in continuous perineural analgesia for outpatient upper extremity surgery. RCTs have begun to establish superior efficacy of continuous peripheral catheter techniques for postoperative analgesia after ambulatory surgery. Recently, for shoulder surgery, 20 patients were randomized to receive continuous interscalene analgesia with either 0.2% ropivacaine or saline for 48 h with a disposable infusion pump at 8 mL/h with patient boluses (2 mL) allowed every 15 min (Fig. 1). Rescue analgesia was provided with oral opioids. During the infusion period, patients receiving ropivacaine had better analgesia and used less oral opioid and had less nausea, sedation, and pruritus and better sleep patterns (8). Continuous infraclavicular analgesia for brachial plexus analgesia has been studied for outpatient upper extremity surgery (9). Thirty patients were randomized to receive either saline or 0.2% ropivacaine with the same disposable pump. Again, during the infusion, patients receiving ropivacaine had better analgesia, used less oral opioid, had less nausea, sedation, and pruritus, and had better sleep patterns.

Update on Techniques

Recent work in ultrasound imaging with high frequency linear arrays demonstrates clear images of brachial plexus anatomy at the interscalene, supraclavicular, infraclavicular, axillary, and midhumeral approaches. Direct visualization of neural structure allows visualization of block placement and may improve efficiency of perineural catheter placement (10). For shoulder surgery, the interscalene approach is typically used. However, the classic (Winnie) approach at C6 directs the needle almost perpendicular to the neural bundle. This orientation is satisfactory for single-shot blocks but may increase the difficulty of placing a catheter parallel to the neural bundle. Recent modifications to improve the parallel orientation of needle/catheter and neural bundle include the intersternocleidomastoidoid and modified lateral interscalene approaches. Prospective surveys for both of these techniques suggest satisfactory success rates for catheter placement with the inter-sternocleidomastoidoid (63 of 70 patients) and modified lateral approach (602 of 700 patients) (11,12).

Another recent technical development is the commercial release of stimulating catheters. Verification of correct catheter placement has been previously reported with fluoroscopy, ultrasound, and computed tomographic scans. All of these techniques may be cumbersome. The stimulating catheters allow direct and immediate functional confirmation of perineural catheter location and may aid in guidance of catheter placement. Preliminary experience in 64 upper extremity perineural stimulating catheters suggests utility of this technique and also that stimulating characteristic of the catheter is different from the needle (1.6 mA versus 0.5 mA) (13).

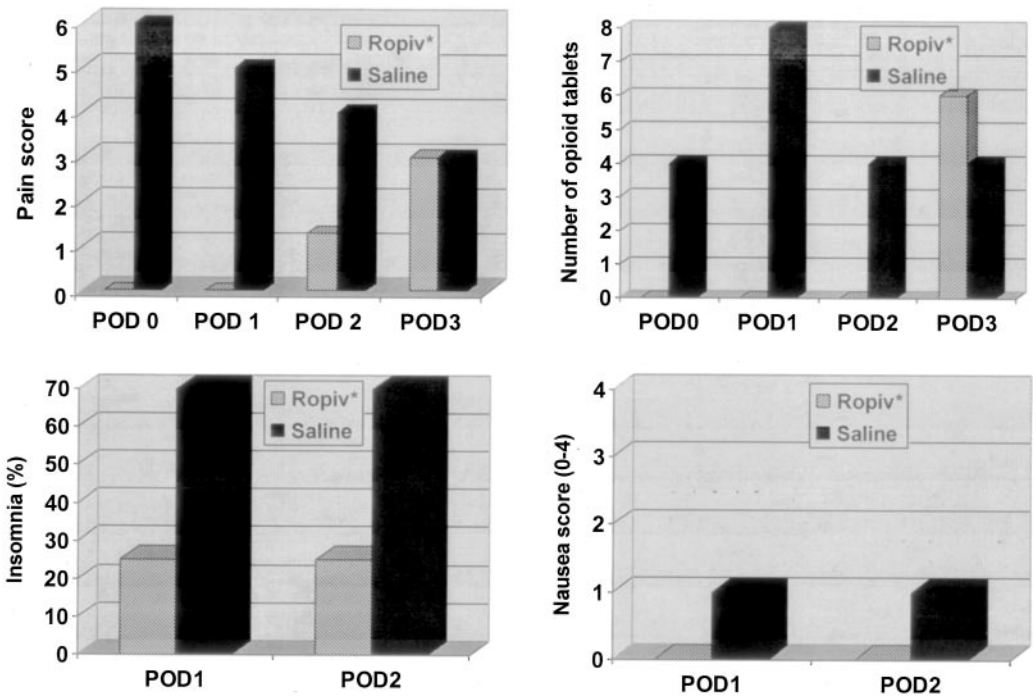

Figure 1. Use of 0.2% ropivacaine for outpatient continuous interscalene analgesia reduces pain, opioid consumption, side effects, and improves sleep after upper extremity surgery. Data from (8).

