British Journal of Anaesthesia **113** (1): 177–85 (2014)
Advance Access publication 25 February 2014 · doi:10.1093/bja/aeu002

BJA

REGIONAL ANAESTHESIA

Does circumferential spread of local anaesthetic improve the success of peripheral nerve block?

D. Marhofer[1], M. K. Karmakar[3], P. Marhofer[1]*, S. C. Kettner[1], M. Weber[2] and M. Zeitlinger[2]

[1] Department of Anaesthesia and Intensive Care Medicine and [2] Department of Clinical Pharmacology, Medical University of Vienna, A-1090 Vienna, Austria
[3] Department of Anaesthesia and Intensive Care, The Chinese University of Hong Kong, Prince of Wales Hospital, Hong Kong, China

* Corresponding author. E-mail: peter.marhofer@meduniwien.ac.at

Editor's key points

- The relation between circumferential or non-circumferential local anaesthetic (LA) spread and peripheral nerve block success is unclear.
- Multiplanar ultrasound imaging was used to compare median nerve block success with or without circumferential LA spread in healthy volunteers.
- Block success was similar with or without circumferential LA spread in this model.

Background. The relation between the pattern of local anaesthetic (LA) spread and the quality of peripheral nerve block is unclear.

Methods. Twenty-one volunteers were randomized to receive a median nerve block with intended circumferential or intended non-circumferential spread of LA. Different predetermined volumes and needle placement techniques were used to produce the different patterns of LA spread. Volumetric, multiplanar 3D ultrasound imaging was performed to evaluate the pattern and extent of LA spread. Sensory block was assessed at predetermined intervals.

Results. Complete circumferential spread of LA was achieved in only 67% of cases in the intended circumferential study group and in 33% of cases in the intended non-circumferential group. Block success was similar (90%) and independent of whether circumferential or non-circumferential spread of the LA was achieved. All block failures ($n=4$) occurred in the intended non-circumferential group with low volumes of LA. The onset of sensory block (independent of group allocation) was faster with circumferential spread of LA [median (IQR) onset time, 15 (8; 20) min] compared with non-circumferential spread of LA [median (IQR) onset time, 20 (15; 30) min]. More LA was used for circumferential blocks [median (IQR) volume of LA 2.8 (1.3; 3.6) *vs* 1.3 (1.1; 2.4) ml].

Conclusions. Even under optimal conditions, it was not possible to achieve circumferential spread of LA in all intended cases. The success of median nerve block seems to be independent of the pattern of LA spread.

Clinical trial registration. DRKS 00003826.

Keywords: anaesthetic techniques, regional; equipment, ultrasound machines; regional anaesthesia

Accepted for publication: 10 December 2013

Peripheral nerve blocks are frequently used for anaesthesia or analgesia during the perioperative period. Despite the widespread use of ultrasound-guided peripheral nerve block,[1] it is not known if circumferential spread of local anaesthetic (LA) around the nerve is essential for block success. Current evidence suggests that partial encirclement of a nerve with LA is adequate for block success.[2 3] The lack of data correlating the distribution of LA with block dynamics might be due to the inability of 2D ultrasound imaging to comprehensively delineate the extent of LA spread since it only allows visualization in one plane (transverse or sagittal). Three-dimensional (3D) ultrasound imaging allows one to simultaneously visualize a volume of interest (e.g. a nerve) in the transverse (*x*-axis), sagittal (*y*-axis), and coronal (*z*-axis) plane.[4 5] Published data on the use of 3D ultrasound for peripheral nerve block are limited, but preliminary reports indicate that it can be used to preview anatomy,[4–6] assist in performing peripheral nerve blocks,[7] facilitate placement of a peripheral nerve catheter,[8] and visualize the spread of the LA in multiple orthogonal planes.[7] The latter might be useful to correlate the pattern of LA spread with block success. The aim of this study was to determine, using multiplanar 3D ultrasound imaging after nerve block, if the pattern of LA spread (circumferential or non-circumferential) affects nerve block success.

Methods

The study was approved by the research ethics committee of the Medical University of Vienna (EK 1313/1012) and by the Austrian Agency for Health and Food Safety (EudraCT 2012-001847-31). The trial was also registered with the German Clinical Trials Registry (registration number DRKS 00003826).

