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Supraclavicular block vs. intravenous regional anaesthesia for forearm surgery

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Abstract

Background: The purpose of this study was to compare the analgesic effect during and after surgery between intravenous regional anaesthesia (IVRA) and the supraclavicular block in forearm surgery.

Methods: Eighty patients aged 30 to 70 years qualified for forearm surgery were divided into a supraclavicular group and an IVRA group. A supraclavicular block was performed with 1% lidocaine at a dose of 20 mL. After anaesthesia was obtained, a single tourniquet was used at a pressure of 200 mm Hg. For the patients in the IVRA group, an intravenous catheter was first inserted in the dorsum of the hand marked for surgery, followed by the placement of a double tourniquet with an elastic bandage wound around it. Once the proximal tourniquet was inflated to a pressure of 200 mm Hg, 1% lidocaine at a dose of 20 mL was injected. When anaesthesia had not been obtained within 30 minutes, the block was judged to have been failure, and general anaesthesia was administered. The onset time of analgesia, to time up to the first sensation of tourniquet pain, and the duration of postoperative analgesia were measured. When patients felt pain at a surgical site during surgery, 50 µg of fentanyl was administered. Any side effects were also checked.

Results: The onset time, the duration of postoperative analgesia, and the time up to the sensation of tourniquet pain were significantly shorter in the IRVA group. Other features of the IRVA group were that the number of patients with tourniquet pain was significantly larger and the number of patients with additional fentanyl was significantly smaller. No patients showed any side effects.

Conclusion: Although IVRA had a shorter onset time and needed less additional anaesthetic during surgery, it induced more tourniquet pain and had a shorter duration of postoperative analgesia than the supraclavicular block in forearm surgery.

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Key words: surgery, orthopaedic; forearm surgery; anaesthesia, intravenous regional anaesthesia; anaesthesia, regional, supraclavicular block

For forearm surgery, either intravenous regional anaesthesia (IVRA) or a brachial plexus block is commonly used. Although IVRA is easy to perform, it induces pain soon after tourniquet release. While a brachial plexus block requires some skills and devices such as a ultrasound or nerve stimulator, it provides longer postoperative analgesia. There are some differences in the effects of the block among supraclavicular, infraclavicular, interscalene, and axillary blocks [1–4]. However, in comparison with IVRA, only one study using the infraclavicular block has been reported [5]. The purpose of the present study was to compare the analgesic effect during and after surgery between IVRA and the supraclavicular block in forearm surgery.

METHODS

After the approval of the Ethics Committee of the hospital and securing informed consent from the patients concerned, 80 patients aged 30 to 70 years with ASA physical status I or II scheduled for forearm surgery with an expected duration of less than 60 minutes were divided into a su-

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praclavicular group or an IVRA group, each comprising 40 patients chosen at random by the envelope method. Those who presented liver, renal, mental, or severe cardiac diseases, had coagulation disorders, allergies to the agents scheduled for use, were in the habit of using hypnotics or analgesics, as well as those who were obese (body mass index > 30 kg m^{-2}) were excluded from the study.

Without any premedication, all patients received intravenously 1 mg of midazolam and 50 µg of fentanyl before the block. Patients in the supraclavicular group received a supraclavicular block with 20 mL of 1% lidocaine using a 50-mm 23-gauge needle under nerve stimulation at 0.5 mA and ultrasound guidance. After the blockade was obtained, a single tourniquet was used at a pressure of 200 mm Hg. For the patients in the IVRA group, a 20-gauge intravenous catheter was first inserted in the dorsum of the hand marked for surgery, followed by the placement of a double tourniquet with an elastic bandage wound around it. Once the proximal tourniquet was inflated to a pressure of 200 mm Hg, 1% lidocaine at a dose of 20 mL was injected. When patients complained tourniquet pain, the distal tourniquet was inflated while the proximal one was deflated. In the IVRA group, the tourniquet was released when at least 60 minutes had passed after inflation, even if surgery had been completed within 60 minutes.

The onset time of analgesia was measured by pin pricking all the patient's fingers each minute before surgery. When anaesthesia had not been obtained within 30 minutes, the block was judged to have been a failure, and general anaesthesia was administered. The time up to the onset of the first tourniquet pain was measured. When patients felt pain at the surgical site during surgery, 50 µg of fentanyl was administered intravenously. The duration of postoperative analgesia was measured as the time up to the first complaint of pain sensation at the surgical site following the completion of surgery. Side effects such as convulsions, arrhythmia, nausea, vomiting, hypotension, bradycardia, dyspnoea, etc. were checked for two hours after surgery.

