Alternative site for median nerve blockade allowing early functional rehabilitation after hand surgery

Autre site pour un bloc du nerf médian permettant une rééducation fonctionnelle précoce après chirurgie de la main

Tatsunori Watanabe, MD · Ippei Watanabe, MD, PhD ·
Masahiro Koizumi, MD · Andrey B. Petrenko, MD, PhD ·
Hiroshi Baba, MD, PhD

Received: 7 August 2011 / Accepted: 18 October 2011 / Published online: 29 October 2011
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Abstract

Purpose *In this report we describe an alternative approach to catheter placement for continuous selective median nerve blockade. It spared the finger movements and therefore allowed early postoperative rehabilitation in a patient who underwent surgical repair of the index finger flexor tendon.*

Clinical features *A patient with a complicated history of traumatic index finger flexor tendon rupture, surgical repair, failed rehabilitation due to poor postoperative pain control, adhesion formation, and subsequent rerupture due to tenolysis was admitted for reconstructive surgery. This time, a continuous regional block was used. Although the insertion of a catheter at the wrist level would have spared*

the anterior interosseous branch of the median nerve and preserved finger movements, a more distant site had to be chosen to avoid proximity to the surgical wound. Therefore, under combined ultrasonography and neurostimulation guidance, the catheter was inserted in the proximal one-third of the patient's forearm distal to the branching-off point of the anterior interosseous nerve. Continuous ropivacaine infusion was initiated and maintained until being stopped on the afternoon of the third postoperative day, providing good analgesia without interfering with postoperative physiotherapy, which was successfully completed during this hospitalization.

Conclusion *Placement of a catheter for continuous median nerve blockade in the proximal one-third of the forearm for effective postoperative pain-free rehabilitation after hand surgery should be considered in cases in which the surgical incision extends toward the patient's wrist. The block site can be readily identified by a combined use of ultrasonography and neurostimulation guidance.*

Author contributions *Tatsunori Watanabe was involved in the concept and design, acquisition and interpretation of data, drafting the article, and final approval. Ippei Watanabe was involved in the concept and design, drafting the article, and final approval. Masahiro Koizumi was involved in the concept and design, drafting the article, and final approval. Andrey B. Petrenko was involved in interpretation of data, revising the article critically, and final approval. Hiroshi Baba was involved in interpretation of data, revising the article critically, final approval.*

T. Watanabe, MD (✉) · A. B. Petrenko, MD, PhD · H. Baba, MD, PhD
Division of Anesthesiology, Niigata University Graduate School of Medical and Dental Sciences, 1-757 Asahimachi, Chuo-ku, Niigata 951-8510, Japan
e-mail: deepimpact034@yahoo.co.jp

I. Watanabe, MD, PhD
Department of Anesthesiology, Niigata Prefectural Central Hospital, Joetsu, Japan

M. Koizumi, MD
Department of Orthopedics, Niigata Prefectural Central Hospital, Joetsu, Japan

Résumé

Objectif *Dans ce rapport, nous décrivons un autre approche de mise en place du cathéter pour un bloc continu sélectif du nerf médian. Il a épargné les mouvements des doigts et a donc permis une rééducation post opératoire précoce chez un patient ayant subi une réparation chirurgicale du tendon du fléchisseur de l'index.*

Caractéristiques cliniques *Un patient ayant des antécédents complexes de rupture traumatique du tendon du fléchisseur de l'index a été hospitalisé pour chirurgie reconstructrice après échec de la rééducation après réparation chirurgicale en raison d'un mauvais contrôle de la douleur postopératoire, de la formation d'adhérences et d'une rupture secondaire par ténolyse. Cette fois-ci, un bloc régional continu a été utilisé. Bien que l'insertion*

d'un cathéter au niveau du poignet aurait épargné la branche antérieure interosseuse du nerf médian et préservé les mouvements de l'index, un site plus éloigné a dû être choisi pour éviter la proximité de la cicatrice chirurgicale. Le cathéter a donc été inséré sous guidage de l'échographie et de la neurostimulation dans le tiers proximal de l'avant-bras du patient, distalement par rapport à l'embranchement du nerf interosseux antérieur. Une perfusion continue de ropivacaïne a été débutée et a été poursuivie jusqu'à son arrêt au cours de l'après-midi du troisième jour postopératoire, procurant une bonne analgésie sans interférer avec la physiothérapie postopératoire qui a été terminée avec succès pendant l'hospitalisation.

