Continuous interscalene block using a stimulating catheter: A review of the technique

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Abstract: The management of postoperative pain after major shoulder surgery can be achieved successfully with a continuous interscalene block. This article reviews the essentials of the stimulating catheter technique for the continuous interscalene block that was described by BOEZAART (1) in 1999. The authors also describe their experience and results with the first two hundred catheters they placed.

Key words: Interscalene block; continuous nerve block; shoulder surgery; stimulating catheter.

INTRODUCTION

In 1999, BOEZAART et al. published a new technique of continuous interscalene nerve block (CISB) (1). We had the opportunity to learn this technique. This article reviews the essentials of the technique and the experiences of the authors with the first 200 catheters they placed for continuous interscalene block.

Continuous interscalene catheters after major shoulder surgery provide excellent analgesia, reduce postoperative opioids requirement and opioid-related side effects and assure patient satisfaction (2, 3, 4). However, compared to the single shot ISB, the insertion of a catheter in the interscalene groove and the fixation afterwards is technically challenging and a secondary block failure rate of up to 25% with conventional “blind” non-stimulating catheter insertion techniques has been described (5). Salinas, for example, describes up to 40% secondary analgesic block failure when using the classic non-stimulating catheter infusion technique (6). Conventional catheter insertion with a neurostimulator confirms correct placement of the needle in the brachial plexus sheath but the catheter is then threaded in a blind way. The concept of the stimulating catheter, which was developed by Dr Boezaart, enables one to reduce the secondary failure rates of continuous peripheral nerve blocks. The essence of the technique is that not only the needle but also the catheter is stimulated during placement so that accurate final positioning of the catheter and not only the needle for threading the catheter through is facilitated.

INDICATION

A CISB is indicated after major shoulder surgery and has also been used in the therapy of chronic upper extremity pain (7). The technique of the stimulating catheter can also be used for other continuous peripheral nervous blocks e.g. infraclavicular block, femoral nerve block, sciatic block, etc. The use of the StimuCath (Arrow Intl, Reading, PA, USA) for the paravertebral approach to the brachial plexus has recently been described (8, 9).

MATERIAL

The Arrow StimuCath, (Arrow International, Reading, PA, USA) is used for continuous nerve block. This set contains an insulated 17 or 18 G Tuohy needle with bare proximal and distal ends and a special 19 or 20 G catheter with an inner steel stylet and an inner steel spring reinforcement. Both ends of this catheter are also unsheathed. One end can be connected to the nerve stimulator while the other is inserted in the interscalene groove and secured with a stitch.
other end can conduct the electrical stimulation to the nerve.

ANATOMY

The anterior and middle scalene muscles are posterior to the clavicular head of the sternocleidomastoid muscle. The fascia, originating from the paravertebral fascia, covers both muscles, and encloses the interscalene space. The brachial plexus lies in this space. The phrenic nerve is located on the belly of the anterior scalene muscle. The posterior scalene muscle is posterior to the middle scalene muscle. The dorsal scapular nerve that innervates the rhomboid muscles is situated posterior to the middle scalene muscle. Another branch of the dorsal scapular nerve innervates the levator scapulae muscle that is situated posterior to the posterior scalene muscle. The trapezius muscle, posterior to the levator scapulae muscle, is innervated by the accessory nerve.

TRANSCUTANEOUS STIMULATION

Assistance in identifying the brachial plexus is obtained by locating all the motor nerves in the posterior triangle region of the neck before entering the skin. This is called “transcutaneous nerve mapping” and is based on a technique described earlier for use in paediatric anesthesia (10). It is especially useful in patients with an interscalenic groove that is difficult to palpate. A nerve stimulator output is set to approximately 5-10 mA and 200-300 µs and is held against the skin overlying the nerve via the “crocodile” clip, the Tuohy needle, or a specially designed stimulator. Careful observation of the elicited muscle contraction, allows five motor nerves in the posterior triangle of the neck region to be identified. Stimulation of the brachial plexus causes a motor response of the deltoid, biceps, triceps or major pectoral muscle. One centimetre anteriorly, stimulation of the phrenic nerve causes ipsilateral contraction of the diaphragm. Posterior to the middle scalene muscle, the dorsal scapular nerve that innervates the rhomboid muscle is located. Stimulation of this nerve results in contraction of the rhomboid muscles and medial movement of the scapula. This is an important nerve, since stimulation of it gives a muscular contraction pattern that can be mistaken for the contraction pattern one sees with brachial plexus stimulation. However, injection of a local anaesthetic on the dorsal scapular nerve will not produce brachial plexus blockade. More cephalad, stimulation of the nerve to the levator scapulae muscle and the trapezius muscle (accessory nerve) will cause elevation of the scapula and shoulder. Transcutaneous stimulation is not painful and can easily be done on non-anaesthetised patients if the patient is well informed.