Risks

Prospective surveys have begun to define potential risks associated with upper extremity perineural catheters. Reports enrolling over 900 patients undergoing continuous interscalene analgesia for 2–5 days observed an approximately 0.7% incidence of catheter site infection and an approximately 0.2%% incidence of neurological complications after 6 months (11).

Lower Extremity Surgery

Prospective clinical trials support the use of continuous femoral analgesia after total knee replacement (14–16). Continuous femoral analgesia provides comparable or better analgesia with fewer side effects than IV PCA and epidural analgesia for at least the first 48 h after surgery. The improved analgesia provided by continuous femoral nerve blocks resulted in faster short-term functional recovery of knee flexion during rehabilitation than IV PCA but without significant differences between the two groups after 6–12 wk (Table 1). Patients undergoing outpatient lower extremity surgery have also been studied (17,18). Thirty patients were randomized to receive either saline or 0.2% ropivacaine with the same disposable infusion pump via a popliteal fossa catheter. Again during the infusion, patients receiving ropivacaine had better analgesia, used less oral opioid, had less nausea, sedation, and pruritus, and had better sleep patterns (Fig. 2). Use of a popliteal fossa catheter may also improve ability to perform outpatient lower extremity surgery. A similar study enrolling 24 patients observed similar benefits and was able to discharge more patients on the same day with 0.25% bupivacaine (40%) versus saline infusions (0%) (19).

The use of high-frequency linear arrays also improves visualization of femoral and sciatic nerves. Case series have described the successful use of ultrasound to guide femoral and popliteal blocks, and direct visualization may also improve catheter placement (20,21). Stimulating catheters have also been used for continuous femoral and sciatic catheters (66 patients) with good success and similar stimulating characteristics as upper extremity placement (13). In volunteers undergoing continuous femoral analgesia, compared with nonstimulating catheters, the use of stimulating catheters produced more intense sensory and motor blocks after 4 h of infusion of 0.2% ropivacaine at 10 mL/h (22). Several recent RCTs have examined different techniques for continuous perineural analgesia for total knee replacement. Use of the posterior psoas compartment technique had been proposed to produce better block of the lumbar plexus than the femoral 3-in-1 approach. However, a RCT examining 3-in-1 (femoral) catheters versus the psoas compartment (posterior) approach observed no differences in pain scores or analgesic consumption (23). Thus, the

Table 1. Continuous Femoral Sheath Analgesia for 48 h After Total Knee Replacement Reduces Side Effects and Accelerates Functional Recovery and Patient Discharge from Rehabilitation Center

	Intravenous patient-controlled analgesia	Epidural analgesia	Femoral sheath analgesia
Incidence of nausea (%)	21*	5	12
Incidence of dysesthesia (%)	0	5	30*
Time until discharge from rehabilitation center (days)	50 (30–80)*	37 (30–45)	40 (31–60)
Knee flexion (degrees)			
Day 5	60 (50–70)*	85 (75–1000)	80 (65–85)
Discharge	80 (65–90)*	90 (78–100)	90 (70–95)
1 mo	90 (85–100)	105 (100–120)	95 (95–100)
3 mo	125 (100–125)	130 (115–130)	125 (105–125)

Intravenous patient controlled analgesia = morphine 1 mg bolus with 7-min lockout; epidural analgesia = 1% lidocaine, 2 μg/mL clonidine, and 0.03 mg/mL morphine at 0.1 mL/kg/h; femoral analgesia = 1% lidocaine, 2 μg/mL clonidine, and 0.03 mg/mL morphine at 0.1 mL/kg/h.
Data from Anesthesiology 1999:91:8.
* Significantly different from other 2 groups ($P < 0.05$).

