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The development of anaesthesia is currently affected by the growing interest in regional anaesthesia and analgesia. In particular, there is an increasing interest in peripheral nerve blocks, and in many clinics the use of this method is preferred to the central blocks whenever possible, thus becoming increasingly more common. What is the reason of the growing interest and what makes the greater educational and practical efforts involved in the use of regional blocks worthwhile?

First of all, it is the implementation of a perioperative anaesthesia and postoperative analgesia concept. A block initiated preoperatively and used intraoperatively continued via a catheter to provide effective postoperative regional analgesia with a low risk of complications. This concept enables early mobilisation and quicker rehabilitation.

The effects of regional anaesthesia (mostly in the form of central neuraxial blocks) on various outcome parameters were demonstrated in the CORTRA meta-analysis (Rodgers et al., *BMJ* 2000; 321:1493) based on the evaluation of 141 clinical studies involving approximately 10,000 patients. Patient groups who underwent surgery under general anaesthesia were compared to those who either received regional anaesthesia or combined general – regional anaesthesia. According to the results, regional anaesthesia reduced postoperative complications and the over-all postoperative mortality rate by 30%. The authors concluded that the most likely reason for the reduction of postoperative complications was the decreased intraoperative stress response due to regional anaesthesia block.

Furthermore, we are well aware of the potential risk of severe pain developing into a chronic pain condition, a situation that can and should be avoided. The most reliable way to prevent pain from becoming chronic comprises regional anaesthesia techniques that block the pain stimulus near its origin, both peri- and postoperatively, thereby eliminating acute pain as a special postoperative risk factor.

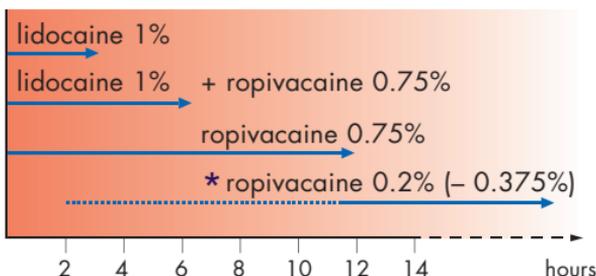
The continuing development of regional anaesthesia and analgesia is important when considering the aspects described above but there are also ethical and economical points of view which call for a wider use of regional anaesthesia. With this compendium of peripheral nerve blocks, we present a brief review of the most commonly used techniques. Thereby we hope to stimulate the interest and understanding among our colleagues for the use of regional anaesthesia techniques.

## Review of the most important local anaesthetics

### Action time of regional anaesthetics:

### Intraoperative and postoperative analgesia

- \* Start infusion before onset of post operative pain; otherwise start with an initial bolus.



### Overview of the most important local anaesthetics for peripheral nerve blocks

Substance	Concentration	Dosage*	Time until effective	Analgesic action time
	Anaesthesia	Anaesthesia		
	Analgesia	Analgesia		
Ropivacaine (Naropin)	0.5% – 0.75%	up to 300 mg	10 – 20 min	8 – 14 h
	0.2% – 0.375%	up to 28 mg/h		
Lidocaine	1% (- 2%)	up to 600 mg	10 – 20 min	2 – 4 h
	–	–		
Mepivacaine	1% (- 2%)	up to 300 mg	10 – 20 min	3 – 4 h
	–	–		
	Anaesthetic potency (ratio to procaine = 1)	Protein binding (%)	Distribution volume (L)	Elimination half-life (h) in plasma
Ropivacaine	16	94	59	1.9
Lidocaine	4	64	91	1.6
Mepivacaine	4	77.5	84	1.9

\* (manufacturers' recommendations)

### Special features:

- Ropivacaine
  - Favourable effective dose/toxicity ratio
  - Good differential block (analgesia >> motor block) at lower concentrations used for analgesia
- Lidocaine
  - Local anaesthetic with medium action time and low toxicity
- Mepivacaine
  - Effectiveness comparable to lidocaine, but less toxic and slightly longer duration

