Complications and Adverse Effects Associated with Continuous Peripheral Nerve Blocks in Orthopedic Patients

Martin Wiegel, MD
Udo Gottschaldt, MD
Ria Hennebach, MD
Thilo Hirschberg, MD
Andreas Reske, MD

BACKGROUND: The increasing popularity of continuous peripheral nerve blocks (CPNBs) warrants further study of their adverse effects and complications.
METHODS: Anterior sciatic, femoral, and interscalene brachial plexus CPNBs were performed preoperatively using standardized catheter techniques in orthopedic patients prior to general or spinal anesthesia. Complications and adverse effects related to CPNBs were prospectively evaluated.
RESULTS: We analyzed 1398 CPNBs in 849 consecutive patients (mean age 65 ± 13 yr) between 2002 and 2004. Two-hundred-twenty-one patients received interscalene, 628 patients femoral, and 549 sciatic CPNBs, respectively. In all the latter patients, we performed both femoral and sciatic CPNBs. Overall, there were 9 cases of local inflammation at the insertion site (0.6%), and 3 local infections (pustule) (0.2%, all femoral CPNBs). In one patient undergoing a femoral technique, a retroperitoneal hematoma led to compression injury of the femoral nerve. Complete denervation of the quadriceps femoris muscle was confirmed by electroneuromyography. No other major neurological complications were noted. There was one case of methemoglobinemia associated with an interscalene CPNB. Vascular puncture occurred in approximately 6% of patients undergoing femoral and sciatic CPNBs. Catheter rupture was noted in one patient.
CONCLUSIONS: Our results add to the evidence that major complications from CPNBs are rare. However, minor adverse effects associated with CPNBs may be more common.
(Anesth Analg 2007;104:1578–82)

Peripheral nerve blocks provide many perioperative benefits, such as reduced opioid requirement, decreased incidence of hemodynamic instability, and less postoperative nausea and vomiting. Moreover, continuous peripheral nerve blocks (CPNBs) significantly improve postoperative pain control (1–7). Although recent studies have established the practicability, quality of pain control and patient satisfaction of various CPNB techniques (1,4,8–14), acceptance of CPNBs may, perhaps, be improved by increasing the availability of systematic data on complications and adverse effects (6,15–21).

In the present study, we prospectively analyzed complications and adverse effects related to sciatic, femoral, and interscalene brachial plexus CPNBs performed in consecutive orthopedic patients.

From the Department of Anesthesiology and Intensive Care Medicine, University Hospital Leipzig, Leipzig, Germany.

Accepted for publication February 8, 2007.

Support was provided solely from institutional sources.

Address correspondence and reprint requests to Dr. Martin Wiegel, Klinik und Poliklinik fuer Anaesthesiologie und Intensivtherapie, Universitaetsklinikum Leipzig, Liebigstrasse 20, D-04103 Leipzig, Germany. Address e-mail to martin.wiegel@medizin.uni-leipzig.de.

DOI: 10.1213/01.ane.0000261260.69083.f3

METHODS

This prospective analysis of consecutive orthopedic patients was approved by our institutional ethics committee and written informed consent was obtained from each patient. Complications and adverse effects associated with CPNBs, as well as details of the CPNB performance, were prospectively entered into a database between January 2002 and December 2004. Data from 200 patients analyzed in a preliminary study had been entered into the same database and were included in the present work (9).

Performance and Handling of CPNBs

All patients underwent their femoral, sciatic, and interscalene CPNBs using standardized aseptic catheter insertion techniques, followed by general or spinal anesthesia. Single-dose perioperative antibiotic prophylaxis (Cefuroxime 1.5 g IV) was administered to all patients. We routinely used a nerve stimulator (Stimuplex HNS 11, Braun, Melsungen, Germany). When stimulation currents of 0.4 mA (starting output 1.5 mA, frequency 2 Hz, pulse width 300 μs) were sufficient to elicit appropriate muscle twitches, local anesthetic was injected and the catheter inserted. Maximum insertion distances beyond the needle tip were 4 cm for sciatic and interscalene, and 8 cm for femoral CPNBs, respectively. The catheter was tunneled, covered by transparent adhesive dressing, and connected to an antimicrobial filter. All patients received

