

Does motor block related to long-acting brachial plexus block cause patient dissatisfaction after minor wrist and hand surgery? A randomized observer-blinded trial

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Editor's key points

- Motor block after regional anaesthesia may have an impact on patient satisfaction.
- The authors compared short- or long-acting regional anaesthesia for wrist and hand surgery.
- Both the groups had similar level of patient satisfaction.
- The importance of studying procedure-specific patient satisfaction is highlighted.

Background. Patient dissatisfaction has been previously associated with motor block in shoulder surgery patients receiving brachial plexus block. For elective minor wrist and hand surgery, we tested whether a regional block accelerating the early return of upper extremity motor function would improve patient satisfaction compared with a long-acting proximal brachial plexus block.

Methods. A total of 177 patients having elective 'minor' wrist and hand surgery under awake regional block randomly received adrenalized infraclavicular lidocaine 2% 10 ml+ropivacaine 0.75% 20 ml ('long acting', $n=90$), or adrenalized infraclavicular lidocaine 1.5% 30 ml+long-acting distal median, radial, and ulnar nerve blocks selected according to the anticipated area of postoperative pain ('short acting', $n=87$). A blinded observer questioned patients on day 1 for numerically rated (0–10) subjective outcomes.

Results. With 95% power, there was no evidence for a 1-point satisfaction shift in the short acting group: satisfaction was similarly high for both groups [median (inter-quartile range)=10 (8–10) vs 10 (8–10), $P=0.71$], and also demonstrated strong evidence for equivalence [mean difference (95% confidence interval)= -0.18 (-0.70 to 0.35)]. There was no difference between the groups for weakness- or numbness-related dissatisfaction (low for both groups), or for numerically rated or time to first pain. Surgical anaesthesia success was similar between the groups (short acting, 97% vs 93%, $P=0.50$), although more patients in the short acting group had surgery initiated in ≤ 25 min ($P=0.03$).

Conclusions. Patient satisfaction is not improved after elective minor wrist and hand surgery with a regional block accelerating the early return of motor function. For this surgery, motor block related to a long-acting brachial plexus block does not appear to cause patient dissatisfaction.

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Our group previously demonstrated an association between upper extremity motor block and patient dissatisfaction during continuous interscalene analgesia for shoulder surgery.^{1,2} Consistent with this evidence, many of these patients voluntarily report dissatisfaction with being unable to use their hand and fingers as a result of block of the caudal/inferior elements of the brachial plexus. Similarly, in patients representing for minor wrist and hand surgery under regional anaesthesia, we have noted some voluntarily

reporting dissatisfaction from the 'dead arm' sensation associated with long-acting brachial plexus block.

An evolving approach to upper extremity regional anaesthesia/analgesia^{3,4} for wrist and hand surgery involves short-acting brachial plexus block combined with long-acting distal blocks.⁵ In addition to previously published evidence demonstrating that this 'combined' technique accelerates block onset and improves block consistency,⁵ it also has the theoretical benefit of promoting the early return of upper

extremity motor function, which might theoretically improve patient satisfaction.

Therefore, in patients undergoing elective minor wrist and hand surgery, we tested whether substitution of a long acting for a short-acting infraclavicular block (supplemented with long-acting distal/peripheral blocks) would improve early patient satisfaction.

Methods

The local institutional review board (Northern Y Regional Ethics Committee, Hamilton, New Zealand) approved the trial. The primary and secondary endpoints, including the specific timing of their measurement together with the intended sample size, were *prespecified* before trial commencement (i.e. *a priori*)⁶ at the Australian and New Zealand Clinical Trials Registry (ACTRN12610000749000, September 2010). A statement regarding the background and rationale for the trial was also made at this time. We enrolled consecutive adult ASA I–III patients, of all BMIs, undergoing elective ‘minor’ wrist and hand surgery in the investigators’ practice at the Southern Cross Northern Clinic and North Harbour Hospitals from September 2010 through December 2011. The following patients were excluded: those who refused brachial plexus block, or were assessed as requiring a postoperative perineural catheter (e.g. wrist fusion, wrist replacement, major radial or ulnar osteotomy, and suspension arthroplasty), or were likely to receive an above elbow cast (therefore expected to benefit only marginally from the accelerated return of motor function) (Fig. 1). Other exclusion criteria were known neuropathy involving the arm undergoing surgery, and known amide local anaesthetic allergy. Written and oral informed consent was obtained from all patients; the trial was in keeping with the Helsinki declaration and we followed the CONSORT guidelines for reporting randomized clinical trials.

