The Feasibility and Complications of the Continuous Popliteal Nerve Block: A 1001-Case Survey

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Perineural catheters are increasingly used worldwide for the treatment of postoperative pain in orthopedics. Long-term complications associated with the placement of a perineural catheter remain largely unstudied. We investigated the efficacy and the acute and late complications associated with the continuous popliteal nerve block. One-thousand-one patients undergoing elective surgery of the ankle or foot and scheduled to have a continuous popliteal nerve block were prospectively evaluated. All patients received an initial bolus of 40 mL ropivacaine 0.5% through the catheter. A continuous infusion of ropivacaine 0.3% initiated 6 h after the initial bolus was administered for the first 24 h and then decreased to ropivacaine 0.2% until the end of the study period. The success rate and acute complications were recorded. The overall success rate was 97.5%. The highest success rate was associated with foot inversion. Acute complications consisted of paresthesias during nerve localization (0.5%), pain during local anesthetic application (0.8%), and blood aspiration (0.4%). No central nervous system toxicity or cardiotoxicity occurred. Late complications were checked at 10 days and 3 mo after surgery. These included two cases of inflammation at the puncture site. No infection or neuropathy was observed. The use of continuous popliteal nerve block for ankle or foot surgery is associated with frequent success and few acute and late complications.

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The recent renaissance of regional anesthesia is explained by improved control of postoperative pain (1), increased patient satisfaction (2), decreased postoperative nausea and vomiting (3), and the beneficial effect on early mobilization and rehabilitation (4). However, studies (5) have shown that outcome data are not substantially improved by single-shot block compared with general anesthesia. These results may explain the growing interest for the placement of perineural catheters (2–4). To date, large prospective studies evaluating long-term complications of each particular perineural catheter location are still limited. In this prospective study we assessed clinical efficacy and the occurrence of acute and late complications of the continuous popliteal nerve block using the modified anatomical posterior approach.

METHODS

After obtaining institutional approval (Gesundheitsdirektion des Kantons Zürich, Kantonale Ethik-Kommission) and patient informed consent, 1001 consecutive patients scheduled for elective ankle or foot surgery with a popliteal fossa anesthesia and continuous postoperative analgesia were prospectively included in this survey. All surgeries were performed by the same surgeon. Exclusion criteria were refusal of regional anesthesia by the patient, patients younger than 18 yr, neurological damage of the limb to be operated, pregnancy, known allergy to local anesthetic drugs, systemic infection or localized infection in the popliteal fossa, popliteal tumor, inability to assume the prone position, and thigh tourniquet inflation for surgical reasons. All patients received enoxaparin 40 mg subcutaneously the evening before surgery.

All patients were orally premedicated with midazolam 0.1 mg/kg (up to a maximum of 7.5 mg) 1 h before the start of regional anesthesia. After arrival in the preoperative anesthetic area, standard monitoring (electrocardiography, blood oxygen saturation, noninvasive arterial blood pressure measurement) and peripheral venous access were attained. The patient was positioned prone and the catheter placed according to the modified posterior anatomical approach (6). A pillow was placed under the ankle on the indicated site for forthcoming surgery to allow free movement of the foot during nerve stimulation. The patient was then asked to elevate the leg from the pillow by flexing the leg at the knee to facilitate the palpation of the muscular border of the popliteal fossa, i.e., the biceps femoris muscle laterally, the semitendinosus and semimembranosus muscles medially. The procedure commenced with the recognition of the biceps muscle

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tendon insertion at the level of the popliteal skin crease. The puncture point was located 0.5 cm below the apex of the popliteal fossa (i.e., the crossing point of the biceps femoris and the semitendinosus and semimenbranosus muscles) on the medial side of the biceps femoris.