ropivacaine (2 mg/mL) by continuous perineural infusion (5–8 mL/h per catheter) in the postanesthesia care unit for 24 h. On the orthopedic ward, ropivacaine (2 mg/mL) was administered as a bolus dose (10–20 mL per each catheter) every 6 h by an orthopedic surgeon. Unless inflammation at the insertion site was noticed (prompting immediate removal), catheters were removed by the anesthesiologist when the orthopedic team considered them unnecessary.

Interscalene CPNB

Meier et al.'s modification of Winnie's technique was used (10): The puncture site was the point of intersection between the interscalene groove and a transverse plane at the level of the superior thyroid notch. The needle was angled 30 degrees to the skin and advanced caudally towards the transition from the middle to the lateral third of the clavicle. The catheter (Stimulong Plus, Pajunk, Geisingen, Germany) was inserted after injection of 300–400 mg prilocaine (10 mg/mL).

Femoral Nerve CPNB

Winnie's classical technique was used (22). The catheter (Stimulong Plus, Pajunk, Geisingen, Germany) was inserted after injection of 200 mg prilocaine (10 mg/mL) and 75 mg ropivacaine (7.5 mg/mL).

Anterior Sciatic Nerve CPNB

Our modified anterior technique to localize the sciatic nerve was used (9). With the leg in the neutral position, we identified the line connecting the puncture site of the femoral CPNB and the midpoint between the lateral and medial femoral epicondyle. The puncture site was located on the latter line 5 cm distal from the puncture site of the femoral CPNB. The needle was advanced perpendicular to the operating table until appropriate muscle twitches were elicited and the catheter advanced (Stimulong Plus) after injection of 200 mg Prilocaine (10 mg/mL).

Study Design

The present study reflected clinical routine. There was no specific request for routine tests such as radiograph, electroneuromyography, or culture of the catheter tip to screen for CPNB-associated complications. However, appropriate diagnostic techniques were requested whenever clinically indicated. All patients were followed by an anesthesiologist for 24 h beyond the removal of the catheter. At the end of this follow-up period, asymptomatic patients were instructed to inform their anesthesiologist or orthopedic surgeon about any problem related to the CPNB. In individuals with suspected complications or adverse effects, follow-up was extended until the symptoms resolved. All patients were queried for longer-term complications by the orthopedic surgeon during routine follow-up consultation 3 mo postoperatively.

The primary end-point of our study was the rate of major complications (nerve injury, bleeding requiring surgical intervention, catheter-associated infection, dyspnea, pneumothorax, and local anesthetic systemic toxicity) associated with CPNBs. Secondary end-points were CPNB-associated minor adverse effects (e.g., uncomplicated accidental vascular puncture, hoarseness and Horner's Syndrome).

The daily postoperative check-up, performed by an anesthesiologist, included the inspection of the catheter insertion site for local hematoma and signs of local inflammation or infection (i.e., redness, induration, or pustule), check of body temperature and, if available, white blood cell count. Catheter-associated infection was suspected in patients with pustules, fever (>38°C), or white blood cell count >9000/mm^3. These patients received antibiotics (Cefuroxime), the catheter was removed immediately and the distal portion (2–3 cm) was cut with sterile scissors, placed in a sterile transport medium, and sent to the microbiology laboratory for culture and sensitivity testing. In patients presenting signs of local inflammation (defined as redness, pain, and induration in the absence of pus) at the insertion site without concomitant symptoms the catheter was removed without further measures. In patients who had both femoral and sciatic CPNBs, both catheters were removed.

The daily postoperative check-up also included the neurological examination of the operated limb for clinical features of nerve dysfunction (e.g., paresthesia, pain, or weakness) by an anesthesiologist. Patients with clinical features of nerve dysfunction persisting longer than 24 h after catheter removal were examined by a neurologist, on whose request electroneuromyography was performed to verify nerve injury. Neurological deficits resolving completely within 24 h after catheter removal were considered related to residual local anesthetic effect and are referred to as transient. Electroneuromyography was not performed in patients with transient neurological deficits. Likewise, patients with hoarseness did not undergo laryngoscopy.