A research assistant invited the patients to participate, and the definitive recruitment was done by the operating investigator. The design was a two-centre, prospective, randomized, observer-blinded trial.

Block technique and randomization⁵

An operator experienced in ultrasound-guided regional anaesthesia (M.J.F. and P.W.) placed all blocks in a dedicated room beside the operating theatre (see <http://www.ultrasoundblock.com/>). Immediately before block placement, all patients received i.v. sedation up to midazolam 2 mg and alfentanil 0.5 mg. Using a computer-generated random number in blocks of 20 (www.random.org), a research assistant remote from the study procedures implemented random assignment to the ‘long acting’ or ‘short acting’ group. Randomization was not stratified by procedure. The groups were concealed by using 183 pre-prepared, sealed, opaque envelopes, opened immediately before block placement.

All patients first received a single-injection infraclavicular brachial plexus block,⁷ which were performed with 18 G Tuohy needles (Portex, Kent, UK) and a high-resolution

ultrasound machine (SonoSite M-Turbo, SonoSite, Bothell, WA, USA). Patients were positioned supine with the arm adducted and the head turned to the contralateral side. A pillow was placed between the shoulder blades to extend both shoulders, and therefore facilitate deltopectoral groove exposure. An 8–5 MHz curvilinear probe (SonoSite C11, Bothell) was placed in the deltopectoral groove with a sagittal orientation and medial-to-lateral position where the clearest image of the middle third of the axillary artery was obtained. First, the skin, subcutaneous tissue, and adjacent pectoralis muscles were infiltrated with local anaesthetic under ultrasound guidance. Subsequently, the 18 G Tuohy needle was advanced using in-plane needle-probe alignment, with the bevel facing dorsally to a position posterior to the axillary artery. This endpoint necessitates a ‘pop’ as the fascia cephaloposterior to the axillary artery is penetrated. At this point, all local anaesthetic was deposited regardless of brachial plexus cord visualization;⁷ however, some needle manipulation in a cephalocaudal direction (not extending beyond the cephalocaudal borders of the axillary artery) was permitted to promote a ‘saucer’ shaped or ‘bubble’ pattern spread dorsal to the artery (sometimes described as a ‘double bubble’ sign: one bubble represents the artery; the other representing local anaesthetic). The ‘short acting’ group received 30 ml lidocaine 1.5% with epinephrine 1/200 000 followed by an ultrasound-guided distal median, radial, and ulnar nerve block (using ropivacaine 0.5%) selected according to the anticipated area of postoperative pain (e.g. wrist arthroscopy, median, radial, and ulnar blocks; carpal tunnel and Dupuytren’s release, median and ulnar blocks) (Fig. 1). The ‘long acting’ group received 30 ml of a 10:20 mixture of lidocaine 2%+ropivacaine 0.75% with epinephrine 1/200 000 (i.e. 30 ml ropivacaine 0.5%). Distal median, radial, and ulnar blocks (using lidocaine 2%) were allowed in this group, if the operating anaesthesiologist deemed them necessary to speed up onset. All distal blocks were performed with the same ultrasound machine, but a 10–5 MHz linear array probe (SonoSite L38), a 22 G 5 cm B-Plex[®] needle (Plexufix, BJBraun, Bethlehem, PA, USA), an in-plane needle imaging technique, and 4 ml local anaesthetic for each nerve.

The procedural objective of distal blocks was to place local anaesthetic in proximity, in at least two positions (ideally each side) around the nerves but specifically avoiding intra-neural injection as follows.

