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Brachial plexus infusion of ropivacaine with patient-controlled supplementation

Purpose: To report the use of continuous brachial plexus analgesia to facilitate physiotherapy

Clinical Features: A 34-yr-old man had contractures of the fingers of his dominant hand following a crush injury in 1996. After several operations, he continued to experience severe pain and disability. In order to facilitate pain-free active and passive physiotherapy, we performed an axillary brachial plexus block. After insertion of a brachial plexus catheter via the axilla, analgesia was continued for a period of one week using a $3 \text{ ml}\cdot\text{hr}^{-1}$ background infusion of ropivacaine 0.2% with the facility for additional patient-controlled 1 ml boluses. Both active and passive physiotherapy was carried out daily for the entire week.

Conclusion: This technique was successful with no major complications and resulted in a marked reduction in pain, with improved range of finger movement and general upper limb function.

Objectif : Rapporter l'usage d'analgésie continue du plexus brachial pour faciliter la physiothérapie.

Éléments cliniques : Un homme de 34 ans présentait des contractures aux doigts de la main dominante après avoir souffert du syndrome d'écrasement en 1996. Il éprouvait toujours des douleurs sévères et de l'incapacité après avoir subi quelques opérations. Afin de faciliter la physiothérapie active et passive indolore, nous avons réalisé un blocage du plexus brachial axillaire. Nous avons inséré, par le creux axillaire, un cathéter dans le plexus brachial et maintenu l'analgésie pendant une semaine avec une perfusion de $3 \text{ ml}\cdot\text{hr}^{-1}$ de ropivacaine à 0,2 % et la possibilité de bolus complémentaires de 1 ml d'analgésie contrôlée par le patient. La physiothérapie active et passive a eu lieu quotidiennement, toute la semaine.

Conclusion : Cette technique a réussi sans complications majeures et a permis une importante réduction de la douleur ainsi qu'une amélioration notable de la motilité des doigts et de la fonction générale du membre supérieur.

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Accepted for publication May 6, 2000.

Case history

A 93 kg, 34-yr-old man presented to our department with pain and loss of function of his right hand that was causing particular difficulty with physiotherapy. A crushed right hand injury during work three years earlier had resulted in a compound fracture of his first and third metacarpal bones with dislocation of fourth and fifth carpo-metocarpal joints and extensive soft tissue damage. Following repeated debridement of necrotic tissue, internal fixation was performed. Late reconstructive surgery had been done requiring tendon release to restore mobility of the digits. However, he continued to have limited movement of his index, middle and ring fingers and restricted adduction and opposition of his thumb. Apart from the presence of pain and allodynia, there was no evidence of temperature or sudomotor changes and the possibility of Complex Regional Pain Syndrome (CRPS) was excluded.

At presentation, he had marked pain during active and passive movement of his fingers and recorded a zero to ten visual analogue score for pain (VAS) of 5 at rest. Following an explanation of brachial plexus block and patient-controlled analgesia (PCA), informed consent was obtained. A brachial plexus block was performed via the axillary approach using an 18G Tuohy needle with a nerve stimulator (Innervator NS272, Fisher & Paykel Health Care). A 14G intravenous catheter sheath (Angiocath, Becton Dickinson) provided insulation for the needle. A corresponding size epidural catheter was inserted through the Tuohy needle that was then removed, and 20 ml of ropivacaine 0.2% were injected slowly through the catheter. Eight centimeters of catheter were left in the axilla for infusion of local anesthetic. A PCA pump (Graseby 9300 Ambulatory Infusion Pump, Graseby Medical, UK) was used to provide a background infusion of ropivacaine 0.2% at 3 ml·hr⁻¹ (6 mg·hr⁻¹) with the facility for a 1 ml (2mg) bolus on patient demand. The lock-out interval was set at 10 min with a maximum hourly limit of 5 ml (10 mg) including both the background infusion and the PCA boluses.

The visual analogue pain score decreased to zero following institution of the block. Due to the large initial bolus dose (20 ml ropivacaine 0.2%), there was also a considerable degree of motor paralysis. He was not able to lift up his shoulder nor could he move his elbow and wrist. The next day, much of the hypoaesthesia in his arm, especially over the distribution of the ulnar nerve, had dissipated but his VAS remained 0-2. Active physiotherapy was being carried out twice a day and a passive physiotherapy device (Mobilimb H2, Hand CPM, Toronto Medical, Canada) was being used for continuous flexion and extension of the mid-

dle finger. The catheter remained *in situ* for a further six days without evidence of site infection.

An observation chart was used by the ward nursing staff to document vital signs, VAS, muscle power (shoulder, elbow and hand), touch sensation by cotton wool ball and any signs of local anesthetic toxicity (dizziness, oral numbness). The observations were done four-hourly. The VAS score remained at 2-3 throughout the six days and he only had 14 additional PCA demands (all successful). The ropivacaine infusion rate was increased to 3.5 ml (7 mg·hr⁻¹) on day 4 following the patient's request for more analgesia. The total cumulative dose of ropivacaine given to the patient was 452 ml (904 mg), an average of 6.79 mg·hr⁻¹.