All the blocks were performed under aseptic conditions according to a standardized procedure by experienced anesthesiologists (4 senior members of the staff). The operator wore a mask and a sterile gown. The skin was prepared with iodine solution (Betadine®, Mundipharma, Basel, Switzerland) and surrounded by drape around the site of puncture. The nerve stimulator (Stimuplex® HNS 11; B. Braun Melsungen AG, Melsungen, Germany) was connected to the 21-gauge short bevel stimulation needle (Stimuplex® HNS 21, B. Braun Melsungen AG). After local anesthetic skin infiltration, the needle was inserted with the bevel upward directed 70° cephalad until an appropriate muscle response was obtained (inversion or plantar flexion as first choice). The initial nerve stimulator settings were as follows: impulse current of 1.0 mA, impulse duration of 0.1 ms and stimulation frequency 2 Hz. The placement of the needle was judged to be adequate when the muscle response was still present by threshold intensity <0.4 mA and an impulse duration of a 0.1 ms. The cannula over needle technique (advancing the cannula over the needle to permit the placement of catheter through it) was used for catheter placement, with a plastic cannula (Polymedic®, Polyplex N 50-T, external diameter 20 gauge; Te me na, Bondy, France) and a catheter with stylet (Polymedic®, Polyplex N 50-T, external diameter 23 gauge). The catheter was advanced 2 cm cephalad past the tip of the cannula and subsequently subcutaneously tunneled for 4–5 cm and fixed to the skin with adhesive tape. For each patient, the distance between the knee skin crease and the apex of the popliteal fossa and the depth of the nerve were assessed. The intraoperative block was performed through the catheter with 40 mL ropivacaine 0.5% (200 mg). After application of the local anesthetic drug, the patient was positioned supine. When required for surgical purposes, a femoral nerve block was performed at the inguinal level with 10 mL of ropivacaine 0.5% using a nerve stimulator technique. All patients had a calf tourniquet inflated at 280 mm Hg for a maximum of 2 h.

The popliteal block was tested every 5 min for loss of cold perception and pinprick response in the distribution area of the tibial, deep peroneal, and superficial peroneal nerves. The block was considered completely successful when, within 30 min after the application of the local anesthetic, the patient had lost the perception of cold and pinprick stimuli in all 3 nerve distributions. Analgesic success was defined as adequate analgesia without supplemental opioids. In case of block failure (perception of cold and pinprick was not abolished in one or more of the 3 nerve distribution areas within 30 min after the drug application), a spinal anesthesia with hyperbaric bupivacaine 0.5% (13–15 mg) was performed. Discomfort or pain associated with the calf tourniquet was treated with target-controlled infusion remifentanil (target-controlled infusion pump, Graseby; SIMS Graseby Limited Watford, Herts, UK, implemented with the Minto Model for remifentanil) if necessary.

All patients received patient-controlled popliteal analgesia (basal rate 5 mL/h, bolus 4 mL, lock-out time 20 min) with ropivacaine 0.3% for the first 24 h, then reduced to 0.2%. Acute complications included: blood aspiration during puncture, hematoma at the site of puncture, paresthesias defined as unpleasant "electrical shock" feeling radiating towards the toes or pain defined as burning or pressure sensation during nerve localization, allergic reaction to the local anesthetic drug, systemic local anesthetic toxic reactions (signs and symptoms of central nervous system and/or cardiac toxicity). Late complications included signs of inflammation (redness, swelling and pain on pressure) or infection (occurrence of pus) at the site of catheter insertion and neuropathy. Neuropathy was defined as any sensory deficit, muscular weakness, or appearance of neuropathic pain (allodynia, hyperalgesia) in any of the 3 nerve distribution areas of tibial, deep peroneal, and superficial peroneal nerves, which persisted at least beyond 96 h after local anesthetic infusion was stopped.

All patients received oral paracetamol 1 g every 6 h and oral valdecoxib 40 mg once a day for the first 5 postoperative days (the first dose given the morning after surgery). Antibiotic prophylaxis was given to all patients (cefuroxim preoperatively 1×1.5 g and postoperatively 2×1.5 g at 8-h interval). Acute complications were recorded by the same anesthesiologist who performed the block. The catheter insertion site was checked once a day by the research nurse, who was not involved in the study, for local signs of inflammation or infection. All patients were interviewed independently at 10 days and 3 mo by one of the 4 members of the anesthesiology staff who performed the block and the surgeon for signs of delayed infection or the appearance of paresthesias, dysesthesias, sensory disorders, neuropathic pain motor weakness, or any other late complication (Appendix). Postoperative pain intensity was assessed by the research nurse not involved in the study in all patients at 8-h intervals by means of the visual analog scale, from 0–100, where 0 represented no pain and 100 was the worst possible pain intensity. A visual analog scale

Table 1. Demographic Data

Number of patients	1001
Male/Female	307/694
Age (yr)	49 (20–79)
Height (cm)	167 (152–193)
Weight (kg)	64 (44–125)

Values are expressed as number or median (range).

