CONTINUOUS INTERSCALENE NERVE BLOCK (ANTERIOR AND POSTERIOR APPROACHES)

BY ANDRÉ P BOEZAART MD, PHD

Author Affiliation: Department of Anesthesia, University of Iowa, Iowa City, IA

Management of acute postoperative pain due to shoulder surgery may be successfully and consistently achieved in ambulatory patients by using continuous interscalene block. This communication outlines the anterior and posterior approaches to the proximal brachial plexus and describes a method of precisely placing a catheter along the brachial plexus by stimulating the plexus through the needle used for placing the catheter as well as through the catheter itself. A technique for securing the catheter by subcutaneous tunneling to prevent dislodgement is also described. Suggested drugs and dosages for initial boluses, continuous infusions and patient controlled interscalene analgesia are discussed. Sedation for block placement, and special precautions, are outlined.

INTRODUCTION

Continuous brachial plexus blocks started with the work of Ansbro in 1946 [1], followed by many different techniques. Most of these early methods were hampered by inaccurate catheter placement or catheter dislodgement. In order to provide reliable analgesia for ambulatory shoulder surgery and prevent readmission due to failed catheter placement, it was necessary to develop a method to assure real-time (while placing the catheter) catheter position. This can be done immediately and not hours later when the initial block had worn off [2,3]. This was combined with a method to secure the catheter so that it does not dislodge, adopted from work on long-term epidural catheterization [2]. A catheter with an inner steel spring capable of conducting electrical impulses to its distal end – a "stimulating catheter" is used for the methods described in this communication (Arrow StimuCath™, Arrow International, Reading, PA, USA)

INTERSCALENE BLOCKS

The proximal brachial plexus in the neck can be approached either anteriorly [2] or posteriorly [4,5].

ANTERIOR APPROACH OR TRUE CONTINUOUS INTERSCALENE BLOCK

An alternative to the classic interscalene approach is the recently described longitudinal approach [2], outlined below, which allows for the catheter to be directed laterally and away from the midline. With this approach, as for all other antero-lateral approaches, stimulation of other nerves, such as the dorsal scapular nerve (to the rhomboid muscles), nerve to the levator scapula muscle and accessory nerve (to the trapezius muscle) can cause confusing muscle twitches around the shoulder girdle during needle and catheter placement.

The complications associated with continuous interscalene block (ISB) are similar to those of single injection ISB, although the incidence of diaphragmatic paralysis due to phrenic nerve block has been reported to be significantly less during continuous ISB (20% vs. 85%). [2] This may be attributable to the more distal injection of the local anesthetic agent.