There was a considerable improvement in mobility of his fingers during and after the ropivacaine infusion (Table I).

Throughout the period of infusion, there were no signs or symptoms of local anesthetic toxicity. His blood pressure and heart rate were normal and sensation to his arm remained intact, after the effects of the initial bolus of ropivacaine had dissipated. His muscle power was mostly graded as 5 (scoring system of 0-5 where 0 = no power and 5 = full power, Table II). However, during the last three days, after a dressing change on day four, his hand power was reduced to 3-4 after an increase in the infusion rate from 6 mg·hr⁻¹ to 7 mg·hr⁻¹.

Upon follow up in the physiotherapy unit, he continued to display an increased range of movement to his index and middle fingers (Table I). His pain score

TABLE I Range of movement (flexion / extension) before and after treatment

	<i>Passive movement before brachial plexus block</i>	<i>Passive movement one week after brachial plexus block</i>
Middle finger MCP joint	30-30°	25-40°
Middle finger PIP joint	15-20°	15-60°
Middle finger DIP joint	40-50°	40-60°

TABLE II Grading of muscle power

Grade 5 = Normal	Complete range of motion against gravity and full resistance for 5 sec
Grade 4 = Good	Complete range of motion against gravity with some resistance
Grade 3 = Fair	Complete range of motion against gravity
Grade 2 = Poor	Complete range of motion with gravity eliminated
Grade 1 = Trace	Slight muscle contraction, no joint motion
Grade 0 = Zero	No evidence of contraction

remained at 2-3 after cessation of the infusion. He continued to receive active physiotherapy three times per week and both his contractures and function were much improved. Further tendon transfers to thumb and middle finger were performed to improve the range of movement and strength of the digits.

Discussion

The treatment objectives for this patient were to improve mobility, decrease pain and allow effective physiotherapy. Non-steroidal anti-inflammatory drugs (NSAIDs) had been used but failed to produce sufficient pain relief. Considering the frequency of treatment, problems of dose titration and the potential for development of tolerance and dependence with chronic use, we were reluctant to administer opioids. We felt that a local anesthetic technique should be better able to provide effective analgesia for a relatively long period of time (one week) while maintaining patient co-operation during treatment. Continuous axillary brachial plexus block has been used extensively in the past to treat acute postoperative pain.¹ The concept of patient-controlled local anesthesia for analgesia has also been studied and well documented² and we felt that this would be a reasonable choice for this patient. An epidural catheter was used because of its flexibility, small size and ease of fixation. The use of an 18G Tuohy needle, with a 14G IV cannula as insulation for the peripheral nerve stimulator, proved to be an effective catheter placement technique.

We chose to use ropivacaine because it is reported to be less cardiotoxic and to preserve muscle movement better than other long acting local anesthetic drugs.^{3,4} There is only one report of ropivacaine infusion on the brachial plexus and it was used to treat phantom limb pain.⁵ It was found to be an extremely useful technique; not only providing analgesia but also preserving muscle power in the upper limbs.

We used a concentration of ropivacaine 0.2% to restrict the infusion volume and minimize the pressure inside the brachial plexus sheath. With any local anesthetic infusion technique, there is always the potential for systemic toxicity because of drug absorption or catheter migration. An initial infusion rate of 6 mg·hr⁻¹ is unlikely to cause systemic toxicity but as the patient had the ability to increase the dosage via PCA, and there is always a danger of man-made or mechanical malfunction of any infusion device, it was important for us to initiate an effective monitoring protocol for early detection and treatment. We did this by measuring blood pressure, heart rate and observing central nervous system signs such as consciousness, dizziness and perioral paresthesia four-hourly. We also made the

patient aware of these risks and encouraged him to report any problems. Based on these clinical observations, there were no complications during the six-day infusion. However, we did not have the appropriate laboratory facilities to measure actual ropivacaine blood concentration.^{6,7}

Due to the selectivity of ropivacaine blockade for sensory nerves, muscle movement should be better preserved than with bupivacaine.⁸ This was particularly beneficial since both active and passive physiotherapy could be undertaken effectively during the infusion period, with minimal pain and good muscle power. Continuous motion machines were used throughout the day and night to improve passive range of movement and prevent further deterioration. Strengthening exercises are also possible in pain free digits.

One disadvantage of our technique is the possibility of catheter related infection,⁹ although this was not a problem in this case. It is often related to the site and duration of insertion and a potential improvement may be to introduce the catheter via a 'tunnel' under the skin, similar to the insertion of a parenteral nutrition catheter for prolonged intravenous use. The exit site of the catheter could then be further away from the axilla, a site that may have a higher potential to become infected.

Although a single case report would not be able to provide sufficient information to conclude that ropivacaine is a safer drug to use in this context, it is our opinion that it is a more logical choice due to its lower potential for systemic toxicity and lack of motor blockade.

The patient was reviewed at the pain clinic four weeks after discharge and in the orthopedic outpatient clinic three months later. He still experiences much less pain, even during physiotherapy (VAS=2), and movement of his hand and fingers continues to improve.

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