- (1) Median nerve. At the mid-forearm level between the flexor digitorum superficialis muscles and flexor digitorum profundus muscles.⁸ The arm was abducted and externally rotated with the palm facing up. Needle advancement was in-plane from the radial to the ulnar side of the forearm.
- (2) Ulnar nerve. At approximately the junction of the middle and proximal thirds of the forearm just proximal to where the nerve diverges from the ulnar artery.⁹ The arm was abducted and externally

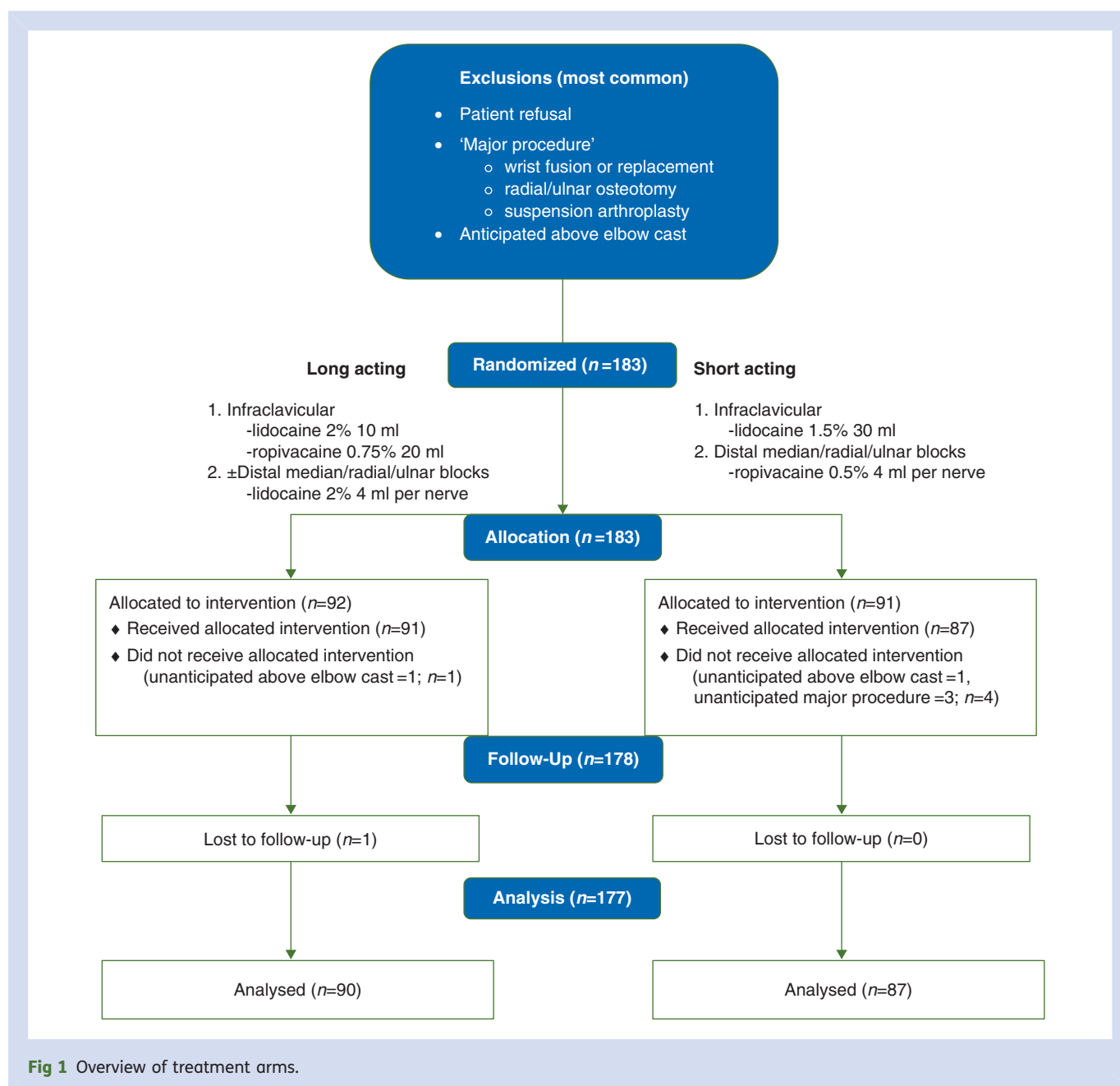


Fig 1 Overview of treatment arms.

rotated with the palm facing up. Needle advancement was in-plane from anterior to posterior.

