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Comparative evaluation of the visibility and block characteristics of a stimulating needle and catheter *vs* an echogenic needle and catheter for sciatic nerve block with a low-frequency ultrasound probe

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Abstract

Background. Clear visibility of the needle and catheter tip is desirable to perform safe and successful ultrasound-guided peripheral nerve blocks. This can be challenging with deeper blocks in obese patients. This study compared the visibility of echogenic and non-echogenic block needles and catheters in proximal sciatic blocks when performed with a low-frequency curved probe.

Methods. Seventy-eight patients undergoing total knee joint arthroplasty were randomized to receive an ultrasound-guided continuous sciatic nerve block using either a non-echogenic needle and stimulating catheter or an echogenic needle and echogenic non-stimulating catheter. Block needles in both groups were placed using both neurostimulation and ultrasound guidance, after which the catheter was positioned using either neurostimulation alone (Stimulating group) or imaging alone (Echogenic group). Three anaesthetists blinded to group allocation graded video clips recorded during the blocks for nerve, needle and catheter visibility. Performance characteristics and block parameters were also compared.

Results. No significant differences between the two groups were observed with regard to needle or catheter visibility ($P=0.516$). The Stimulating group required more needle redirections ($P=0.009$), had a longer procedure time [Echogenic median 274 s *vs* Stimulating 344 s ($P=0.016$)], and resulted in greater patient discomfort ($P=0.012$). There were no significant differences between the two groups in terms of block onset or completion time.

Conclusions. Use of echogenic needles and catheters reduced procedure time and patient discomfort compared with a stimulating catheter system. There were no differences in the visibility scores of the two systems.

Clinical trial registrastration. CTR Protocol ID: R-11-495, Clinical Trials.Gov ID: NCT 01492660.

Key words: acute pain; equipment, needles; equipment, ultrasound machines; regional anaesthesia; regional techniques

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Editor's key points

- The use of ultrasound for peripheral nerve blocks may increase success rate and speed.
- This randomized controlled trial compared the performance of echogenic with non-echogenic block needles.
- Echogenic needle and catheter systems were faster than stimulating systems, with less patient discomfort.
- Further study is needed to establish the role of the echogenic systems in regional anaesthesia.

Awareness of the precise location of the needle and catheter tip is desirable for performing safe and successful peripheral nerve blocks. Current techniques used to determine the needle and catheter tip location include use of electrical nerve stimulation and ultrasonography; each technique has its own benefits and drawbacks. With ultrasonography, failure to see the needle tip is the commonest error, which continues to be a problem even after experience of performing >100 blocks.[1] Use of ultrasound (US) can be particularly challenging with deep blocks because the angle of needle insertion is steep, which has been shown to markedly degrade visibility of the tip and the shaft.[2 3] Echogenic needles and catheters are of similar design to the existing peripheral nerve block needles but have the potential advantage of improved visibility during US imaging.

In comparison with neurostimulation, ultrasonography has been shown to reduce procedural time and improve success rates in some studies and not to worsen them in others.[4–6] Use of stimulating catheters has been shown to improve block success rates compared with use of non-stimulating catheters,[7] but this was without the use of US. When purely US-guided needle and continuous catheter placement has been compared with purely nerve stimulator-guided needle and catheter placement, reductions in procedure time with similar or improved block success rates have been shown.[8–10] Commonly available block catheters are often not clearly seen by US, and echogenic catheters have the potential for improved visibility. Whether the technological improvement with needle and catheter visibility makes a difference to success of peripheral nerve blocks has not been extensively investigated. Damage to nerves and surrounding structures is a significant clinical concern with deep blocks, such as proximal sciatic blocks, where there can be difficulty in needle visualization because of anatomical considerations and acute angles of insonation. Electrical nerve stimulation can be unreliable, leading to unnecessary needle movements during the process of attaining the desired muscle twitch end points.[11 12]