ANATOMY

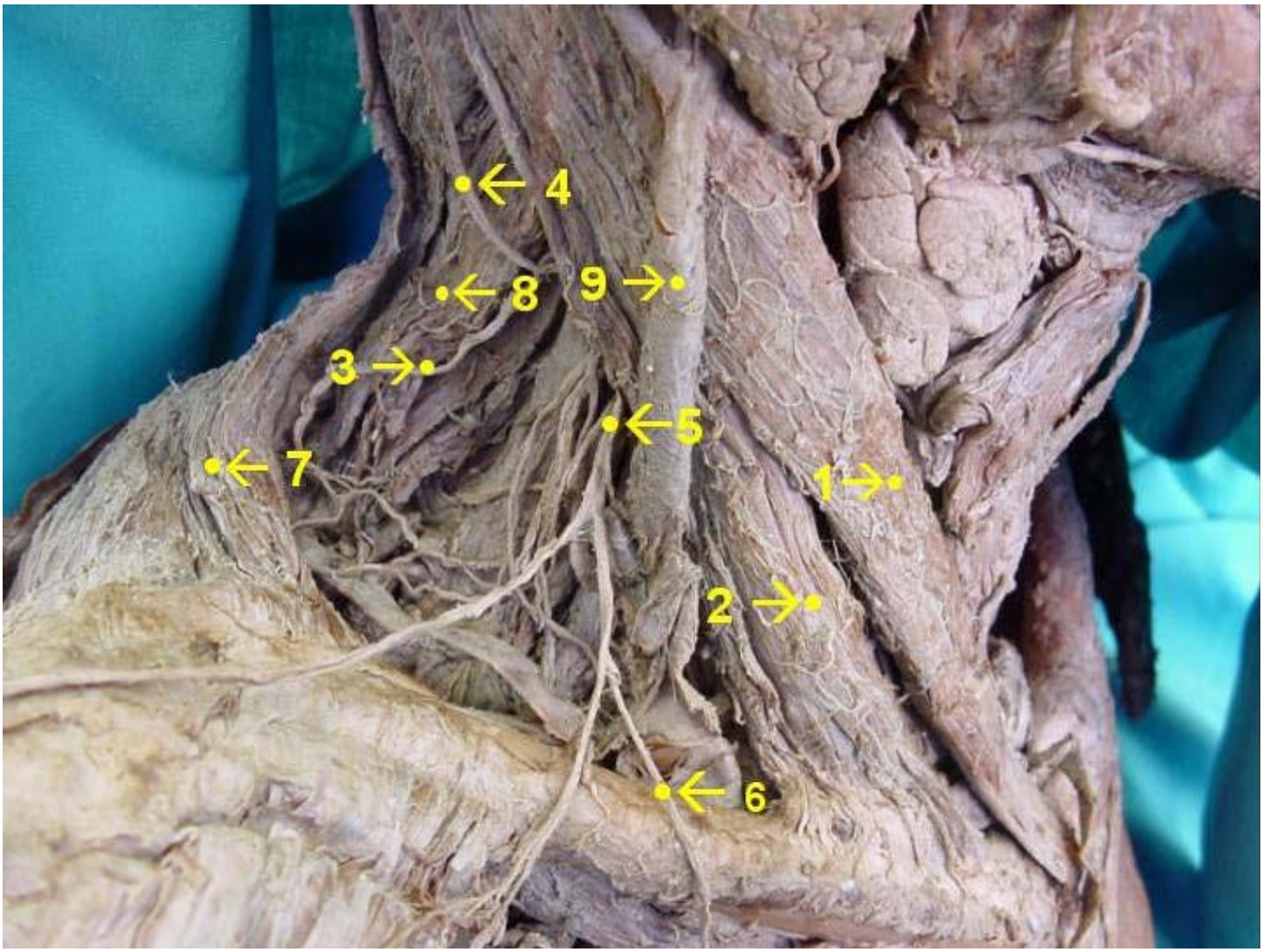

Figure 1: *Superficial anatomy*

The sternal head of the sternocleidomastoid muscle (1) is anterior to its clavicular head (2), which forms the anterior border of the posterior triangle of the neck. The accessory nerve (3) is superficial to the fascial floor of the posterior triangle of the neck and originates close to the lesser occipital nerve (4). The superficial cervical plexus (5) is superficial to the fascial floor of the posterior triangle of the neck and gives rise to the supraclavicular nerves (6). The superficial cervical plexus originates from C2 and supplies the ipsilateral skin of the neck, shoulder and occipital area with sensory fibers. The trapezius muscle (7) is innervated by the accessory nerve (3), and the nerve to levator scapulae innervates the levator scapulae muscle (8).