### General technical aspects on peripheral nerve blocks

- Use aseptic technique.
- Resuscitation equipment and drugs should always be available when regional anaesthesia is used.
- Local cutaneous infiltration anaesthesia.
- Skin incision with a lancet before insertion of a short-beveled needle (e. g. 45° bevel).
- Nerve stimulation: Ascending from 0.1 – 1.0 mA, until visible muscle contractions in the corresponding innervation area; then reduction to between 0.3 – 0.5 mA/0.1 ms before injection of the local anaesthetic.
- Repeated aspiration attempts before and during injection of the local anaesthetic. A negative aspiration test does not completely exclude an intravascular needle position.
- With larger doses of a local anaesthetic, use fractional injection and verbal patient monitoring for early recognition of accidental intravascular injection.
- In poorly cooperative patients, patients under sedation or when performing a block distal to an established central block (e. g. femoral nerve block in the presence of spinal anaesthesia) a nerve stimulator and unipolar needle should be used (no neuromuscular relaxation!). Exception: Infiltration anaesthesia of purely sensory nerves.
- Catheter technique: Placement of the catheter tip 3 – 5 cm beyond the tip of the introducing needle, to be inserted normally after injecting the loading dose of the local anaesthetic.
- Monitoring: When performing blocks in the head and neck area and when larger doses of local anaesthetic are used the patient should have an i.v. cannula, ECG and pulse oximetry applied before the block. Standard monitoring includes ECG, pulse oximetry, blood pressure and the degree of consciousness.
- Catheter: Daily control of the catheter insertion site, written documentation (see p. 9).

### Side effects, complications/contraindications (general)

Side effects and complications

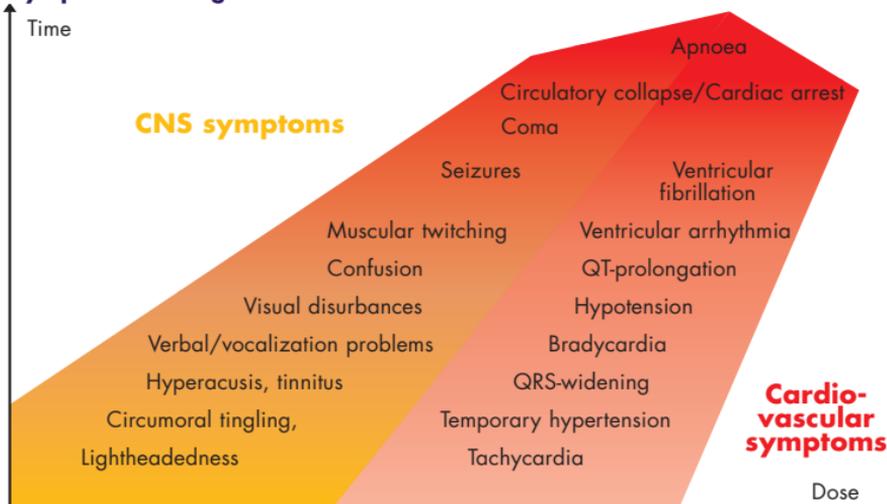
- Systemic toxicity of the local anaesthetic  
Most common reason: Unintended intravascular injection  
Minimize risk by
  - Adhering to the recommended dosages
  - Repeated aspiration and fractional injection
  - Slow injection, observe and maintain verbal contact with the patient (NB: negative aspiration does not entirely exclude intravascular injection!)
- Nerve damage (extremely rare)  
Minimize risk by
  - Trying to avoid paresthesias when inserting the needle
  - Correct use of a suitable nerve stimulator ( $\geq 0.3 - 0.5$  mA/0.1 ms)
  - The use of atraumatic needles
- Hematoma  
Minimize risk by
  - No blocks in the presence of a clinically manifest coagulation disorder or anticoagulation treatment
- Infection (especially when using continuous techniques)  
Minimize risk by
  - Aseptic needle insertion
  - Regular planned checks of the catheter insertion site (at least once a day)
  - Most sensitive indicator: Tenderness at the point of catheter entry (requires immediate removal of the catheter)

### General contraindications to regional anaesthesia

- Rejection of the technique by the patient
- Clinically manifest coagulation disorders
- Infection or hematoma at the injection site
- Relative contraindication: Neurological deficits (previous documentation necessary)

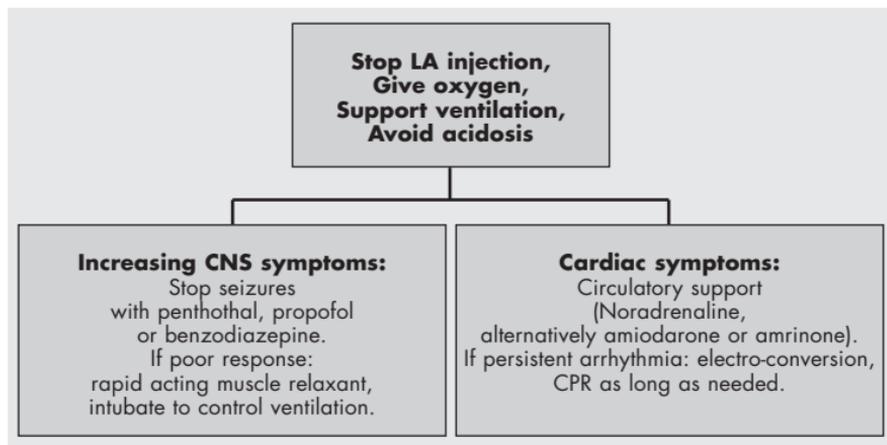
## Systemic effects of local anaesthetic intoxication