THE BLOCK

A sterile technique is essential when introducing and removing the catheter. After identifying the interscalene groove by palpation, the needle is introduced posterior to the clavicular head of the sternocleidomastoid muscle, halfway between the mastoid and the clavicular. The Tuohy needle is advanced in a caudad direction and parallel to the vertebral column, using the longitudinal approach to the plexus that Boezaart first described (1). In doing so, the contact surface between the needle or catheter and the brachial plexus is increased.
It is important that the nerve stimulator is always properly connected to the needle before starting the procedure. After entering the skin, the brachial plexus is located with the Tuohy needle. A usual depth is 4 centimetres. On anaesthetized patients, an initial current of 2 mA and a pulse width of 200-300 µs can be used, while a current of 1 mA is usually sufficient for anaesthetized and unanaesthetized patients. A pop can sometimes be felt when the sheath of the brachial plexus is penetrated. Once brisk twitches of typically the biceps muscle are encountered, the nerve stimulator output is reduced to 0.3-0.5 mA. The brisk motor response should still be present. The stylet of the needle is removed and, after connecting the nerve stimulator to the proximal end of the catheter, the catheter is advanced through the needle. It is essential to observe the muscle contractions during the advancement of the catheter and not to inject saline or local anaesthetic agent through the needle before passing the catheter. This will disperse the current density and the motor response will disappear, making nerve stimulation via the catheter impossible. Unchanged and brisk muscle twitches should be observed. A change or decrease of the contractions indicates malpositioning of the catheter. In that case the catheter is carefully withdrawn until the tip is inside the shaft of the needle, the needle is turned 45° clockwise or counter clockwise and the catheter is advanced again. The disappearance of the motor response after more than two corrections indicates that the needle probably is not deep enough. The needle must then be advanced one or two millimetres. Do not manipulate the needle if the catheter tip is not fully withdrawn to inside the needle shaft. This may damage the catheter.

Feeding the catheter through the needle next to the nerve is met with slightly more resistance than we are used to when introducing a catheter in the epidural space. It is essential not to advance the catheter more than 3-5 centimetres past the needle. It is essential not to advance the catheter past the needle. A pop can sometimes be felt when the sheath of the brachial plexus is penetrated. Once brisk twitches of typically the biceps muscle are encountered, the nerve stimulator output is reduced to 0.3-0.5 mA. The brisk motor response should still be present. The stylet of the needle is removed and, after connecting the nerve stimulator to the proximal end of the catheter, the catheter is advanced through the needle. It is essential to observe the muscle contractions during the advancement of the catheter and not to inject saline or local anaesthetic agent through the needle before passing the catheter. This will disperse the current density and the motor response will disappear, making nerve stimulation via the catheter impossible. Unchanged and brisk muscle twitches should be observed. A change or decrease of the contractions indicates malpositioning of the catheter. In that case the catheter is carefully withdrawn until the tip is inside the shaft of the needle, the needle is turned 45° clockwise or counter clockwise and the catheter is advanced again. The disappearance of the motor response after more than two corrections indicates that the needle probably is not deep enough. The needle must then be advanced one or two millimetres. Do not manipulate the needle if the catheter tip is not fully withdrawn to inside the needle shaft. This may damage the catheter.

