Outpatient Management of Continuous Peripheral Nerve Catheters Placed Using Ultrasound Guidance: An Experience in 620 Patients

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BACKGROUND: Continuous peripheral nerve block (CPNB) is an optimal choice for analgesia after orthopedic procedures, but is not commonly used in outpatients because of concern regarding the possibility of catheter-related complications. In addition, it may be difficult to provide adequate patient access to physicians in this setting. We present 620 outpatients who were treated with CPNB using an established protocol.
METHODS: All catheters were placed using direct ultrasound visualization. These patients received extensive oral and written preoperative instruction and were provided continuous telephone access to the anesthesiologist during the postoperative period. All patients were also contacted at home by telephone on the first postoperative day. In addition, each patient was seen and examined by the surgeon within 2 wk of hospital discharge.
RESULTS: Of the 620 patients, there were 190 interscalene (brachial plexus), 206 fascia iliaca (femoral nerve), and 224 popliteal fossa (sciatic nerve) catheters. Two patients (0.3%) had complications related to the nerve block. In both of these patients, the symptoms resolved within 6 wk of surgery. Twenty-six patients (4.2%) required postoperative interventions by the anesthesiologist. One patient returned to the hospital for catheter removal.
CONCLUSIONS: In this large series of outpatients treated with CPNB, there were surprisingly few interventions requiring an anesthesiologist. Likewise, patients were able to manage and remove their catheters at home without additional follow-up. This suggests that with adequate instruction and telephone access to health care providers, patients are comfortable with managing and removing CPNB catheters at home.
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Continuous peripheral nerve block (CPNB) may be an optimal choice for analgesia after orthopedic procedures of the lower and upper extremities (1–5). A number of studies have demonstrated that resting and break-through pain scores are lower with CPNB when compared with conventional therapy using oral or parenteral analgesics (6–12). Additionally, CPNB is associated with decreased time to functional recovery during rehabilitation (2).

Despite this evidence, patients having orthopedic procedures associated with significant postoperative pain are rarely sent home with CPNB. Only a limited number of studies have been reported on patients sent home with CPNB (3–5). Reluctance on the part of surgeons and anesthesiologists to treat these patients with CPNB reflects the limited data in the literature regarding this practice, as well as concern about complications such as catheter failure, infection, and local anesthetic toxicity (5). Additionally, there may be limited resources to provide adequate patient access to physicians in this setting. No large studies have addressed practical questions for the anesthesiologist who incorporates outpatient CPNB as a standard of care. For example, how often would the anesthesiologist be required to make a patient intervention during evenings or on weekends? How often might patients call if provided easy telephone access to the anesthesiologist? Can patients reliably remove their catheters at home? Is the complication rate higher for outpatient catheters?

One of the most common problems associated with CPNB involves accurate placement of the catheter. Failure rates of up to 40% have been reported when conventional techniques for catheter placement are used (7–10). The recent introduction of ultrasound (US) for placement of catheters is promising. US guidance during peripheral nerve block allows for direct visualization of nerves, blood vessels, and other surrounding structures. It is also associated with

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higher success rates and an improved effectiveness of the block when compared with nerve stimulator techniques (13–16).

We present a series of 620 outpatients who were treated with CPNB placed using direct US visualization and managed using a standard protocol.

METHODS

IRB approval was obtained to perform a retrospective review of 620 outpatients from a single orthopedic hospital who were treated with CPNB using an established protocol. We reviewed the records of all patients who were discharged with CPNB catheters placed using US guidance during a 15-mo period between November 1, 2004 and January 30, 2006.

The decision to manage outpatient CPNB at the University of UT Orthopedic Center was made only after establishing a strict protocol for documented patient follow-up, quality assurance, reporting of complications, and direct patient access to physicians in the event of unsatisfactory care. This protocol did not allow outpatient CPNB in patients with morbid obesity, sleep apnea, a known history of chronic opioid use, or significant cardiopulmonary disease. The patient population consisted of three surgical groups: shoulder or proximal humerus, foot and ankle, and knee procedures. These patients were treated with interscalene (brachial plexus), popliteal fossa (sciatic nerve), and fascia iliaca (femoral nerve) CPNB, respectively.

