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Distal forearm tourniquet for hand surgery

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Abstract To evaluate the usefulness of the tourniquet placed at the distal forearm, 30 patients were operated with the tourniquet set at the distal forearm using nerve-block anaesthesia. Pain during surgery, flexion of the fingers, bloodless field, and general complications during surgery and 18 months thereafter were recorded. The mean time of ischemia was 19.6 ± 7.5 (10–50) min. A bloodless field was achieved in all cases, and pain during operation was low. Flexion of the fingers were found in most cases but was reducible and not annoying for the surgeon. There were no serious complications during surgery or at follow-up. The tourniquet placed at the distal forearm is painless, safe, and useful in hand surgery.

Résumé Pour évaluer l'utilité du garrot placé à la partie distale de l'avant-bras, 30 malades ont été opérés avec le garrot dans cette position et une anesthésie par bloc nerveux. La douleur pendant la chirurgie, la flexion des doigts, l'exsanguinité du champ opératoire et les complications générales pendant la chirurgie et 18 mois ensuite ont été enregistrées. Le temps moyen d'ischémie était de $19,6 \pm 7,5$ min (10–50). Un champ exsangue a été obtenu dans tous les cas. La douleur pendant l'opération était faible. La flexion des doigts a été notée dans la plupart des cas, mais était réductible et ne gênait pas le chirurgien. Il n'y avait pas de complication sérieuse. Seulement une blessure nerveuse a été suspectée. Le garrot placé à la partie distale de l'avant-bras est indolore, sûr et utile dans chirurgie de la main.

Introduction

A pneumatic tourniquet is usually employed during surgery of the hand to provide a bloodless field. The tourniquet has been traditionally placed at the upper arm, but recent work has shown that it is possible to set it more distally at either the forearm [4, 6] or wrist [3, 5]. Local anaesthesia or peripheral blockades are commonly used [4, 8, 9] to prevent complications related to regional or general anaesthesia. Nevertheless, some concern has arisen regarding pain due to tourniquet when it is placed at the forearm [8] and only local anaesthesia is used. The objective of this work was to test the utility of the tourniquet placed at the distal forearm.

Patients and methods

Thirty consecutive patients subjected to hand surgery enrolled the study. They all gave informed consent to participate, and ethical approval from our institution was obtained.

Technique

A complete nerve block anaesthesia at the distal forearm (three finger breadths proximal to the palmar wrist crease, or about 5 cm) was performed with mepivacaine 2%. The median nerve was first blocked with 5 ml just radial to the palmaris longus tendon. The ulnar nerve was blocked with 5 ml of solution delivered between the flexor carpi ulnaris muscle and the ulna 5 cm proximal to the palmar wrist crease. Using the same puncture, the dorsal branch of the ulnar nerve and the terminal endings of the anterior and posterior branch of the medial cutaneous nerve of the forearm were blocked with a subcutaneous bar of 4 ml directed anteriorly and posteriorly for about 3–4 cm each. The superficial branch of the radial nerve, the terminal endings of the posterior cutaneous nerve of the forearm (radial nerve) and the lateral cutaneous nerve of the

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forearm (musculocutaneous nerve) were blocked through a subcutaneous bar of 4 ml directed anteriorly and posteriorly from a subcutaneous puncture in the radial border of the radius 5 cm proximal to the palmar wrist crease.

At least 10 min were allowed for the block to set. After that, the hand was exsanguinated with an Esmarch bandage, and an 8-cm-wide cuff was placed with its distal border located two finger breadths proximal to the palmar wrist crease. The cuff was inflated 75 mmHg over the systolic blood pressure of the patient registered in the operating room (Fig. 1). When pain related to the surgical zone was rated as high (Visual Analogue Scale, VAS>5), local anaesthesia (same anaesthetic solution) was infiltrated around the surgical zone, and those cases were registered. In no case was the cuff deflated to perform more blockades at the forearm or wrist.

Evaluation

During surgery, pain was registered using VAS 0–10 every 10 min related to the site of surgery (incision) or to the cuff or ischemic areas. A mean of all measurements in every patient was obtained. Evaluation of the bloodless field was done through a subjective evaluation by the surgeon on a scale from 0 to 100. Flexion of the fingers was evaluated through two methods: subjective evaluation by the surgeon in a 4-deg scale: (1) no finger flexion; (2) present, not disturbing; (3) present, disturbing; and (4) unable to operate; and the measurement of the angle between three points: third finger tip, third metacarpophalangeal joint, and base of the third metacarpal with the hand resting on the table. Local or general complications were also recorded. At a mean of 18 months after surgery, 27 patients were evaluated for zones of pain, numbness, neurological, and vascular disturbances.

Results

Mean patient age was 45 ± 16 years; nine were men and 21 women. The right hand was operated upon in 22 cases and the left in eight. Surgical procedures performed were carpal tunnel release 22 cases, hand cysts extirpation four,

Fig. 1 The tourniquet set (distal border two finger breadths above the palmar wrist crease)

trigger-finger release two, one dorsal ganglion of the wrist excision, and one fifth metacarpal shaft fracture osteosynthesis. The mean time of ischemia (time when tourniquet was inflated) was 19.6 ± 7.5 (10–50) min. Mean systolic blood pressure was 150 ± 16 mmHg. Mean pressure of the tourniquet was 235 ± 18 mmHg.

