Journal of Clinical Anesthesia (2010) **22**, 363–366

ELSEVIER

Journal of Clinical Anesthesia

Case report

Femoral and sciatic nerve block with 0.25% bupivacaine for surgical management of diabetic foot syndrome: an anesthetic technique for high-risk patients with diabetic nephropathy

Aysu Kocum MD (Staff Anesthesiologist)*, Ayda Turkoz MD (Associate Professor), Nesrin Bozdogan MD (Staff Anesthesiologist), Esra Caliskan MD (Assistant Professor), Evren H. Eker MD (Staff Anesthesiologist), Gulnaz Arslan MD (Professor)

Department of Anesthesiology and Reanimation, Baskent University Faculty of Medicine, Ankara 06530, Turkey

Received 23 September 2008; revised 20 April 2009; accepted 28 April 2009

Keywords:
Bupivacaine;
Diabetic foot;
Diabetic nephropathy;
Femoral nerve block,
sciatic nerve block

Abstract A case series of patients with diabetic nephropathy, who underwent lower limb debridement or amputation below the knee during successful combined sciatic and femoral nerve block with bupivacaine 0.25%, is presented. Because impaired nerve conduction in diabetes mellitus results in lower local anesthetic agent requirement, a dose-sparing, minimal effective concentration for surgical anesthesia for peripheral nerve blockade may be more favorable for patients with diabetes and chronic renal disease.

1. Introduction

Patients with longstanding diabetes mellitus are of special concern to the anesthesiologist, as they are most likely to have multiple-organ system failure. Subsequent diabetic damage becomes manifest in macroangiopathy as coronary heart disease, peripheral arterial occlusive disease, or cerebrovascular insufficiency; and in terms of microangiopathy, as nephropathy and neuropathy [1].

Diabetic foot syndrome often requires surgical management. Perioperative mortality among diabetic foot amputation may reach up to 5.8% [2]. It is controversial to perform peripheral nerve blockade in diabetic patients who have peripheral neuropathy [3]; peripheral nerve blocks provide better hemodynamic stability than neuroaxial blockade and general anesthesia [4-6].

Combined femoral and sciatic nerve blockade was previously described as an effective anesthetic technique for lower limb amputations below the knee. However, large volumes of anesthetic drug may be required during combined femoral and sciatic nerve blockade. This may result in a higher risk of systemic toxicity, especially in diabetic patients with chronic renal disease. Thus, a dose-sparing, minimal effective concentration for surgical anesthesia for peripheral nerve blockade may be more favorable for patients with diabetes and chronic renal disease.

A case series of high-risk patients with diabetic nephropathy, who had lower limb debridement or below-

* Corresponding author. Baskent University, Faculty of Medicine, Adana Teaching and Medical Research Center, 01110, Seyhan/Adana, Turkey. Tel.: +90 322 458 6868 1226; fax: +90 322 459-2622.
E-mail address: aysuinan@yahoo.com (A. Kocum).

0952-8180/$ – see front matter © 2010 Published by Elsevier Inc.
doi:10.1016/j.jclinane.2009.04.009

knee amputation with combined sciatic and femoral nerve block with bupivacaine 0.25%, is presented.

2. Case reports

Twelve ASA physical status III and IV patients, 45 to 84 years of age, with longstanding adult-onset diabetes mellitus and ≥ stage 3 renal disease (National Kidney Foundation Classification) [7] due to diabetic nephropathy, received combined sciatic and femoral nerve block. Fourteen operations in 12 patients were performed for diabetic foot syndrome [5 pts for debridement, 6 pts for amputation, and one pt who underwent three procedures for the same limb (debridement, amputation, and revision of amputation)].

One patient was receiving oral anti-diabetic treatment and all the others were taking insulin in the preoperative period. An insulin infusion adjusted to blood glucose levels was started on the morning of surgery in all patients. No patient received premedication. The usual doses of any medication for associated systemic disease were continued during the perioperative period. Patients receiving hemodialysis had preoperative dialysis within 24 hours of surgery, and those receiving peritoneal dialysis continued with their routine peritoneal dialysis program. Patient demographics and clinical and preoperative characteristics are shown in Table 1.

