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Blocks at the wrist using nerve stimulation for ambulatory hand surgery

Elisabeth Ternisien [a], Marc E. Gentili [b], Carole Orain [a], Eric Wodey [a], Claude Ecoffey [a,*]

[a] Department of Anesthesiology and Surgical Intensive Care, 2 Hôpital Sud, Université Rennes 1, Rennes, France
[b] Department of Anesthesiology A, Centre Hospitalier Privé Saint -Grégoire, Saint-Grégoire, France

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Abstract

One hundred and fifty-five patients were included in this prospective, open, multicenter study to examine the use of nerve stimulation to locate the median and ulnar nerves in ambulatory hand surgery. A sensory response was obtained in 65% of cases and a motor response in 65% with median nerve: the failure to elicit a motor response during median nerve stimulation was related to a higher failure rate of blocks ($P = 0.041$). A sensory response was reported in 63% and a motor response in 70% of the cases concerning the ulnar blocks: a sensory response was associated with greater success in the ulnar nerve ($P = 0.01$), while fourth and fifth fingers flexion increased the likelihood of failure ($P = 0.075$). This technique does not impair the organization of the surgical theatre (4 ± 3 min, mean ± S.D. block performance time) and 96% of patients were satisfied with the technique.

Keywords: Regional anesthesia; Wrist block; Median block; Ulnar block; Nerve stimulation; Surgery; Hand

1. Introduction

Ambulatory practice for hand surgery is wide used. Hand surgery with tourniquet under wrist blocks was first described in the early 1970s [1], but interest in this technique has recently increased. Wrist blocks appear to be effective, rapidly to perform and well tolerated by patients [2–4]. They are appropriate for short time procedures in ambulatory hand surgery including carpal tunnel release. They also reduce the time for discharge patients home [5] and may also offer cardiovascular stability when compared to general anesthesia [5]. Nerve trunks are usually identified by searching for paresthesia at this level but actively seeking paresthesia may increase the risk of postanesthetic neurological sequelae [6,7]. The use of a nerve stimulator is appealing in this setting. In wrist blocks for hand surgery, it has not been previously studied. Therefore, the current study have evaluated the easiness and acceptance, and tried to determine the most appropriate responses (either motor or sensory) of nerve stimulation at the wrist.

2. Methods

After Ethics Committee's approval and patient's written informed consent, 155 ASA I-III patients scheduled for carpal tunnel release were included in this prospective open, multicenter trial.

The local anesthetic was always plain 2% mepivacaine. Punctures sites were located 10 cm above the wrist crease. When surgery included the cutaneous distributions of radial and musculo-cutaneous nerves, both were blocked with a subcutaneous injection of 6 and 3 ml of solution, respectively. Nerve stimulation of the median and ulnar nerves used a nerve stimulator (HNS 111, B. Braun, Melsungen, Germany) with a 22 gauge, 30° bevel, 50 mm long insulated needles (Stimuplex, B Braun, Germany). The output of the nerve stimulator was initially set at an intensity of 1 mA (1 Hz) and then decreased as soon as any kind of response was observed until this one disappeared. The pulse duration was kept at the

* Corresponding author. Tel.: +33 29928 2422; fax: +33 29928 2421.
E-mail address: claude.ecoffey@chu-rennes.fr (C. Ecoffey).

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same setting for motor and sensitive responses. Then, 6 ml of 2% mepivacaine were injected on the site. No sedation was used during the performance of the block.

When stimulating the median nerve that is located between flexor carpis radialis and palmaris longus we looked for three kinds of responses: (1) fingers flexion, (2) thenar movements and (3) paresthesia in the fifth finger. The ulnar nerve (stimulated under flexor carpi ulnaris), was identified by four different responses: (1) fourth and fifth finger flexion, (2) thumb adduction, (3) hypothenar movements, (4) paresthesia in the fifth finger. After the block, patients were asked to grade discomfort during block performance on a graduated scale: 0 no pain, 1 medium pain, 2 severe pain.

The sensory block was assessed by a pin-prick using a 22 gauge needle, 15 min later. The ulnar distribution was tested at the medial aspect of the hand. The median nerve was evaluated at the palmar aspect of the hand at the level of the second finger and in the lateral part of the wrist was checked to test the cutaneous distribution of radial and musculocutaneous branches. If required, the anesthesiologist repeated the peripheral block by injecting, additional local anesthetic (3 ml per trunk) and reported any unblocked area (primary failure). When surgical incision was painful (secondary failure), physicians had the choice among, general anesthesia with 2–4% sevoflurane via a face mask, local infiltration by the attending surgeon (1–4 ml of 2% mepivacaine) and/or i.v. injection of alfentanil.