Conclusion *Le positionnement d'un cathéter pour bloc continu du nerf médian dans le tiers proximal de l'avant-bras doit être envisagé pour une rééducation efficace et indolore postopératoire après chirurgie de la main dans les cas où l'incision se prolonge vers le poignet du patient. Le site du bloc peut être facilement identifié en utilisant conjointement un guidage échographique et la neurostimulation.*

Although early active mobilization after tendon repair is critical for preventing scar tissue formation and adhesions,¹ it is often hindered by postoperative pain. Continuous peripheral neural blockade has been shown to improve early rehabilitation and to provide better pain relief than intravenous patient-controlled analgesia with opioids.^{2,3} However, the use of regional analgesia may lead to varying degrees of motor blockade, which can compromise postoperative rehabilitation. It is particularly necessary to preserve active flexion finger movements during rehabilitation after index finger flexor tendon repair.

The palmar surface of the index finger is innervated by the median nerve. The index flexion movements are controlled by the flexor digitorum profundus muscle, which is innervated by the anterior interosseous nerve (AIN) and branches off the median nerve 224 mm from the carpal joint.⁴ To preserve the function of the AIN, Broekhuysen *et al.*⁵ reported that inserting a catheter immediately proximal to the carpal tunnel for continuous infusion of local anesthetic provided analgesia with preservation of motor function and proprioception for early rehabilitation after hand surgery. However, in cases when the surgical wound extends to the palm, insertion of the catheter at the level of the carpal tunnel should be avoided because of possible wound swelling and leakage of anesthetic solution.

In recent years, regional anesthesia techniques have become more reliable because of implementation of ultrasonography and neurostimulation guidance. The combined use of these methods not only allows selective blockade of sensory

nerves while sparing motor branches, it facilitates catheter placement at unconventional locations.

We describe a patient in whom a continuous selective sensory blockade of the median nerve was possible because of placing a catheter in the proximal one-third of the forearm distal to the branching-off point of the AIN under combined ultrasonography and neurostimulation guidance. Good pain relief and preservation of finger movements without motor blockade were obtained in this patient throughout the rehabilitation period after index finger flexor tendon repair surgery.

The patient gave her consent for publication of this case report.

Case report

A 30-yr-old woman (160 cm height, 49 kg body weight) with a right index finger flexor tendon rupture was admitted for reconstructive surgery. She had injured the flexor digitorum superficialis and profundus (FDP) tendon in zone 2 of her right index finger one year previously and underwent FDP tendon repair by direct suturing. However, at that time she could not undergo sufficient postoperative rehabilitation because of severe pain. No regional block was performed, and her pain medication included only nonsteroidal antiinflammatory drugs. As a result of insufficient analgesia, the patient developed heightened anxiety about painful procedures. Tendon adhesion then developed, causing contracture of the proximal interphalangeal joint; and a subsequent effort to attain tenolysis by forced exercise caused rerupture.

Therefore, she was scheduled for a reconstructive procedure that had to be performed in two stages. For stage 1, three months prior to the present admission, a silicon rod was inserted that extended from the fingertip to the distal forearm, and an A3 pulley reconstruction was carried out. For stage 2, which was performed during the present admission, the silicon rod was removed, and the harvested palmaris longus tendon was passed into the remaining space. A standard tendon graft was employed for the tendon grafting procedure. The distal end of a free tendon was attached to the distal phalanx with four 4/0 sutures according to the Kessler method. The sutures were pulled out from the distal phalanx to the dorsal side of the nail and tied over a button. Tendon suturing at the palmar end was performed by the Pulvertaft interlacing technique.

Anesthesia was induced with propofol and maintained with sevoflurane and fentanyl. Spontaneous breathing was maintained via a laryngeal mask throughout the operation. Upon completion of the surgery and before emergence from anesthesia, a catheter was placed for continuous