### Symptoms and signs of local anaesthetic intoxication



A relatively small dose of local anaesthetic, if accidentally injected intravascularly, may lead directly to seizures with both respiratory and cardiovascular problems, depending on drug and patient conditions.

### Treatment of local anaesthetic intoxication



Allergy for amide local anaesthetics is extremely rare and should be treated like any allergic reaction.

## Postoperative analgesia with Naropin® Polybag



Mobile pump system (CADD-Legacy PCA) for administration of Naropin® Polybag



Pump and Polybag in a carrier bag for mobile patient use

### Naropin® 2 mg/ml, 200 ml Polybag analgesically effective concentrations

*Real volume of Naropin® in 200 ml Polybag is 210 ml	ml additional volume	total mg	total volume ml*	concentrations mg/ml
Reduce concentration by dilution with NaCl 0.9 %	<b>80</b>	420	290	<b>1,4</b>
	<b>60</b>	420	270	<b>1,6</b>
	<b>40</b>	420	250	<b>1,7</b>
	<b>20</b>	420	230	<b>1,8</b>
<b>Polybag</b>	<b>standard</b>	420	210	<b>2</b>
Increase concentration by adding <b>Naropin® 10 mg/ml</b>	<b>10</b>	520	220	<b>2,4</b>
	<b>20</b>	620	230	<b>2,7</b>
	<b>40</b>	820	250	<b>3,3</b>
	<b>60</b>	1020	270	<b>3,8</b>

### Check-up rounds

- At least once a day
  - Check catheter insertion site
  - Assess effectiveness
  - Analyse indications critically
  - Careful documentation (see p. 9)
- In case of insufficient effectiveness
  - Catheter positioned correctly? Dislocated?
  - In case of partial effectiveness: Injection of a bolus (e. g. 20 ml ropivacaine 0.75%)
  - Supplemental analgesics (NSAID, opioids orally) as needed
  - Additional pain medication when removing catheter
- Duration of treatment
  - Up to 4 – 5 days – depending on the indication. (For chronic pain therapy a duration of more than 100 days has been described.)
  - Analgesic catheter can be used in out-patients, but the corresponding prerequisites must be considered

### Requirements for a nerve stimulator (acc. to Kaiser)

Electrical layout:

- Adjustable constant current in the presence of a load of 0.5 – 10 kOhm
- Monophasic square output impulse
- Selectable impulse width (0.1 – 1.0 ms)
- Impulse amplitude (0 – 5.0 mA) with precision adjustment and digital display of the actual current
- Impulse frequency 1 – 2 Hz

Safety device:

- Alarm upon interruption of circuit
- Alarm when the max. impedance is exceeded
- Alarm when an error occurs inside the device
- Unmistakable assignment of outputs
- Adequate operating instructions for use, indicating the deviations tolerated