Table 2. Surgical Procedures

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Ankle fracture osteosynthesis*	49*
Triple arthrodesis*	34*
Subtalar arthrodesis*	21*
Achilles tendon repair/augmentation	57
Gastrocnemius release	21
Total ankle replacement*	29*
Hallux valgus surgery	253
Hammertoes surgery	71
Tibial posterior tendon reconstruction*	49*
Calcaneus osteosynthesis*	62*
Metatarsal osteotomy I-V	121
MP-I arthrodesis	105
Lisfranc arthrodesis	50
Ankle ligament reconstruction*	46*
Tendon transfer	33

*Patients in which the popliteal catheter was completed with a femoral block.

score below 30 was considered as acceptable and a score over 30 was unacceptable and those patients received supplementary analgesics (sc morphine 0.1 mg/kg). Patients were asked at the same time for presence of paresthesias (pins and needles) in the foot or in the leg, motor blockade (inability to move the toes) and for some pain not directly linked to the surgical wound. The popliteal catheter was removed if it was no longer required for analgesia, if analgesia could not be satisfactorily achieved, or if there was any sign of inflammation or infection at the puncture site. No bleeding complications were observed.

Descriptive statistics were used for other data. Results are presented as median and range unless otherwise specified. Categorical data were compared by using the χ^2 test. $P < 0.05$ was considered significant.

RESULTS

A total of 1001 patients were included during a 28-mo period (Table 1). They have all been successfully followed-up for long-term assessment. The popliteal catheter was supplemented with a femoral block for surgical purposes in 290 patients (Table 2). The median duration of the catheter was 48 h (range, 30–192 h). The analgesic success rate was 97.5%. After obtaining a foot inversion response in 949 cases, 21 block failures occurred (2%). Among the 52 plantar flexions that were obtained, 5 block failures occurred (5%) ($P < 0.05$) (Table 3). In 16 cases partial tibial nerve anesthesia was noted. Insufficient blockade of the superficial and deep peroneal block occurred in 2 and 8 patients, respectively. For 97% of the patients, one puncture attempt was sufficient to obtain inversion or plantar flexion. A second puncture site (more lateral) was necessary in 3%. No catheter had to be removed because of inadequate postoperative analgesia. Acute complications were observed in 17 patients (1.7%): 5 (0.5%) reported transient paresthesias during nerve localization, which resolved immediately after needle repositioning; 8 (0.8%) noted painful sensations during application of local anesthetic, which resolved after slight withdrawal of the catheter. In 4 patients (0.4%), blood was aspirated through the needle. In these patients, the needle was withdrawn, the puncture point compressed until bleeding stopped, and the block was successfully performed. No central nervous system or cardiac toxicity occurred. No early (3 days) or late (3 mo) paresthesias, sensorimotor deficit, or unusual pain (not related to the surgical wound) was noted. Two catheter dislocations (0.2%) occurred. Late complication consisted of 2 occurrences of inflammation at the puncture site (0.2%). Bacteriological culture was positive for *Staphylococcus epidermidis* in one and *S. aureus* in the second. Neither infection nor neuropathy was noted in any patient.

The median depth of the nerve was 4.3 cm with a range from 2.0 to 7.0 cm, and the median knee skin crease to apex distance was 9.0 with a range from 7.0 to 13.0 cm. Difficulty in threading the catheter or any other technical problem was not encountered.

The tourniquet tolerance in those who had no saphenous block was good in 95% of patients. The remaining 5% required 1 to 2.4 ng/mL remifentanil concentration at the effect site during surgery because of pain/discomfort localized at the calf tourniquet site. For the other patients no supplementary analgesics or sedatives were needed. Among all patients the duration of tourniquet application was 85 ± 21 min.

Supplementary morphine was needed postoperatively in 86% (250 of 290) of the patients who received a single-injection femoral block. For these patients, morphine consumption was 20 ± 5, 28 ± 4, and 16 ± 6 mg for the first, second, and third postoperative days, respectively. No supplementary analgesics were required by other patients (711 of 1001) whose surgery did not involve the territory of the saphenous nerve and who had a successful perioperative popliteal catheter.

DISCUSSION

This prospective study demonstrated that the placement of a popliteal catheter is associated with few acute and late complications and frequent success.

Table 3. Success and Failure According to Muscle Response During Performance of the Popliteal Block

	Total	Success	Failure	TN failure	DP failure	SP failure
Inversion	949 (95)	928 (98)	21* (2.2)	12 (1.3)	7 (0.7)	2 (0.2)
Plantar flexion	52 (5)	47 (90)	5 (10)	4 (8)	1 (2)	0
Total	1001 (100)	975 (97.5)	26 (2.5)			

Values are expressed as number (%).

TN = tibial nerve; DP = deep peroneal; SP = superficial peroneal.

* $P < 0.05$.