This review includes records of telephone contacts made in all patients on the first postoperative day, all patient to physician telephone contacts occurring during the postoperative period, and postoperative clinic visits with the surgeon. Based on this review, complications such as infection (erythema, pain, or swelling that was reported by the patient or noted on clinic visit), local anesthetic toxicity, and nerve injury were recorded. The interventions required by anesthesiologists managing these catheters were also recorded. Interventions were defined as any problem that required the involvement of the anesthesiologist after the patient was discharged from the hospital. Interventions included equipment malfunctions, inadequate pain control, and issues involving patient education.

Protocol for Outpatient CPNB

The standard protocol for education and follow-up in outpatients treated with CPNB at the University of UT Orthopedic Center is similar to protocols reported at other institutions (3–5) and includes:

1. Specific informed consent for placement of the CPNB after discussion of the risks and benefits.
2. Detailed verbal instructions to the patient, family, or caregivers regarding side effects, catheter care, and management (Available for review at University of UT web site, anesthesia.med.utah.edu/pain).
3. Written instructions outlining management, side effects, and care of the catheter given immediately before discharge home (Available for review at University of UT web site, anesthesia.med.utah.edu/pain).
4. Written contact information including the personal telephone number of an anesthesiologist who was directly available for 24 h. A single anesthesiologist managed all patient follow-ups at any given time.
5. A follow-up telephone contact was on the first postoperative day by the anesthesiologist. The patient was questioned specifically about adequate pain control. All patients were reminded about how to contact the anesthesiologist and how to remove the catheter after 48 h.
6. A postoperative visit at the outpatient clinic within 2 wk after surgery, where the sensory and motor function of the patient was assessed and the operative limb was examined for erythema, discharge, or swelling.
7. Outpatient follow-up data sheet maintained for each patient, discharged with a CPNB.
8. Prescriptions for oral opioid analgesics as an adjunct to catheter-based analgesia. Patients received 1–2 tablets of either hydrocodone (5–7.5 mg) or oxycodone (5–10 mg) with acetaminophen as needed at 4–6 h intervals.
9. Removal of all catheters after 48 h of local anesthetic infusion.

Protocol for Catheter Placement

All catheters were placed using direct US visualization. Standard aseptic technique was observed, including sterile skin preparation (chlorhexidine) and draping procedures. In each case, a 20-gauge polyamide epidural catheter was placed through a 2.5-in. thin-walled 18-gauge needle (Arrow International, Reading, PA). No nerve stimulator or paresthesia techniques were used. Documentation of motor weakness and loss of temperature and light touch sensation were noted for the sciatic, femoral, and brachial plexus distributions, respectively. This was done both before surgery and again before discharge from the postanesthesia care unit (PACU). After placement, all catheters were injected with 3 cc of 0.25% bupivicaine containing epinephrine 5 mcg/mL. This was done to verify that the catheter injected easily, as well as to detect intravascular placement.

Popliteal Fossa (Sciatic) CPNB

Using US guidance, the sciatic nerve was identified in the proximal popliteal fossa between the biceps femoris and the semimebranosus/semitendinosus muscles. Under direct visualization, the 18-gauge, thin-walled needle was advanced into the space between the biceps femoris and semimembranosus/semitendinosus muscles, approximately 1.0 cm medial to the sciatic nerve. The injection of local anesthetic was also observed in real time to document adequate distribution around the

nerve. Catheters were then placed through the 18-gauge thin-walled needle after the initial injection of 30 mL of 0.5% preservative-free bupivicaine with 1:200,000 epinephrine. All catheters were inserted to a depth of 10–15 cm at the skin, covered with a sterile gauze sponge and secured with a clear adhesive dressing. Patients having major foot and ankle procedures also received a single saphenous nerve block at the knee using 5 mL of 0.5% preservative-free bupivicaine with 1:200,000 epinephrine. These patients were given special education regarding the return of sensation on the medial aspect of the ankle, as the saphenous nerve function returned.