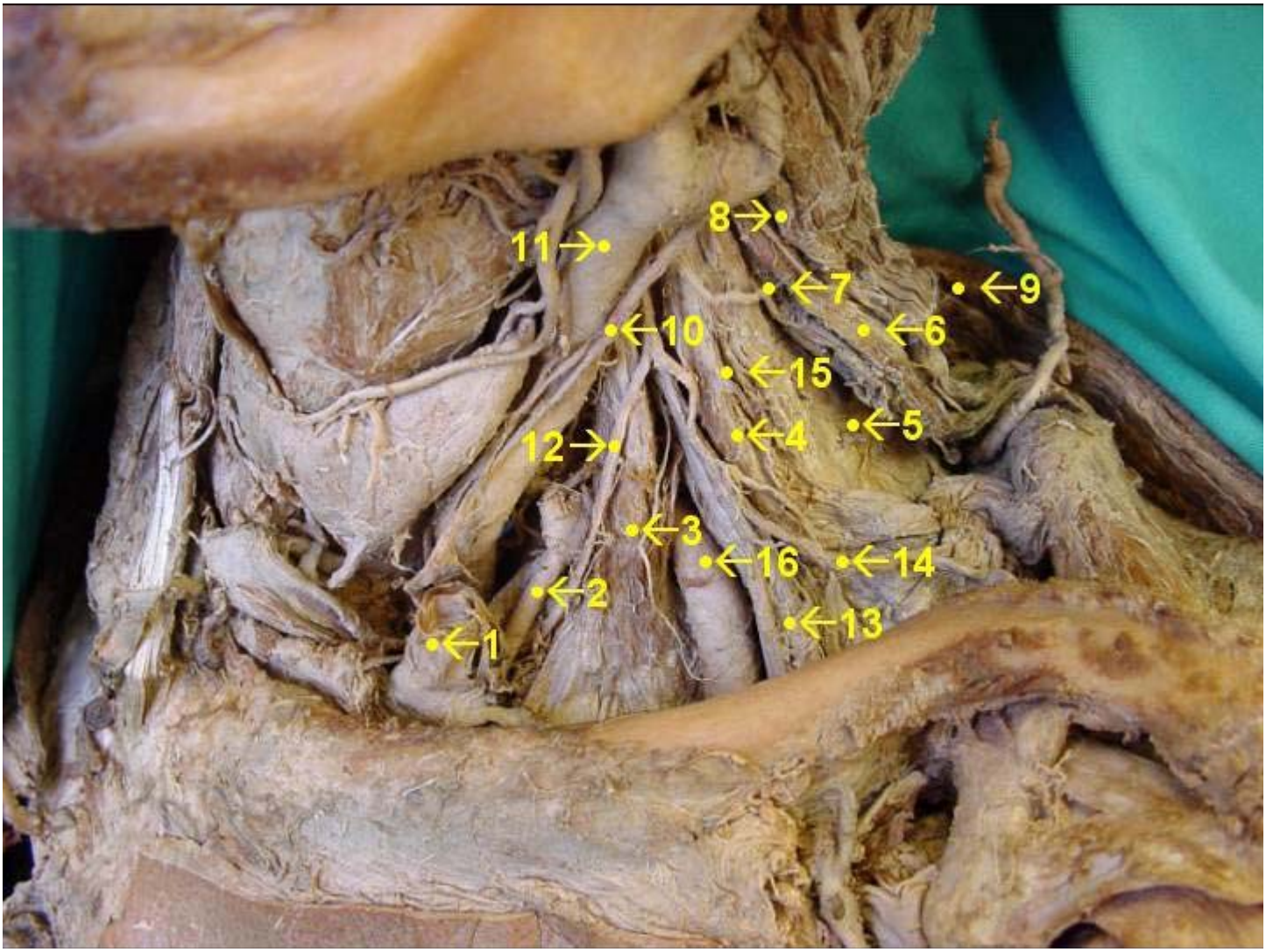

Figure 2: *Deeper anatomy*

A view of the anatomy with the sternocleidomastoid muscle removed shows the position of the internal jugular vein (1) (cut off here). Deep to the internal jugular vein is the thoracic duct (2) on the left side of the neck and adjacent to that the anterior scalene muscle (3). Posterior to that is the middle scalene muscle (4) and more posterior, the posterior scalene muscle (5). Posterior to the posterior scalene muscle is the levator scapulae muscle (6) with the nerve to the levator scapulae muscle (7). The accessory nerve (8) as well as the trapezius muscle (9) can be seen. Also note the vagus nerve (10), which is situated in close relationship to the carotid artery (11), and the phrenic nerve (12), which is situated on the belly of the anterior scalene muscle (3). The brachial plexus (13) is situated between the anterior and middle scalene muscles. The suprascapular nerve (14) and the dorsal scapular nerve (15) (which innervates the rhomboid muscles) branches from the brachial plexus. Note that the subclavian artery (16) lies anterior to the brachial plexus.

"NERVE MAPPING"

To facilitate proper anatomical orientation, the relative positions of the motor nerves in the posterior triangle of the neck can be identified before the skin is penetrated [7] (Figures 3 & 4).