median nerve blockade and preservation of index finger movements during rehabilitation. For this purpose, the skin was disinfected with 10% povidone-iodine and draped sterilely. A high-frequency (5–10 MHz) ultrasonography probe (SonoSite MicroMaxx; SonoSite, Tokyo, Japan) was placed on the forearm approximately 5 cm from the elbow, and the median nerve was readily identified (Fig. 1). To spare the AIN and preserve the contractive function of the flexor digitorum profundus muscle, a nerve stimulation needle (Pole Needle; Top Corporation, Tokyo, Japan) connected to a neurostimulator (Neutracer; Top Corporation) set at 0.5 mA and 1 Hz was inserted using a plane method to identify the stimulation position that caused contraction of the thenar muscle without contraction of the index finger flexor. After hydraulic separation of the surrounding tissues by a 5% glucose solution injected through the stimulation needle, an 18-gauge Tuohy needle (Hakko, Nagano, Japan) was inserted using an out-of-plane method, and a catheter (nonstimulating, 0.8 × 950 mm; Hakko, Nagano, Japan) was advanced 10 cm distally through the needle without difficulty (Fig. 2). Next, to verify the perineural placement of the tip of the catheter, we injected a small amount of air through it and confirmed air spread around the nerve circumference via ultrasonography examination. After a negative aspiration test, 10 mL of 0.1% ropivacaine was injected, and the catheter was secured with a transparent adhesive dressing. A patient-controlled infusion system (Coopdech Balloonjector; Dai-ken Medical, Osaka, Japan) was started with 0.1% ropivacaine ($4 \text{ mg} \cdot \text{hr}^{-1}$ as a basal infusion rate) via the catheter. Patient-controlled boluses of 3 mg were available every 30 min. She also received loxoprofen (Loxonin; Daiichi Sankyo, Tokyo, Japan), 60 mg three times a day, starting on the first postoperative day. We would have resorted to opioids only if continuous nerve block was

Fig. 2 Catheter insertion

insufficient; this was not the case, however, and opioids were not required.

The effectiveness of the neural blockade was evaluated upon the patient's emergence from anesthesia by subjective pain ratings reported by the patient. Sensory levels in the hand could not be tested because of the presence of the wound dressing.

During the daytime, the patient's interphalangeal joints were in the flexed position, held in place by rubber bands (Fig. 3); at night, they were fixed in the extended position. Dynamic flexion traction with a palmar pulley was applied to all four digits. Mobilization started on the first postoperative day and was performed twice a day during morning and afternoon sessions with the assistance of a physiotherapist. Each session was preceded by a bolus dose of ropivacaine. Full, active extension was ensured by unloading the tension of the rubber bands; this was accomplished by uncoupling them proximally during the extension phase. The passive flexion produced by the

Fig. 1 Ultrasonographic image of the median nerve. A cross section of the forearm is shown

Fig. 3 Fixed flexed position using rubber bands

Fig. 4 Numerical rating scale (NRS) scores in the flexed and extended positions and during exercise. The patient experienced only mild to moderate pain that did not significantly affect her general state or rehabilitation exercise

rubber bands was increased by the patient pushing down on the tips of the digits with the help of a physiotherapist. While passively flexing the interphalangeal joints as much as possible, the patient actively contracted her flexor muscles for approximately two to three seconds each time. In addition to daily physiotherapy, the patient performed ten active interphalangeal joint extension exercises hourly without the need for analgesic ropivacaine boluses.

Pain intensity was assessed by a numerical rating scale (NRS).⁶ The patient recalled that her NRS score was 7–8/10 during the previous rehabilitation, and she had been unable to perform enough exercise because of severe pain. This time, however, there was no pain hindering the rehabilitation process, which went much more smoothly (Fig. 4). Moreover, the patient experienced no weakness or numbness in her arm, and she required bolus doses of ropivacaine only twice a day, before each physiotherapy session.

Because the patient's pain scores were significantly reduced, the continuous infusion was provisionally stopped on the afternoon of the third postoperative day. No pain hindered the rehabilitation exercise on the morning of the fourth postoperative day, and the catheter was removed without complications or residual symptoms. She was then able to complete the full rehabilitation course successfully without pain.

Discussion

Early active mobilization after free tendon grafting for finger flexor tendon injury is essential to prevent the formation of scar tissue and adhesions,¹ and it plays a significant role in uneventful functional recovery. The early active mobilization program used here was a combination of dynamic traction, additional passive flexion with the help of a physiotherapist, and simultaneous active flexion and active extension.¹

In this case, to avoid blockade of AIN and preserve index finger movements, a catheter for continuous median nerve blockade was inserted distally to the branching-off site of the AIN. However, because of the small caliber of the AIN, we foresaw that its identification would be difficult with ultrasonography alone. As expected, the AIN was not visible, so we resorted to neurostimulation to identify the location at which stimulation did not result in flexion of the index finger. We selected a location distal to the point where the AIN branches off as the puncture point. This combined ultrasonography- and nerve stimulation-guided approach for continuous nerve blockade spared the anterior interosseous branch of the median nerve and preserved the function of the flexor digitorum profundus muscle.

We advanced a catheter to 10 cm from the assumed branching-off point of the AIN to prevent its possible block by the spread of the anesthetic solution. Although we experienced no difficulties in threading the catheter, and no catheter kinking or displacement occurred in our patient, a more distal site and a lesser catheter insertion length (3–5 cm) should result in wider acceptance of this technique.