Dislodgement of the catheter will be likely if left in this position. Boezaart tried to secure the catheter by using adhesive tape, sutures, even glue, but the only effective way he found to secure the catheter is by tunnelling it subcutaneously (personal communication AP Boezaart, 1999). To do so, the stylet is first entered 2-3 mm from the entry point of the catheter and advanced subcutaneously in the direction of the suprasternal notch, avoiding the external jugular vein in doing so. The Tuohy needle is then “rail-roaded” back over the stylet and the catheter fed retrogradely through the needle. In this way, a small “skin-bridge” is left after tunnelling and the chance of damaging the catheter with the needle is minimal. Leaving a “skin-bridge” also makes catheter removal easier. The Luer lock device (Snaplock, Arrow International, Reading, USA) is now attached to the catheter and, while stimulating the catheter, a bolus dose of 20-30 mL local anaesthetic agent is injected through the catheter. The muscle twitches should stop immediately, again indicating close proximity of the catheter to the nerve. The catheter is then covered with a sterile transparent dressing. On completion of the surgery a continuous infusion of dilute local anaesthetic agent can be started at a rate of 5-10 mL per hour. We typically use ropivacaine 0.5% for the bolus injection and 0.2% for the continuous infusion. Further patient or nurse initiated boluses of 10 mL can be used for “breakthrough” pain, but these are seldom necessary. No additives such as epinephrine or clonidine are used.

**Placement under local or general anesthesia?**

All blocks are placed under anaesthesia of some sort. Some under general and some under local anaesthesia. Choosing general or local anaesthesia to place the catheter must be done according to the local hospital protocol and one’s own beliefs. The safety of the material, the thorough knowledge of the material and anatomy and attention to detail of the technique, assure a safe way of placing catheters in anaesthetised and non-anaesthetised patients. One of the safety principles (pain during injection of the local anaesthetic agent) can not be used when general anesthesia is used. Neither can the patient be curarised. Intubation, if necessary, can be performed with remifentanil or short-acting depolarizing muscle relaxants. If placed under local anesthesia, one must be careful not to accidentally anesthetize the brachial plexus while injecting the local anesthetic agent. Very little or no sedation is typically required. One can use midazolam 10-50 µg/kg combined with remifentanil 0.3-0.5 µg/kg in a bolus one minute before placement of the block.

**Catheter removal**

Sterile conditions must be used when removing the catheter. The end of the catheter distal to the
“skin-bridge” must first be removed. The complete catheter can then gently be removed. The catheter must not be cut at any stage. If the catheter is cut, there is a risk that a part may be left behind, making surgical removal necessary.

**Precautions**

Continuous interscalene block is contra-indicated in patients that complain of paresthesia, dysesthesia or pain distal to the elbow. This usually indicates existing brachial plexitis. It can indicate that the plexus has been compressed in the narrow space between the first rib and the clavicle or other causes of brachial plexitis. If one introduces a catheter and infuses a drug here, it may cause an aggravation of preoperative symptoms. It is in that case probably safer to perform a cervical paravertebral brachial plexus block (9). During and after surgery, however, precautions must be taken to avoid traction on the arm and brachial plexus. The ulnar nerve at the elbow and the radial nerve in the mid-humeral region must be especially protected after the operation for the duration of the block.

**Results**

In the study of Boezaart *et al.* (1), good post-operative analgesia and no failures were reported. It is also interesting to note a considerable lower percentage of phrenic nerve block (20%) compared to the classic single shot interscalene block were up to a 100% incidence of hemidiaphragmatic paralysis has been reported (11). This is probably due to the more distal injection through the catheter of the local anaesthetic agent (12). The incidence of recurrent laryngeal nerve block and Horner’s syndrome is also lower (1). No dislodging of catheters and no pain on the insertion site was encountered.

**Our Experience with the First 200 CISB**

We reviewed our experience with the first 200 CISB that we placed. The patients were ASA physical status I, II and III and included 130 men and 70 women. One hundred and forty eight patients received the block after induction of general anesthesia, fifty two blocks were placed with local anesthesia only. All blocks were placed for major shoulder surgery (Table 1).

