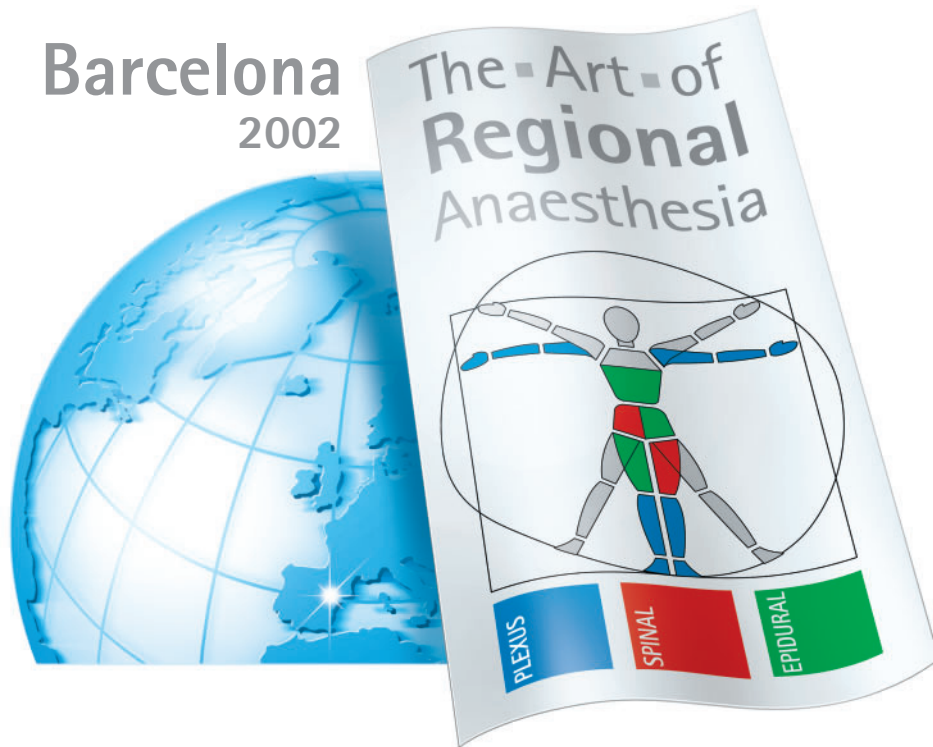


"Peripheral Nerve Block Catheter Techniques – The way ahead?"



Chairperson: Dr. Nicholas Denny, United Kingdom, Introduction

Presenters and lectures:

Prof. Hans-Hinrich Mehrkens, Germany

Dr. Paolo Grossi, Italy

Prof. José De Andrés, Spain

Prof. Susan Steele, USA

First joint World Congress on Regional Anaesthesia and Pain Therapy

**B. Braun Satellite Symposium
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- No. I Continuous Regional post-operative Analgesia:
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XVII. ESRA Congress, Geneva, September 1998
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German Congress of Anaesthesiology,
Wiesbaden, May 1999
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The Road to Sciatic and Femoral Nerve Catheters: More than 10 Years Experience

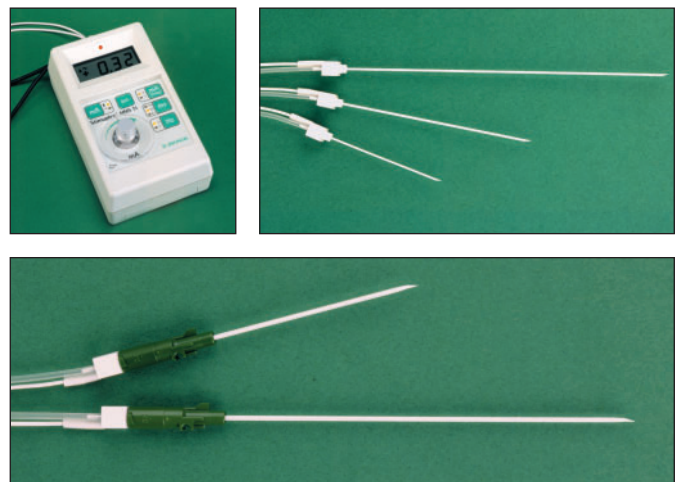
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In general peripheral regional blockades are very useful but still are underused anaesthetic techniques particularly in orthopedic surgery of the lower extremities. Both femoral and sciatic nerve blockades have been performed from the very beginning of the regional anaesthesia era, however, continuous catheter techniques have only been used quite recently.

Presumably, central blockades (spinal or epidural) are still in the first place in ranked order of employed regional anaesthetic techniques which are performed. However, in many cases the possible different types of peripheral regional anaesthesia offer equivalent anaesthetic efficacy with less upset (e.g. circulation depression, feeling of „paraplegia“, bladder dysfunction) to the patient although, in comparison, it should not be denied that some extra -but absolutely tolerable - side effects with the peripheral techniques do occur.