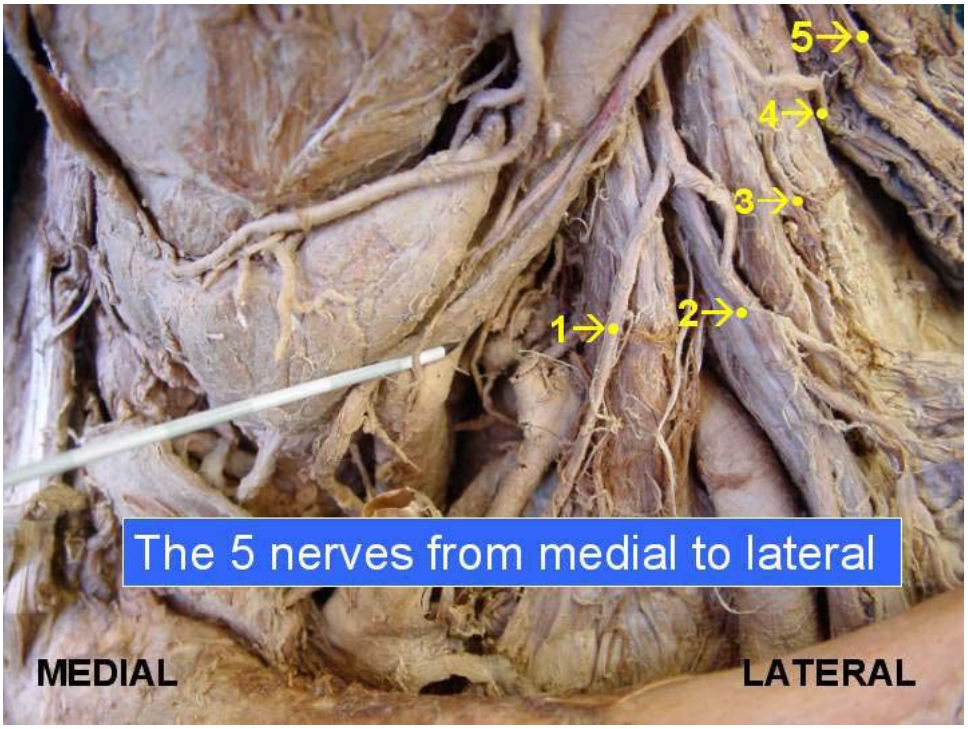

Figure 3: *"Nerve Mapping"*
Five nerves can be identified in the posterior triangle of the neck by percutaneous stimulation with 5 – 10 mA. Stimulating the phrenic nerve (1), just posterior to the clavicular head of the sternocleidomastoid muscle on the level of the cricoid cartilage (C6) causes unmistakable twitches of the diaphragm. Moving the needle one centimeter posteriorly will stimulate the brachial plexus (2). This causes twitching of the biceps, triceps, major pectoral and/or the deltoid muscles. Posterior to the brachial plexus and posterior to the middle scalene muscle is the dorsal scapular nerve (3), which innervates the rhomboid muscles. Stimulation of this nerve causes the scapula and shoulder to move when the rhomboid muscles contract. This often causes confusion when stimulated and is a common cause of failed interscalene nerve blocks. The next nerve that can be identified percutaneously is the nerve to the levator scapulae muscle (4). Stimulating this nerve percutaneously will elevate the scapula and cause movements of the shoulder. More cephalad and higher up in the posterior triangle of the neck is the accessory nerve (5), which innervates the trapezius muscle.

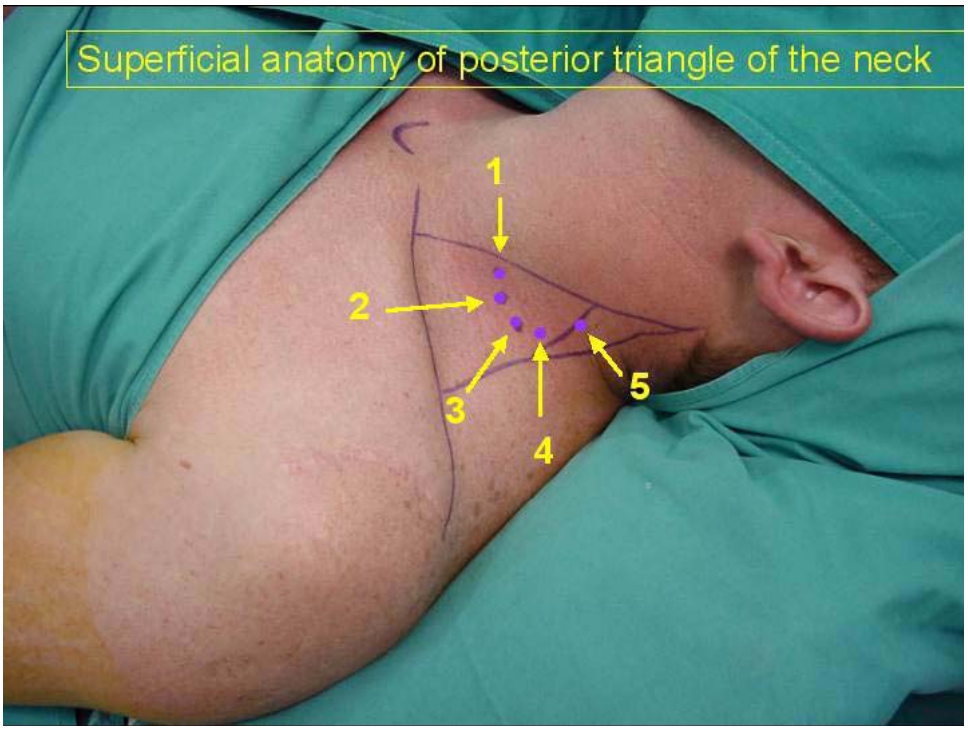

Figure 4: *Surface anatomy*
1 = Phrenic nerve
2 = Brachial plexus
3 = Dorsal scapular nerve (to rhomboid muscles)
4 = Nerve to levator scapulae

Blocking any nerve other than the brachial plexus will result in a failed ISB.

TECHNIQUE (ANTERIOR APPROACH OR TRUE INTERSCALENE BLOCK)

NEEDLE PLACEMENT

- The patient is placed in the supine position with the neck slightly flexed (to prevent the sternocleidomastoid muscle from covering the interscalene groove) and the head is slightly turned to the opposite side. The operator stands at the head of the bed, which is raised slightly to facilitate venous drainage so that venous congestion and accidental venous puncture are minimized.
- Feel for the interscalene groove with the middle and index fingers of the non-dominant hand (Figure 5)
- Split the fingers and apply light pressure with the middle finger. This causes the external jugular vein to become visible. The index finger applies traction to the skin for easy penetration by the needle.
- After appropriate skin infiltration with local anesthetic agent, the sheathed Tuohy needle (Arrow International, Reading, PA, USA) enters the skin halfway between the clavicle and the mastoid process just posterior to the posterior border on the sternocleidomastoid muscle (Figure 5).