An aspiration test was performed daily by the orthopedic surgeon responsible for the administration of the local anesthetic in order to reduce the probability of intravascular migration of the catheter. Test doses with epinephrine were not used. The orthopedic surgeon also assessed the efficacy of the catheters qualitatively by asking the patients whether they experienced pain relief or not. CPNBs associated with inadequate analgesia were removed immediately.

Statistical Analysis

Descriptive data analysis was performed using SPSS 11 (SPSS Software GmbH, Munich, Germany). Data are given as mean ± SD.

RESULTS

We analyzed 1398 CPNBs in 849 consecutive orthopedic patients, of which 500 (59%) were female.

Table 1. Demographics and Indications for CPNBs

	Overall	Interscalene	Femoral	Sciatic
Total number	1398	221	628	549
Age (yr)	65 ± 13	55 ± 13	69 ± 11	70 ± 10
Catheter duration (d)	5.8 ± 1.9	4.0 ± 1.6	6.2 ± 1.8	6.2 ± 1.7
Shoulder				
Subacromial decompression		86	—	—
Rotator cuff repair		79	—	—
Instability repair		50	—	—
Arthroplasty		6	—	—
Knee				
Arthroplasty		—	549	549
Synovectomy		—	36	—
ACL reconstruction		—	25	—
Manipulation		—	14	—
Femur fracture		—	4	—

CPNB–continuous peripheral nerve block; interscalene–interscalene brachial plexus CPNB; femoral–femoral CPNB; sciatic–anterior sciatic CPNB; ACL–anterior cruciate ligament.

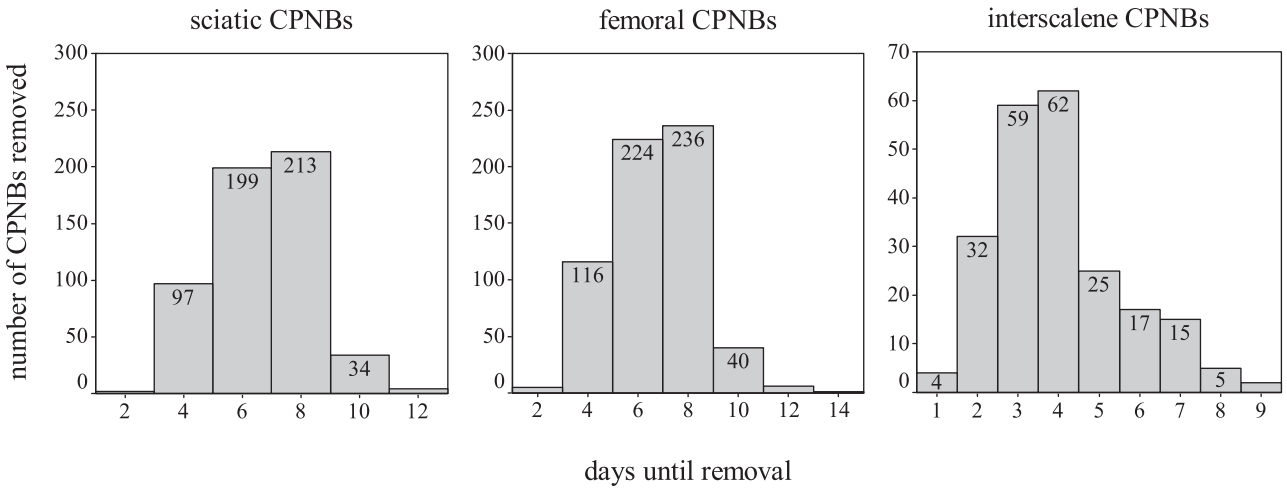

Figure 1. Histograms depicting the time until removal of the catheter for sciatic, femoral, and interscalene brachial plexus continuous peripheral nerve blocks (CPNBs).