The values are expressed as mean ± S.D. The statistical analysis used Mann–Whitney test was used to compare quantitative values when a χ^2-test served for qualitative values.

3. Results

In 155 patients (50 ± 17 years old, male/females: 46%/54%), 143 median nerve blocks, 127 ulnar nerve blocks and 119 radial nerve and musculocutaneous nerve infiltrations were performed combined. No minor or severe complication related to the use of local anesthetics was reported. For median nerve blocks, paresthesia was elicited in 65% of the cases and a motor response was obtained in 65% of the cases. Fifty eight per cent of patients had thenar movements and 19% of them had fingers flexion. For ulnar nerve blocks, paresthesia was obtained in 63% and a motor response in 70% of the cases: 58% of fourth and fifth finger flexion, 26% of thumb adduction and 26% of carpe flexion.

Reinjections were performed in 14% of the cases: 4.6% for the median nerve, 8% for the ulnar nerve and 2% for the radial nerve. Secondary failure rate occurred in 15% of the cases: local infiltration was used to treat failure in 11.3% of the cases, i.v. alfentanil injections in 0.7% of the cases and general anesthesia in the remaining 3%. As soon as any kind of adjustment was needed, either pre or intra-operative, the block was considered as unsuccessful (global failure): the total failure rate was 25%. Age, sex, premedication (intravenous midazolam 0.5–1.5 mg accordingly to clinical judgment at arrival in the operating room), emergency surgery, difficult anatomical landmarks or time between blocks and surgery did not seem to have any impact on the rate of anesthesia failure or success.

In the median nerve territory, failed motor response was associated with significant 10% primary failure rate ($P = 0.041$). We identified a group of 25 people who received only single median nerve block. No failure was observed when a motor response was elicited while failure rate reached 40% when only paresthesia were elicited ($P = 0.0075$). Thenar or fingers movements had the same positive predictive value, i.e. success if a motor response was elicited. Primary and global failure rates were 2 and 14%, respectively, for finger movements, 0 and 16% for thenar movements and 7 and 13% when both of movements were found.

Obtaining paresthesia was statistically associated with a lower rate of primary failures in the ulnar nerve distribution ($P = 0.01$). In a group where motor responses were obtained (whether they were associated or not with sensory response), we noticed that fourth and fifth finger flexion was correlated with a higher rate of primary failure ($P = 0.014$).

No patient experienced severe pain during block performance, 30% of them described moderate pain and 70% described the technique as not painful. The average block performance lasted 4 ± 3 min.

4. Discussion

The use of nerve stimulation to block the median and ulnar nerve at the wrist is rapidly performed and well accepted by patients' in hand ambulatory surgery.

The only way to predict success may be to examine the quality of the responses. Examination of the types of motor sensory responses showed that median nerve motor responses and ulnar nerve sensory responses were associated with a higher rate of success. Some anatomical consideration may explain these findings. The median nerve is located between the flexor carpi radialis and the palmaris longus, just under a superficialis aponeurosis. Its motor fibers are mostly posterior and the sensitive fibers are more superficial [8,9]. Therefore, we consider that an only paresthesia could indicate a too shallow location of the tip of the needle. In this case, the local anesthetic may spread above the aponeurosis (Fig. 1). Furthermore, we know that the sensitive dorsal branch of the ulnar nerve arises at an average distance of 8.5 cm from the wrist crease and then passes dorsal to the flexor carpi ulnaris [10]. The path of the ulnar nerve suggests that the lack of a paresthesia could mean that this dorsal branch is not stimulated (because it may be already separated from the main branch). As a consequence, this dorsal branch may be excluded from local infiltration (Fig. 2). Fourth and fifth finger flexion is due to flexor digitorum profundus whose nerve emerges from the ulnar several centimeters above our puncture site (Fig. 3). Therefore, this response may be the

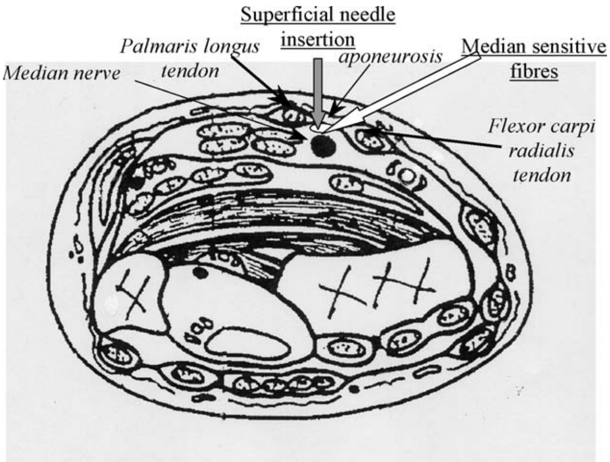

Fig. 1. Forearm section 10 cm above the wrist crease: median sensitive fibers are superficial. Just sensitive responses correspond to superficial needle localizations. Local anesthetic is injected partly above aponeurosis.