Interscalene Brachial Plexus CPNB

Using US guidance, the scalene muscles, brachial plexus, and subclavian artery were identified above the clavicle. While keeping the scalene muscles and brachial plexus in view, an imaging probe was then moved superiorly on the neck to the level of the cricoid ring. Under real-time visualization, the thin-walled 18-gauge needle was advanced into the space deep to the prevertebral fascia and between the scalene muscles. Local anesthetic was injected under real-time visualization to document accurate distribution in the interscalene space. Catheters were placed though an 18-gauge thin-walled needle after initial injection between the scalene muscles using 20 mL of 0.5% preservative-free bupivicaine with 1:200,000 epinephrine. Catheters were inserted to a depth of 8–12 cm at the skin, covered with a sterile gauze sponge and secured with a clear adhesive dressing.

Fascia Iliaca (Femoral) CPNB

Using US guidance, the fascia iliaca, femoral artery, and femoral nerve were identified immediately inferior to the inguinal ligament. Using real-time US guidance, the thin-walled 18-gauge needle was advanced into the plane deep to the fascia iliaca and approximately 1 cm lateral to the femoral nerve. The correct position of the injecting needle was confirmed by observing real-time distribution of the local anesthetic in the plane of the fascia iliaca from the injecting needle to the femoral nerve. Catheters were placed through the 18-gauge thin-walled needle after initial injection of 30 mL of 0.5% preservative-free bupivicaine with 1:200,000 epinephrine. The catheters were then inserted to a depth of 10–15 cm at the skin, covered with a sterile gauze sponge and secured in place with a clear adhesive dressing.

PACU Protocol

In the PACU, the catheter was attached to a disposable fixed rate elastomeric infuser (Baxter Infusor LV, Baxter, Deerfield, IL) filled with a volume of 250 mL of plain, preservative-free 0.25% bupivicaine set to infuse at 5 mL/h. The connections and patency of the catheter were assessed by hand injection at the time the catheter was attached. Special education was given to each patient regarding the possibility of increased sensation after the transition phase between the initial bolus of 20–30 mL 0.5% bupivicaine, and subsequent infusion of a lower concentration of a more dilute solution in the CPNB (5 mL/h of 0.25% bupivicaine). The patients were discharged home with the infuser from the PACU when they met Aldrete score criteria (Aldrete score ≥9).

Table 1. Interscalene (Brachial Plexus) Catheters by Age, Procedure, and Sex

	Age (yr) and sex (M/F)		
Procedures	15–39 yr	40–60 yr	>60 yr
Bankart repair	36 (32/4)	3 (0/3)	1 (1/0)
Clavicular/acromial procedures	4 (3/1)	7 (4/3)	5 (3/2)
Elbow arthroplasty	1 (0/1)	3 (0/3)	1 (0/1)
Shoulder arthroplasty	4 (3/1)	9 (4/5)	12 (6/6)
Labral repairs	6 (3/3)	2 (2/0)	0
Humerus procedures	4 (2/2)	3 (3/0)	2 (0/2)
Rotator cuff repair	4 (4/0)	44 (24/20)	25 (13/12)
Other procedures	4 (2/2)	5 (2/3)	5 (4/1)
Totals	*63 (49/14)*	*76 (39/37)*	*51 (27/24)*

The values given in parenthesis are the number of males/number of females.

RESULTS

This review includes 620 patients who were discharged with CPNB catheters placed using US guidance during a 15-mo period between November 1, 2004 and January 30, 2006. The interscalene group included 115 men and 75 women and ranged in age from 15 to 80 yr of age. The femoral group included 134 men and 72 women and ranged in age from 14 to 76 yr of age. The popliteal fossa group included 121 men and 103 women and ranged in age from 14 to 85 yr of age. The specific demographics for age, sex, type of CPNB, and surgical procedure are demonstrated in Tables 1–3. In all 620 patients, a telephone follow-up within 24 h of discharge was documented. Surgical clinic notes documenting follow-up within 2 wk of discharge were also identified in all patients. Tables 4–6 provide information about the required interventions and complications associated with each type of catheter. Details for each patient are included in the Appendices.

