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Postoperative sciatic and femoral or saphenous nerve blockade for lower extremity surgery in anesthetized adults

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ABSTRACT

Background: Guidelines warn of increased risks of injury when placing regional nerve blocks in the anesthetized adult but complications occurred in patients that received neither sedation nor local anesthetic. This restriction of nerve block administration places vulnerable categories of patients at risk of severe opioid induced side effects. Patient and operative technical factors can preclude use of preoperative regional anesthesia. The purpose of this study was to assess complications following sciatic popliteal and femoral or saphenous nerve blockade administered to anesthetized adult patients following foot and ankle surgery.

Materials and Methods: Postoperative patients administered general anesthesia received popliteal sciatic nerve blockade and either femoral or saphenous nerve blockade if operative procedures included medial incisions. Nerve blocks were placed with nerve stimulator or ultrasound guidance. A continuous nerve catheter was inserted if hospital admission was over 24 hours. Opioid analgesic supplementation was administered for inadequate pain relief. Postoperative pain scores and total analgesic requirements for 24 hours were recorded. Nerve block related complications were monitored for during the hospital admission and at follow up surgical clinic evaluation.

Results: 190 anesthetized adult patients were administered 357 nerve blocks. No major nerve injury or deficit was reported. One patient had numbness in the toes not ascribed to a specific nerve of the lower extremity. Perioperative opioid dose differences were noted between male and female and between opioid naïve and tolerant patients.

Key Words: Anesthesia complications, femoral nerve block, patient safety outcomes, regional anesthesia, sciatic nerve block

BACKGROUND

Major nerve blockade administered to adult patients under general anesthesia is a controversial practice style. Established conservative guidelines warn of increased risks of injury and the technique of placing regional nerve blocks in the anesthetized adult has been admonished in several reviews.[1,2] Critics of the prohibition of regional blockade for anesthetized adults consider it a counter-intuitive dictum because in the pediatric population it is the standard norm to follow this practice.[3] Paradoxically, regional blockade under general anesthesia has been successfully administered to patients with pre-existent severe comorbidities including neurologic, circulatory and metabolic disorders.[4-7] Neurologic injury and complications resulting from regional anesthesia techniques have been reported in patients that received neither sedation nor local anesthetic.[8,9] The restriction of major nerve blockade techniques to adults that are not anesthetized or sedated places the excluded categories of patients at greater risk

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of more common and severe opioid analgesic induced side effects.[10] Reduced mobility for positioning as a result of major trauma, arthritis, contractures or morbid obesity, traumatic brain injury, cognitive decline, stroke, developmental delay, movement disorders, severe anxiety and other psychiatric disorders are some of the categories in which benefit surpasses the risk for nerve blockade under general anesthesia. A long duration of complex surgery outlasting the local anesthetic duration of action, nerve block injection sites lying within the sterile operative field, and the use of tourniquets over catheter placement sites for patients with continuous nerve blockade are some of the technical factors that prevent use of preoperative regional anesthesia techniques.[11] Practitioner surveys and databases demonstrate that regional blockade under general anesthesia is more widely performed than previously reported in French and UK groups.[12,13]

The purpose of this study was to assess the incidence of injury and complications following sciatic popliteal and femoral or saphenous nerve blockade administered to adult patients under general anesthesia for foot and ankle surgery.

MATERIALS AND METHODS

After receiving institutional review board approval from the University of Washington Human Subjects Division, patients provided written informed consent prior to undergoing foot and ankle surgery and were enrolled for participation in this prospective study of the perioperative analgesic effects of popliteal sciatic and femoral or saphenous nerve blockade using either nerve stimulator or ultrasound guidance techniques administered under general anesthesia. All procedures were performed at Harborview Medical Center, Seattle. The preoperative data collected were age, gender, ASA physical status, height, weight, calculated body mass index (BMI), recent traumatic lower extremity injury, pre-existing nerve deficits or neuropathy and chronic pain syndromes affecting the operative lower extremity, worst pain score in the preceding 24 hour interval and maintenance preoperative 24 hour opioid dosage converted to mg of intravenous morphine sulfate (MS).

All patients received general inhalational endotracheal anesthesia with sevoflurane and intraoperative analgesia in the form of intravenous fentanyl, morphine and/or hydromorphone for their surgery. The dose of intraoperative opioid administered was recorded for each patient. Postoperative analgesia in those patients with inadequate pain relief following sciatic nerve blockade was administered as intravenous fentanyl, morphine and/or hydromorphone in bolus doses and oral oxycodone in the immediate postoperative period and as patient controlled analgesic infusions in the 24 hour period following surgery.

