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Displacement of popliteal sciatic nerve catheters after major foot and ankle surgery: a randomized controlled double-blinded magnetic resonance imaging study†

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Abstract

Background: Popliteal sciatic nerve catheters (PSNCs) are associated with a high frequency of displacement. We aimed to estimate the frequency of catheter displacement after 48 h with magnetic resonance imaging (MRI) in patients with PSNCs after major foot and ankle surgery randomized to catheter insertion either with a short-axis in-plane (SAX-IP) approach perpendicular to the nerve or with a short-axis out-of-plane (SAX-OOP) approach parallel to the nerve.

Methods: Forty patients were randomly allocated to SAX-IP or SAX-OOP PSNC. Ropivacaine 0.75% 20 ml was injected via the catheter followed by ropivacaine 0.2% 10 ml h^{-1} infusion. Correct primary catheter placement was ensured after initial injection of local anaesthetic via the catheter. Forty-eight hours after insertion, MRI was performed after injection of saline with added contrast (Dotarem) via the catheter. The primary outcome was catheter displacement estimated as the frequency of spread of contrast exclusively outside the paraneurium.

Results: All patients had correct primary catheter placement. The frequency of displacement 48 h after insertion of the PSNC was 40% when inserted perpendicular to the nerve *vs* 10% parallel to the nerve (difference was 30 percentage points, 95% CI: 3–53 percentage points). The relative risk of displacement was four times larger (95% CI: 0.8–10, $P<0.028$) in the SAX-IP *vs* the SAX-OOP group. The morphine consumption was 150% greater in the SAX-IP compared with the SAX-OOP group.

Conclusion: Popliteal sciatic nerve catheters for major foot and ankle surgery inserted with ultrasound guidance parallel to the sciatic nerve have a significantly lower frequency of displacement compared with those inserted perpendicular to the nerve.

Clinical trial registration: NCT02200016.

Key words: anaesthesia, local; ankle; magnetic resonance imaging; pain; postoperative; sciatic nerve

† The study was performed at the Department of Anaesthesiology, Aarhus University Hospital, Aarhus, Denmark.

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Editor's key points

- Technical problems with popliteal sciatic nerve catheter (PSNC) placement can impact on postoperative analgesia.
- The optimal approach to siting PSNCs is unclear. Catheter position can be assessed with magnetic resonance imaging.
- Patients were randomly assigned to either a perpendicular or parallel ultrasound-guided approach for PSNC placement.
- Magnetic resonance imaging assessment found that PSNC displacement was less likely if inserted using a parallel approach.

Popliteal sciatic nerve catheters (PSNCs) are widely applied to alleviate postoperative pain after major foot and ankle surgery.[1–6] Peripheral nerve catheter displacement seems to be a large and underestimated problem.[7] However, to our knowledge, the frequency of PSNC displacement has never been explicitly studied by direct viewing.

A PSNC can be placed either parallel or perpendicular to the sciatic nerve (SN).[8–10] Using ultrasound guidance, the plane of the ultrasound beam can intersect and display the sciatic nerve in either long- or short-axis view (LAX or SAX) with simultaneous in- or out-of-plane (IP or OOP) needle guidance.[8–10] Previous reports indicate that the frequency of PSNC displacement is low with SAX-OOP and high with SAX-IP.[8 10 11]

A wrong position of a peripheral nerve catheter can be a result of misplacement during catheter insertion or subsequent displacement. Displacement has mostly been evaluated by unreliable proxy markers, such as pain, sensibility, opioid consumption, or patient satisfaction.[6 8 10] A few trials have systematically evaluated catheter tip position ultrasonographically after a predefined and relevant time interval.[7 9 12] Ultrasound is unreliable for evaluation of subparaneural catheter tip position after hours of infusion, with oedema and overlying dressings. Magnetic resonance imaging (MRI) is not limited by these impediments.

The objective of this blinded, randomized, controlled, prospective trial was to use MRI to determine whether the SAX-OOP technique would reduce the frequency of PSNC displacement 48 h after catheter placement compared with the SAX-IP technique.