There were two complications in patients treated with CPNB. Both of these occurred in patients treated with catheters in the popliteal fossa (Table 4). One patient had weakness and sensory loss postoperatively in the distribution of the common peroneal nerve after tarsometatarsal osteotomies. The patient described this deficit during surgical follow-up 1 wk after surgery. It originated distal to the popliteal fossa at the head of the fibula, and was most consistent with a compression injury. In this patient, motor and sensory function returned to normal without intervention after 6 wk. A second patient treated with CPNB in the popliteal fossa reported severe burning pain and allodynia in the plantar and dorsal aspects of the foot

Table 2. Popliteal Fossa (Sciatic Nerve) Catheters by Age, Procedure, and Sex

	Age (yr) and sex (M/F)		
Procedures	14–39 yr	40–60 yr	>60 yr
Achilles tendon repair/lengthen	13 (9/4)	7 (5/2)	1 (0/1)
Ankle fracture reduction	25 (17/8)	15 (7/8)	10 (3/7)
Ankle fusion	5 (1/4)	7 (4/3)	19 (9/10)
Below the knee amputation	0	4 (4/0)	1 (0/1)
Calcaneal osteotomies or fractures	17 (12/5)	11 (8/3)	3 (1/2)
Tarsal/metatarsal fixation	6 (3/3)	12 (6/6)	6 (3/3)
Tarsal/metatarsal osteotomies	11 (7/4	16 (5/11)	8 (2/6)
Fixation of the tibia/fibula	10 (9/1)	6 (2/4)	1 (0/1)
Ankle tendon reconstructions	3 (2/1)	4 (1/3)	1 (0/1)
Other popliteal fossa catheters	2 (1/1)	0	0
Totals	*92 (61/31)*	*82 (42/40)*	*50 (18/32)*

The values given in parenthesis are the number of males/number of females.

Table 3. Fascia Illiaca (Femoral Nerve) Catheters by Age, Procedure, and Sex

	Age (yr) and sex (M/F)		
Procedures	14–39 yr	40–60 yr	>60 yr
Anterior cruciate ligament	129 (93/36)	31 (21/10)	1 (0/1)
Knee arthroplasty	2 (0/2)	3 (1/2)	4 (2/2)
Patella/patellar tendon reconstruction	23 (11/12)	2 (1/1)	1 (0/1)
Proximal tibia/fibula reduction	5 (3/2)	1 (0/1)	0
Other procedures	1 (0/1)	3 (2/1)	0
Totals	*160 (107/53)*	*40 (25/15)*	*6 (2/4)*

The values given in parenthesis are the number of males/number of females.

Table 4. Interscalene (Brachial Plexus) Catheters Complications and Interventions

Total interscalene catheters	190
Interventions	
Patient education issues[a]	3
Equipment malfunction[a]	2
Inadequate pain control[a]	8
Total interventions	*13*
Complications	0
Infection	0
Toxicity (seizures, perioral numbness)	0
Nerve injury	0
Total complications	*0*

[a] The details are given in Appendix.

Table 5. Popliteal Fossa (Sciatic Nerve) Complications and Interventions

Total sciatic nerve catheters	224
Interventions	
Patient education issues[a]	1
Equipment malfunction[a]	1
Inadequate pain control[a]	3
Total interventions	*5*
Complications	
Infection	0
Toxicity (seizures, perioral numbness)	0
Nerve Injury	2
Total complications	*2*

[a] The details are given in Appendix.

Table 6. Fascia Illiaca (Femoral Nerve) Complications and Interventions

Total femoral nerve catheters	206
Interventions	
Patient education issues[a]	5
Equipment malfunction[a]	1
Inadequate pain control[a]	2
Total interventions	*8*
Complications	
Infection	0
Toxicity (seizures, perioral numbness)	0
Permanent nerve damage	0
Total Complications	*0*

[a] The details are given in Appendix.