Electrocardiography, blood pressure, and oxygen saturation via pulse oximeter were monitored in the operating room. Oxygen was delivered by face mask. Ten patients received titrated doses of intravenous (IV) midazolam and/or fentanyl, and the other two patients were given dexmedetomidine for moderate sedation (arousable on command) for comfort before the block procedure and during the operation. Dexmedetomidine was administered via a 15-minute loading infusion with a dose of 0.4 - 1.0 μg/kg followed by a maintenance infusion of 0.1 - 0.4 μg/kg/hr. The sciatic-femoral nerve block was performed with a nerve stimulator and insulated 22-gauge needle (Stimuplex; B. Braun, Melsungen, Germany) of 100 mm for the sciatic nerve and 50 mm for the femoral nerve. A stimulation frequency of 2 Hz, with a duration of 0.1 μs and initial setting current of 1.5 mA, was employed. Patients were placed in the lateral decubitus position, with the operative side exposed. Sciatic nerve block was achieved using the posterior approach described by Labat [8]. Sciatic nerve block was confirmed by plantar flexion of the foot. Following negative aspiration for blood, 20 mL of 0.25% bupivacaine was injected for this site in 5 mL aliquots. Then the patient was placed supine and a femoral nerve block was achieved using the technique described by Winnie [8]. The femoral nerve was confirmed by a quadriceps contraction. Again, following negative aspiration for blood, 20 mL of 0.25% bupivacaine was injected in 5 mL aliquots for this site. Following successful nerve localization with either a 1.5 mA or 3.0 mA current, the needle was repositioned when necessary to reach muscle twitching by 0.5 mA current. In three sciatic nerve block procedures and in one femoral nerve block procedure, we could not achieve a 0.5 mA current.

Time to readiness for surgery was determined by assessing sensory and motor blockade every three minutes. Pinprick test was used to assess sensation. Motor block was tested by attempting to extend the affected leg while the hip was passively flexed and attempting plantar and dorsal flexion of the foot. Degree of pain during surgery was assessed by a 4-point verbal rating scale (VRS), in which 0 = no pain; 1 = mild or moderate pain; 2 = severe pain; and 3 = unbearable pain. Any patient who reported a VRS score > 1 received 0.5 - 1.0 μg/kg of supplemental fentanyl. Appropriate amounts of fluid for maintenance, replacement of deficit, and replacement of blood loss were all calculated and administered accordingly. Complete sensory blockade was achieved in all but three patients who showed incomplete motor blockade. Failure of complete motor

Table 1 Patients' demographic, clinical, and preoperative characteristics

Age (yrs)	58.5 ± 10.8
Weight (kg)	68.04 ± 12.64
Gender (female/male) (n)	5/7
ASA physical status (III/IV) (n)	5/7
Duration of diabetes mellitus (yrs)	16.5 ± 7.0
Glomerular filtration rate	
59-30 mL/min (n)	3
29-15 mL/min (n)	2
< 15 mL/min (hemodialysis/PD) (n)	7 (6/1)
Other co-morbidities:	
Hypertension (n)	10
Coronary artery disease	11
–previous MI (n)	4
–previous CABG or PTCA (n)	3
Heart failure(n)	5
–atrial fibrillation(n)	3
–pleural effusion(n)	2
Peripheral artery disease	6
Chronic liver disease(n)	3
Cerebrovascular accident (n)	4
COPD/Pneumonia (n)	2/1

Values are means ± SD or numbers (%).
PD = peritoneal dialysis, MI = myocardial infarction, CABG = coronary artery bypass graft surgery, PTCA = percutaneous transluminal coronary angioplasty, COPD = chronic obstructive pulmonary disease.

Table 2 Block procedure and intraoperative variables

Onset of sensory block (min)	11.0 ± 3.8
Onset of motor block (min)	16.0 ± 5.5
Total midazolam required (mg) [a]	1.4 ± 1.1
Total fentanyl required (μg) [a]	23.2 ± 24.9
Duration of operation (min)	40.7 ± 16.3
First analgesic requirement (hrs) [b]	16.1 ± 7.5

[a] During the block procedure and surgery.
[b] Interval between local anesthetic injection and the first request for postoperative analgesic for pain at the operative site.