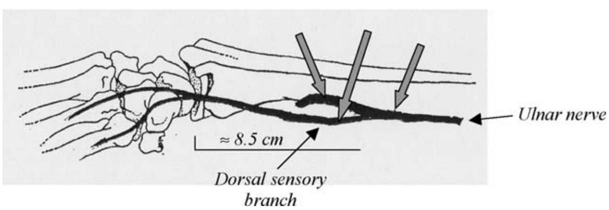

Fig. 2. Ulnar dorsal sensory branch: anatomy and different punctures sites.

result of a direct muscular stimulation leading to a useless, intramuscular injection (Fig. 4).

The main limit of our study is the inability to determine which nerve was insufficiently blocked during surgery (secondary failure). This constraint prevented us from finding any relation between nerve stimulation and global failure (that

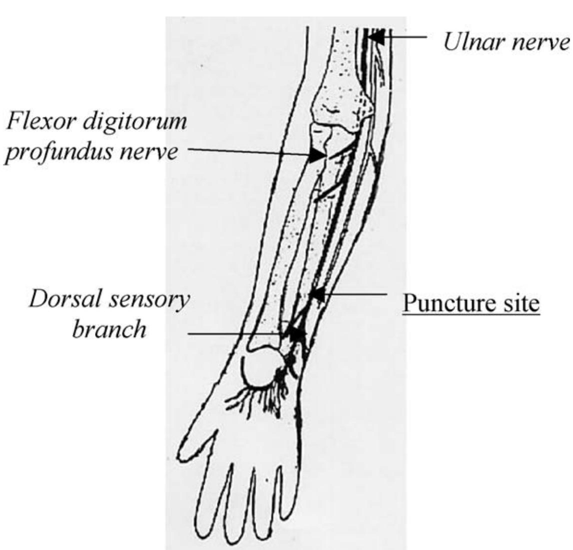

Fig. 3. Ulnar nerve anatomy. Flexor digitorum profundus nerve emerges several cm above our puncture site.

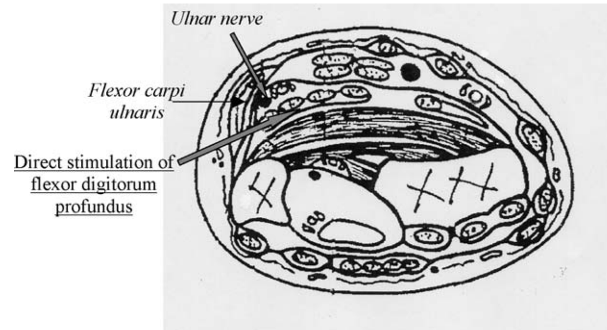

Fig. 4. Forearm section 10 cm above the wrist crease. A needle inserted in a posterior direction can stimulate directly flexor digitorum profundus.

totals pre and intra-operative adjustments and as a result is less specific than primary failure). On the other hand, per operative adjustments are undesirable events that should have been avoid by testing. We link this observation to our pinprick method which stimulates only A beta and A delta fibers when C fibers are not tested [11].

Despite these drawbacks, our results led us to believe that response analysis could help to determine needle position. If one stimulates the median nerve and obtains just a paresthesia and no motor responses, the needle is certainly placed on the surface of the nerve. When no sensitive response is found at ulnar stimulation, the needle may have been inserted after the emergence of the dorsal branch. As a fourth and fifth finger flexion is obtained, the needle is too posterior, in flexor digitorum profundus muscle. The rate of 25% of global failure may seem high. However, it is lower than those observed in previous studies that did not use neurostimulation [4]. Furthermore, we have shown that some stimulated responses may induce poor results. As a result, we think that it would be possible to improve the technique in the future by searching for the right response during neurostimulation.

In conclusion, nerve stimulation at distal forearm may be an alternative to other more extensive regional techniques [12]. Time to perform the block was short and discomfort produced by the technique was well tolerated. Elicitation of a motor response for median nerve and of a sensory response for ulnar nerve block may improve the results of this technique.

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