In order to quantify the opioids administered to patients in equivalent dosing units and to compare the opioid usage between patients as a result of the variety of analgesic narcotic medications administered peri-operatively due to both patient and prescribing practitioner preferences, all dosages were converted to equipotent values in mg of intravenous morphine sulphate (MS) using standardized opioid conversion formulae.

Postoperative popliteal sciatic nerve blockade (SNB) by the lateral approach at a point 10 cm proximal to the popliteal crease was performed in the post anesthesia care unit (PACU) by anesthesia resident physicians and nurse anesthetists supervised by regional anesthesia physician faculty with added expertise in ultrasound guided imaging. The level of training of the practitioner performing the SNB was recorded.

All patients were administered 25 ml 0.375% (93.7 mg) bupivacaine for the SNB using a Life-Tech ProBloc II 20 Gauge 100 mm 30 degree bevel needle. The procedure was performed in the first 18 months of the study with the use a Life-Tech Tracer III nerve stimulator (NS) and the bolus dose of local anesthetic was injected when toe plantar flexion was observed at a current of less than 0.6 mA and greater than 0.3 mA. In the second 18 month interval the procedure was performed with ultrasound (US) guidance using a SonoSite M Turbo with a linear 38 mm probe to locate the sciatic nerve in the short axis view proximal to its branch point. Using an in plane approach for needle visualization the local anesthetic was injected when the needle tip was observed to be within close proximity to the nerve.

Continuous SNB was administered to patients that sustained extensive foot and ankle surgery and were admitted over 24 hours for postoperative care. A 20 Ga 100 mm ProLong continuous nerve block needle was used to insert a 22 Ga nerve block catheter after injection of the local anesthetic bolus dose through the needle and its position was secured at a distance 3 cm beyond the needle tip. An infusion of 0.125% bupivacaine at 10 ml/hr (12.5 mg/hr) was administered through the sciatic nerve catheter and this infusion was titrated upwards in increments of 2 ml/hr to a maximum rate of 14 ml/hr (17.5 mg/hr) if the patient reported inadequate analgesia.

Patients that sustained incisions and surgical interventions that included the medial side of the lower extremity also received either a single bolus or continuous femoral nerve block (FNB). The same equipment employed for SNB under nerve stimulator guidance was used to

elicit quadriceps femoris or patellar tendon twitches at 0.3-0.6 mA intensity after the stimulating needle was inserted 2 cm lateral to the palpable femoral pulse in the inguinal region. FNB under ultrasound guidance used the same equipment listed for SNB and the technique employed short axis visualization during an in plane approach to place the needle in close proximity to the posterolateral aspect of the femoral artery in the inguinal region. After negative aspiration for blood a bolus dose of 12 mL 0.375% bupivacaine (45 mg) were injected. Using the same equipment and local anesthetic infusions for continuous SNB, a continuous femoral nerve block catheter was inserted 3 cm distal to the needle tip if the hospital admission was greater than 24 hours for extensive operative intervention on the medial side of the lower extremity.

As an alternative to FNB, a single bolus or continuous saphenous nerve blockade (SaphNB) was also used to provide analgesia when surgical procedures included the medial side of the lower extremity. SaphNB was performed under ultrasound guidance using the same equipment listed for SNB and the technique employed short axis visualization with an in plane approach to place the needle in close proximity to the saphenous nerve in the subsartorial space at a point 10 cm proximal and medial to the medial femoral condyle. After negative aspiration for blood a bolus dose of 12 mL 0.375% bupivacaine (45 mg) were injected. Using the same equipment and infusions for continuous SNB, a continuous saphenous nerve block catheter was inserted at a distance 3 cm beyond the needle tip if the hospital admission was greater than 24 hours for extensive operative intervention on the medial side of the lower extremity.

Intravenous patient controlled analgesia (PCA) using hydromorphone was prescribed to all patients for relief of breakthrough pain at a rate of 0.2 mg every 6 minutes with an escalation dose of 0.4 mg without a 6 hour maximum dose lockout restriction.

The patient maximum self-reported pain score, observation of voluntary toe plantar flexion, and the total postoperative opioid doses converted to mg of intravenous MS at the time of discharge from the post anesthesia care unit (PACU) and for the first 24 hour postoperative interval were recorded.

Patients were assessed and monitored for new onset of neurologic deficits or neuralgias in the operative lower extremity immediately postoperatively and upon termination and after regression of the effects of the regional nerve blockade upon the affected leg. Follow up evaluation for residual nerve deficit was performed at the patients' first postoperative visit to the surgical clinic or by telephone interview a week after hospital discharge.

RESULTS

Table 1 summarizes the patient demographics and postoperative analgesic interventions and pain scores at discharge from the post anesthesia recovery unit (PACU) and at 24 hours after nerve block administration. There were a combined total of 357 sciatic, femoral and saphenous nerve blocks administered to 190 patients. All patients maintained voluntary toe plantar flexion in the immediate and 24 hour postoperative observation intervals.