- (3) Radial nerve. At approximately the junction of the middle and distal thirds of the arm just distal to the nerve leaving the spiral groove of the humerus.^{9 10} The arm was adducted and internally rotated with the forearm resting on the chest. Needle advancement was in-plane from anterior to posterior.

Patients were then taken to the operating theatre and prepared for surgery by the application of surgical tourniquet.

Anaesthesia and analgesia

A standardized technique was used. Multimodal analgesia consisted of preoperative oral acetaminophen 1 g, and

intraoperative i.v. parecoxib 0.5 mg kg⁻¹ (maximum 40 mg). Most surgery was conducted awake. The primary surgeon (M.R.B., S.C.), blinded to the treatment group, determined whether additional surgical site infiltration or deep sedation was needed in the case of inadequate surgical anaesthesia. Anxious patients received additional midazolam as requested with the intention of remaining responsive to verbal commands throughout the procedure. Subjects refusing awake surgery received a propofol infusion (target plasma propofol concentration 2.0–3.0 µg ml⁻¹) with supplemental oxygen 1–4 litre min⁻¹ by a facemask as necessary. If deep sedation could not be maintained (e.g. inability to maintain a patent natural airway), the patients received general anaesthesia using a laryngeal mask airway.

Post-anaesthesia care unit protocol

In the post-anaesthesia care unit (PACU), patients emerging from general anaesthesia reporting a numerical rating pain score (NRPS, 0–10) of more than 2 were given morphine 2 mg every 2–3 min to achieve an NRPS of ≤ 2 .

Multimodal analgesia was continued after surgery: regular acetaminophen (1 g every 6 h) and diclofenac slow release (75 mg every 12 h) and in selected patients, PRN tramadol slow release (100 mg every 12 h, 50 mg every 12 h if age >70 or weight <60 kg) if the NRPS increased to >2, despite regular acetaminophen and diclofenac. Discharge home occurred 1–4 h after surgery.

Data collection

Infraclavicular block procedural time was recorded by the operating investigator and was defined as the time from the ultrasound probe being placed on the skin before needle puncture until the needle exited the skin after local anaesthetic administration. Subsequent distal nerve blocks were recorded, but associated procedural time was not. The operating investigator recorded the occurrence of inadvertent vascular puncture and asked subjects: 'How would you rate your discomfort during the block on a scale of zero to 10 if zero is no discomfort and 10 is the worst discomfort imaginable?' and 'Did you experience an electric shock-like sensation in the arm during the procedure?' The operating investigator recorded the surgical start time, the need for surgical infiltration and patient requested sedation or general anaesthesia, and whether take home tramadol was prescribed. Block to surgical incision time was defined as the time from the ultrasound probe being placed on the skin to surgical incision, and surgical anaesthesia success as surgery without the requirement for surgical site infiltration or deep sedation administered for intraoperative pain. Patients who received deep propofol sedation because of refusal to undertake awake surgery *per se* were not designated as having failed surgical anaesthesia. The patient's primary PACU nurse recorded the emergence wrist/hand NRPS and the requirement for morphine rescue. A research assistant phoned all subjects at 24 postoperative hours and questioned for overall satisfaction with the pain relief during the previous 24 h, supplemental tramadol consumption, time to first pain, NRPS (worst and 'average' pain during the previous 24 h), and for numbness- and weakness-related dissatisfaction. Numerically rated scales were scored 0–10; 0, no pain, no numbness- or weakness-related dissatisfaction, very unsatisfied overall; 10, worst imaginable pain, worst imaginable numbness/weakness-related dissatisfaction, very satisfied overall. Subjects were also asked (yes/no) whether they would have this anaesthetic/analgesic technique again for this surgery.

Blinding of treatments

All data collection could be considered observer blinded except data collected by the operating investigator. For ethical reasons, placebo distal peripheral nerve block

injections were not used in the 'long acting' group; therefore, patients were not blinded to the treatment group.

Study endpoints

The primary endpoint was numerically rated (0–10) pain relief satisfaction assessed at 24 postoperative hours. The main secondary endpoints were time to first pain, numerically rated pain, and weakness- or numbness-related dissatisfaction during the first 24 h.