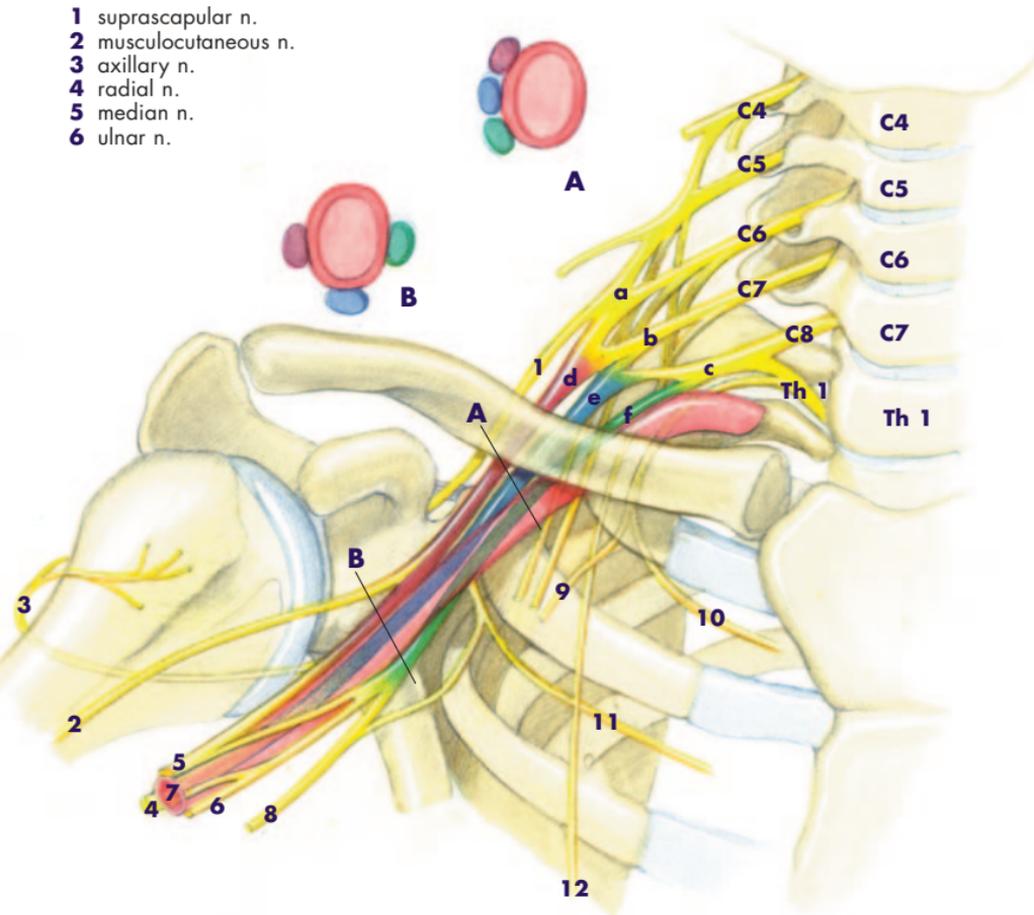


## Anatomy of the brachial plexus

- a** superior trunk  
(rami ventrales C5 and C6)
- b** middle trunk  
(ramus ventralis C7)
- c** inferior trunk  
(rami ventrales C8 and Th1)
- d** lateral cord
- e** posterior cord
- f** medial cord

- 1** suprascapular n.
- 2** musculocutaneous n.
- 3** axillary n.
- 4** radial n.
- 5** median n.
- 6** ulnar n.

- 7** medial antebrachial cutaneous n.
- 8** medial brachial cutaneous n.
- 9** intercostobrachial n.
- 10** intercostal n. I
- 11** intercostal n. II
- 12** long thoracic n.



**A + B:** Sectional plane in the infraclavicular and axillary region. Please note the position of the cords.

The brachial plexus is formed by the ventral rami of the C5 to Th1 (variably C4 and Th2) spinal nerves

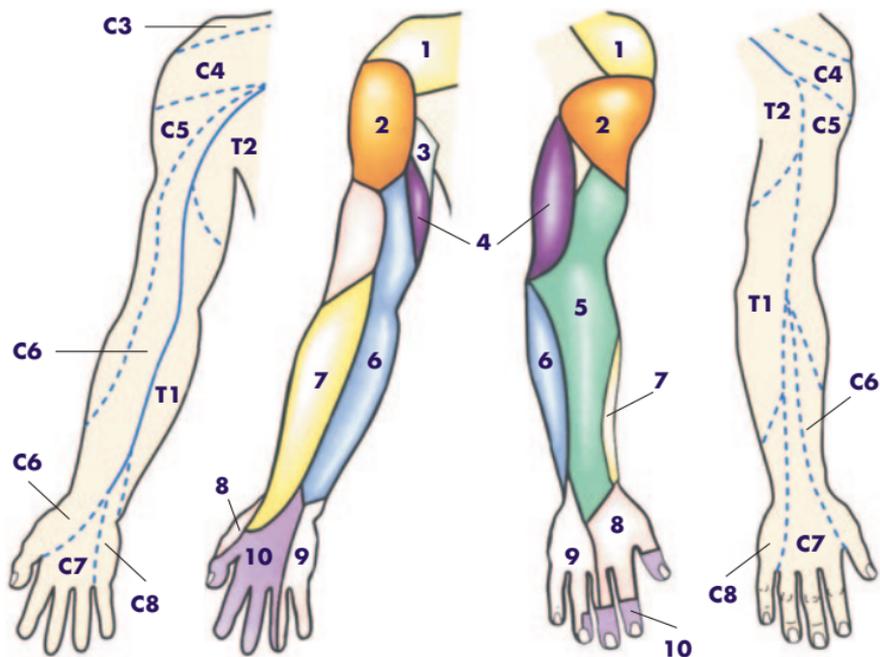
### **Anaesthesia techniques for blockade of the upper extremities**