5 days after osteotomy of the first metatarsal. Examination of the extremity also revealed edema and color changes consistent with complex regional pain syndrome. There was no associated motor or sensory deficit. The patient had rapid resolution of symptoms after a series of three sympathetic blocks of the lower extremity over a 2-wk period.

The overall intervention rate for all groups was 26 of 620 patients (4.2%). Interventions were required most frequently in the interscalene group in which 13 of 190 patients (6.8%) required assistance by the anesthesiologist after discharge from the hospital. Fascia iliaca and popliteal fossa catheters were less likely to require interventions having rates of seven of 206 (3.9%) and five of 224 (2.2%), respectively. The most common intervention was a repeat injection or "bolus" of the catheter for inadequate pain control in seven of 620 patients (1.1%). The next most common intervention was for an accumulation of fluid (most likely local anesthetic) in three of 620 patients. One patient returned to the hospital for a dressing change

because of fluid accumulation under the dressing. In the two other patients who called with concern about fluid accumulation under the dressing, the issue was resolved by telephone. At any given time, a single anesthesiologist was responsible for all outpatient catheters. Of the 26 interventions, seven occurred during the evening or on weekends. The remaining 19 interventions were managed during normal work hours.

Only one patient was unable to remove the CPNB catheter at home. In this case, a single knot at the catheter tip caused resistance at the skin when the patient attempted to remove a fascia iliaca catheter. This catheter was easily removed with gentle traction by the anesthesiologist. The catheter was accidentally dislodged in five patients in the interscalene group. This prompted three patients to return to the hospital for a repeat single interscalene injection. One patient in the interscalene group was readmitted to the hospital and treated with IV morphine using patient-controlled analgesia. His catheter was dislodged on postoperative Day 1 after rotator cuff repair. Further questioning revealed that he was being treated chronically with opioids (more than 1 yr) for back pain at the time of his shoulder surgery.

DISCUSSION

Many practical aspects of managing outpatient CPNB catheters have not been addressed in the literature. The limited use of CPNB by surgeons and anesthesiologists may reflect concerns about patient safety (5) and the time constraints involved in providing appropriate follow-up and physician access for outpatients with CPNB. The intent of this study is not to describe catheter insertion techniques but, rather, to report the experience of managing a large group of outpatients in whom catheters have been successfully placed. Special emphasis was placed on patient education and consistent follow-up in these patients. This study suggests that patients are quite capable of managing and removing their catheters when they have received appropriate preoperative instruction. Despite having immediate access to anesthesiologists, patients seldom requested intervention by the anesthesiologist. As in other studies (2), the anesthesiologist easily addressed patients' concerns.

This series includes a number of patients who normally would have required hospitalization for postoperative pain management. For example, the group includes 25 shoulder arthroplasties, nine knee arthroplasties, five below-knee amputations, and 31 patients with calcaneal fractures and/or osteotomies. These patients were not only managed successfully at home, but required little intervention after discharge from the PACU.

There did not appear to be any complications related to initial placement of the CPNB. Instead, the single nerve injury in this series was likely caused by compression of the peroneal nerve during the intraoperative or postoperative period. This underscores the importance of vigilance during the entire treatment period. Specifically, patients must be instructed about careful padding and positioning of the extremity affected by CPNB. Other authors have also reported very low complication rates for infection, nerve injury, or local anesthetic toxicity in CPNB placed using nerve stimulators (2). Although the use of US has been suggested to avoid complications such as intravascular or intra-neuronal injection of local anesthetics (14,17), data from this case series do not specifically address the relative benefits of one catheter placement technique over another.