Above all successful practical clinical use is based firstly on profound anatomical knowledge and -secondary on essential and proper - understanding and adequate application of electrical nerve stimulation. Whereas surgical procedures on the lower extremities mostly require separate blocks of both lumbar plexus/femoral and sciatic nerves as well for postoperative and longterm pain relief, treatment often can be managed by using only one catheter, either a femoral or a sciatic depending on the location of pain origin. Among our own patients over the last 10 - 15 years a remarkable increase in use of peripheral catheters has occurred mainly due to growing numbers of psoas-compartment and sciatic nerve catheters (Fig. 1).

To achieve adequate regional anaesthesia and subsequent continuous pain relief proper equipment -including nerve stimulator, stimulation cannula, catheter and introducer- is essential:



Tab. 1: Equipment

Nervestimulator	e.g. Stimuplex® HNS 11 (B. Braun Comp.)
Stimulation Cannula	insulated, unipolar
-single shot	e.g. Stimuplex® D 50/80/120 mm
-continuous technique	Contiplex® D 55/ 80 mm 110 mm (B. Braun Comp.)

In summary: Continuous peripheral regional blockades in lower extremities offer not only best effective anaesthetic quality for surgery but also excellent pain relief treatment both of which, in addition, will be highly appreciated by the patients.

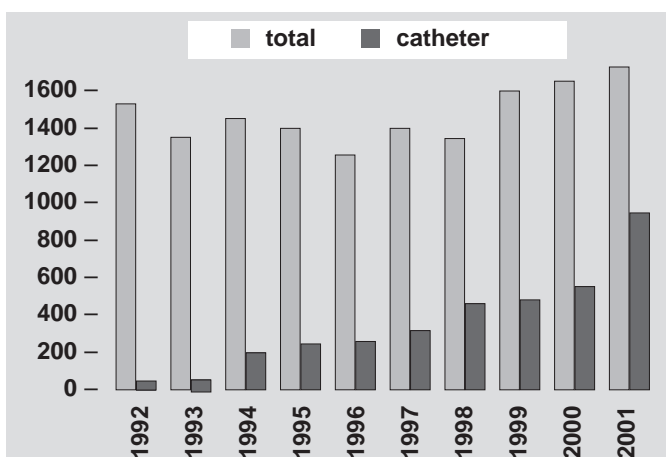


Fig.1: Peripheral blockades for lower extremity surgery 1992 - 2001 (RKU)

Why Use Brachial Plexus Catheters?

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The control of non-malignant chronic pain and intra- and post-operative pain effectively is based on the application of the principles of preemptive analgesia, dense neural blockade and prolongation of analgesia. The optimal technique for obtaining these effects is related to the use of continuous regional techniques.

Today, catheterisation of peripheral nerves and the brachial plexus has become a more widely used technique. This observation is born out by the following :

- Better quality of the materials used (catheters, needles, ENS)
- A motivated demand for adequate postoperative analgesia
- Prevention of post-traumatic pain dystrophy
- Prolonged surgical techniques (like reimplantation of the limbs)
- Request for vasodilatation of peripheral tissues.
- Need for aggressive early post operative physiotherapy which can only be successfully accomplished if the analgesia is good enough.
- Treatment of chronic pain syndromes.

Actually, continuous brachial plexus block has become one of the most interesting therapeutic methods for chronic pain syndromes.

The sympathetic nerve chain, especially the postganglionic fibres, lies very near the somatic fibres of the trunk that innervates the upper limb. Anaesthetic block includes a sympathetic block, referred to by the patient as an early sensation of warmth, and so it can be accepted as a sign of proper localisation of the nerve structures, beside the phenomena which favour the healing of ischaemic peripheral tissues.

In 1973 Ray proposed the infraclavicular approach to the brachial plexus, to include those fibres which innervate the main part of the upper limb. This technique followed the previously described techniques by others (Bazy 1914; Babitsky 1918) and had more modifications in the following years (Sims 1977; Whiffler 1981). Winnie was severely critical of this method, and was not convinced of its advantages.

The modified technique by Grossi (1999) showed some advantages:

- The possibility of positioning a catheter
- The inclusion of the musculocutaneous nerve block
- The simplicity of the approach and catheterisation with the help of electrical nerve stimulation (ENS)
- Safe fixation to the skin, with less incidence of mobilisation compared with infraclavicular and axillary approach
- Minor complications compared to central blocks
- Major sterility compared to axillary blocks
- Less possibility of obstruction or angulation of the catheter
- An ideal alternative when ankylosis or reduced mobility of the shoulder is present

The infraclavicular approach is performed by the introduction of the ENS needle (at least 10 cm long) at a point 3 cm below the clavicle, immediately medial to the coracoid process, on a line traced by the posterior border of the sternocleidomastoid muscle and the axilla, where the pulsation of the axillary artery is palpated. This line, ideally, demonstrates the position of the brachial plexus under the skin (anaesthetic line, Grossi, 2001).