- Interscalene brachial plexus block (interscalene block, ISB) acc. to Meier
- Vertical infraclavicular plexus block (vertical infraclavicular block, VIB)
- Suprascapular nerve block
- Axillary plexus block
- Blocks in the upper arm region (mid-humeral approach, radial n.)
- Blocks in the region of the elbow (radial, musculocutaneous, median, ulnar nerves)
- Blocks in the wrist region (radial, median, ulnar nerves)

## Sensory supply

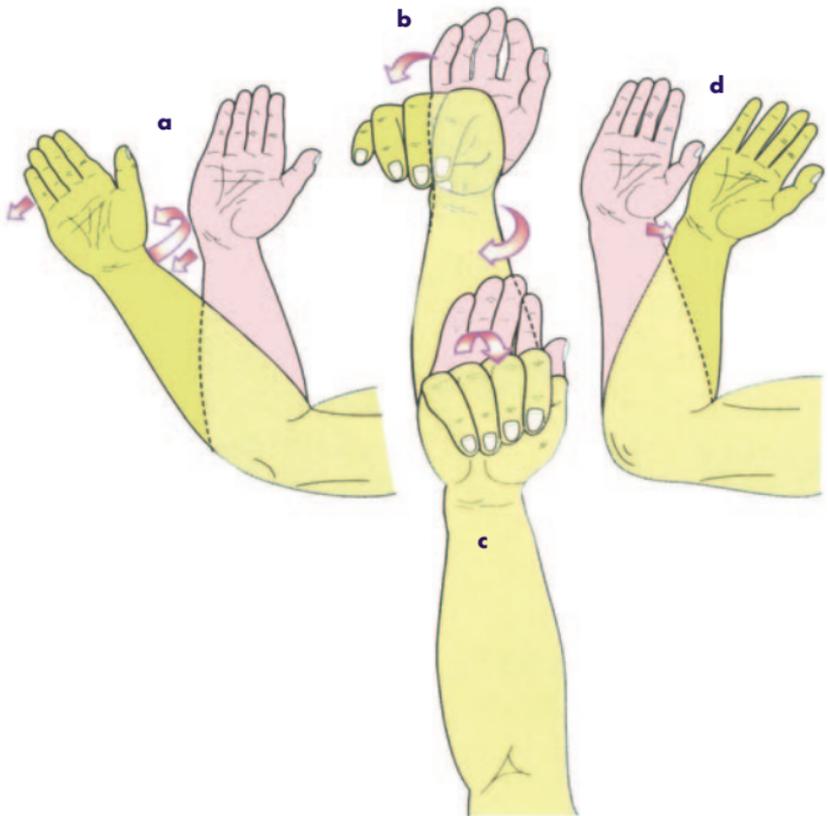
### Sensory supply of the upper extremities

- |   |  |
|---|--|
| <b>1</b> supraclavicular n.                           | <b>6</b> medial antebrachial cutaneous n.                        |
| <b>2</b> axillary n. (lat. cut. brachial)             | <b>7</b> lateral antebrachial cutaneous n. (musculocutaneous n.) |
| <b>3</b> intercosto-brachial n.                       | <b>8</b> radial n.   |
| <b>4</b> medial brachial cutaneous n.                 | <b>9</b> ulnar n.  |
| <b>5</b> antebrachial cutaneous dorsal n. (radial n.) | <b>10</b> median n.  |



### Motor functions of the peripheral nerves in the upper extremities

- a** radial n.: stretching elbow and fingers
- b** median n.: flexion of the fingers
- c** ulnar n.: flexion of the forth and fifth fingers with opposition of the first finger
- d** musculocutaneous n.: flexion (and supination) of the forearm



## Patient position and method:

Patient supine

## Guiding structures:

Lateral border of the sternocleidomastoid m., interscalenus groove  
The insertion site is at the level of the thyroid notch (approx. 2 cm above the level of the cricoid cartilage) at the posterior edge of the sternocleidomastoid muscle. The direction of insertion is along the interscalene groove (in a caudal and lateral direction) at an angle of approx. 30° to the skin. Stimulus response: Deltoid m., biceps m. Injection of the local anaesthetic when an adequate stimulus response of 0.3 mA/0.1 ms is reached.

## Comments on the technique:

- The aiming point is in the middle third of the clavícula
- The subclavian a. marks the caudal end of the interscalene groove.  
It can be identified by palpation or with the aid of a vascular doppler.