In our case, although the surgical wound extended to the palm, there were no resultant wound complications because the catheter was placed near the elbow, away from the wound. Thus, our method has a certain amount of flexibility because it can be adjusted to the type of surgery.

For sensory analgesia we chose 0.1% ropivacaine, a concentration that prevented the development of numbness in the extremity. Although higher concentrations of ropivacaine could potentially provide better pain relief, the 0.1% concentration was sufficient for successful rehabilitation, and numbness was not reported.

It has been reported that after knee surgery continuous peripheral blockade provides significantly better knee flexion than intravenous patient-controlled analgesia with morphine during the early stage and until six weeks after surgery, although these benefits do not affect the outcome

at three months.⁷ Particularly for finger flexor tendon repair, however, good pain relief obtained by continuous peripheral nerve blockade facilitates early active mobilization and thus prevents the formation of scar tissue and adhesions at finger joints. Although its efficacy must be verified in future studies, it could potentially improve long-term outcomes.

Peripheral nerve blockade should not be performed routinely in adults under general anesthesia.⁸ The risk-to-benefit ratio of performing this procedure in anesthetized patients may be acceptable in select cases, such as in our patient, who had severe anxiety regarding painful procedures because of her past experience with poorly controlled pain. In such cases, all necessary precautions—avoidance of high-pressure injections, sufficient hydraulic separation of surrounding tissues, performance of the procedure under ultrasonography guidance—should be taken to minimize the risk of nerve injury.

When a patient is enrolled in a continued and intensive rehabilitation program immediately after surgery, an indwelling catheter is probably preferable to a single-shot technique. The catheter allows constant local anesthetic delivery and preemptive bolus injections before each active exercise session.

Although our patient was admitted for scheduled in-hospital treatment, we believe that the analgesia technique we used can be easily adapted for outpatient management given appropriate care of the catheter. In fact, Ilfeld *et al.*⁹ reported that continuous peripheral nerve blockade with a portable infusion pump could be used effectively and safely for postoperative pain control at home.

In conclusion, we report successful use of a combined ultrasonography- and nerve stimulation-guided approach for continuous selective sensory median nerve blockade. This approach spares the AIN and preserves the function of the flexor digitorum profundus muscle. In our patient, who

underwent reconstructive surgery of the index finger flexor tendon, the technique proved effective for pain control during early active mobilization.

Competing interests None declared.

References

1. Silyferskiold KL, May EJ. Early active mobilization of tendon grafts using mesh reinforced suture techniques. *J Hand Surg Br* 1995; 20: 301-7.
2. Capdevila X, Barthelet Y, Biboulet P, Ryckwaert Y, Rubenovitch J, d'Athis F. Effects of perioperative analgesic technique on the surgical outcome and duration of rehabilitation after major knee surgery. *Anesthesiology* 1999; 91: 8-15.
3. Borgeat A, Tewes E, Biasca N, Gerber C. Patient-controlled interscalene analgesia with ropivacaine after major shoulder surgery: PCIA vs PCA. *Br J Anaesth* 1998; 81: 603-5.
4. Sunderland S. The median nerve. Anatomical and physiological features. In: Sunderland S, editor. *Nerves and Nerve Injuries*. 2nd ed. Edinburgh London and New York: Churchill Livingstone Inc.; 1978. p. 656-90.
5. Broekhuysen CL, Fechner MR, Kerckamp HE. The use of a selective peripheral median nerve block for pain-free early active motion after hand surgery. *J Hand Surg Am* 2006; 31: 857-9.
6. Breivik H, Borchgrevink PC, Allen SM, *et al.* Assessment of pain. *Br J Anaesth* 2008; 101: 17-24.
7. Singelyn FJ, Deyaert M, Joris D, Pendeville E, Gouverneur JM. Effects of intravenous patient controlled analgesia with morphine, continuous epidural analgesia, and continuous three-in-one block on postoperative pain and knee rehabilitation after unilateral total knee arthroplasty. *Anesth Analg* 1998; 87: 88-92.
8. Neal JM, Bernards CM, Hadzic A, *et al.* ASRA Practice Advisory on Neurologic Complications in Regional Anesthesia and Pain Medicine. *Reg Anesth Pain Med* 2008; 33: 404-15.
9. Ilfeld BM, Morey TE, Enneking FK. Continuous infraclavicular brachial plexus block for postoperative pain control at home: a randomized, double-blinded, placebo-controlled study. *Anesthesiology* 2002; 96: 1297-304.