Figure 5: *Needle placement*

- Aim the needle tip to the interscalene groove and the point where the brachial plexus had previously been identified by percutaneous "mapping" (sometimes referred to as "Winnie's point"), and direct the bevel of the needle outwards. Brisk twitches of the biceps, triceps or major pectoral muscles will occur when the needle approaches the brachial plexus and the nerve stimulator is set to 1 mA. Reduce the output of the nerve stimulator and look for brisk muscle twitches at approximately 0.5 mA (200 – 300 μs), which indicates penetration of the fascial sheath surrounding the brachial plexus.

CATHETER PLACEMENT

- Hold the needle steady, remove the nerve stimulator lead from the needle and attach it to the proximal end of the catheter. Remove the stylet from the needle and insert the distal end of the catheter into the needle shaft (Figure 6).
- Keep the nerve stimulator output constant between 0.5 and 1.5 mA, advance the catheter point beyond the tip of the needle and observe unchanged and brisk muscle twitching during catheter advancement.
- If the muscle twitches stop during advancement, it means that the catheter tip has moved away from the nerve.
- Withdraw the catheter carefully so that the distal end is again inside the shaft of the needle.
- Adjust the needle slightly (for example turn the needle 45 degrees clockwise, or counter clockwise, move it 1 or 2 mm outward or inward) and advance the catheter again.
- Repeat this maneuver until the correct muscles twitch briskly during catheter advancement.
- Do not manipulate the needle if the catheter tip is not withdrawn inside the shaft of the needle, and do not advance the catheter further than 5 cm beyond the needle tip, since it may curl around nerves and possibly injure them on removal.

Figure 6: *Catheter Placement*

- The catheter is now correctly placed on the plexus, but will most likely dislodge over time unless secured. Muscle twitches should be brisk at a nerve stimulator setting of 0.3 – 0.8 mA and 200 – 300 µs.

TUNNELING TO SECURE CATHETER

- Insert the inner steel stylet of the needle through the catheter entry site or 1 – 3 mm from the site if a "skin bridge" is desired.
- Advance the stylet subcutaneously to exit near the suprasternal fossa.
- "Rail-road" the needle over the stylet to bring the needle point to the catheter entry site.
- Remove the stylet and feed the catheter retrogradely through the needle. After successful passage of the catheter, remove the needle.
- (Other successful methods of tunneling have also been described and may be preferred by some practitioners [8]).

Figure 7: *Tunneling*.

- Apply the SnapLock (Arrow International, Reading PA, USA) device to the catheter
- Apply the nerve stimulator to the SnapLock device and perform a final stimulation test – sometimes referred to as the "Raj test" (Figure 8).