Notice the difference to the classical interscalene approach acc. to Winnie; the puncture site is 1 to 2 cm above (cranial) the puncture site of Winnie's interscalene block, the direction of the needle is lateral in contrast to Winnie's technique (medial, dorsal, caudal). You will come in contact with the plexus at easily a more tangential angle in contrast to the classical approach, where the needle approaches the plexus at a right angle. Meier's approach is suitable for continuous catheter techniques.

## Indications:

- Anaesthesia and analgesia of the shoulder and/or of the proximal upper arm region
- Mobilisation (e. g. frozen shoulder)
- Physiotherapy in the shoulder region (e. g. postoperative, following mobilisation)
- Therapy for pain syndromes
- Sympathicolysis

## Special contraindications:

- Contralateral phrenic paresis
- Contralateral recurrent paresis
- COPD (relative)

**Side effects, complications:** Horner s., ipsilateral phrenic block, recurrent block

## Local anaesthetics:

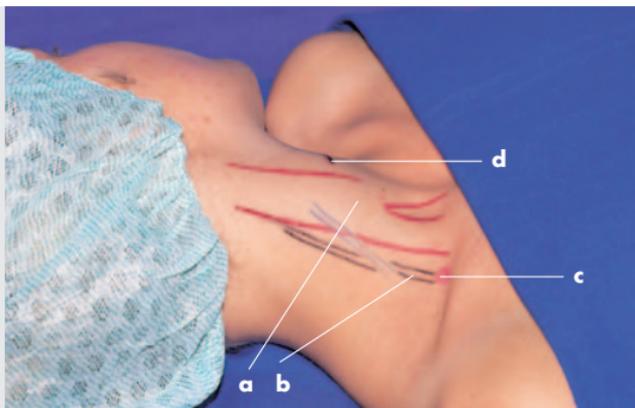
**Initial:** 30 – 40 ml lidocaine 1% or mepivacaine 1% or 30 ml ropivacaine 0.75%

**Continuous:** Ropivacaine 0.2 – 0.375% 6 ml/h (5 – 15 ml), max. 37.5 mg/h bolus (alternatively): 10 – 20 ml ropivacaine 0.2 – 0.375% (approx. every 6 hours)

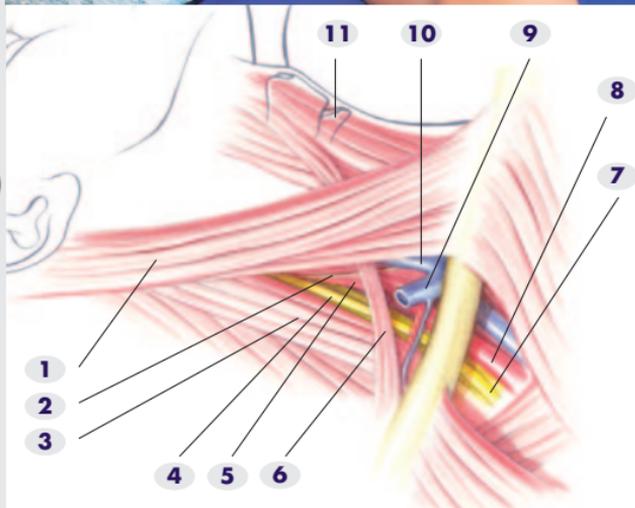
**Needle:** Single shot: Short-bevel unipolar 22 G x 4 – 6 cm needle

Continuous: E. g. 19.5 G x 6 cm (Plexolong B-Set®, Pajunk co., or Contiplex D®, B. Braun) with a 20 G catheter (advance catheter 4 cm beyond the tip of the cannula).

- a** sternocleidomastoid m.
- b** interscalene groove
- c** subclavian a.
- d** cricoid cartilage



- 1** sternocleidomastoid m.
- 2** phrenic n.
- 3** middle scalene m.
- 4** brachial plexus (supraclavicular part)
- 5** anterior scalene m.
- 6** omohyoid m.
- 7** brachial plexus (infraclavicular part)
- 8** subclavian a.
- 9** external jugular v.
- 10** internal jugular v.
- 11** cricoid cartilage



The direction of insertion is caudally and laterally along the interscalene groove, 30° angle to the skin.



VIB (= vertical infraclavicular block)  
(acc. to Kilka, Geiger and Mehrkens)

### Patient position:

Patient supine

Jugular notch, ventral acromial process of the scapula.

### Guiding structures:

The distance between the jugular notch and the ventral acromial process is bisected. The insertion site must be directly under the clavicle and take place in a strictly vertical direction. The plexus is reached after approx. 3 cm (max. 5 cm!). Flexion of the fingers at 0.3 mA/0.1 ms form the desired stimulus response.