The anaesthetist stands either behind the shoulder or by the side of the patient. After local infiltration of the skin, he/she introduces the needle perpendicularly to the skin and then angles it in a 30° direction to the axilla, taking it further away from the thorax. The upper limb can be abducted or adducted, depending on the pathology. The brachial plexus is more superficial if the arm is abducted. If adducted, you will find the neuro-vascular bundle at the depth of approximately 5cm, and evoke the typical twitches (flexion-extension of the elbow, wrist and fingers). After localisation, the catheter is introduced in the direction of the axilla.

The axillary approach is the most widely used technique, because of the easy reference points and the possibility of the catheter reaching the cervical roots. With this technique there is a tangential approach to the nerve bundle (perivascular of Winnie). Looking for the peripheral twitches is similar to the infraclavicular approach, except for the musculocutaneous nerve, which is never included. But this advantage is overruled by the difficulty of fixation of the catheter, which easily kinks (unless it is armoured, but with the risk of generating ulcers on the nerve structures), easily migrates and the position is full of contaminated structures (hair, sweatglands) .

EQUIPMENT AND TECHNIQUES.

In the past the most simple technique consisted of the introduction of an ordinary intravenous cannula; after withdrawing the needle, it was possible to leave the plastic cannula in situ . The disadvantages were many:

- Positioning of the cannula was not safe and stable because of its rigidity
- Its use was confined to superficial nerves

The materials are actually classified in two main groups of devices, depending on the technique adopted to introduce the catheter.

1. Catheter inside of the needle
2. Catheter on/outside of the needle

In both methods it is possible to use the insulated/sheath part of the needle, having the point of the needle or the tip of the wire just outside the catheter, to obtain a correct electrical stimulation. It is now possible to use a modified epidural set with an insulated Tuohy needle and catheter.

Some problems may arise with the introduction of the Tuohy needle, following routes like the interscalene. These are caused by the size of the needle if confronted with the small size of the nervous structure. To ease passage of the Tuohy needle through

the skin, it is better to make a small skin incision having first infiltrated the skin with a small amount of local anaesthetic solution.

From the hypothetical point of view it would be useful to study a modification of the device that has been developed for continuous spinal anaesthesia (CSA, Spinocath, BBraun), which consists of a catheter, with a rigid shape due to an inner wire with a Quincke bevel type.

Once in situ, the wire may be electrically stimulated, to check the correct positioning, near to the peripheral nerve structure, then withdrawn, and the soft catheter left in place.

Looking at future applications it surely will be worth developing more equipment and performing studies in order to increase safety and efficacy rate.

DRUGS AND METHODS OF ADMINISTRATION.

The ideal drug should have some specific properties.

- Long-acting analgesia
- Less effect on the motility
- Little toxicity and tachyphylaxis

The most recent drug for treatment of chronic pain is ropivacaine and l-bupivacaine, with a lower toxicity profile because of their levo enantiomeric status. Some authors prefer to use low concentration of 0.125-0.2% and small volumes delivered in a volumetric pump (0,5 % / 2 ml hr). This method seems to be more indicated for the treatment of localised chronic pain, especially if it is associated with clonidine. For the treatment of postoperative pain the use of low concentrations (0,25-0,125%) and higher volumes of infusion (2-5-7 ml/hr) are preferred. The safest administration depends on the type of pump whether electronic, mechanic or elastomeric. Whereas clonidine seems to prolong the effect of the local anaesthetic (Syngelyn 1992, Tryba 1992), morphine does not increase the performance of the anaesthetic drug (James 1992). Actually, in the postoperative period it could worsen the respiratory dynamics, because of systemic absorption, especially when there is also a block of the phrenic nerve (interscalenic brachial plexus block).

CONCLUSIONS.

Catheterisation of peripheral nerve structures is still a method that needs more studies on selected group of patients with adequate equipment and correct and safe administration of the drugs. The technique is essential for postoperative pain control, especially when permanent peripheral vasodilatation is required, in treatment of pain dystrophy and chronic pain pathologies of the upper limb (diabetes, ischemia, connective tissue disorder, vasculitis). Lastly, but not least, it offers the possibility of aggressive early postoperative physiotherapy and treatment of ankylosed joints.

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If not a Catheter what else?

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Introduction

Continuous peripheral neural blockade is an important technique in the management of patients with moderate to severe postoperative pain. From review of the literature many different advantages have been shown with the use of continuous plexus techniques. In addition to intra-operative and post-operative pain relief, the maintenance of an adequate blood supply to the limb both during surgery and postoperatively, due an increased arterial blood flow, venous capacity and patency of microvascular arterial anastomoses, has been demonstrated a long-time ago¹⁻⁵.

The pharmacological properties of the local anaesthetics determine their clinical profile, as they exert most of their clinical actions by inhibiting the normal function of voltage-sensitive Na⁺ channels. But in addition to this essential mechanism of membrane excitability, other factors can also influence the quality of the clinical regional anaesthesia^{6,7}. The mass of administered drug (volume x concentration) not only influences the onset time, but also the depth and duration of the sensory itive and motor blockade as well.