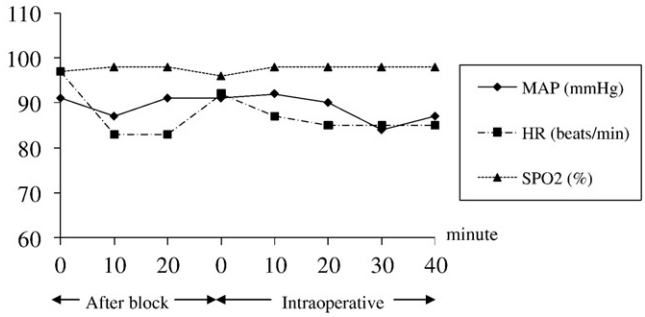

Fig. 1 Perioperative hemodynamic data. MAP = mean arterial pressure, HR = heart rate, $Sp0_2$ = arterial oxygen saturation via pulse oximeter.

blockade did not interfere with surgery. Tourniquet was applied to the thigh in 7 operations. Surgical data are given in Table 2. Hemodynamic data are shown in Fig. 1.

Surgery was uneventful in all patients. The blockade was considered incomplete in two patients who required 50 μg IV fentanyl supplementation during surgery. No patient required conversion to general anesthesia. Systolic blood pressure decreased below 90 mmHg in one patient who received dexmedetomidine.

Ephedrine 5 mg IV was administered for this patient. Two patients who did not require additional intraoperative analgesia needed intraoperative antihypertensive treatment. None of the subjects' mean arterial pressure values was lower than 60 mmHg, and the lowest heart rate recorded was 60 bpm. No patient experienced any symptoms or signs of local anesthetic toxicity, nerve injury, or hematoma secondary to the procedure. One patient with previous angina pectoris due to chest pain, and one patient with previous atrial fibrillation due to tachycardia were transferred to the intensive care unit postoperatively. No perioperative mortality was noted. The technique was regarded by all patients as satisfactory.

3. Discussion

This case series shows that a combined femoral and sciatic nerve block using 0.25% bupivacaine may be an adequate and safe anesthetic technique for surgery below the knee for diabetic foot syndrome. It provides intraoperative hemodynamic stability and an acceptable postoperative course for such patients with multiple co-morbidities.

Bupivacaine has been used at concentrations of 0.5% for lower extremity anesthesia by peripheral nerve blockade [6,9]. Combined femoral and sciatic nerve blockade using 0.375% bupivacaine provided adequate anesthesia for lower extremity vascular surgery with stable hemodynamic status in high-risk patients [10]. We obtained adequate surgical anesthesia in all of our study patients with 0.25% bupivacaine.

Impaired nerve conduction in diabetes mellitus results in lower local anesthetic agent requirement to produce anesthesia [11]. Underlying nerve dysfunction, in combination with diabetes-associated microangiopathy of peripheral blood vessels, provides the basis for the hypothesis that patients with diabetes have a reduced need for local anesthetic drugs. In addition, microvascular disease, resulting in impaired neural blood flow, may reduce the rate at which anesthetic distributes away from the site of administration [11]. These factors may contribute to the high success rate of the low dose of bupivacaine given to our patients.

Fibers in the diabetic nerve, thus, may be more susceptible to anesthetic toxicity because they are exposed longer to local anesthetic and are already stressed by chronic ischemic hypoxia. In an experimental study, Kalichman et al. tested the effects of increasing concentrations of local anesthetics on nerve fiber injury; more concentrated local anesthetic induced significantly more edema in diabetic nerves than in controls [11]. Uremic neuropathy is also associated with demyelinization of the axon cylinders [12]; thus, it might be expected that this complication would also render the nerves more vulnerable to local anesthetics.