Statistical analysis

An independent statistician (Richard White), blinded to the treatment group, performed all calculations. Categorical outcomes were compared using the Fisher exact test (procedure-related paraesthesia, number undergoing surgery within 25 min, surgical anaesthesia success, proportion prescribed and requiring tramadol). Non-normally distributed continuous variables (infraclavicular procedural and block to surgical incision time) and ordinal outcomes (all numerically rated scores) were compared using the Mann-Whitney *U*-test. Many patients had not reported pain at the 24 h consultation; therefore, time to first pain was compared using the Log-rank (Mantel-Cox) test. *P*-values of <0.05 were considered statistically significant. Two-sided tests were used for all study outcomes.

Other data were described using appropriate descriptive statistics [mean/standard deviation (*SD*) or mean/range for normally distributed or symmetric variables; median/inter-quartile ranges (IQRs) for skewed variables; number/proportion for categorical variables]. Statistical analyses were conducted with R 2.12.1 (R Foundation, Vienna, Austria).

Sample size estimates were based on the demonstration of an arbitrary 1-point shift in overall patient satisfaction between the groups. In contrast to NRPS data, no previous data have established what constitutes a clinically relevant patient satisfaction change; the arbitrary 1-point value was based on two previous studies demonstrating a similar 1-point satisfaction shift.^{1 2} Pooled satisfaction data (*n*=143) from a previous study revealed an *SD* of 1.5.² Allowing for a 15% adjustment for the use of the *t*-test when a subsequent non-parametric test was expected, we estimated that demonstration of a 1-point satisfaction shift with 95% power would require ~160 patients (unpaired *t*-test, Statmate 2.0; GraphPad Software, San Diego, CA, USA). We aimed to recruit 180 patients to allow for dropouts.

Given the lack of treatment effect shown for the primary outcome, we performed *post hoc* power analysis. Satisfaction *SD* was 1.9 and 1.6 in the long-acting (*n*=90) and short-acting (*n*=87) groups, respectively; therefore, the study had 80% and 95% power to detect a shift of 0.8 and 1.0 points, respectively (Statmate 2.0). A test for equivalence was also performed for the primary outcome by calculating the mean difference [95% confidence interval (CI)] between the groups.

Results

One hundred and eighty-three patients presenting for elective wrist and hand surgery were recruited during the study period: 92 patients were randomized to the long-acting group and 91 to the short-acting group (Fig. 1). Six patients were excluded after randomization: one patient in each group received an unanticipated above elbow cast; three patients in the short-acting group required a postoperative perineural catheter for an unanticipated more extensive procedure, and one patient in the long-acting group could not be contacted on day 1. The remaining 177 patients were followed according to the study protocol. Patient and surgical characteristics were similar between the groups (Table 1).

Overall patient satisfaction did not differ between the groups: [median (IQR)=10 (8–10) vs 10 (8–10), $P=0.71$] and demonstrated strong evidence for equivalence: mean difference (95% CI)=−0.18 (−0.70 to 0.35) (Table 2). Tramadol was prescribed in 46% of patients in both groups. Requirement for rescue tramadol, numbness- and weakness-related dissatisfaction (both very low for both groups), time to first pain, and numerically rated pain did not differ between the groups (Table 2). Surgical anaesthesia success was similar between the groups (short acting, 97% vs 93%), but more patients in the short-acting group underwent surgery in ≤ 25 min (25 vs 14, $P=0.03$) (Table 3). Conscious sedation was requested in 21 and 27 patients in the long- and short-acting groups, respectively, while deep sedation was requested in two and three patients, respectively.