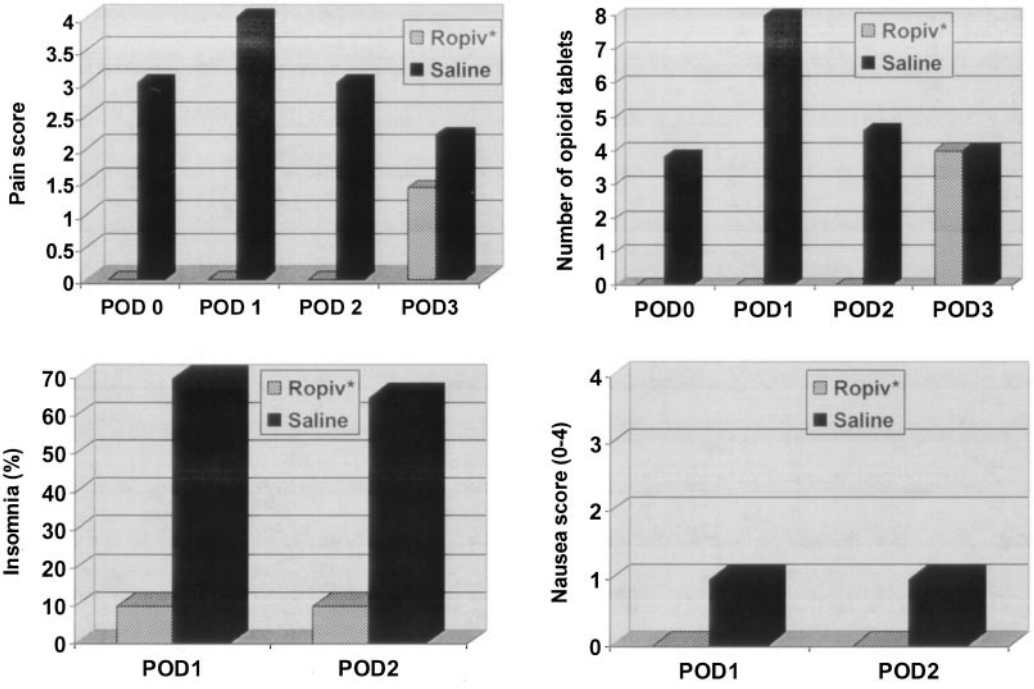

Figure 2. Use of 0.2% ropivacaine for outpatient continuous sciatic analgesia reduces pain, opioid consumption, side effects, and improves sleep after lower extremity surgery. Data from (17).

technique appears to be equivalent to the femoral approach but is probably technically easier. Within the femoral approach, a RCT has compared use of a nerve stimulator versus the loss of resistance fascia iliac technique for placement of nonstimulating catheters. The fascia iliac technique was equally effective and required less time than the nerve stimulator technique (24).

Risks

One prospective survey of 211 femoral catheters noted a 1.4% incidence of infectious complications and a 0.4% incidence of neurological complications after 12 mo (25).

Agents For Continuous Perineural Analgesia

Local Anesthetics

There are insufficient data to determine an optimal analgesic solution for the various types of continuous plexus analgesia. Lidocaine, bupivacaine, and ropivacaine have all been used as primary local anesthetic for continuous plexus analgesia, with bupivacaine and ropivacaine being the most commonly used. The use of bupivacaine (0.1% to 0.25%) typically does not result in toxic blood levels when used for postoperative analgesia for 24–72 h in current regimens (Table 2).

Table 2. Typical Delivery Regimens for Continuous Perineural Catheters for Postoperative Analgesia

Catheter	Agent	Infusion rate (mL/h)	PCA bolus (mL)	Lockout (min)
Interscalene Infraclavicular	Bupivacaine 0.15–0.2% or Ropivacaine 0.2%	5–8	2–4	15–20
Femoral Popliteal	Bupivacaine 0.1–0.25% or Ropivacaine 0.2%	5–10		
		5–8	2	15–20

PCA = patient-controlled analgesia.

Typical venous total bupivacaine concentrations during continuous brachial plexus analgesia are 0.5–1.0 μg/mL (2), and during continuous lumbar plexus analgesia they are 0.5–1.8 μg/mL (26), whereas levels greater than 2 μg/mL are considered toxic. The use of ropivacaine may provide several advantages over bupivacaine and levobupivacaine for providing continuous plexus analgesia. Studies suggest that ropivacaine produces less motor block compared with bupivacaine, which may result in improved participation in postoperative rehabilitation. A comparison of continuous interscalene analgesia with ropivacaine 0.2% versus bupivacaine 0.15% showed equivalent analgesia in both groups, but less motor block with ropivacaine (27). The decreased cardiotoxicity of ropivacaine may provide an additional safety margin over both bupivacaine and levobupivacaine. Animal studies comparing ropivacaine, levobupivacaine, and bupivacaine suggest cardiac toxicity ratios of approximately 1:1.7:3.0 (28). Typical perineural infusions of ropivacaine 0.2% at 6–12 mL/h for 48 hr results in peak plasma levels of approximately 1.7- 2.5 μg/mL with toxic levels considered to be approximately 4 μg/mL (29). In addition to local anesthetics, analgesic regimens may include clonidine or opioids. However, efficacy of these additives has not been demonstrated (30,31).

Delivery of Continuous Plexus Analgesia

Continuous plexus analgesia may be provided with boluses, continuous infusion, PCA, or a combination of background infusion and PCA boluses. Evidence is accumulating that patient-controlled regimens (either background infusion plus patient-controlled boluses or patient-controlled boluses only) may be advantageous for delivery of continuous plexus analgesia. Several RCTs indicate that the use of a background infusion + PCA provides superior analgesia, reduces local anesthetic consumption, and improves patient satisfaction when compared with infusion-only or PCA-only administration for continuous interscalene and infraclavicular analgesia (32,33). RCTs indicate similar findings in femoral catheters for PCA delivery but do not support the addition of a background infusion for femoral analgesia (34). Typical dosing regimens are listed in Table 2.

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