Determination of an adequate dose for producing, and most importantly for maintaining the block if necessary, depends on formulations of volume and concentration as well as adjuvants and pH. Once the solution is injected in the close vicinity of the nerve, only a small percent of the drug is driven into the nerve. The rest is taken up by fat surrounding neural structures and removed by the local circulation, and only the epineural local anaesthetic concentration is responsible for determining the success of nerve block⁷.

Once this point has been reached, if maintainance of analgesia after first anesthetic block is required what is the best way for the patient to be managed? Obviously it will be necessary to increase the efficiency of delivered drug/s and improve the balance between neuronal and systemic drug uptake⁸⁻¹⁰.

To increase the permeation of the perineurium and reduce the local vascular removal two basic strategies have been used, these alkalization of the solution, and the use of vasoconstrictors (epinephrine)⁸⁻¹⁰. In addition, adjuvants as Hyaluronic acid¹¹ and dextrans¹² have also been used. Finally the relative susceptibility of nociceptive fibers (Ad and C), is dependent on the variable and dynamic presence of different kind of receptors, which are activated by different noxious stimuli. Furthermore these can be blocked by other different classes of drugs which have been previously demonstrated in humans¹³ e.g. Opioids^{14,15} ; alfa-2 agonists¹⁶⁻¹⁹; acetyl cholinesterase inhibitors²⁰⁻²², and other miscellaneous drugs like ketorolac²³.

Epinephrine

Epinephrine added to the solution of local anaesthetic exerts its strong action early in the block (maximum value in 5 minutes

after injection), by enhancing the initial neural uptake that drives local anesthetic deeper into the nerve, more effectively reaching those afferent axons that innervate distal regions and are somatologically located deeper in the core of a nerve fascicle. A 4-fold increase in duration can be achieved by the combined use of 1:100.000 epinephrine in the local anesthetic solution (5.5 x 10⁻⁵ mol/L)⁷.

Dextrans

The use of macromolecules, after the clinical presentation by Hassan et al in 1985, for prolonging neural blockade, is no longer countenanced today, because of their possible toxic and immunogenetically related effects. The increase in the viscosity of the solution is an important factor in its final effect. The Hyaluronic acid (Healon[®]) has a dose-dependent effect as an adjuvant in the local anaesthetic used, but does not have intrinsic local anaesthetic power. When used in concentrations of 0.1-0.5% it produces significant increases in the latency and action duration of action for 2% Prilocaine (500%), 0.5% Bupivacaine (282%), and 2% Lidocaine (123%).

Alkalinization of Localanesthetic

To increase the perineural uptake of the injected drug, the simplest strategy is to increase the pH of the solution within the limits of solubility and stability of the formulation. Improved results in onset and depth of blockade have been obtained with the carbonated salt of Lidocaine as opposed to the classic hydrochlorhydrate, although these same results have been obtained by Mitolo-Chiepa et al with the salicilate²⁴. Alkalinization increases the fraction of the drug in the base the form (up to 10 – fold) that permeates the cell membranes far more rapidly than the charged form. Differences were obtained in the block characteristics between the use of sodium bicarbonate (NaHCO₃) or Na OH. Alkalinization of local anaesthetic solution to 7.8 pH with sodium hydroxide gave a faster, more extensive and longer-lasting block than when bicarbonate-alkalized solution of Lidocaine was used in rat's sciatic nerve block⁷.

Opioids

There is some evidence for a small number of opioid receptors on axons of peripheral nerves, and addition of different opioids enhance peripheral nerve block from local anaesthetics in some studies²⁵⁻³¹. However, controls with systemic administration suggest this may represent an effect due simply to systemic absorption. Perineural application of an opioid (i.e., injection alongside a nerve trunk) is less effective than application to the nerve terminal (e.g., intraarticular), possibly because opioid receptors are synthesized in the dorsal root ganglion during peripheral inflammation and transported intracellularly along axons toward peripheral nerve endings. Axonal receptors are therefore "in transit," not coupled to intracellular processes, and in this sense less functional than receptors that have reached their destination in the cell membrane of the nerve terminal.

In a randomized, prospective study with 80 patients, Antonucci¹⁴ showed that 100 mg of Tramadol when used as an adjuvant with ropivacaine 0.75% 20 ml, provides a significant reduction in onset time, prolongation of anaesthesia and analgesia, with a quality of block similar to that obtained with Clonidine 1.5 mg/kg and sufentanil 20 mg. It also produced a lower incidence of side effects when compared to Clonidine (sedation, bradycardia and hypotension) and sufentanil (itch and sedation).

Reuben et al¹⁵, examined the analgesic effects of administering morphine 5 mg, verapamil 2.5 mg, or its combination into the brachial plexus sheath with 40 mL of 1.5% Lidocaine and epinephrine 5 mg/mL. Analgesic duration was significantly increased in those patients receiving brachial plexus blocks with morphine ($P < 0.005$) but with less consumption of rescue analgesics during 24h follow-up study period ($P < 0.03$). Duration of anaesthesia was significantly increased in those patients receiving brachial plexus blocks with verapamil ($P = 0.002$).

Evidence regarding the analgesic benefit of opioid adjuncts remains equivocal and more evidence is required before their routine use can be recommended for prolonging analgesia after plexus block¹³.