Table 2 is a summary of the significant postoperative neurologic and clinical changes recorded during the course of the patients' stay in hospital and at the time of either clinic or telephone follow up assessment.

Table 3 demonstrates the distribution of the number and type of nerve blocks administered categorized by

Table 1: Perioperative demographics for sciatic nerve blockade administered to anesthetized patients

Sciatic nerve block patients (190)	Female	Male
Patients	85 (44.7%)	105 (55.3%)
Age in years	53.7 (14.3)	51.8 (14.7)
BMI	28.8 (5.6)	29.7 (9.9)
ASA status	2	2 (1)
Diabetes	8 (9.4%)	11 (10.5%)
Pre-existing neuropathy	19 (22.4%)	24 (22.9%)
Preoperative pain score	6 (4)	5 (3)
Opioid tolerant	34 (40%)	40 (38.1%)
24 hour maintenance opioid dose	41 (60.2)	38.6 (58.9)
Intraoperative opioid dose	28.7 (18.7)	36.1 (18.2)*
Nerve Stimulator guided nerve blockade	30 (35.3%)	33 (31.4%)
Ultrasound guided nerve blockade	55 (64.7%)	72 (68.6%)
Postoperative femoral nerve block	22 (25.9%)	23 (21.9%)
Postoperative saphenous nerve block	55 (68.8%)	67 (63.8%)
PACU discharge pain score	2 (3)	2 (2)
Total PACU opioid dose	13.4 (15.7)	8.9 (14)*
24 hour postoperative pain score	4 (3)	4 (2)
24 hour cumulative opioid dose	99.1 (156.6)	83.5 (85.9)

Numbers in parentheses are standard deviations. *$P<0.05$ by paired *t*-test. ASA: American society of anesthesiology, BMI: Body mass index, PACU: Post anesthesia care unit

Table 2: Postoperative incidents in anesthetized patients administered sciatic nerve blockade

Sciatic nerve blocks (190)	Female (85)	Male (105)
New onset numbness		1
Tenderness at injection site	1	
Numbness at incision site	2	1
Respiratory depression	1	
Total (%)	4 (4.7%)	2 (1.9%)

Table 3: Level of regional anesthesia expertise for practitioners administering nerve blocks

Level of expertise	Number of patients	Sciatic nerve block	Femoral nerve block	Saphenous nerve block
First year trainee (intern)	7	7	3	4
Second year trainee	25	25	5	16
Third year trainee	21	21	5	8
Fourth year trainee	30	30	7	20
Regional anesthesia fellow	13	13	3	10
Nurse anesthetist	49	49	16	23
Regional anesthesia faculty	28	28	2	24

level of regional anesthesia expertise of the practitioner performing the procedures.

DISCUSSION

There were no cases of nerve injury or other major clinical event reported in this group of 190 patients that received 357 different nerve blocks. The intraoperative use of tourniquets to reduce blood loss was used in all operative procedures in this study and the pressure and duration of insufflation were recorded for all patients. No cases of lower extremity injury were reported as a result of tourniquet use.

The conversion from nerve stimulator guidance to ultrasound guidance for regional anesthesia occurred at the midpoint in the study. This change in procedural technique allowed the possibility to determine if the transition of technology improved patient outcomes and safety with respect to nerve blockade. The use of ultrasound guided nerve blocks made it possible to offer patients saphenous nerve blockade as an alternative to femoral nerve blockade. The advantages of saphenous nerve blockade were the absence of thigh musculature weakness and improved mobility in contrast to the femoral nerve block, and a lower risk of infectious complications.

The level of electrical current causing foot inversion or toe plantar flexion used during nerve stimulator guided SNB is less than 0.6 mA.[14] A stimulus response at a current level less than 0.3 mA increases the odds that the needle tip may be within the sciatic nerve or one of its branches and cause nerve injury.[15] In this study NS current levels accepted for effective NS guided SNB were greater than 0.3 mA and less than 0.6 mA.

The paraneural compartment visualized proximal to the sciatic nerve branch point during ultrasound guided SNB has been shown to be the location at which injection of local anesthetic is highly effective when compared to other sites and was selected as the point for universal needle localization in this study.[16] Conventional ultrasound technology allows localization of this plane and when compared to the subparaneural or intraepineural injection technique using high definition imaging processors the risk of nerve injury is lower.[17]

Meticulous documentation of pre-existing neurologic deficits related to neuropathy and other metabolic, traumatic, orthopedic and previous surgical causes is critical in the evaluation of any patient presenting with new onset symptoms potentially attributable to regional anesthesia related injury. Table 4 is a summary of the neurologic symptoms reported by patients prior to their surgery and nerve blockade.