STATISTICAL ANALYSIS

Data were expressed as a number of patients or a mean ± standard deviation. Statistical analysis was performed with a factorial analysis of variance (ANOVA) and the chi-square test. A *P*-value less than 0.05 was considered to be statistically significant. A post hoc power analysis was performed for AVOVA and fixed effects with an effect size of 0.25 (G Power^{TM} 3.1, Kiel University, Germany).

RESULTS

The power of this study was 0.72, while no patients needed general anaesthesia. Demographic data did not differ between the groups (Table 1). The onset time, the duration of postoperative analgesia, and the time up to the onset of tourniquet pain were significantly shorter in the IVRA group (Table 2). The number of patients with tourniquet pain was significantly larger in the IVRA group (Table 2). The number of patients with additional fentanyl and total fentanyl doses used in anaesthesia was significantly larger in the supraclavicular group (Table 2). No patients in this study showed any observed side effects.

DISCUSSION

The present study showed that when 1% lidocaine at a dose of 20 mL was used, IVRA had a shorter onset time and, although it needed less additional anaesthetic during surgery, it had more tourniquet pain and a shorter duration of postoperative analgesia than the supraclavicular block for forearm surgery.

While the power of this study was 0.72, significant differences were observed in onset time, additional anaesthetic, tourniquet pain, and the duration of postoperative analgesia. Therefore, the number of the patients in this study may be considered sufficient in order to discuss the difference between the supraclavicular block and IVRA.

We used 1% lidocaine at a dose of 20 mL in both groups. In upper arm IVRA, 0.5% lidocaine at a dose of 40 mL was used in a study by Narang *et al.* [6]. Lidocaine 0.225% at a dose of 40 mL provided sufficient anaesthesia for surgery of the upper limb in IVRA [7]. Although our lidocaine con-

Table 1. Demographic data

	Supraclavicular block	IVRA group
Male/Female	12/28	20/20
Age (years)	45 ± 14	41 ± 12
Body mass (kg)	58 ± 11	61 ± 14
Height (cm)	156 ± 13	160 ± 15
Duration of surgery (min)	48 ± 21	45 ± 15

Number of patients or mean ± standard deviation were shown

Table 2. Results

	Supraclavicular group	IVRA group
Onset time (min)	16 ± 5	7 ± 3*
Number of patients with tourniquet pain	4/40	20/40*
Time to tourniquet pain (min)	60 ± 12	42 ± 8*
Number of patients with additional fentanyl	11/40	4/40*
Total dose of fentanyl (µg)	68 ± 31	84 ± 38*
Duration of postoperative analgesia (min)	55 ± 17	8 ± 5*

Number of patients or mean ± standard deviation were shown
*$P < 0.05$ vs. Supraclavicular group

centration was higher, and the volume smaller than these studies, the total dose of lidocaine in the present study was similar to other studies. In contrast, for the supraclavicular block, 1.5 to 2% lidocaine at doses of 15 to 32 mL were used in previous reports [1, 8, 9]. Therefore, 1% lidocaine at a dose of 20 mL in our study may not be sufficient. This could be the reason of more additional fentanyl being administered during surgery in the supraclavicular block.

For forearm surgery, the interscalene block did not provide effective anaesthesia [10]. Although the interscalene block had a longer onset time, it had a higher rate of phrenic nerve palsy than the supraclavicular block [2]. The infraclavicular block may have a faster onset and greater success than the supraclavicular block [3]. However, Tran *et al.* [4] reported both blocks had similar onset times and success rates. Although there has been one study to compare the infraclavicular block and IVRA [1], none has compared the supraclavicular block and IVRA. Therefore, we used the supraclavicular block.

The onset time of analgesia in IVRA has a large variation among the reports in the literature. Atanassoff *et al.* [11] reported IVRA with 0.5% lidocaine at a dose of 40 mL induced anaesthesia at 1.5 minutes. The onset time of the sensory block by IVRA with 2% lidocaine at doses of 12 to 15 mL was about 4 minutes, while that with 0.5% lidocaine at doses of 30 to 50 mL was about 7 minutes in a study by Ulus *et al.* [12]. However, Hartmannsgruber *et al.* [13] showed that loss of pinprick sensation occurred at 18 minutes in IVRA with 0.5% lidocaine at a dose of 40 mL. When considered in the light of these variations, our onset time of 7 minutes in IVRA may be deemed adequate. The onset time of the supraclavicular block was 16 minutes in our study. We could not find any studies using 1% lidocaine only in the supraclavicular block. Pinprick sensory block occurred at 22 minutes in the supraclavicular block with 2% lidocaine at doses of 25 to 30 mL and 5 μg mL^{-1} of epinephrine [1]. Tran *et al.* [4] reported an onset time of 18 minutes in the supraclavicular block with 1.5% lidocaine at a dose of 35 mL and 5 μg mL^{-1} of epinephrine [4]. Although these two studies used epinephrine, it usually did not delay the onset time [14]. While their study also used a higher concentration and volume of lidocaine than ours, contrary to our expectations, the onset time was slower than ours. Although we did not know the reason, either way, IVRA has a shorter onset time than the supraclavicular block.