Clonidine

Clonidine achieves a depression of action potential in nerves fibres, which could be partly responsible for its anaesthetic/analgesic effect³²⁻³⁵. This has been demonstrated in vitro on nerves fibres bathed by solutions of different Clonidine concentrations. The depression of the action potential resulting from the administration of Clonidine is less important than the one produced by Lidocaine. On the contrary the depression depresses the action potential of tetrodotoxine resistant fibres by Clonidine shows that its effect is not related to blockade of sodium channels.

Eledjam et al³³, have demonstrated that 150 mcg of Clonidine were more effective than 200 mcg of epinephrine at prolonging the duration of brachial plexus block. Gaumann et al³⁶, found a comparable duration of action of Clonidine and epinephrine-containing solution when used in axillary blocks, but plasma concentrations of local anaesthetic were lower in the group of patients who were given epinephrine-containing solutions compared to patients who received Clonidine. Thus, indicating that Clonidine did not prolong the duration of action of local anaesthetic agent through a decrease in plasma absorption, as a result of resulting from its potential vasoconstrictive effect.

Syngelin et al have clearly pointed out that while perineural administration of Clonidine effectively prolongs the duration and the analgesic effect of mepivacaine after of brachial plexus block³⁷ in a dose related manner³⁸, subcutaneous administration of Clonidine had no effect. A single dose of 0.3 mg/kg produces analgesia of very long duration. Marinangeli F, et al¹⁹ in a double-blind randomized study evaluated the optimal intravenous dose of Clonidine administered during the peri-operative period, after lumbar hemilaminectomy for herniated disk repair. The "optimal intravenous dose" was defined as that providing minimal analgesic request, stable haemodynamic profile and a minimal sedation score during 12h after extubation. Three different loading doses of intravenous Clonidine 5 mg/kg, 3 mg/kg, 2 mg/kg were given randomly, followed by the same infusion of intravenous Clonidine (0.3 mg/kg per hour) in all the groups. The conclusion of this study was that, when sedation and the analgesic effect of Clonidine are required, 3 mg/kg bolus dose followed by a continuous infusion of 0.3 mg/kg per hour has to be considered the optimal intravenous dose.

Neostigmine

The acetyl cholinesterase inhibitor neostigmine has shown peripherally mediated analgesic action in recent preclinical and clinical studies. Bone et al²⁰, in a double-blind, randomized study, investigates the effectiveness of adding neostigmine 500 mg to mepivacaine, in patients receiving axillary brachial plexus block for upper extremity surgery. No influence on onset, duration of sensory and motor block was recorded, but patients receiving neostigmine had significantly lower pain ratings and supplemental analgesic consumption during the first 24 hours postoperatively.

Van Elstraete et al²², in a prospective, randomized, double-blind, placebo-controlled study concluded that when Neostigmine 500 mg was added to 1.5% Lidocaine 450 mg and epinephrine 5 mg/mL-1, produced no advantage over the local anesthetic solution alone. Same result was obtained by Bouaziz H et al²¹ after studying sixty-nine outpatients scheduled for carpal tunnel syndrome repair with axillary plexus block and concluded that 500 mg neostigmine added to mepivacaine had no effect on sensory and motor block, but gastrointestinal side effects occurred in 30% of patients in neostigmine groups

These last two well-designed studies raise doubts about the use of neostigmine associated with local anesthetics for prolong the effect of local anesthetics in plexus block.

Ketorolac

Ketorolac has been shown to enhance postoperative pain relief when added to local anesthetics used for wound infiltration during hand surgery and hernia repair³⁹. Reuben et al^{40,41}, have also suggested ketorolac efficacy when injected intra-articularly for arthroscopic knee surgery.

In a double-blinded, placebo-controlled, and randomized study Reinhardt et al²³, studied the effect of adding ketorolac (4 mg/mL) to the local anesthetic solution. The results of the study showed not only significantly lower overall VAS and verbal pain scores for the groups using Ketorolac, but also having a significantly longer time to the first reported pain and oral pain medications. The authors also demonstrated that the ethanol vehicle is unlikely to be responsible for the analgesic effects of ketorolac. There were no untoward side effects reported from any group. Chemical analysis by gas chromatography and capillary electrophoresis showed Ketorolac retains its chemical stability when placed in local solutions of Lidocaine or bupivacaine and stored at 37°C for 1 week.

Conclusion

Continuous neural blockade with infusions of analgesic concentrations of local anaesthetics is the easiest and best method for providing intense intra- and postoperative analgesia facilitating postoperative rehabilitation while reducing opioid analgesic requirements and opioid-related side effects.

Perineural administration of combinations of local anesthetics with adjuvants like opioids and α_2 agonists produce potent and selective analgesia in peripheral sites. Other possible adjuvant drugs need to be carefully studied prior to their routine clinical use in plexus anesthesia.

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Experiences with the Insulated Tonky Needle: 4 New Dawn?