Five patients (3%) said that they would not have the same anaesthetic/analgesic technique again for similar surgery: one patient in each group because of the ‘dead’ feeling in the arm; one patient in the long-acting group because of discomfort

Table 1 Patient and surgical characteristics ($n=177$). Values are mean (range), or n

	Long acting ($n=90$)	Short acting ($n=87$)
Sex (male/female)	49/41	39/48
Age (yr)	46 (17–85)	49 (17–88)
Weight (kg)	85 (50–141)	80 (55–126)
Anaesthesiologist 1/2	56/34	57/30
Surgery		
Wrist arthroscopy/debridement	30	20
Carpal tunnel release	19	16
Ganglion/mucous cyst excision	6	16
Dupuytren's release	3	5
Metacarpal/digital ORIF	9	6
A1 pulley/trigger finger procedure	7	11
Plate removal	3	1
Radial/ulnar collateral ligament repair	4	1
Other	9	11

Table 2 Postoperative outcomes ($n=177$). Values are n (%), median, or median (IQR). NRS, numerical rating score (0–10; 0, no numbness- or weakness-related dissatisfaction, no pain, or very dissatisfied overall; 10, worst numbness- or weakness-related dissatisfaction, worst imaginable pain, or very satisfied overall)

	Long acting ($n=90$)	Short acting ($n=87$)	P-value
Satisfaction NRS	10 (8–10)	10 (8–10)	0.71
Tramadol required	32 (36)	30 (34)	1.00
Numbness-related dissatisfaction NRS	2 (0–4)	1 (0–3)	0.19
Weakness-related dissatisfaction NRS	0 (0–3)	0 (0–2)	0.76
Time to first pain (h)	13.5	11.9	0.16
‘Average’ pain NRS	1 (0–3)	2 (0–3)	0.42
‘Worst’ pain NRS	3 (1–5)	3 (1–5)	0.80

Table 3 Block placement details ($n=177$). Values are median (IQR), n , or n (%). NRPS, numerical rating pain score (0, no pain; 10, worst pain imaginable); PACU, post-anaesthesia care unit

	Long acting ($n=90$)	Short acting ($n=87$)	P-value
Infraclavicular procedural time (s)	130 (80–169)	120 (62–150)	0.33
Procedure-related NRPS	1 (0–2)	1 (0–3)	0.63
Procedure-related paraesthesia	7	8	0.79
Distal peripheral nerve block	Lidocaine	Ropivacaine	
Total	9	87	
Median	9	73	
Ulnar	5	53	
Radial	2	44	
Block to surgical incision time	35 (30–50)	35 (25–50)	0.45
Block to surgical incision ≤ 25 min	14	25	0.03
Surgical anaesthesia success	84 (93%)	84 (97%)	0.50

experienced during surgery; one patient in the short-acting group because of discomfort experienced during block placement, and one patient in the short-acting group, who in retrospect, would have preferred a general anaesthetic.

There were three inadvertent vascular punctures, all in the long-acting group and all without significant consequence. No patient demonstrated symptoms or signs of systemic local anaesthetic toxicity.

Discussion

After minor wrist and hand surgery, we found no evidence to support the hypothesis of improved patient satisfaction by

substituting a long-acting for a short-acting infraclavicular block (supplemented with long-acting distal/peripheral blocks). Patient satisfaction was equally high for both techniques.

The tested hypothesis arose from our clinical experience with continuous interscalene analgesia for shoulder surgery, in which some patients report dissatisfaction from the inability to move the hand. Similarly, some patients representing for wrist and hand surgery under regional anaesthesia report dissatisfaction from the motor block associated with a long-acting single injection infraclavicular block. This anecdotal evidence is supported by two previous continuous interscalene analgesia studies, in which higher patient satisfaction was associated with reduced motor block.^{1, 2} In a randomized comparison of ropivacaine 0.2% and 0.4% for continuous interscalene block,¹ the only outcomes demonstrating a between-group difference were (i) episodes of an insensate or densely blocked extremity and (ii) patient satisfaction. The former was higher in the 0.4% group (15% vs 0%, $P=0.05$), while patient satisfaction was higher for the 0.2% group [mean difference (95% CI)=1.3 (0.3–2.4), $P=0.01$]. In a randomized comparison of two primary bolus doses of ropivacaine for continuous interscalene analgesia (20 ml 0.375% vs 30 ml 0.5%),² patient satisfaction was higher for the lower dose [median (IQR)=10 (10–10) vs 9 (8–10), $P=0.007$].² There was a suggestion that this satisfaction difference was related to motor block: pooled data linear regression analysis showing a positive association between ropivacaine concentration and hand weakness ($P=0.01$). There are several possible explanations for the lack of similar findings in the present study. First, it is possible that the previous statistically significant satisfaction outcomes represent type 1 errors; such errors being more common with multiple secondary rather than pre-specified primary outcomes.⁶ More likely, however, was the difference in surgery and block type. With continuous interscalene analgesia using judicious local anaesthetic doses, it is possible to block the shoulder area while sparing the distal forearm and hand.² A 'non-selective' interscalene block (i.e. not selectively confined to the 5th and 6th cervical roots, but also involving the 7th, 8th cervical, and first thoracic root) manifests not only as shoulder girdle paralysis, but also elbow, wrist, and hand paralysis. The resulting impairment of fine motor function may contribute to patient dissatisfaction. In the present study involving wrist and hand surgery, both study techniques inevitably resulted in distal forearm, hand, and finger paralysis. The short-acting technique of the present study enabled a more rapid return of proximal arm motor function, specifically, shoulder movement and elbow function. It may be that dissatisfaction from brachial plexus motor block relates more to inability to use the hand and fingers rather than the proximal arm, particularly after wrist/hand surgery, when patient expectations are that the forearm will be immobilized in a cast and supported with a sling. A final possibility is that 'short acting' technique motor block resulting from lidocaine brachial plexus block may have reduced the trial's ability to demonstrate a