In IVRA, a lower concentration of lidocaine initially diffuses into the small vein around the nerves, has effects on the small nerves and nerve endings, while a higher concentration involves nerve trunks [7, 15]. The faster onset of IVRA than the supraclavicular block may be explained by the greater susceptibility of small nerves to lidocaine. About 20 to 30 minutes after tourniquet inflation, ischemia induces hypothermia and acidosis, both tending to intensify analgesia by the use of lidocaine in IVRA [16, 17].

The duration of postoperative analgesia was 8 minutes in IVRA and 55 minutes in the supraclavicular block in the present study. Atanassoff *et al.* [11] showed the return of sensation occurred in 4.5 to 10 minutes in IVRA with 0.5% lidocaine at a dose of 40 mL. This is compatible with our results. However, times of 14.2 minutes with 2% lidocaine at doses of 12 to 15 mL and 14.6 minutes with 0.5% lidocaine at doses of 30 to 50 mL were reported in IVRA by Ulus *et al.* [12]. In this study, the duration of postoperative analgesia was determined as the time up to when the first postoperative analgesic was administered when the numerical rating score rose to more than 4, while sensory block disappeared at 9 minutes duration. In our study, the numerical rating scale was not assessed, and we judged the duration of analgesia by the patients' complaints of pain at the surgical site. Therefore, we had shorter duration of analgesia than the study by Ulus *et al.* [12]. In IVRA, although only a small dose of lidocaine should be enough to produce the block, it may be rapidly removed when circulation is restored. This would explain the rapid recovery of sensory function after tourniquet release.

In the supraclavicular block, we could not find any studies on the duration of postoperative analgesia using 1% lidocaine. Song *et al.* [14] used 1% mepivacaine, a short-acting local anaesthetic similar to lidocaine, at a dose of 40 mL, and had 290 minutes duration of sensory block in the supraclavicular block. Although they counted the time from the start of the block, our study used the time after surgery as the duration of postoperative analgesia is clinically more important, not the duration of the block itself. However, if we count the time from the start of the block, the analgesic duration was 95 minutes, which was shorter than their results. This difference may be due to the different effects between lidocaine and mepivacaine, or the different volume used. However, postoperative analgesia lasts longer in the supraclavicular block than in IVRA.

For upper extremity surgery, a tourniquet is usually used to decrease haemorrhage. We observed tourniquet pain at 42 minutes in IVRA and at 60 minutes in the supraclavicular block. In IVRA with 0.5% lidocaine at doses of 35 to 45 mL, 2/45 patients had tourniquet pain within 30 to 40 minutes in a study by Chan *et al.* [18]. Estebe *et al.* [19] also showed tourniquet pain at about 40 minutes after initial inflation in IVRA. Our results in IVRA were similar to these reports. Only one study reported tourniquet pain under the supraclavicular block with a combination of 0.75% ropivacaine, 2% mepivacaine and epinephrine at doses of 30 to 50 mL, and which occurred at 107 minutes [3]. The shorter emergence time of tourniquet pain in our study may be due to the difference in local anaesthetics. Tourniquet pain occurred later in the supraclavicular block than in IVRA.

We released the tourniquet at least 60 minutes after lidocaine administration in IVRA as our routine practice and did not observe any toxic side effects. As about 30% of local anaesthetic is fixed in the tissues within 20 minutes, toxicity was reported to have decreased after 20 minutes [7].

The limits of this study were as follows. Although we administered fentanyl during surgery according to a patient's complaint of feeling pain, some patients felt numbness as pain. In addition, postoperative analgesia was also checked against the patient's complaint not by a numerical rating scale. Both, therefore, may depend on the character of patient. Although the supraclavicular block was performed under nerve stimulation and ultrasound, the skill of anaesthesiologists still had a great effect on the quality of the block. Finally, side effects were checked only for two hours after surgery because of the duration of their stay in the recovery room.

CONCLUSION

For forearm surgery, although IVRA had shorter onset time and needed less additional fentanyl during surgery, it induced more tourniquet pain and had a shorter duration of postoperative analgesia than the supraclavicular block when 1% lidocaine at a dose of 20 mL was used.

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