Table 4: Neurological symptoms in patients presenting with neuropathy prior to sciatic nerve blockade

Symptoms	Female (19)	Male (24)
Peripheral neuropathy	4	5
Post-polio syndrome	2	1
Multiple sclerosis		1
Sciatica	1	1
Peroneal nerve injury	1	1
Numbness dorsum of foot	3	2
Numbness plantar region	1	4
Numbness of toes	4	3
Other neuropathies	3	6

In the postoperative follow up evaluation period one male patient without pre-existing neuropathy or other neurologic condition reported new onset numbness in the toes that did not follow the pattern of distribution of the sciatic nerve branches. The sciatic and femoral nerve blocks in this patient were administered by a first year trainee with nerve stimulator guidance. If this were attributable to regional anesthetic related nerve injury, then one would estimate the rate of such an event between 0.3% (1/357 nerve blocks) and 0.5% (1/190 patients).

Two female patients and one male patient reported persistent numbness in the areas surrounding the operative incision sites. There was no specific dermatome pattern of distribution of the areas of postoperative numbness in these patients that could be ascribed to injury of a specific branch of the sciatic, femoral or saphenous nerves. All three patients had the sciatic and femoral nerve blocks placed with nerve stimulator guidance by different levels of trainees.

One female patient developed erythema and tenderness at the sciatic nerve catheter insertion site that resolved upon removal of the device and one opioid naïve female sustained opioid induced respiratory depression in PACU that resolved with naloxone administration.

There was a significant gender difference between the total intraoperative and PACU opioid doses even though the PACU pain scores were comparable. Males were administered higher opioid doses intra-operatively and females required higher opioid doses post-operatively.

There were several significant findings observed in the perioperative pain scores and analgesic requirements of opioid tolerant (OT) compared to opioid naïve (ON) patients and these are summarized in Table 5. In summary, OT patients were of a younger age in years and had higher preoperative, PACU discharge and 24 hour pain scores as well as higher PACU and 24 hour opioid analgesic supplementation requirements. The challenges posed by achieving pain relief in opioid tolerant patients following surgery have been observed previously.[18] The gender difference in intraoperative opioid dosing was not observed between the OT groups or between OT and ON

Table 5: Perioperative demographics and postoperative pain scores and analgesic requirements for opioid naïve (ON) and opioid tolerant (OT) anesthetized patients administered sciatic nerve blockade

Sciatic nerve block patients (190)	Female ON	Female OT	Male ON	Male OT
Patients	51	34	62	43
Age in years	58.1 (14.2)	48.3 (13.1)^	54.2 (14.8)	48.4 (14.1)*
BMI	27.4 (5)	29.5 (8.3)	30.8 (11.9)	28.1 (5.8)
ASA status	2	2 (1)	2	2 (1)
Diabetes	4	4	7	4
Pre-existing neuropathy	9	10	11	13
Preoperative pain score	4 (4)	7 (3)^	4 (3)	6 (3)^
24 hour maintenance opioid dose		22.8 (23.4)		39.6 (59.3)
Intraoperative opioid dose	26.4 (13.5)	37.1 (23)^	33.1 (14.9)*	39.6 (59.3)
Nerve stimulator guided nerve blockade	17	13	23	10
Ultrasound guided nerve blockade	34	21	39	33
Postoperative femoral nerve block	14	8	17	6
Postoperative saphenous nerve block	31	24	36	32
PACU discharge pain score	2 (2)	4 (3)^	2 (2)	3 (3)*
Total PACU opioid dose	10.6 (12.1)	22.7 (20.3)^	7.3 (10.9)	11.3 (17.3)
24 hour postoperative pain score	4 (2)	5 (3)	3 (2)	5 (2)^
24 hour cumulative opioid dose	53.1 (51.7)	164.8 (184.7)^	50.8 (44)	130.5 (107.9)^

Numbers in parentheses are standard deviations. *$P<0.05$ by paired *t*-test. ^$P<0.01$ by paired *t*-test. ASA: American society of anesthesiology, BMI: Body mas index, PACU: Post anesthesia care unit

males but a significant difference was observed between ON females administered lower doses than ON males. Further evaluation may be warranted to determine if this is a clinically significant or a gender biased phenomenon.

Nerve injury related to regional anesthesia techniques are an infrequent occurrence and the number of anesthetized patients may not permit an accurate estimate of the risk of neurological complications but none were observed to be directly linked to nerve blockade in this study. Registries that monitor for this occurrence and periodic update of Cochrane based reviews will continue the debate over the controversial topic of nerve block administration for anesthetized adult patients.

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Conflicts of interest

There are no conflicts of interest.

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