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Ultrasound compared with nerve stimulation guidance for peripheral nerve catheter placement: a meta-analysis of randomized controlled trials

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Editor's key points

- An area of topical discussion is the role of ultrasound (US) in regional block.
- This systematic review and meta-analysis used Cochrane methodology to explore for possible differences between regional techniques.
- There was little difference between US-guided regional blocks and nerve stimulator-placed blocks.
- Further work is needed to clarify what a 'successful' block is before doing larger scale studies.

Background. The aim of this meta-analysis was to compare the efficacy and safety of ultrasound (US) *vs* nerve stimulation (NS) guidance for peripheral nerve catheter placement.

Methods. This meta-analysis was performed according to the PRISMA statement and the recommendations of the Cochrane Collaboration. For dichotomous outcomes relative risks [RRs; 95% confidence intervals (CIs)] were calculated, while for continuous outcomes, mean differences (MDs; 95% CI) were calculated. All statistical analyses were performed using the Revman® statistical software (Version 5.1).

Results. Fifteen randomized controlled trials including 977 patients satisfied the inclusion criteria. Peripheral nerve catheters placed under US guidance showed a higher RR of 1.14 (95% CI: 1.02–1.27; $P=0.02$) for an overall successful block in comparison with NS. However, postoperative pain scales at movement (numeric rating scale: 0–10) were comparable between US- *vs* NS-guided peripheral nerve catheters 24 (MD: 0.08; 95% CI: −0.77 to 0.94; $P=0.85$) and 48 (MD: 1.0; 95% CI: −0.3 to 2.3; $P=0.13$) h after surgery. Patients receiving a US-guided peripheral nerve catheter had a lower RR of 0.13 (95% CI: 0.04–0.38; $P=0.0002$) for an accidental vascular puncture.

Conclusions. There is evidence that US-guided peripheral nerve catheters show a higher success rate and a lower risk for an accidental vascular puncture compared with NS guidance. However, this difference resulted only in marginally lower postoperative pain scores at rest. Nevertheless, these results were influenced by heterogeneity and should be interpreted with caution.

Keywords: acute pain, regional techniques; anaesthetic techniques, regional; regional anaesthesia

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The perioperative use of ultrasound (US) as the primary guiding technique for regional anaesthesia has significantly increased during the past two decades and might have replaced the former 'gold standard' nerve stimulation (NS).[1 2] Two recent meta-analyses demonstrated numerous advantages of US-guided peripheral nerve blocks in comparison with NS, including higher success rates, lower need of local anaesthetics, reduced performance, and onset time and also reduced complication rates.[3–8] However, as mentioned in a recent editorial by Ilfeld and colleagues,[9] data focusing specifically on US- compared with NS-guided peripheral nerve catheter placement are currently lacking in the literature.

Therefore, the aim of the present meta-analysis was to compare the success rates, performance times, postoperative pain outcomes, and rates of neurological complications of US- *vs* NS-guided peripheral nerve catheters for postoperative pain therapy.

Methods

This systematic review of randomized controlled trials was performed according to the criteria of the PRISMA statement[10] and the current recommendations of the Cochrane Collaboration.

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Search strategy and study selection

A systematic search of the databases MEDLINE, CENTRAL, and EMBASE was performed by two authors (A.S./C.H.M.-F.) using free text words ('regional anaesthesia' or 'peripheral nerve catheter' or 'continuous nerve block' or 'electrical stimulation' or 'nerve stimulation' or 'ultrasound') combined with MeSH terms (peripheral nerve and ultrasonography) but limited to randomized controlled trials. There were no restrictions regarding publication language or publication year. The last search was in June 2012. Two reviewers (A.S./C.H.M.-F.) primarily reviewed titles and abstracts in order to exclude irrelevant studies. Any controversy at any stage was discussed with a third author (P.K.Z.).

Inclusion criteria

We included all randomized controlled trials comparing the efficacy and safety of US *vs* NS guidance for peripheral nerve catheter placement. Additionally, we included all trials investigating a combination of both techniques *vs* one guiding technique alone (e.g. US combined with NS *vs* NS or US combined with NS *vs* US). All data irrespective of type of surgery (upper, lower extremity surgery) or utilized local anaesthetics were analysed.

