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Quantification of the vasodilatory effect of axillary plexus block. A prospective controlled study



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ABSTRACT

Background: Axillary plexus block is a common method for regional anesthesia, especially in hand and wrist surgery. Local anesthetics (e.g., mepivacaine) are injected around the peripheral nerves in the axilla. A vasodilatory effect due to sympathicolysis has been described, but not quantified.

Materials and methods: In a prospective controlled study between October 2012 and July 2013, we analyzed 20 patients with saddle joint arthritis undergoing trapeziectomy under axillary plexus block. Patients received a mixture of mepivacaine 1% and ropivacaine 0.75% in a 3:1 ratio. The measurements were carried out on the plexus side and the contralateral hand, which acted as the control. Laser-Doppler spectrophotometry (oxygen to see [O2C] device) was used to measure various perfusion factors before and after the plexus block, after surgery and in 2-h intervals until 6 h postoperatively.

Results: Compared with the contralateral side, the plexus block produced an enhancement of tissue oxygen saturation of $117.35 \pm 34.99\%$ (cf. control SO_2 : $92.92 \pm 22.30\%$, $P < 0.010$) of the baseline value. Furthermore, blood filling of microvessels (rHb: $131.36 \pm 48.64\%$ versus $109.12 \pm 33.25\%$, $P < 0.0062$), peripheral blood flow ($219.85 \pm 165.59\%$ versus $129.55 \pm 77.12\%$, $P < 0.018$), and velocity ($163.86 \pm 58.18\%$ versus $117.16 \pm 45.05\%$, $P < 0.006$) showed an increase of values.

Conclusions: Axillary plexus block produces an improvement of peripheral tissue oxygen saturation of the upper extremity over the first 4 h after the inception of anesthesia.

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Introduction

Axillary brachial plexus block is a common method for regional anesthesia in hand and wrist and forearm surgery. Blocking of the median, ulnar, radial, and musculocutaneous

nerves produces numbness and palsy in the forearm and the distal upper arm and thereby enables pain-free surgery.¹ The patient is usually set in supine position, the arm is abducted in the shoulder, the elbow slightly flexed, and the local anesthetic is injected adjacent to the four nerves.² Often a solution

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of rapid onset and long-lasting anesthetic, of the amid type, is used for nerve block (e.g., ropivacaine and lidocaine or mepivacaine).³ The use of ultrasound or dual guidance (ultrasound and peripheral nerve stimulation) has increased rapidly as this increases axillary block success rates, reduces onset times, and therefore reduces the dosage of local anesthetic needed.⁴

The effect of local anesthetics and their effects on peripheral vasodilation have been previously reported. Authors have claimed that this is a side effect of axillary plexus block, based on a nonendothelium-dependent but sympatholytic effect.^{5–8} However, the enhancement of peripheral blood flow and its duration of the effect have not been adequately quantified yet.

In the following prospective study, we recorded measurements of skin microcirculation with noninvasive laser-Doppler spectrophotometry in 20 patients undergoing trapeziectomy for arthritis of the thumb saddle joint.

Materials and methods

Study sample

Between October 2012 and July 2013, 50 patients with thumb saddle joint arthritis underwent resection and suspension arthroplasty in our clinic. Because this is a standardized procedure in our department, nearly all elective hand surgeries are done in axillary plexus block and exsanguination. Ethical approval for this prospective controlled study (Ethical Committee N° 051/2013BO2) was provided by the Ethical Committee of the medical faculty of Eberhard Karls University Tuebingen, Germany (Chairperson Prof. Dr D. Luft) on March 26, 2013. Patients were informed of the nature and aim of the study and gave their written consent.

We conducted general medical history of all 50 patients and excluded those with a history of thrombosis, peripheral arterial disease, or high blood pressure ($n = 9$). Smokers were not excluded, did however not smoke during the length of their clinical stay. Two patients were also excluded if the axillary block failed and conversion to sedoanalgesia was needed, and four patients were excluded because they refused to have a plexus block at the outset. Furthermore, we excluded 10 patients with incomplete measurements or technical faults with partial loss of results. Five patients refused to participate in the study. Twenty patients filled our requirements and were included in this study group.

Measurements of skin microcirculation with the laser-Doppler and white light spectroscopy system O2C

Changes in peripheral blood flow of the middle finger on both sides (plexus arm versus control arm) in each patient were observed with the oxygen to see (O2C) device (LEA Medizintechnik, Gießen, Germany). We carried out our measurements on the middle finger of each hand, to rule out error due to the operation site. With a glass fiber probe, the O2C device enables noninvasive recording of local oxygen supply in about 8 mm depth of tissue. Blood flow (“Flow,” as the number of moving erythrocytes in tissue) and blood flow velocity

(“Velocity”) are determined by detecting the Doppler shift of laser light. On the other hand, the O2C uses the white light for the detection of capillary venous oxygen saturation (“SO₂”) and blood filling of microvessels (“rHb,” as the relative amount of hemoglobin). Measurements emphasize on the venous side of peripheral microcirculation because the biggest amount of blood volume lies within the capillaries. Data were collected for each arm separately before and after axillary plexus block (when the patient reported numbness and palsy), then again immediately after surgery and in a 2-h interval until 6 h postoperatively. To avoid interpersonal bias in handling the glass fiber probe, the recording of data was done by a single person. In addition, blood pressure, pulse, and body temperature were also recorded at the definite time points. The decision of the total amount of local anesthetics given and the ratio of rapid onset (mepivacaine) versus long-lasting (ropivacaine) anesthetic used, lied within the anesthesiologist’s judgment.

Statistical analysis

Because the parameters observed with the O2C device are given in arbitrary units, we set all the post plexus measurements in relation to the baseline data for each side separately. After evaluation of the normal distribution, we then did a paired t-test to evaluate the changes in peripheral blood flow of plexus versus nonplexus hand. In addition, we did a comparison of smokers and nonsmokers. All statistical analysis was done with Microsoft Excel for Mac 2008 (Microsoft Corporation, Redmond, WA). *P* values < 0.05 (one-tailed) were considered significant.

Results

Patient’s characteristics

We conducted blood flow parameters in 20 patients (13 females and seven males) with a mean age of 58.0 ± 7.27 y. Fifteen patients had surgery to the right hand and hence five to the left. The mean surgery time was 67.0 ± 15.8 min, and patients received on average 40 ± 10.9 mL of mepivacaine (Scandicain) and 12 ± 5.2 mL of ropivacaine (Naropin) for

Table 1 – An overview of patient’s characteristics.

Patient’s characteristics	
Sex	13 female, 7 male ($n = 20$)
Age at time of surgery	58.0 ± 7.27
Height	1.67 ± 0.08 m
Weight	76.15 ± 13.24 kg
BMI	27.18 ± 4.70
Smoking status	5 smokers, 15 nonsmokers
Surgery time	67 ± 15.8
Local anesthetics used	40 ± 10.9 mL mepivacaine 1% 12 ± 5.2 mL ropivacaine 0.75%

BMI = body mass index.

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