The infrequent incidence of inflammation and infection at the puncture site observed in this trial is in accordance with those found in a previous study (6) using the same approach for performing popliteal block and catheter placement and in a multicenter study performed by Capdevila et al. (7). Interestingly, severe infectious complications have still not been reported after popliteal block with or without a catheter. However, they have been reported after continuous femoral block (8), continuous and single-shot axillary block (9,10), or continuous interscalene block (11,12). Cuvillon et al. (13) found, after continuous infusion of ropivacaine or bupivacaine for 48 h through a femoral catheter, a 57% catheter colonization rate and 1.5% incidence of bacteremia. Catheter duration has been implicated as a risk factor for catheter inflammation and infection (14). In the present study, inflammation occurred after 4 or 8 days respectively. *S. epidermidis* and *S. aureus* have each been identified once. This is consistent with published results (11,13).

In this study no occurrence of neuropathy was observed. This is in accordance with the results reported by Capdevila et al. (7). The incidence of neurologic complications after continuous perineural block is still not well established. Borgeat et al. (11,12) observed the occurrence of postoperative neurologic deficit in 0.2% and 0.4% after 700 and 234 continuous interscalene catheters, respectively. Capdevila et al. (7), dealing with popliteal block, and Cuvillon et al. (13) each found a 0.4% incidence of nerve damage after 683 and 211 femoral catheters, respectively. Other sources observed an incidence of 0.9% (1 patient) of neurologic deficit after continuous femoral block for hip arthroplasty (15). Bergman et al. (9), in a retrospective study involving 405 axillary catheters, cited 4 cases (1%) of nerve damage.

Acute complications during placement (paresthesias) and performance (pain) of the popliteal catheter were rare and transient. Their incidence and severity were comparable to those observed in a previous study (6).

The frequent success of continuous popliteal nerve block (97.5%) may be linked to its placement at the top of the popliteal fossa, increasing the chances to block the sciatic nerve before it divides into its tibial and peroneal components (16,17). Inversion was associated with a 98% success rate, which is in accordance with the results reported by Benzon et al. (18), showing this response to be associated with the most frequent success. The results of this study may be criticized because the blocks were performed exclusively by 4 experienced consultant anesthesiologists. The frequent success rate may also have been influenced by the large volume of cases in our department (10–15 popliteal catheters per week). Another limitation of this study is that acute complications were assessed by the same anesthesiologist who performed the block. However, this bias does not involve success rate, which is mainly dependent on the possibility to perform surgery. The fact that late complications were recorded independently by one of the anesthesiologists involved in the study and the surgeon, who was not directly involved in the study, minimizes the possibility of observational bias.

Catheter insertion no more than 2 cm past the tip of the needle and subsequent subcutaneous tunneling through an 18-gauge IV cannula and fixation with adhesive tape may decrease the rate of postoperative technical problems, as encountered in this investigation. We had 2 catheter dislocations in contrast with the 6.7% (2 in 30 patients) catheter displacements reported by di Benedetto et al. (19). In this study no subcutaneous tunneling was performed.

We observed in a previous pilot study that blockade of the saphenous nerve was rarely necessary to avoid pain from the calf tourniquet. The present study determined that the tolerance of the calf tourniquet was good for 95% of the patients not having a saphenous block. The discomfort of the remaining 5% was easily controlled by a relatively small concentration of remifentanil at the effect site. This suggests that the saphenous nerve territory does not play a major role in pain associated with the calf tourniquet. However, further studies focusing on this question are required.

The use of a perineural catheter is growing worldwide and is becoming considered as the "gold standard" for the control of postoperative pain in orthopedics. The long-term complications, infection and neuropathy, are key issues for the success of these techniques and are major concerns for the surgeon. Very few large prospective studies have considered these issues. In this context this trial shows that the continuous popliteal nerve block is effective and safe. Compared with other sites, popliteal block with or without a catheter first has clean anatomical surroundings and, second, at this site the sciatic nerve is relatively quite far from the surgical location and is not submitted to surgical stress. These specific elements for the popliteal block may contribute to the few late severe complications encountered in this investigation.

APPENDIX

Questionnaire Used 3 Months After Surgery

1. Do you have unusual sensation in your foot?
2. Do you feel "pins and needles" sensations in your foot?
3. Do you feel electricity in your foot?
4. Do you feel burning pain in your foot?
5. Do you feel pain when you touch your foot/when you wear socks?
6. Is your skin sensitivity decreased/changed compared to preoperatively?
7. Is your muscle strength decreased when flexing the big toe upwards?
8. Is your muscle strength decreased when flexing the big toe downwards?

9. Did the pain increase/decrease/change during the last couple of days?

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