### Comments on the technique:

Risk of pneumothorax

Therefore, **make absolutely sure to avoid:**

- Insertions too far medially
- Deviation from the sagittal (plumb bob) direction of insertion
- Advancing the needle > 6 cm

When the index finger is placed to have contact with the coracoid process laterally and the clavicle cranially ("Mohrenheim's fossa") the medial border of the finger marks the injection point/"**finger point**". Always perform this block using a nerve stimulator. A stimulus response only in the biceps m. yields poor results. Pull back the needle to a s.c. position, shift it slightly laterally and advance it again in a strictly sagittal direction. In comparison with the Raj/Borgeat technique (ref. to this) this technique does not require abduction of the arm.

### Indications and contraindications:

see infraclavicular plexus block, Raj technique (mod. by Borgeat)

**Side effects, complications:** Horner syndrome, pneumothorax, intravascular injection.

### Local anaesthetics:

#### Initial:

30 – 40 ml lidocaine 1% or mepivacaine 1% or  
30 ml ropivacaine 0.75%

#### Continuous:

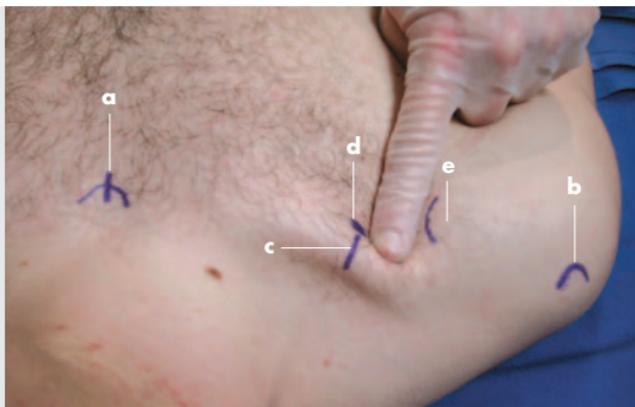
Ropivacaine 0.2 – 0.375% 6 ml/h (5 – 15 ml), max. 37.5 mg/h  
Bolus (alternatively): 20 ml ropivacaine 0.2 – 0.375% (approx. every 6 hours)

#### Needles:

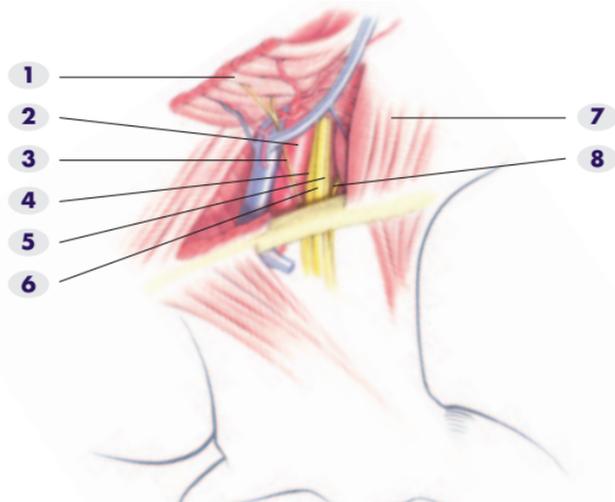
Single shot: Short-bevel 22 G x 4 – max. 6 cm.

Continuous: E. g. Contiplex D® 18 G x 5.5 cm (B. Braun) alternatively Plexolong A® 19.5 G x 5 cm with catheter (Pajunk co.). The catheter is advanced 3 – 4 cm beyond the tip of the cannula.

- a** jugular notch
- b** ventral acromial process
- c** 1/2 distance from a – b
- d** "finger point"
- e** coracoid process



- 1** major pectoral m.
- 2** subclavian a.
- 3** pectoral n.
- 4** medial cord
- 5** posterior cord
- 6** lateral cord
- 7** deltoid m.
- 8** suprascapular n.



Strictly vertical  
needle insertion  
(perpendicular to  
the underlying  
surface)



## Patient position:

Patient supine.

## Guiding structures:

Jugular notch, ventral acromial process of the scapula. The needle insertion site is located halfway between the anterior tip of the acromion and the jugular notch approx. 1 cm below the clavicle. For injection, the arm is abducted 90° and elevated 30°. The needle is directed laterally at an angle of approx. 45° – 60° towards the most proximal point at which the axillary artery can still be palpated in the axilla.

## Comments on the technique:

The risk of pneumothorax is low because of the lateral direction of the needle. Intravascular injection (usually venous, cephalic vein) has been observed. Between 3 – 8 cm there should be a motor response in the hand or fingers. Because of the tangential approach to the plexus, a catheter can be advanced readily.