A problem we encountered when starting this technique was finding a stimulator that can produce the desired output (0.1-15 mA). Most of the commercially available stimulators do not have the ability of delivering a current output of more than 5 mA. We have found a Digistim III nerve stimulator satisfactory to perform these blocks. It is also essential for the anaesthesiologist to have the support of the surgeon when starting to provide a service to offer this block to his/her patients. Initially the learning process may implicate up to 20 minutes to perform the block. We now require an average of 8 minutes to place the catheter.

Successful blocks were defined as blocks where the patients reported a pain score of 0 or 1 cm on a visual analogue scale of 0 cm (no pain) to 10 cm (the worst imaginable pain) in the recovery room and 8 hours after the surgery. The overall success rate was 97%. Two of the six unsuccessful blocks were in very obese patients. The four other failures were in patients that had no analgesia in the recovery room. The catheters were removed and no specific cause for the failures could be identified. All four these cases were among the first twenty blocks we performed and, in retrospect, showed doubtful motor responses during placement of the catheters. The catheters were probably placed on the dorsal scapular nerve and failure can possibly be attributed to our inexperience at that stage. In two other patients, the catheters dislodged during the first night after surgery. One block had to be

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**Table 1**

<table>
<thead>
<tr>
<th>Number of patients</th>
<th>%</th>
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<tbody>
<tr>
<td>Age (yr) 59</td>
<td></td>
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<tr>
<td>Gender (m / f) 130 / 70 65 / 35</td>
<td></td>
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<tr>
<td>General / local anaesthesia 148 / 52 74 / 26</td>
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<tr>
<td>Operation Open rotator cuff repair 165 82.5</td>
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<tr>
<td>Total shoulder arthroplasty 8 4</td>
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<tr>
<td>Hemi shoulder arthroplasty 4 2</td>
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<tr>
<td>Open Bankart repair 23 11.5</td>
<td></td>
</tr>
<tr>
<td>Successful 194 97</td>
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<tr>
<td>Unsuccessful 6 3</td>
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discontinued due to respiratory problems because of phrenic nerve block. Horners syndrome and hoarseness were encountered from time to time, but posed no problems. We did not evaluate patient acceptance in our series but generally the technique was well accepted by the patients.

Initially we used the regimen that Boezaart used: a starting bolus of 20 mL ropivacaine (0.5%) followed by a continuous infusion of ropivacaine (0.2%) and 10 mL boluses in between if necessary. We now use an initial bolus dose of 20 mL ropivacaine (0.5%) and only intermittent patient controlled bolus injections of 10 mL of the same ropivacaine concentration if necessary. We do not use continuous infusions and this results in excellent analgesia and a reduction in ropivacaine consumption and therefore cost. We have not encountered any patients with postoperative neurological complications or nerve damage in our series.

The future

The result of a successful catheter technique is that ambulating management of acute pain is now receiving attention (14). The continuous cervical paravertebral block that has been described (8, 9) may be promising. It seems easy to learn and to perform with possibly a lower incidence of complications. This remains to be evaluated though it seems ideal for pain relief following shoulder surgery, especially arthroscopic shoulder surgery. The use of disposable elastomeric infusion pumps in combination with a working catheter (13) is very interesting. These pumps release their medication at a fixed rate, are small and easy to carry and the patient can be discharged home from the hospital with the catheter in situ and the pump filled with 270 mL of local anesthetic. This may provide a shorter hospital stay and may have obvious financial implications.

A lot of questions remain to be answered. What is the cost / benefit ratio of using stimulating catheters and does the use of stimulating catheters improve the quality of analgesia in CPNB? Some recent publications (15, 16) offer a first step in answering these questions but large-scale prospective randomized clinical trials are needed to answer these questions.

Conclusion

The StimuCath™ technique for continuous interscalene block is a interesting technique with very good results and minimal side effects. It offers real-time assessment of correct catheter placement during placement of the stimulating catheter.

Acknowledgements

The authors wish to thank Professor Boezaart (University Hospital of Iowa, USA) for his assistance and guidance in the preparation of this manuscript. There is an interesting website with the theory and videos of the different techniques with the StimuCath™: http://uianesthesia.com/rasci.

References