Systemic local anesthetic toxicity is a special risk in patients with compromised renal function. Some authors have proposed reducing the dose of local anesthetic for peripheral nerve block in patients with renal failure [13]. Rice et al. [14] compared the plasma concentration of bupivacaine after brachial plexus blockade with 30 mL of 0.5% bupivacaine in patients with chronic renal failure and in patients with normal renal function. Their data indicate that these patients show similar pharmacokinetics to those of normal patients. However, Gould and Aldrete [13] reported cardiotoxicity in a patient with chronic renal failure who was given bupivacaine 250 mg for brachial plexus block. It is hoped that the 0.25% concentration of bupivacaine would avoid this complication.

Reports have shown the difficulty in performing a peripheral nerve block by using a nerve stimulator in patients with underlying neuropathy; the muscle twitches necessary to locate the nerve could not be induced as needed in these patients [15,16]. Our experience is also consistent with this finding. Ultrasonography allows direct visualization of peripheral nerves, which may result in identification of the exact localization of nerves, especially in patients in whom conventional nerve stimulation is problematic [16].

Combined sciatic and femoral nerve blocks with bupivacaine 0.25% may be considered an alternative anesthetic technique for high-risk patients with diabetic nephropathy who require lower limb debridement or amputation below the knee.

References

[1] Lichtenauer UD, Seissler J, Scherbaum WA. Diabetic complications. Micro and macroangiopathic end-organ damage. Internist 2003;44: 840-6.

[2] Reiber GE, Boyko EJ, Smith DG. Lower extremity foot ulcers and amputations in diabetes. In: Aubert R, editor. Diabetes in America. 2nd ed. Darby (PA): Diane Publishing Co.; 1995. p. 408-29.

[3] Horlocker TT, O'Driscoll SW, Dinapoli RP. Recurring brachial plexus neuropathy in a diabetic patient after shoulder surgery and continuous interscalene block. Anesth Analg 2000;91:688-90.
[4] Robertshaw HJ, Hall GM. Diabetes mellitus: anaesthetic management. Anaesthesia 2006;61:1187-90.
[5] McAnulty GR, Hall GM. Anaesthesia for the diabetic patient. Br J Anaesth 2003;90:428-9.
[6] Chia N, Low TC, Poon KH. Peripheral nerve blocks for lower limb surgery–a choice anaesthetic technique for patients with a recent myocardial infarction? Singapore Med J 2002;43:583-6.
[7] National Kidney Foundation. K/DOQI clinical practice guidelines for chronic kidney disease: evaluation, classification, and stratification. National Kidney Foundation. Am J Kidney Dis 2002;39(2 Suppl 1): S1-S266.
[8] Dilger JA. Lower extremity nerve blocks. Anesthesiol Clin North Am 2000;18:319-40.
[9] Fanelli G, Casati A, Beccaria P, et al. A double-blind comparison of ropivacaine, bupivacaine, and mepivacaine during sciatic and femoral nerve blockade. Anesth Analg 1998;87:597-600.
[10] Yazigi A, Madi-Gebara S, Haddad F, Hayeck G, Tabet G. Combined sciatic and femoral nerve blocks for infrainguinal arterial bypass surgery: a case series. J Cardiothorac Vasc Anesth 2005;19:220-1.
[11] Kalichman MW, Calcutt NA. Local anesthetic-induced conduction block and nerve fiber injury in streptozotocin-diabetic rats. Anesthesiology 1992;77:941-7.
[12] Bolton CF. Peripheral neuropathies associated with chronic renal failure. Can J Neurol Sci 1980;7:89-96.
[13] Gould DB, Aldrete JA. Bupivacaine cardiotoxicity in a patient with renal failure. Acta Anaesthesiol Scand 1983;27:18-21.
[14] Rice AS, Pither CE, Tucker GT. Plasma concentrations of bupivacaine after supraclavicular brachial plexus blockade in patients with chronic renal failure. Anaesthesia 1991;46:354-7.
[15] Lok C, Kirk P. Problems performing a sciatic nerve block in an amputee. Anaesthesia 2003;58:289-90.
[16] Sites BD, Gallagher J, Sparks M. Ultrasound-guided popliteal block demonstrates an atypical motor response to nerve stimulation in 2 patients with diabetes mellitus. Reg Anesth Pain Med 2003;28: 479-82.