At present, there are no prospective data showing the superiority of a specific local anesthetic, concentration, infusion rate, or infusion pump for peripheral nerve catheters. Studies in which CPNB have been used show a variety of local anesthetics and infusion rates ranging from 3 to 12 mL/h with and without programmable bolus available to the patient (7,18). Further studies are needed to define optimal local anesthetic dosing regimens in this population. In this series, we used a fixed infusion of bupivicaine 0.25% at 5 mL/h in all patients. A simple elastomeric infusion device was used that did not include features such as occlusion alarms or bolus capability. This was done in an attempt to simplify management for the patient. Despite a relatively low and fixed infusion rate, very few patients (1.1%) requested additional injections for inadequate pain control. In light of the potential cost difference between nonprogrammable versus programmable disposable pumps (7), our results are encouraging from an economic perspective. Other authors have reported both increased block density and lower anesthetic dose requirements with US-guided techniques when compared with conventional techniques using nerve stimulators (14,15).

In this group of 620 outpatients who received extensive preoperative education and were treated with CPNB placed using US guidance, there were two complications (both of which resolved) and an overall intervention rate of 4.2%. Only one patient was readmitted to the hospital for inadequate pain control. Further studies are needed to determine if outpatient management of CPNB is a widely applicable standard of care.

APPENDIX: INTERVENTIONS AND COMPLICATIONS

Interscalene (Brachial Plexus) Catheters Complications and Interventions

Patient Education Issues

- A 16-year-old male for Bankart repair of the shoulder felt short of breath when lying flat, so he pulled his catheter after 24 h. The patient had adequate analgesia with the oral medications. The patient was managed by telephone during working hours.

- A 62-year-old woman for shoulder arthroplasty had her catheter pull out at 36 h. She was adequately controlled on oral analgesics. The patient was managed by telephone during working hours.
- A 68-year-old woman for rotator cuff repair was unsure if the balloon in the elastomeric balloon pump was deflating. She was reassured. The patient was managed by telephone during working hours.

Equipment Malfunctions

- A 39-year-old woman for Bankart repair returned to the hospital because of inadequate pain control. On arrival, it was noted that the proximal catheter tip had been occluded. This was corrected, and the patient received an injection of 15 mL of 0.5% bupivicaine through the catheter, the balloon pump was reconnected and she had no other sequelae. The anesthesiologist treated the patient during working hours.
- A 47-year-old woman for rotator cuff repair noted that her balloon pump was disconnected from the catheter. She returned to the hospital, and the device was reattached. The anesthesiologist treated the patient during working hours.

Inadequate Pain Control

- A 27-year-old man for Bankart repair accidentally pulled out his catheter on postoperative Day 1 and returned to the hospital for another single injection interscalene block. The anesthesiologist treated the patient in the evening.
- A 20-year-old woman for Bankart repair, while having her mother arrange her hair postoperatively, had her catheter inadvertently pulled out. The patient returned to the hospital for a repeat single injection interscalene block. The patient received an additional block during working hours by the anesthesiologist.
- A 24-year-old man for labral repair with previously undiagnosed chronic opioid use reported pain despite motor and sensory block in the brachial plexus. He required additional opioids. The anesthesiologist saw the patient during normal working hours.
- A 27-year-old man for Bankart repair accidentally pulled his catheter out postoperative Day 1 and returned to the hospital for another single injection interscalene block. The patient was seen during normal working hours by the anesthesiologist.
- A 41-year-old man for rotator cuff repair whose catheter inadvertently removed on postoperative Day 1 developed severe pain. He was readmitted to the hospital for IV opioid analgesia. The patient was seen by the anesthesiologist and readmitted to the hospital in the evening.
- A 58-year-old man for rotator cuff repair pulled his catheter early on postoperative Day 1. He suffered inadequate pain control. Additional opioid analgesics were given. The anesthesiologist saw the patient during normal working hours.
- A 58-year-old man for rotator cuff repair experienced inadequate pain control and returned to the hospital for an additional injection of 15 mL of 0.5% bupivicaine through his interscalene catheter. The patient had no further sequelae. The anesthesiologist saw the patient during normal working hours.
- A 70-year-old man for shoulder arthroplasty had inadequate pain control on postoperative Day 1, and returned to the hospital for an additional injection of 10 mL of 0.5% bupivicaine through his interscalene catheter. He had no further sequelae. The anesthesiologist saw the patient during normal working hours.