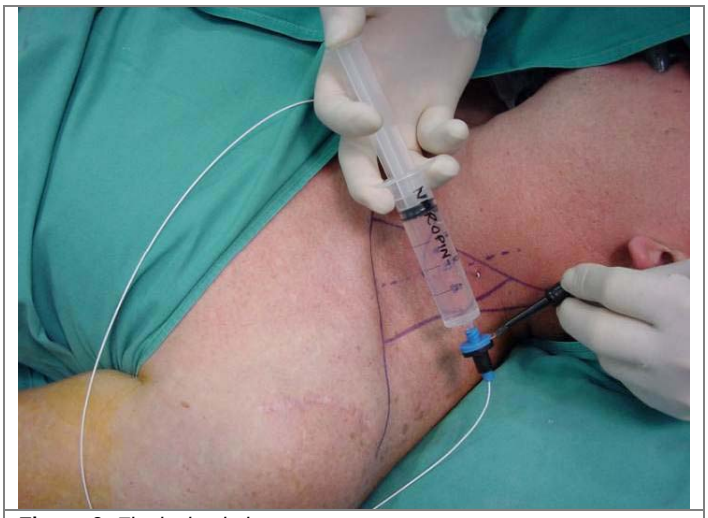

Figure 8. *Final stimulation test.*

DRESSINGS

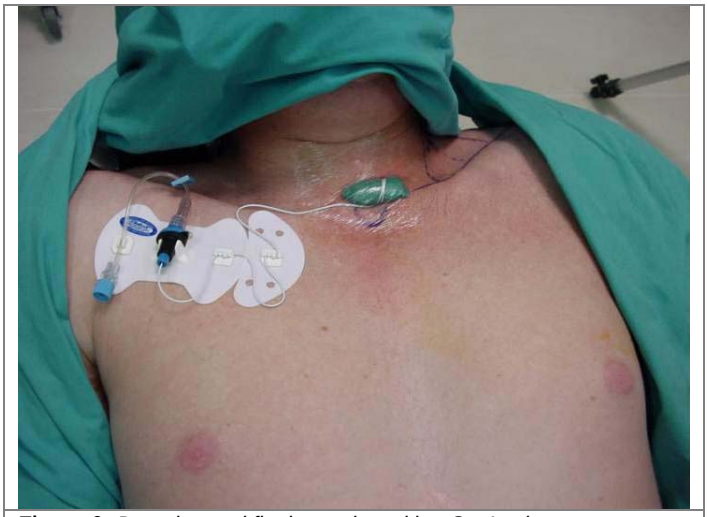

Figure 9: *Dressing and final securing with a StatLock*

- Cover the catheter and the entry sites with a dressing and finally secure the catheter and SnapLock with the StatLock device (Arrow International, Reading PA, USA) (Figure 9).

POSTERIOR APPROACH (OR CONTINUOUS CERVICAL PARAVERTEBRAL BLOCK)

Kappis originally described this approach to the brachial plexus in 1912 [9]. Pippa re-introduced it in 1990 [4] and catheter placement via this approach has recently been described. [5].

The continuous cervical paravertebral block is ideal for relief of postoperative pain following shoulder surgery, especially arthroscopic shoulder surgery. This approach sometimes does not involve the nerves of the superficial cervical plexus and the skin around the shoulder area will therefore not be anesthetized. Although not yet evaluated by formal research, the experience of this author is that loss of resistance to air as well as nerve stimulation may be used for the placement in this block. If proven successful, this should make this block ideally suited for postoperative use, and when severely painful conditions such as fractures of the shoulder are present where nerve stimulation is not advisable or impractical.

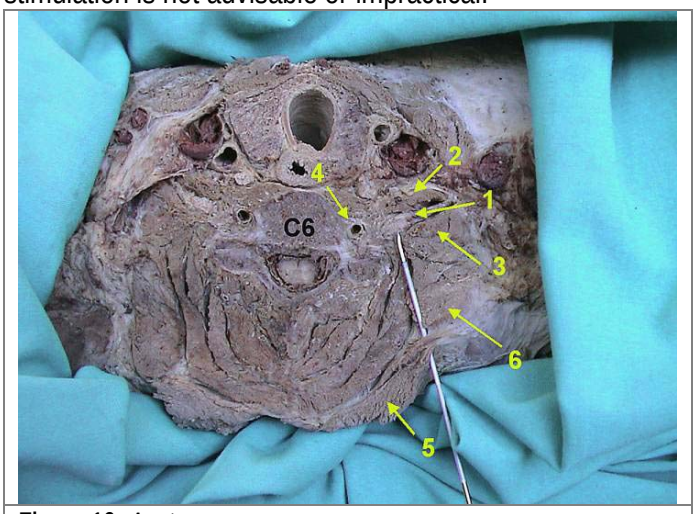

Figure 10: *Anatomy*
The brachial plexus (1) is situated between the anterior (2) and middle (3) scalene muscles, while the vertebral artery (4) is guarded by the bony structures of the vertebrae. The posterior approach for ISB is antero-lateral to the trapezius muscle (5) and postero-medial to the levator scapulae muscle (6).

TECHNIQUE (CONTINUOUS CERVICAL PARAVERTEBRAL BLOCK)

- The patient can be in the sitting or lateral decubitis position.
- After liberal skin and subcutaneous tissue injection of local anesthetic agent, the needle enters at the apex of the "V" formed by the trapezius and levator scapulae muscles (Figures 10 – 12).
- Attach the nerve stimulator and loss of resistance to air device to the needle and set the current output to 2 – 3 mA. Because the roots of the plexus have to a large extent split into motor (anterior) and sensory (posterior) fibers here, more current is required to elicit a motor response.
- The needle is aimed medially and approximately 30 degrees caudate towards the suprasternal notch and advanced until the short transverse process of C6 is encountered.
- The needle is "walked off" this bony structure and there is a distinct change of resistance to air, which occurs simultaneously with muscle twitches in the arm when the cervical paravertebral space is entered (Figure 13).
- When the tip of the needle is at the roots of the brachial plexus, it is held steady and the loss of resistance device is removed. The nerve stimulator is now clipped to the proximal end of the catheter and catheter placement and tunneling is now performed as described for the anterior approach. (A non-stimulating standard soft epidural catheter may be advanced through the needle, and nerve stimulation via the needle and catheter omitted if muscle twitches are undesirable or painful. A lower success rate may have to be accepted if this is done, but this requires further research).