Volunteer recruitment

Twenty-one volunteers (aged 18–45 yr) who gave written informed consent were recruited for this prospective, randomized, double-blind, controlled trial (Fig. 1). Three weeks before the start of the investigation, each volunteer underwent a health screening examination, which included a general physical examination, arterial pressure, and heart rate measurements, blood tests (red and white blood cell counts, coagulation profile), and a 12-lead ECG. Volunteers were excluded if they refused to participate, had any anatomical abnormality in the forearm, gave history of allergy to mepivacaine or amide LA drugs, reported using non-steroidal anti-inflammatory drugs during the preceding 2 weeks, had recently (in the previous 4 weeks) participated in a clinical trial, or had coagulopathy or ECG abnormalities. The volunteers also had an ultrasound examination of the median nerve in the forearm of the non-dominant upper limb using a Supersonic Aixplorer ultrasound system (SuperSonic Imagine™, Aix-en-Provence, France) and a SuperLinear™ Volumetric ultrasound transducer (SLV 16–5 MHz, integrated mechanical transducer). The median nerve was identified as a round to oval, hyperechoic, or honey-comb like structure between the flexor digitorum superficialis and the flexor digitorum profundus muscles of the forearm (Fig. 2A). The ultrasound image was optimized and the site for the subsequent median nerve block was determined using the following criteria: (i) the

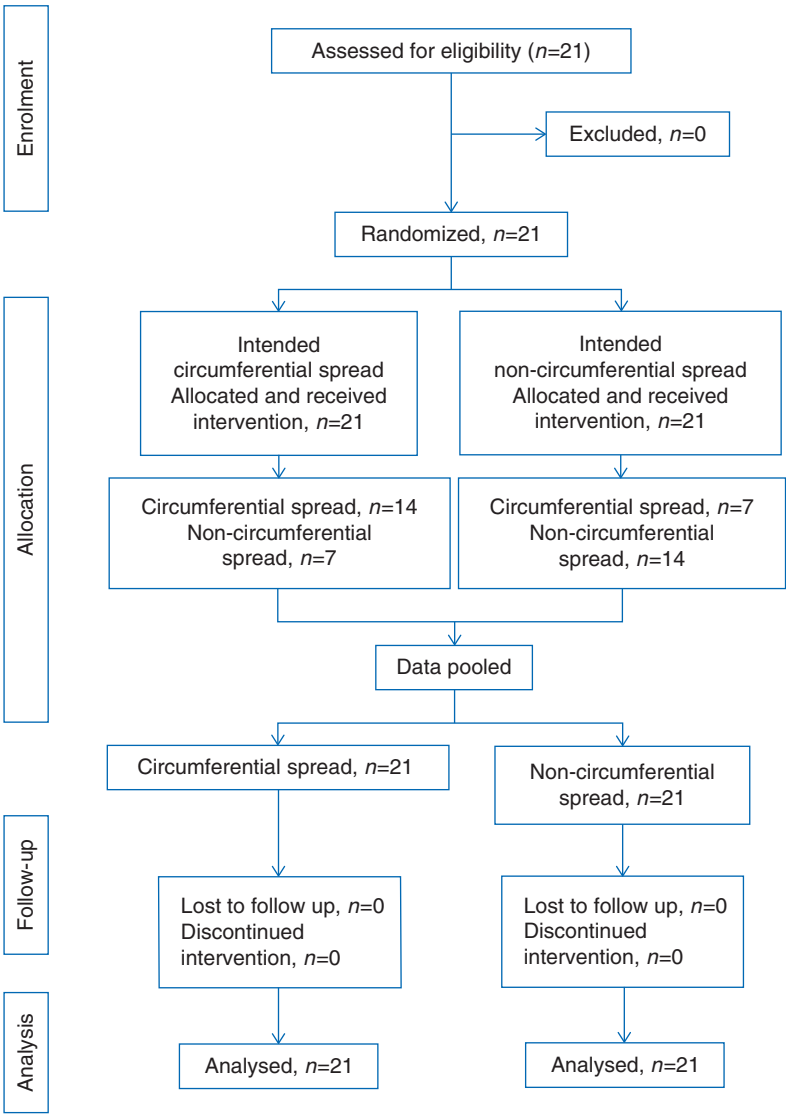

Fig 1 Consort E-flowchart.