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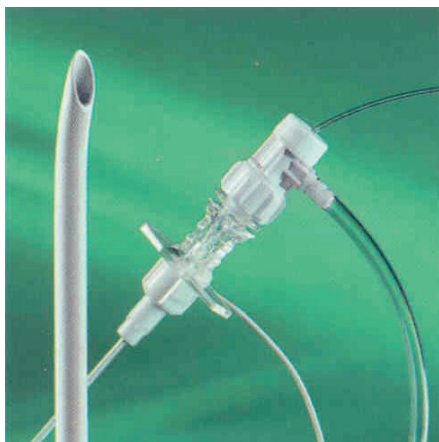
Peripheral nerve blockade has long been successful in providing surgical anesthesia and post-operative analgesia with a paucity of side effects. Single shot regional nerve block techniques provide only a limited duration of post-operative analgesia. Continuous peripheral nerve blockade (CPNB) not only safely provides effective, efficient surgical anesthesia but also provides prolonged duration of post-operative analgesia for patients undergoing painful limb surgery. Despite the efficacy and safety of CPNB techniques, the lack of exclusively designed equipment has contributed to multiple catheter insertion and maintenance difficulties. Another significant barrier to the widespread use of CPNB techniques is the lack of formal education regarding this technique during anesthesia training programs. With the advent of new effective, user-friendly needle/catheter/infusion pump systems, CPNB techniques are destined to be the preferred anesthesia/analgesia technique of the new millennium.

The following are important contributions in the history of development of Continuous Regional Anesthesia/Analgesia (CRA) techniques:

1946 Ansbro described the first method of continuous brachial plexus block. He used a supraclavicular approach with a blunt needle, tubing and cork to relieve pain and improve upper extremity circulation after arterial embolization.¹

- 1962 Greenblatt built his own nerve stimulator
- 1973 Raj described the first infraclavicular brachial plexus block to ensure catheter stability
- 1977 Selander described a catheter technique for axillary block and warned that paresthesia techniques may be associated with more residual dyesthesias.
- 1979 Winnie described the sheath concept for plexus anesthesia, which could be accomplished by a single injection.
- 1980 Raj described the use of the nerve stimulator for peripheral nerve blocks
- 1981 Rosenblatt and Cress described modified Seldinger technique for continuous interscalene block
- 1983 Tuominen reported blood levels of bupivacaine during continuous infusion via an axillary catheter
- 1985 Raj expressed the requirement for well-designed equipment and a sound knowledge of anatomy as being essential for successful CPNB techniques
- 1993 Concepcion wrote a review on continuous brachial plexus catheter techniques which has an extensive reference list²
- 1998 Greengrass and Steele describe a new continuous catheter delivery system³
- 1999 Boezaart described a new technique for continuous interscalene block using a stimulating catheter⁴

The ideal CPNB catheter system designed over the past 7 years at the author's institution includes:



- 1) an insulated Tuohy needle with blunt Huber bevel allowing pinpoint electrical stimulation when connected to a nerve stimulator
- 2) an adapter that facilitates the ability to simultaneously nerve stimulate while aspirating for blood and ability to inject local anesthetic through an extension tubing using an immobile needle technique
- 3) an end port on the adapter which can be preloaded with an epidural catheter that facilitates a single person operator to pass a catheter through the needle without the need to disassemble the equipment

The initial description of CRA was by Ansbro in 1946. Prior to the 1980s, only a few series of patients received CRA techniques for various procedures. CRA is being increasingly utilized for treatment of acute pain, particularly for major plastic, orthopedic and vascular procedures, on both an In- and Out-patient basis. When single shot blocks are insufficient to control severe protracted post-operative pain: the use of CRA, specifically continuous interscalene brachial plexus block (CISB), for open shoulder surgery has been highly successful. Significant advantages were found with CISB which allowed a significant reduction in narcotic consumption, improved pain control, and the facilitation of earlier aggressive physiotherapy. Newer studies show CPNB techniques for the first 72 hours post-operatively for major shoulder and knee procedures have resulted in high levels of patient satisfaction resulting from superior analgesia, minimal narcotic requirements, absence of post-operative nausea and vomiting, improved sleep patterns and maintained cognitive function (author's experience).

The sympathectomy associated with CRA enhances blood flow, which is an essential component to successful re-implantation surgery and free flap surgery. The advantage of limb specific continuous catheters in such surgery is not only for enhancement of blood flow and prevention of pain, but also for abolition of the endocrine stress response to surgery. CRA also avoids the complications of centroneuraxial blocks such as epidurals with the associated hypotension, urinary retention, pruritus and difficulty in mobilization and respiratory depression. The use of CRA in the treatment of cancer pain has also been reported. This humanitarian use of CRA has allowed significant reduction in the use of narcotics and other analgesics with improvement in the quality of life. CRA has also been successfully used in chronic pain syndromes such as sympathetic maintained pain where patients can receive either continuous infusion or intermittent bolus of local anesthetics on an In or Out-patient basis. Investigational uses of CRA include use in amputation procedures to produce an area of deafferentation, which, if continued postoperatively, has been shown to decrease the incidence of chronic pain syndromes such as phantom pain.