Data extraction and quality assessment

All relevant data were extracted from the original text or extrapolated from figures and tables by two authors (A.S./C.H.M.-F.) and entered on Excel sheets (Microsoft®, Redmond, WA, USA), which were specifically modified for this meta-analysis. Apart from the outcome parameters (see below), we extracted the type of surgery, the needle guidance technique used in the US group ('in plane' *vs* 'out of plane'), the use of final confirmation of catheter position in the US group, the type of anaesthesia (regional anaesthesia combined with general anaesthesia, regional anaesthesia alone), and the scheme of postoperative local anaesthetics (long-lasting or short-lasting local anaesthetics). If there were missing data, the reviewers tried to contact the corresponding authors of included trials to receive additional unpublished data.

Two reviewers (A.S./C.H.M.-F.) performed the critical evaluation of study quality; a modified Oxford scale published in several other meta-analyses was used.[11] This scale assessed the method of randomization (2 points), concealment of allocation (1 point), blinding (3 points), and description of dropouts (1 point).

Definition of outcome parameters

The primary outcome was the overall number of patients with a perioperative successful peripheral nerve catheter placement ['success rate (overall)']. As already published in another meta-analysis comparing US *vs* NS for single peripheral nerve blocks all definitions (e.g. successful surgical block, successful sensory/motor block preoperative/postoperative, and successful needle/catheter placement within a defined time period) for successful peripheral nerve catheter placement were rated as equivalent.[7] As secondary outcomes, the number of patients with a primary successful catheter placement (within a defined time period), pain scores [numeric rating scale (NRS): 0–10] during catheter placement ('procedure-related pain'), the time to perform (min), and postoperative pain scores at rest and movement (='worst pain') [in the postoperative care unit (PACU) (up to 2 h after operation), after 24 and 48 h] were calculated. If the included trials reported pain scores at more points in time, the highest scores within the time period would have been extracted. Finally, the number of patients with procedure-related complications [accidental vascular puncture, catheter-related infections, and neurological impairments (early/permanent)] were compared.

Statistical analysis

We decided to analyse the outcome parameters separately according to the type of guiding technique, if more than two trials were included for this comparison (US *vs* NS; US combined with NS *vs* NS). The relative risk (RR), mean difference (MD), and their corresponding 95% confidence intervals (CIs) were calculated for the dichotomous and continuous outcome data using a fixed-effect model. Statistical heterogeneity was assessed with the I^2-test and assumed, if an I^2-value exceeding 30% was observed. If significant heterogeneity was detected, it was assumed that there was no single 'true' effect underlying the data, which was constant across different populations. In these cases, a random-effects model was used.[12] If continuous data were not reported as mean [standard deviation (SD)], the missing data were calculated as previously reported.[13] Significance was assumed if the 95% CI did not include the value 1.0. If relevant data heterogeneity was detected for the primary outcome, the following subgroups were separately analysed and compared: location of nerve catheter (interscalene, infraclavicular, femoral, and sciatic) and the use of final confirmation of catheter position in the US group ('yes' *vs* 'no'). Additionally, sensitivity analyses were planned to detect the influence of study quality (high-quality trials *vs* low-quality trials). All statistical analyses were performed with the Review Manager (RevMan®; Computer program; Version 5.1; Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration, 2011).

Results

Description of included and excluded studies

Our systematic search identified 206 trials, of which 191 studies were subsequently excluded (Fig. 1).

Fifteen studies (including 977 patients) satisfied the inclusion criteria and were finally included in the present meta-analysis[14–28] (Table 1). Within these 15 studies, nine studies compared US *vs* NS guidance.[15–17 19 24–28] The remaining studies investigated either US combined with NS *vs* NS[14 18 22 23] or US *vs* NS combined with US.[20 21] Four trials performed a distal-sciatic,[15 23 25 27] one performed a proximal-sciatic,[17] four performed a femoral,[14 22 26] four performed an interscalene,[16 19 28] and two performed an infraclavicular peripheral nerve catheter.[18 25]