Table 2. Complications and Minor Adverse Effects Associated with CPNBs

Complication/adverse event	Overall *n* (%)	Interscalene *n* (%)	Femoral *n* (%)	Sciatic *n* (%)
Local inflammation	9 (0.6)	1 (0.5)	4 (0.6)	4 (0.7)
Local infection	3 (0.2)	0	3 (0.5)	0
Positive culture	2 (0.1)	0	2 (0.3)	0
Neurological deficit				
Transient	12 (0.9)	3 (1.4)	3 (0.5)	6 (1.0)
Permanent	1 (0.1)	0	1 (0.2)	0
Methemoglobinemia	1 (0.1)	1 (0.5)	0	0
Dyspnea	0	0	0	0
Hoarseness	32 (2.3)	32 (14.5)	0	0
Horner's syndrome	25 (1.8)	25 (11.3)	0	0
Vascular puncture	72 (5.2)	0	36 (5.7)	36 (6.6)
Catheter breakage	1 (0.1)	0	0	1 (0.2)

CPNB–continuous peripheral nerve block; interscalene–interscalene brachial plexus CPNB; femoral–femoral CPNB; sciatic–anterior sciatic CPNB; positive culture–culture of the catheter tip.

Demographic data and indications for CPNB are given in Table 1 and Figure 1. Complications and minor adverse effects are specified in Table 2.

Analyzing all CPNBs we noticed local inflammation at the insertion site of nine catheters (0.6%). Three patients (0.2%, all femoral CPNBs) presented with a pustule at the insertion site. In two of these, local infection could be confirmed by culture of the catheter, one was positive for *Staphylococcus epidermidis* and one for *Staphylococcus aureus*. The culture of the third catheter remained sterile. No patient presented with signs of systemic inflammation.

Thirteen of the 1398 CPNBs (0.9%) were associated with neurological deficits persisting after catheter removal. The symptoms were transient in 12 of these patients. Only one CPNB (femoral technique) was complicated by permanent nerve injury. This patient complained of inguinal pain, numbness, and weakness of the thigh on the sixth day after total knee replacement. These symptoms persisted despite termination of the local anesthetic administration. Computed tomography revealed a retroperitoneal hematoma requiring surgical intervention. It is suspected that the bleeding most likely originated from the femoral artery, the direct injury of which, however, could not be verified. Complete denervation of the quadriceps femoris muscle was diagnosed by electroneuromyography and confirmed in repeat examinations.

One patient (interscalene CPNB) presented with low oxygen saturation on pulse oximetry intraoperatively. Co-oximetry (ABL 625, Radiometer, Copenhagen, Denmark) revealed a methemoglobin level of 9%.

There was one case of catheter breakage. During performance of a sciatic CPNB the catheter was withdrawn back into the needle after it had passed the tip and a 2-cm catheter fragment was shorn off at the bevel of the needle. As the fragment could not be localized, operative removal was declined by the orthopedic surgeon. No late occurring complications were noted at 6 and 12 mo follow-up.

DISCUSSION

The results of our study add to the body of evidence that major complications of CPNBs are rare. Nevertheless, our data confirm that minor adverse effects are not uncommon after interscalene, femoral, and sciatic CPNBs (6,15–17,19,23).

In contrast to single-shot nerve blocks, catheter-induced complications need to be considered in addition to needle-induced and local anesthetic-induced complications when studying complications and adverse effects associated with CPNBs (23). Possible catheter-induced complications include infection and anatomical damage (e.g., intravascular or intrathecal migration) (6,17,19,20,24). Both the overall rates of local inflammation and infection observed in our patients correspond well with data from other groups (6,8,15–17,19,20). This is of interest to us, as we removed the catheters considerably later (Table 1, Fig. 1) than others who removed the catheters after 3–5 days (3,6,8,10,13,15–17,19,20). Moreover, we administered the local anesthetic as bolus on the ward which increased the frequency of catheter manipulations and could have increased the risk of infectious complications. As the analgesic approach requires consideration of orthopedic, physiotherapeutic, and anesthesiologic concerns, we let the orthopedic team decide when the catheters should be removed. This approach has led us to accept durations of around 4 days for interscalene, and around 6–8 days for femoral and sciatic CPNBs, respectively. However, as reported by Ben-David et al., such "standard institutional practice" should be challenged from time to time (3). For example, Pham Dang et al. noticed that the beneficial analgesic effects of sciatic CPNBs after total knee replacement disappear after 36 h (11). As an unusual catheter-associated complication we describe a case of catheter shearing. Although the retained catheter fragment caused neither irritation nor infection in our patient, one should ideally avoid withdrawing any catheters back into the needle (25).