One study has documented better needle visibility with echogenic needles compared with non-echogenic needles for femoral and sciatic nerve blocks.[2] That study used only linear mid- to high-frequency transducers (>5 MHz). Visualization of deeper structures requires the use of a low-frequency probe. There are no studies that have compared echogenic catheters with stimulating catheters with regard to catheter visibility, safety, and success rate of blocks. We wanted to compare the visibility of echogenic needles and echogenic catheters (Sonolong, Pajunk® GmBH, Geisingen, Germany) with non-echogenic needles and stimulating catheters (Stimulong NanoLine Plexus catheter set; Pajunk®) with regard to visibility, safety, and efficacy when used for proximal sciatic nerve blocks with a low-frequency (2–5 MHz) curved probe. The primary outcome of our study was the visibility of the needle on initial contact with the nerve. Secondary outcomes were block performance characteristics and catheter visibility.

Methods

After local Institutional review board approval (HSREB 17757) and registration with ClinicalTrials.Gov (NCT 01492660), patients of ages 18–80 yr with ASA ratings I–IV and undergoing unilateral total knee joint arthroplasty were reviewed before surgery to assess suitability to receive continuous peripheral nerve block for postoperative analgesia. Exclusion criteria included contraindications to regional anaesthesia (local infection, coagulopathy), allergy to study medications, diabetic neuropathy, pre-existing nerve injury, and pregnancy.

Randomization and allocation concealment were achieved by means of placing group assignment labels into envelopes, which were then sealed and thoroughly shuffled before being sequentially numbered. Allocation was to either the control ('Stimulating') group or the intervention ('Echogenic') group (CONSORT diagram; Fig. 1). Participants and evaluators of the visibility of needles and catheters were blinded to group allocation. Participants randomized to the stimulating group had the sciatic nerve blocks performed with a Pajunk stimulating needle and stimulating catheter (Stimulong NanoLine Plexus catheter set; Pajunk®). Those randomized to the echogenic group had the sciatic block performed using a Pajunk stimulating echogenic needle and non-stimulating echogenic catheter (Sonolong; Pajunk®). Procedures were performed in a block room using standard monitors, including non-invasive blood pressure and pulse oximetry. All patients received supplemental oxygen and titrated conscious sedation with fentanyl and midazolam. All participants initially received a continuous femoral nerve block using US guidance (Sonosite M Turbo, Bothell, WA, USA) and a stimulating catheter (Arrow; Teleflex Medical, Research Triangle Park, NC, USA) whilst in the supine position. After siting of the femoral catheter, patients were moved to the lateral decubitus position with the operative side uppermost for the proximal sciatic nerve block. In both groups, a pre-procedural scan was performed using a 2–5 MHz curved array probe placed at the level of the greater trochanter, and the US view was adjusted until the ischial tuberosity could also be seen, with the sciatic nerve lying deep to the subgluteal fascia and superficial to the quadratus femoris muscle (Fig. 2). The point of needle entry was marked adjacent to the lateral aspect of the probe. The skin was prepared with chlorhexidine 2% in alcohol 70%. The US probe was covered using a sterile probe cover and positioned to obtain the best possible image of the sciatic nerve in short axis. The 18 gauge block needle was inserted in a lateral-to-medial direction in plane with the ultrasound beam. The needle position was confirmed using neurostimulation by obtaining an appropriate twitch in the sciatic distribution (plantarflexion, dorsiflexion, eversion, or inversion of the foot) at a current intensity between 0.2 and 0.6 mA. The needle position was also confirmed with hydrolocation by injection of dextrose 5% (1–2 ml) through the needle. After this, the catheter was advanced through the needle. The catheters in the Echogenic group were positioned under US guidance alone, whereas the catheters in the Stimulating group were guided into position solely by maintenance of muscle twitches during catheter advancement. In the Echogenic group, the catheter was inserted by a second anaesthetist using US guidance alone to a maximal distance of 4 cm beyond the tip of the needle. A colour Doppler interrogation was performed by injecting agitated dextrose 5% (2–5 ml) to assess the catheter tip location in both groups (Fig. 3). Once the catheter was deemed appropriately