Absolute contraindications to CRA include infection at the site of catheter insertion, and acute progressive neuropathies.

Various methods of catheter introduction have been performed over previous years each with its own problems. At the author's institution surgical anesthesia is initiated using 0.5% Ropivacaine. Analgesia is continued using 0.2% Ropivacaine at 8 -10 mls/hr via continuous infusion in an adult, or 0.25 mgs/kg/hour in children via continuous infusion. In adults, a basal continuous infusion with a patient-controlled bolus capability allows similar pain relief with lower local anesthetic doses and potentially less motor blockade. We use a 4-6 ml/hr basal rate with 2-4 ml boluses available with a 15 to 30 minute lockout interval for up to 72 hours post-operatively. Studies are ongoing

looking at peripheral nerve catheters with continuous infusions plus a patient controlled bolus capability using disposable infusion pumps on an outpatient basis.

For upper extremity surgery, continuous interscalene, subclavian perivascular, infra-clavicular or axillary approaches are utilized. For lower extremity, lumbar plexus block utilizing either the psoas or inguinal perivascular approach is utilized. For continuous sciatic block, either classic approach, the Raj posterior approach, or the popliteal is utilized. For thoracic chest wall surgery (i.e. thoracotomy, bilateral breast reduction) single or bilateral continuous paravertebral catheters have been reported. Various CPNB techniques will be discussed and illustrated.

At the Duke University Ambulatory Surgery Center, 65-70% of surgical cases are performed using a regional anesthesia technique. The vast majority are peripheral nerve blocks. The percentage of continuous peripheral nerve blocks continues to increase to provide optimal quality and duration of postoperative analgesia. See figures 1-10.

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Fig. 1 Continuous Peripheral Nerve Block Techniques

(Number of patients = 1556 / Number of catheters = 1715)

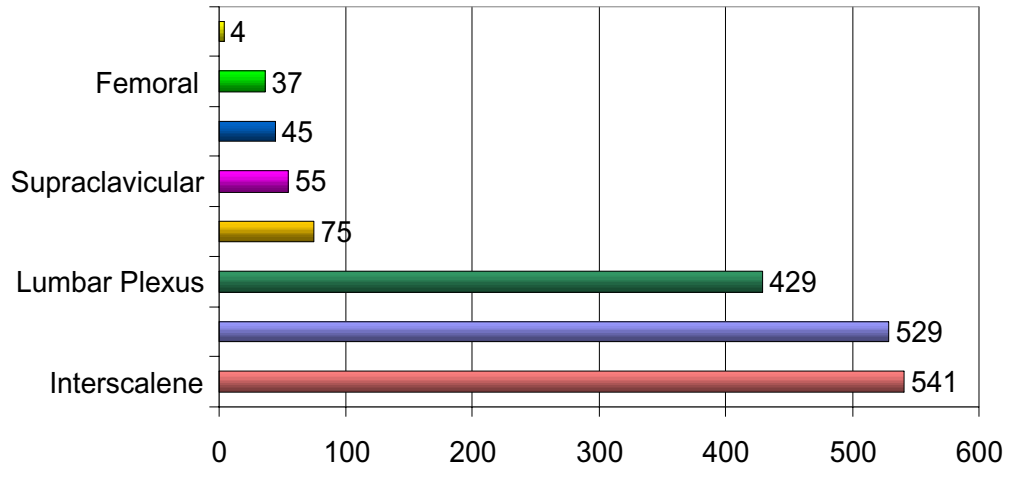


Fig. 2 Regional Anesthesia Techniques
(Number of patients = 12,023 / Number of techniques = 14,439)

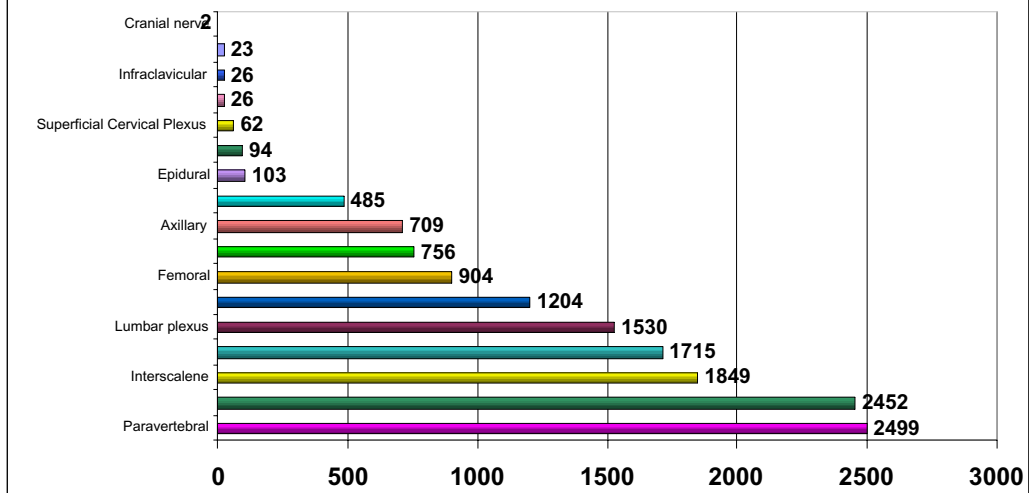


Fig. 3 Patient Age with CPNB Technique
(N = 1556)