Our data confirm that major needle-induced complications are rare (15,23). In agreement with a previous report, we found that accidental vascular puncture was not uncommon during performance of femoral and sciatic CPNBs (17). Although accidental vascular puncture does not usually result in significant bleeding, hematoma formation can cause nerve injury due to pressure ischemia, either as perineural hematoma or by occupying and pressurizing an anatomic compartment, e.g., the retroperitoneum (as in our patient) or the axilla (26). In our patient, the unusual magnitude of bleeding may be explained by the patient's self-medication with acetylsalicylic acid (1 g/day), which she did not disclose during the preanesthetic visit and continued postoperatively.

We recognized only one local anesthetic-induced complication (methemoglobinemia). Although the incidence of seizures reportedly ranges from 1 to 4 per 1000 of regional anesthesia procedures, we observed neither seizures nor cardiovascular complications (21).

Major complications of interscalene CPNBs are pneumothorax and impaired pulmonary function due to hemidiaphragmatic paresis. Common minor adverse effects are hoarseness and Horner's Syndrome (8,10,13,18,23). We did not identify a single patient developing dyspnea or respiratory insufficiency after interscalene CPNB. However, since we neither performed routine postoperative chest radiograph nor sonography in asymptomatic patients, we cannot provide additional insight from our patients. Using Meier et al.'s modification of Winnie's approach (10), we found 14.5% of patients presenting transient hoarseness coinciding with regional anesthetic application. Horner's Syndrome developed in 11.3% of patients. Compared to other reports, these effects occurred more often in our patients (8,10,13). Borgeat et al. reasoned that the incidence of hoarseness and Horner's syndrome was less frequent when the local anesthetic was injected through the catheter and thus administered more caudally (8,13). This could explain the higher incidence in our patients because we injected the local anesthetic first and then inserted the catheter. However, Meier et al. used the same methodology but reported a lower incidence of hoarseness (10). Different doses of local anesthetic administered for postoperative analgesia could be an explanation.

Limitations of Our Study

As mentioned earlier, the present study was intentionally designed to assess major complications and minor adverse effects related to CPNBs as they would appear in clinical practice. Therefore, we monitored our patients clinically and requested appropriate diagnostic techniques whenever clinically indicated. Transient or minor adverse effects may have remained undetected.

In conclusion, our results add to the existing evidence that major complications from CPNBs are rare. We also noted that minor adverse effects are not uncommon after CPNBs.