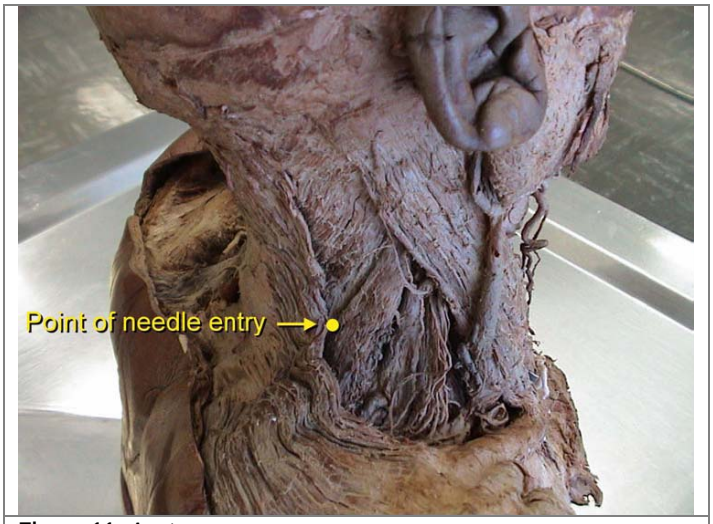

Figure 11: *Anatomy*
The point of needle entry is in the apex of the "V" formed by the trapezius muscle posterior and the levator scapulae muscle anterior – the "B"-spot

DRUGS

Initial bolus injection

The author has successfully used 0.25ml/kg ropivacaine (0.5%) or bupivacaine (0.5%) as a bolus injection for intra- and postoperative analgesia if the block is combined with general anesthesia [3]. If used as sole anesthetic, up to 0.5ml/kg may be required. Other authors have described volumes up to 35 ml [10,11,12] when combining the block with general anesthesia.

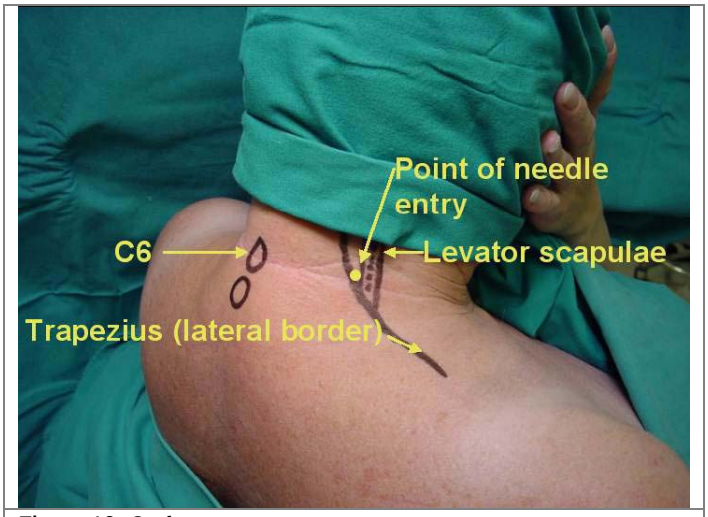

Figure 12: *Surface anatomy*
Needle entry should be at the level of C6 and just antero-lateral to the trapezius muscle and postero-medial to the levator scapulae muscle in the apex of the "V" formed by these two muscles.

Figure 13: *Needle placement*
The nerve stimulator is clipped to the needle and a loss-of-resistance to air device is placed on the needle. The needle is directed mesiad, anteriorly and caudad, aiming for the suprasternal notch. The needle is carefully "walked off" the transverse process of C6 and loss of resistance to air and muscle twitches of the shoulder girdle appear simultaneously.

Infusion

Breakthrough pain was rare and patient satisfaction high in a recent study when patients were discharged from hospital with disposable elastometric infusion pumps delivering 5ml/hr of 0.25% ropivacaine or 0.25% bupivacaine [3]. We use 0.1ml/kg/hr of o.25% ropivacaine of bupivacaine in children. Other authors have good results with 0.2% ropivacaine infused at 10 ml/hr [10]. Two studies by Borgeat demonstrated that patients who received continuous interscalene blocks through a patient controlled interscalene analgesia (PCIA) method experienced superior analgesia and diminished side effects following major shoulder surgery when compared with those who received patient controlled intravenous morphine[11, 12] Patients in both treatment groups received interscalene block prior to endotracheal general anesthesia, and those in the PCIA groups were maintained with a background infusion of 0.15% bupivacaine in one study [11] and ropivacaine 0.2% in the other [12] at 5 ml/hr. PCIA boluses of 3ml (patients < 65kg) to 4ml (patients > 65 kg) of the drug were administered every 20 minutes as required. In the experience of this author, boluses and "multimodal" analgesia is seldom required if the catheters are properly placed.