Popliteal Fossa (Sciatic Nerve) Complications and Interventions

Patient Education Issues

- A 65-year-old woman for tarsometatarsal osteotomy experienced breakthrough pain on the dorsum of her foot during postoperative Day 1. Of note, she was not aware that she could take oral analgesics with the catheter in place. She was instructed to take the oral opioids as prescribed, and had no further sequelae. The patient was managed by telephone during normal working hours by the anesthesiologist.

Equipment Malfunction

- A 21-year-old man for open reduction and internal fixation of the ankle had the catheter disconnected from the elastomeric infusion pump. The patient returned to the hospital, had the catheter reconnected by the anesthesiologist, and patient had excellent pain control. The anesthesiologist saw the patient on a weekend.

Inadequate Pain Control Issues

- A 27-year-old man for open reduction and internal fixation of the ankle fracture had moderate to severe pain on postoperative Day 1. He returned to the hospital for an additional injection through the catheter of 15 mL of 0.5% bupivicaine. The patient subsequently had good analgesia. The anesthesiologist saw the patient during normal working hours.
- A 42-year-old woman for calcaneal osteotomy experienced pain after 36 h and returned to the hospital for an additional injection of 15 mL of 0.5% bupivicaine through the catheter. Her pain was then well controlled. The anesthesiologist saw the patient during normal working hours.
- A 46-year-old woman for ankle tendon repair experienced inadequate pain control and returned for a bolus of 10 mL 0.5% bupivicaine within the first 24 h. Her pain was then well

managed. The anesthesiologist saw the patient during normal working hours.

Complications

- A 58-old-man for left metatarsal osteotomy developed a complex regional pain syndrome of uncertain etiology. The syndrome resolved after three sympathetic blocks over a 2-wk period. The patient was seen during normal working hours by the anesthesiologist.
- A 41-year-old man for tarsometatarsal osteotomies experienced weakness and loss of sensation in the peroneal nerve distribution. His symptoms were noted 1 wk after surgery during the postoperative clinic visit. The injury localized to the level of the head of the fibula. The etiology was consistent with a compression injury. The symptoms continued for approximately 6 wk after which they resolved completely. The patient regained all sensation and motor control. The anesthesiologist examined the patient during normal working hours.

Fascia Illiaca (Femoral Nerve) Complications and Interventions

Patient Education Issues

- An 18-year-old male for anterior cruciate ligament repair inadvertently removed his catheter after 36 h. His pain was well managed with oral analgesics. The anesthesiologist offered to replace the catheter, but as his pain control was adequate, he declined. The patient was managed over the telephone by the anesthesiologist in the evening.
- A 38-year-old woman for anterior cruciate ligament repair returned to the hospital because of fluid accumulation under her dressing. The dressing was removed, the catheter was verified to be in place, and functioning well, and a new dressing was applied. The patient was educated about local anesthetic tracking along the catheter. The anesthesiologist saw the patient during normal working hours.
- A 29-year-old man for anterior cruciate ligament repair was concerned that his block was still present 1 h after pulling the catheter. The patient was reassured, and the block did wear off within a few hours. The anesthesiologist managed the patient over the telephone on a weekend.
- A 29-year-old woman for anterior cruciate ligament repair was concerned about the catheter leaking and called the anesthesiologist at the hospital because of fluid accumulation under her dressing. The patient was educated about local anesthetic tracking along the catheter. The anesthesiologist managed the patient over the telephone at in the evening.
- A 20-year-old man for anterior cruciate ligament repair called with concerns about the catheter leaking because of fluid accumulation under his dressing. The patient was educated about local anesthetic tracking along the catheter. The anesthesiologist managed the patient over the telephone during normal working hours.

Equipment Malfunction

- A 44-year-old woman for anterior cruciate ligament repair experienced resistance when attempting to withdraw the catheter. The patient returned to the hospital for catheter removal. The catheter was removed with gentle traction, and was noted to have a simple overhand knot at the tip. The tip was intact, and there were no further sequelae. The anesthesiologist saw the patient during normal working hours.