REFERENCES

1. Singelyn FJ, Deyaert M, Joris D, et al. Effects of intravenous patient-controlled analgesia with morphine, continuous epidural analgesia, and continuous three-in-one block on postoperative pain and knee rehabilitation after unilateral total knee arthroplasty. Anesth Analg 1998;87:88–92.
2. Capdevila X, Barthelet Y, Biboulet P, et al. Effects of perioperative analgesic technique on the surgical outcome and duration of rehabilitation after knee surgery. Anesthesiology 1999;91:8–15.
3. Ben-David B, Schmalenberger K, Chelly JE. Analgesia after total knee arthroplasty: is continuous sciatic blockade needed in addition to continuous femoral blockade? Anesth Analg 2004;98:747–9.
4. Singelyn FJ, Ferrant T, Malisse MF, Joris D. Effects of intravenous patient-controlled analgesia with morphine, continuous epidural analgesia, and continuous femoral nerve sheath block on rehabilitation after unilateral total-hip arthroplasty. Reg Anesth Pain Med 2005;30:452–7.
5. Evans H, Steele SM, Nielsen KC, et al. Peripheral nerve blocks and continuous catheter techniques. Anesthesiol Clin North Am 2005;23:141–62.
6. Capdevila 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.
7. 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.
8. Borgeat A, Dullenkopf A, Ekatodramis G, Nagy L. Evaluation of the lateral modified approach for continuous interscalene block after shoulder surgery. Anesthesiology 2003;99:436–42.
9. Wiegel M, Reske A, Hennebach R, et al. Anterior sciatic nerve block–new landmarks and clinical experience. Acta Anaesthesiol Scand 2005;49:552–7.
10. Meier G, Bauereis C, Heinrich C. [Interscalene brachial plexus catheter for anesthesia and postoperative pain therapy. Experience with a modified technique]. Anaesthesist 1997;46:715–9.
11. Pham Dang C, Gautheron E, Guilley J, et al. The value of adding sciatic block to continuous femoral block for analgesia after total knee replacement. Reg Anesth Pain Med 2005;30:128–33.
12. Chelly JE, Greger J, Gebhard R, et al. Continuous femoral blocks improve recovery and outcome of patients undergoing total knee arthroplasty. J Arthroplasty 2001;16:436–45.
13. Boezaart AP, de Beer JF, du Toit C, van Rooyen K. A new technique of continuous interscalene nerve block. Can J Anaesth 1999;46:275–81.
14. Morau D, Lopez S, Biboulet P, et al. Comparison of continuous 3-in-1 and fascia Iliaca compartment blocks for postoperative analgesia: feasibility, catheter migration, distribution of sensory block, and analgesic efficacy. Reg Anesth Pain Med 2003;28:309–14.
15. Bergman BD, Hebl JR, Kent J, Horlocker TT. Neurologic complications of 405 consecutive continuous axillary catheters. Anesth Analg 2003;96:247–52.
16. Borgeat A, Ekatodramis G, Kalberer F, Benz C. Acute and nonacute complications associated with interscalene block and shoulder surgery: a prospective study. Anesthesiology 2001;95:875–80.
17. Cuvillon P, Ripart J, Lalourcey L, et al. The continuous femoral nerve block catheter for postoperative analgesia: bacterial colonization, infectious rate and adverse effects. Anesth Analg 2001;93:1045–9.
18. Borgeat A, Perschak H, Bird P, et al. Patient-controlled interscalene analgesia with ropivacaine 0.2% versus patient-controlled intravenous analgesia after major shoulder surgery: effects on diaphragmatic and respiratory function. Anesthesiology 2000;92:102–8.
19. Neuburger M, Breitbarth J, Reisig F, et al. [Complications and adverse events in continuous peripheral regional anesthesia. Results of investigations on 3,491 catheters]. Anaesthesist 2006;55:33–40.
20. Morin AM, Kerwat KM, Klotz M, et al. Risk factors for bacterial catheter colonization in regional anaesthesia. BMC Anesthesiol 2005;5:1.
21. Brown DL, Ransom DM, Hall JA, et al. Regional anesthesia and local anesthetic-induced systemic toxicity: seizure frequency and accompanying cardiovascular changes. Anesth Analg 1995;81:321–8.
22. Winnie AP, Ramamurthy S, Durrani Z. The inguinal paravascular technic of lumbar plexus anesthesia: the "3-in-1 block". Anesth Analg 1973;52:989–96.
23. Ben-David B. Complications of peripheral blockade. Anesthesiol Clin North Am 2002;20:695–707.
24. Adam F, Jaziri S, Chauvin M. Psoas abscess complicating femoral nerve block catheter. Anesthesiology 2003;99:230–1.
25. Coventry DM, Timperley J. Perineural catheter placement: another potential complication. Reg Anesth Pain Med 2004;29:174–5.
26. Ben-David B, Stahl S. Axillary block complicated by hematoma and radial nerve injury. Reg Anesth Pain Med 1999;24:264–6.