Methods

Ethics

The study was approved by the Danish Health and Medicines Authority (EudraCT no. 2014-000707-28), the Central Denmark Region Committee on Biomedical Research Ethics (1-10-72-137-14), and the Danish Data Protection Agency (1-16-02-476-14) and monitored by the Good Clinical Practice Unit at Aalborg and Aarhus University Hospitals. Written informed consent was obtained from all patients. The study was registered at ClinicalTrials.gov (NCT02200016) and complied with the 2010 CONSORT checklist and the Helsinki II declaration.

Patient population

Patients were recruited at Aarhus University Hospital, Denmark from November 2014 to April 2015. Eligibility criteria for the study were age >18 yr, ASA I–III, and undergoing major foot and ankle surgery procedures. Patients were excluded if they were allergic to local anaesthetics, unable to cooperate, undergoing immunosuppressive treatment, pregnant, had peripheral neuropathy involving their lower limbs, had a daily intake of opioids, or if they did not meet the MRI safety criteria (implanted metal, claustrophobia, or an abdominal diameter >140 cm).

Randomization and blinding

Patients were randomly allocated to two parallel groups: ultrasound-guided PSNC insertion either parallel to the SN (SAX-OOP group) or perpendicular to the SN (SAX-IP group). Both catheters were inserted deep to the paraneural sheath of the SN. The random allocation sequence was manually generated using a one-to-one allocation ratio. A random number table and sealed opaque envelopes were consecutively numbered 1–40 by two independent assistants not involved in other parts of the study. All investigators, the staff, and the patients were blinded to group allocation except for the single anaesthetist who inserted the catheters.

Anaesthesia and monitoring

On the day of surgery, a peripheral 18-gauge i.v. catheter was inserted into a superficial dorsal hand vein, and an infusion of isotonic saline was established. Acetaminophen 1000 mg was administered orally to all patients 1–2 h before surgery.

Patients were subjected to standard monitoring that consisted of continuous ECG, non-invasive blood pressure measurement, and pulse oximetry. All patients had general anaesthesia with laryngeal mask or tracheal intubation and total i.v. anaesthesia with propofol and remifentanil.

Before awakening, fentanyl 100 μg was administered i.v. Patients were transferred to the postanaesthesia care unit (PACU) for observation and immediate PSNC placement.

Surgery

The major foot and ankle surgical procedures were performed by four foot and ankle specialist surgeons. The procedures were total ankle alloplasty, calcaneal osteotomy, and triple and subtalar arthrodesis. A thigh tourniquet was used in all patients. At the end of surgery, a circular plaster cast was applied from the toes to the proximal part of the lower leg, allowing catheter placement in the popliteal fossa in the PACU.

Study interventions

An experienced anaesthetist (T.F.B.) inserted all popliteal sciatic catheters in the PACU after surgery. Placement of the PSNC was performed with the patients in the lateral decubitus position and extended lower limb. The area of catheter insertion was swabbed with chlorhexidine 2% in isopropyl alcohol 70% and draped with a sterile fenestrated sheet. The transducer was draped with a sterile cover (Transducer cover and gel from B. Braun Nerve Block Support Tray Kit, Melsungen AG, Germany). The skin and subcutaneous tissue were infiltrated with lidocaine 2% 2 ml before catheter needle insertion. The catheter insertions and nerve blocks were performed under ultrasound guidance (FlexFocus 700; BK Medical, DK-2730 Herlev, Denmark) with a 50 mm linear array transducer (15–6 MHz, HFL 50) and a hydrodissection technique. Closed tip catheters with three pairs of lateral microholes were introduced through an 80 mm Tuohy needle (Contiplex S; B. Braun, Melsungen AG, Germany). The catheter tip was typically inserted ~5 cm past the needle tip. Often, the catheter tip escaped outside the paraneural sheath through fenestrations, and the catheter tip position had to be adjusted by ultrasound-guided retraction of the catheter until appropriate