satisfaction advantage from eliminating the long-acting brachial plexus block. Inclusion of a treatment arm without any peripheral nerve block could potentially overcome this limitation. However, compared with general anaesthesia, regional anaesthesia improves early outcome for this surgery (reduced nausea/vomiting and sore throat, improved analgesia, earlier ambulation, earlier recovery room and hospital discharge).^{11, 12} Therefore, it would be difficult eliminating the effect of these confounders on patient satisfaction with such a comparison.

Few previous regional anaesthesia studies have used patient satisfaction as a primary endpoint.¹³ Indeed, there is controversy regarding how best to assess this outcome, as simple one-dimensional numerical rating instruments typically produce results skewed to the highly satisfied end of the scale.^{14, 15} Ideally, satisfaction is assessed using an instrument that has undergone psychometric validation.^{16–18} The use of such an instrument would have increased the validity of our findings; however, the simple numerical rating scale we used is very similar to a scale shown to demonstrate convergent validity with a multidimensional psychometrically constructed 40-item questionnaire.¹⁹ Regardless, further support for our conclusions were that numbness- and weakness-related dissatisfaction scores were low for both groups.

There was a non-significantly higher surgical anaesthesia success rate in the short-acting group (97% vs 93%). In addition, more patients in the short-acting group underwent surgery within 25 min—making a statistical chance explanation for the trend to higher success less likely. Combined, they support our recent study demonstrating that this approach accelerates upper extremity anaesthesia and improves block consistency.⁵ It should be noted that the surgical start time was not strictly controlled; the operating anaesthesiologist may have, intentionally or unintentionally, advanced or discouraged progression with surgery depending on informal assessment of motor block. Based on the results of our previous study for the 'combined' technique, our practice is to proceed with surgery immediately after the final distal nerve block.

The main drawback of using only short-acting local anaesthetic for brachial plexus block is the limited tourniquet analgesia time—typically <90–120 min from block placement (~30–90 min after tourniquet application). Secondly, because the combined technique involves several blocks (short-acting brachial plexus block and long-acting distal blocks), it is theoretically a more invasive technique. Nevertheless, those who practice in settings requiring rapid upper extremity anaesthesia onset time may consider the advantages of the short-acting technique outweigh the potential problems.

In summary, this study shows that in patients undergoing minor wrist/hand surgery, there is no satisfaction benefit when administering a regional block technique designed to accelerate the early return of upper extremity motor function when compared with a brachial plexus block incorporating proximally administered long-acting local anaesthetic. For

this surgery, motor block related to a long-acting brachial plexus block does not appear to cause patient dissatisfaction.

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Declaration of interest

None declared.