Inadequate Pain Control

- A 35-year-old man for anterior cruciate ligament repair had moderate to severe pain. He returned to the hospital after 18 h, where he received an additional injection of 15 mL of 0.5% bupivicaine through the catheter. Pain control was then adequate. The anesthesiologist saw the patient on a weekend.
- A 31-year-old man for anterior cruciate ligament repair had severe pain postoperatively, and returned to the hospital after 24 h, where he received an additional injection of 15 mL of 0.5% bupivicaine through the catheter, after which his pain control was adequate. The anesthesiologist saw the patient during normal working hours.

REFERENCES

1. Enneking FK, Wedel DJ. The art and science of peripheral nerve blocks. Anesth Analg 2000;90:1, 2.
2. Capdevelia X, Pirat P, Bringuier S, et al. Continuous peripheral nerve blocks in hospital wards after orthopedic surgery: a multicenter prospective analysis of the quality of postoperative analgesia and complications in 1,416 patients. Anesthesiology 2005;103:1035–45.
3. Ilfeld BM, Morey TE, Enneking FK. Continuous infraclavicular brachial plexus block for postoperative pain control at home: a randomized, double-blinded, placebo-controlled study. Anesthesiology 2002;96:1297–304.
4. Ilfeld BM, Morey TE, Wang RD, Enneking FK. Continuous popliteal sciatic nerve block for postoperative pain control at home: a randomized, double-blinded, placebo-controlled study. Anesthesiology 2002;97:959–65.
5. Ilfeld BM, Morey TE, Wright TW, et al. Continuous interscalene brachial plexus block for postoperative pain control at home: a randomized, double-blinded, placebo-controlled study. Anesth Analg 2003;96:1089–95.
6. White PF, Issioui T, Skrivanek GD, et al. The use of a continuous popliteal sciatic nerve block after surgery involving the foot and ankle: does it improve the quality of recovery? Anesth Analg 2003;97:1303–9.
7. Ilfeld BM, Enneking FK. Continuous peripheral nerve blocks at home: a review. Anesth Analg 2005;100:1822–33.
8. Coleman MM, Chan VW. Continuous interscalene brachial plexus block. Can J Anaesth 1999;46:209–14.
9. Ganapathy S, Wasserman RA, Watson JT, et al. Modified continuous femoral three-in-one block for postoperative pain after total knee arthroplasty. Anesth Analg 1999;89:1197–202.
10. Salinas FV. Location, location, location: continuous peripheral nerve blocks and stimulating catheters. Reg Anesth Pain Med 2003;28:79–82.
11. Ilfeld BM, Esener DE, Morey TE et al. Ambulatory perineural infusion: the patients' perspective. Reg Anesth Pain Med 2003;28: 418–23.

12. Richman JM, Liu SS, Courpas G, et al. Does continuous peripheral nerve block provide superior pain control to opioids? A meta-analysis. Anesth Analg 2006;102:248–57.
13. Marhofer P, Greher M, Kapral S. Ultrasound guidance in regional anesthesia. Br J Anaesth 2005;94:7–17.
14. Marhofer P, Schrögendorfer K, Koinig H, et al. Ultrasonographic guidance improves sensory block and onset time of three-in-one blocks. Anesth Analg 1997;85:854–7.
15. Marhofer P, Schrögendorfer K, Wallner T, et al. Ultrasonographic guidance reduces the amount of local anesthetic for 3-in-1 blocks. Reg Anesth Pain Med 1998;23:584–8.
16. Marhofer P, Sitzwohl C, Greher M, et al. Ultrasonographic guidance for infraclavicular plexus anaesthesia in children. Anaesthesia 2004;59:642–6.
17. Sandhu NS, Capal LM. Ultrasound-guided infraclavicular brachial plexus block. Br J Anaesth 2002;89:254–9.
18. Lui SS, Salinas FV. Continuous plexus and peripheral nerve blocks for postoperative analgesia. Anesth Analg 2003;96:263–72.