The mean VAS pain (0–10) during the entire procedure was 0.35 ± 1.25 related to the surgical site and 0.41 ± 0.99 related to the tourniquet. In 13 cases with ischemia time shorter than 20 min, the mean VAS was 0.07 ± 0.27 related to the cuff and 0.04 ± 0.13 to the surgical site. In 17 cases lasting more than 20 min, the mean VAS was 0.67 ± 1.24 related to the cuff and 0.60 ± 1.63 related to the surgical site. In 21 cases, there was absolutely no pain during surgery. The two longer cases (40 and 50 min) showed no pain during the procedure. Three cases required supplemental anaesthesia during the procedure, all of which were at the beginning of surgery. The bloodless field was rated as 100 (excellent) in 27 cases and 90 (very good) in three cases. In one case, it was necessary to raise cuff pressure to 100 mmHg over systolic blood pressure to achieve a bloodless field. Finger flexion was rated as present but not disturbing in 28 cases and “no finger flexion” in two cases. The mean angle of flexion of the tip of the third finger was $93 \pm 41^\circ$ (range 30 – 180°).

During surgery, there was one mild hypertensive crisis and two mild vagal reactions, which resolved without treatment. Twenty-seven patients were reviewed at follow-up at a mean of 18.1 ± 3.5 months after surgery (range 11–22 months). There were no cases of vascular or neural lesions due to the cuff or to punctures.

Discussion

The tourniquet placed at the distal forearm proved to be quite painless. In our study, we believe that those results were enhanced because of the performance of a complete distal forearm blockade just where the tourniquet was placed. In this way, the entire area subjected to ischemia was completely anaesthetised and most parts of the area where the tourniquet rests also lay on anaesthetised territories. VAS values (scale 0–10) were rated a mean of 0.4, and only three cases required supplemental anaesthesia during the procedure. Those findings are similar to those found at the ankle [1, 2]. One study [2] compared a complete versus a selective ankle blockade with an ankle tourniquet, and it was found that tourniquet tolerance and pain was much better when all the nerves were blocked. We used this technique, blocking all nerves that innervate the hand, in order to get the lowest possible pain due to both direct tourniquet pressure and tourniquet-induced ischemia.

To diminish pain due to the tourniquet, many methods have been explored in the literature. Vatahsky et al. [9] used a subcutaneous ring anaesthesia to prevent tourniquet pain due to direct pressure under the cuff. In fact, the complete blockade of the forearm implies a “ring anaesthesia” of the forearm, like those achieved by those

authors. Derkash et al. [3] used a complete wrist blockade, which completely blocks the pain due to the ischemic area, but it does not cover the pain due to the direct cuff pressure. Other studies performed other types of local anaesthesia [4, 6, 8, 9], partial wrist blockades [9], regional [5, 6, 9], or general anaesthesia [5].

It has been stated that a tourniquet can be tolerated without anaesthesia from 20 [4] to 25 min [7]. In our study, in 17 cases that lasted more than 20 min, pain related to the cuff was something higher (0.07 in shorter cases versus 0.67 in longer cases) but also quite low. Moreover, the two patients in which surgery lasted longer (40 and 50 min) had no pain during the entire procedure. We believe this technique partially relieves pain related to the lengthy use of tourniquets because the anaesthetic blockade anaesthetises nearly the entire area where the tourniquet rests and the entire area subjected to ischemia.

One concern with complete distal forearm blockade is the need of several painful punctures. To avoid this, it is useful to sedate the patient slightly during the moment of the punctures (i.e. incremental doses of propofol). In this study, we did not use sedation because that could alter the perception of pain. Another option is to block only the nerves that innervate the areas undergoing surgery, which can be a good option for surgeries lasting less than 20 min.

The bloodless field was excellent, achieving similar results as other authors [3, 6]. The tourniquet was inflated 75 mmHg over systolic pressure measured in the operating room (always higher than measurements performed on admission). Only in one case was that pressure not enough, but it performed very well by simply raising it 25 mmHg (100 mmHg over systolic blood pressure).

Finger flexion has been rarely reported. Only one study [8] indicated that "the fingers may curl up". We defined a method of evaluating finger flexion based on the subjective feeling of the operating surgeon in four degrees. The most common response was the second one: present, not disturbing. We believe that this finding may be related to the pressure exerted by the cuff over the muscle-tendinous junction of the flexor muscles. Regardless, in all cases, this flexion of the fingers was reducible and was not related as a problem in the surgeries performed. The objective

measurement of finger flexion (angle between third finger tip, third metacarpophalangeal joint, and third metacarpal) was also moderate: about 90°. Even when finger flexion was quite variable for every patient (range 30–180°), in all cases, that flexion was reducible.

Complications were minimal in the short and long term. Only one light hypertensive crisis and two mild vagal reactions were noted, which resolved without treatment. As we evaluated pain in our study, no sedation was given pre-operative or intra-operatively in order not to disturb the evaluation of pain. This fact could have produced those adverse effects. Regarding long-term complications, we found no problems due to the cuff or the punctures. In conclusion, the tourniquet placed at the distal forearm is a painless, safe, and useful technique for hand surgery.

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