## Indications:

- Anaesthesia and analgesia for surgery of the upper arm, lower arm and hand
- Treatment of pain syndromes
- Analgesia for physiotherapeutic treatment
- Sympathicolysis

## Contraindications:

- Thorax deformity
- Dislocated healed clavicular fracture
- Foreign bodies in the area of insertion (e.g. pacemaker, port etc.)
- Untreated coagulation disorder

**Side effects, complications:** intravascular injection, pneumothorax

## Local anaesthetics:

### Initial:

30 – 40 ml lidocaine 1% or mepivacaine 1% or 30 ml ropivacaine 0.75%

### Continuous:

Ropivacaine 0.2 – 0.375% 6 ml/h (5 – 15 ml), max. 37.5 mg/h bolus (alternatively): 20 ml ropivacaine 0.2 – 0.375% (approx. every 6 hours)

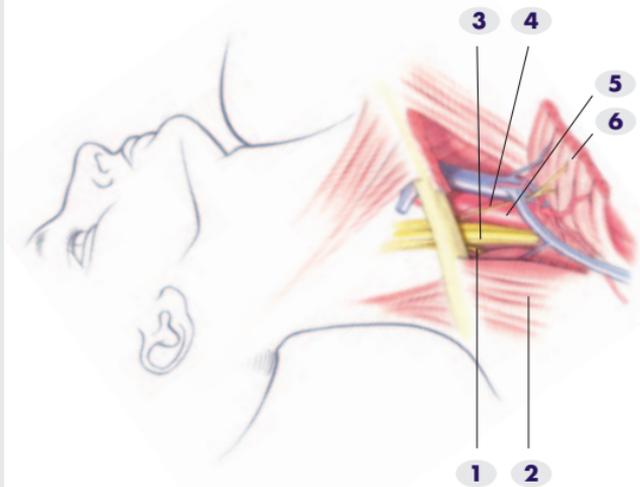
**Needle:** Single shot: unipolar 22 G x 6 – 10 cm needle

Continuous: E. g. 19.5 G x 10 cm Plexolong with catheter (Pajunk co.). The catheter is advanced 3 – 4 cm beyond the tip of the cannula.

- a** axillary a.,  
anatomical land-  
mark for establishing  
the needle insertion



- 1** suprascapular n.  
**2** deltoid m.  
**3** brachial pl.  
**4** pectoral n.  
**5** subclavian a.  
**6** major pectoral m.



Needle insertion  
site according to  
VIB anatomical  
landmarks (p. 16),  
direction towards  
the most proximal  
point of the  
axillary a., approx.  
45° – 60° angle.



### Patient position:

The patient is sitting.

### Guiding structures:

Scapular spine, posterior portion of the acromion, medial end of the scapular spine. The midpoint of the line between the lateral posterior portion of the acromion and the medial end of the scapular spine is marked. The insertion site is 2 cm cranial (above) and 2 cm medial of this point. The unipolar needle is advanced 3 – 5 cm laterocaudally and only slightly ventrally at an angle of approx. 30° (in the direction of the head of the humerus) until a correct needle position is indicated by a stimulus response in the infra- or the supraspinous muscles, or until the needle shows a pain-free "knocking" sensation in the shoulder after 3 – 5 cm.

### Comments on the technique:

There is no risk of pneumothorax if these guidelines are followed. Aspiration is necessary in order to avoid intravascular injection (suprascapular artery, extremely rare). The method can also be performed without nerve stimulation (bone contact) and be used with a continuous technique.

### Indications:

- Diagnostic: Shoulder pain of unclear origin
- Anaesthesia: Incomplete interscalene plexus block
- Pain therapy: Adhesive capsulitis (frozen shoulder), arthritis, rupture of the rotator cuff, etc.

### Special contraindications:

None

**Side effects:** Nothing specific

### Local anaesthetics:

#### Initial:

10 – 15 ml lidocaine 1% or mepivacaine 1 % or ropivacaine 0.75%

#### Continuous:

Ropivacaine 0.2 – 0.375% 6 ml/h (5 – 15 ml), max. 37.5 mg/h bolus (alternatively): 10 ml ropivacaine 0.2 – 0.375% (approx. every 6 hours)

**Needles:** Single shot: Unipolar needle 22 G x 6 – max. 8 cm long.  
Continuous: E. g. Plexolong B® 19.5 G x 6 cm (Pajunk co.) or Contiplex (B. Braun). The catheter is advanced approximately 3 cm beyond the tip of the cannula.