Sedation

Very little or no sedation is typically required, but based on a study of sedation for retrobulbar block [13], the author used midazolam 10 – 50 µg/kg combined with remifentanil 0.3 – 0.5 µg/kg given as an intravenous bolus 1 minute before the placement of the block successfully. The remifentanil injection can be repeated when necessary. Another sedation regime found satisfactory by other authors is fentanyl 0 – 3 µg/kg combined with midazolam 10 – 50 µg/kg [10]. If continuous cervical paravertebral block is done with the patient in the upright position, no or very little sedation should be used.

Blocks are performed in anesthetized patients under certain circumstances such as in children, when very painful conditions, e.g. fractures, are present or when the patient is very anxious. The skin and subcutaneous tissue should always be properly anesthetized for blocks as well as for the intended tunneling path of the catheter. Care should, however, be taken not to block the plexus accidentally in the process, since this would make correct catheter placement very difficult.

Special precautions

- Conditions such as existing brachial plexitis or pre- or sub-clinical complex regional pain syndromes should be specifically documented before ISB is done. Pain distal to the elbow is usually an indication of one of the above conditions. Patients with shoulder joint pathology present with shoulder pain, but very seldom or never with pain distal to the elbow.
- Since an indwelling catheter is left in situ for some time, formal sterile procedures are necessary. The entry

point of the catheter should be inspected daily for early signs of infection.

- The catheters should never be cut while being removed and sensation should be allowed to return to the arm before catheter removal. If the pain is still intolerable, a bolus of the local anesthetic agent should be injected and the infusion should again be initiated for a further 24 hours. If the pain is tolerable or manageable with simple analgesics, the catheter may be removed by first pulling the distal part out from the skin bridge and then removing the tunneled portion or by gently pulling on it in the direction of the tunneling. If resistance is encountered, skin traction in the opposite direction will often facilitate removal. Radiating pain experienced during removal may indicate that the catheter has curled around a nerve root. Surgical removal of catheters may have to be considered if radiating pain with attempted removal persists. In the experience of this author of well over 6000 catheter placements, this has never been necessary.
- Because the whole arm is likely to be insensitive for the duration of the continuous block, the ulnar nerve at the level of the elbow and the radial nerve at the mid-humeral level should be protected. Special attention should also be given to the positioning of the patient on the operating table, and ambulatory patients with continuous brachial plexus blocks in place should always use a properly fitted arm sling to prevent traction injury to the brachial plexus.

Practical points

- Nerve stimulation via both needle and catheter is the key to consistently successful and proper catheter placement for continuous nerve block.
- Our experience taught us that the better the catheter is placed, the less boluses or "multimodal" drugs are required. This author believes that "multimodal" is a compromise for a poorly placed catheter.
- The anterior approach to the interscalene space is probably best suited for "open" shoulder surgery, while the posterior approach is ideal for arthroscopic surgery.
- The posterior approach provides less motor block than the anterior approach, but does not usually provide anesthesia of the skin around the shoulder joint.
- Horner's syndrome almost always accompanies the posterior approach, while phrenic nerve block occurs less often with continuous ISB than with single injection ISB. This raises the interesting question of using the posterior approach for CRPS.
- The loss of resistance to air technique for placement of the cervical paravertebral block (posterior approach to ISB) may makes it ideally suited for postoperative placement or other instances where nerve stimulation is undesirable or painful. A lower success rate may have to be accepted when the plexus is not simulated during catheter placement.
- An initial bolus of 0.25 ml/kg of ropivacaine 0.5% or bupivacaine 0.5% is used when the block is combined with general anesthesia. If used as sole anesthetic 0.5ml/kg is probably required.
- Continuous infusion of 5ml/hr in adults and 0.1ml/kg/hr in children of 0.25% of the drug used for the bolus dose will provide satisfactory results in most cases if the catheter is properly placed.
- Patient-controlled interscalene analgesia has been used successfully, but in the experience of this author it is seldomly used if the catheter is properly placed.
- Sedation with midazolam 10 – 50 µg/kg plus remifentanil 0.3 – 0.5 µg/kg as a bolus intravenous injection one minute before placing the block should give good results. Other sedation regimes are also used successfully, but sedation is seldom necessary.
- Existing brachial plexitis and pre- or subclinical CRPS (pain distal to elbow) should be ruled out before ISB is attempted.
- Allow full return of sensation to the arm before removing the catheter and be very careful when radiating pain is experienced down the arm upon attempted removal.
- Protect the ulnar nerve (at the elbow) and radial nerve (mid-humeral area) while the arm is insensitive.
- Prevent traction injury to the brachial plexus by proper positioning on the operating table during surgery and by using a properly fitted sling in the ambulatory patient.
- Patients on anticoagulants who undergo ISB should be managed with the same precautions as patients on anticoagulants who undergo epidural block.
- If the extensor muscles of the neck or the levator scapulae are not avoided totally and the catheter is partially placed through one of these muscles, one can expect that the patient will complain of pain at the catheter site. This pain can be severe enough to warrant premature catheter removal.

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