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References

- 1 Fredrickson MJ, Price DJ. Analgesic effectiveness of ropivacaine 0.2% vs 0.4% via an ultrasound-guided C5–6 root/superior trunk perineural ambulatory catheter. *Br J Anaesth* 2009; **103**: 434–9
- 2 Fredrickson MJ, Smith KR, Wong AC. Importance of volume and concentration for ropivacaine interscalene block in preventing recovery room pain and minimizing motor block after shoulder surgery. *Anesthesiology* 2010; **112**: 1374–81
- 3 Marhofer P, Harrop-Griffiths W, Kettner SC, Kirchmair L. Fifteen years of ultrasound guidance in regional anaesthesia: part 1. *Br J Anaesth* 2010; **104**: 538–46
- 4 Marhofer P, Harrop-Griffiths W, Willschke H, Kirchmair L. Fifteen years of ultrasound guidance in regional anaesthesia: part 2—recent developments in block techniques. *Br J Anaesth* 2010; **104**: 673–83
- 5 Fredrickson MJ, Ting FS, Chinchana S, Boland MR. Concomitant infraclavicular plus distal median, radial, and ulnar nerve blockade accelerates upper extremity anaesthesia and improves block consistency compared with infraclavicular block alone. *Br J Anaesth* 2011; **107**: 236–42
- 6 Fredrickson MJ, Ilfeld BM. Prospective trial registration for clinical research: what is it, what is it good for, and why do I care? *Reg Anesth Pain Med* 2011; **36**: 619–24
- 7 Fredrickson MJ, Wolstencroft P, Kejrival R, Yoon A, Boland MR, Chinchana S. Single versus triple injection ultrasound-guided infraclavicular block: confirmation of the effectiveness of the single injection technique. *Anesth Analg* 2010; **111**: 1325–7
- 8 McCartney CJ, Xu D, Constantinescu C, Abbas S, Chan VW. Ultrasound examination of peripheral nerves in the forearm. *Reg Anesth Pain Med* 2007; **32**: 434–9
- 9 Kathirgamanathan A, French J, Foxall GL, Hardman JG, Bedford NM. Delineation of distal ulnar nerve anatomy using ultrasound in volunteers to identify an optimum approach for neural blockade. *Eur J Anaesthesiol* 2009; **26**: 43–6
- 10 Foxall GL, Skinner D, Hardman JG, Bedford NM. Ultrasound anatomy of the radial nerve in the distal upper arm. *Reg Anesth Pain Med* 2007; **32**: 217–20
- 11 Hadzic A, Arliss J, Kerimoglu B, et al. A comparison of infraclavicular nerve block versus general anesthesia for hand and wrist day-case surgeries. *Anesthesiology* 2004; **101**: 127–32
- 12 McCartney CJ, Brull R, Chan VW, et al. Early but no long-term benefit of regional compared with general anesthesia for ambulatory hand surgery. *Anesthesiology* 2004; **101**: 461–7
- 13 Heidegger T, Husemann Y, Nuebling M, et al. Patient satisfaction with anaesthesia care: development of a psychometric questionnaire and benchmarking among six hospitals in Switzerland and Austria. *Br J Anaesth* 2002; **89**: 863–72
- 14 Schug SA. Patient satisfaction—politically correct fashion of the nineties or a valuable measure of outcome? *Reg Anesth Pain Med* 2001; **26**: 193–5
- 15 Wu CL, Naqibuddin M, Fleisher LA. Measurement of patient satisfaction as an outcome of regional anesthesia and analgesia: a systematic review. *Reg Anesth Pain Med* 2001; **26**: 196–208
- 16 Auquier P, Pernoud N, Bruder N, et al. Development and validation of a perioperative satisfaction questionnaire. *Anesthesiology* 2005; **102**: 1116–23
- 17 Heidegger T, Saal D, Nuebling M. Patient satisfaction with anaesthesia care: what is patient satisfaction, how should it be measured, and what is the evidence for assuring high patient satisfaction? *Best Pract Res Clin Anaesthesiol* 2006; **20**: 331–46
- 18 Mui WC, Chang CM, Cheng KF, et al. Development and validation of the questionnaire of satisfaction with perioperative anesthetic care for general and regional anesthesia in Taiwanese patients. *Anesthesiology* 2011; **114**: 1064–75
- 19 Myles PS, Williams DL, Hendrata M, Anderson H, Weeks AM. Patient satisfaction after anaesthesia and surgery: results of a prospective survey of 10,811 patients. *Br J Anaesth* 2000; **84**: 6–10