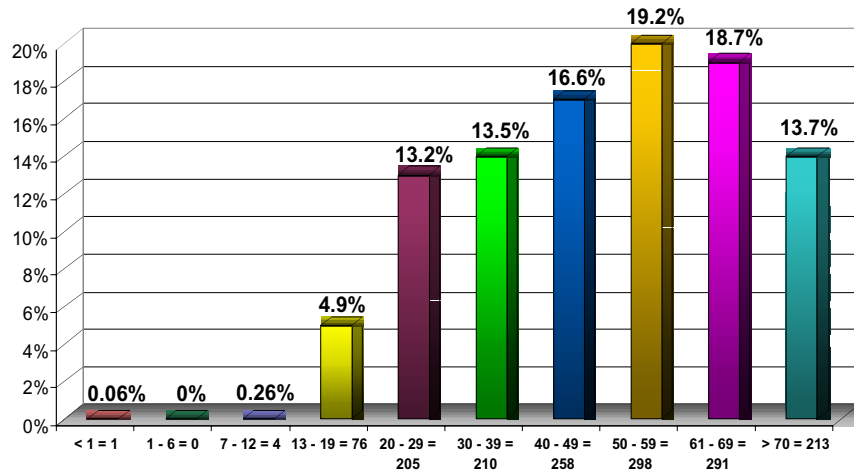


Fig. 4 ASA Physical Status in Patients with CPNB
(N = 1556)

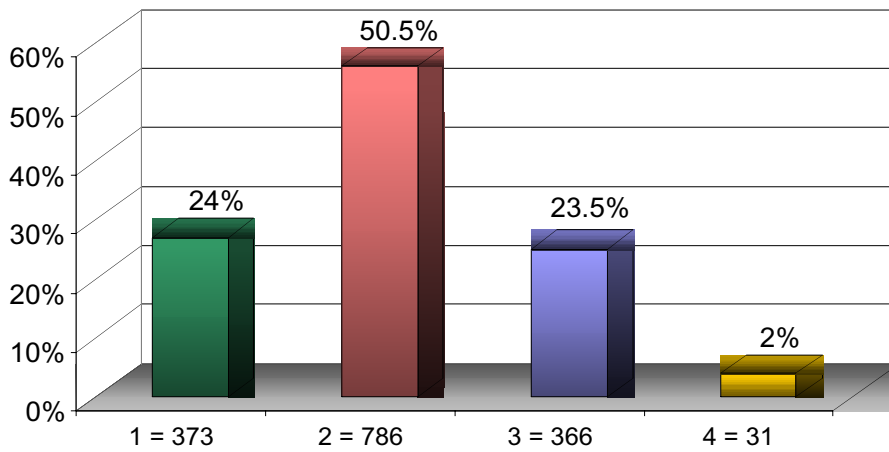


Fig. 5 Efficacy of CPNB Techniques

(N = 1556)

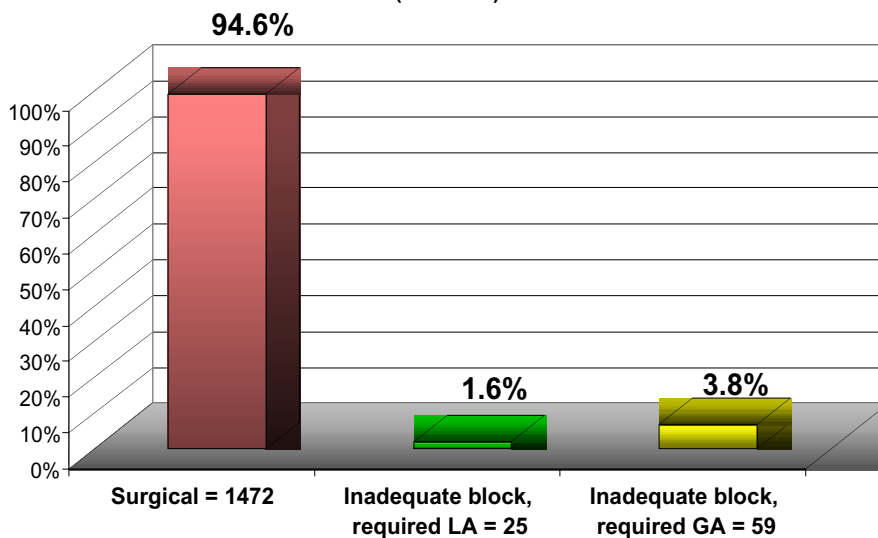


Fig. 6 Acute Complications with CPNB Technique

(Non-sustained / Non-life threatening Complications)

(Number of patients = 1556 / Number of catheters = 1715)

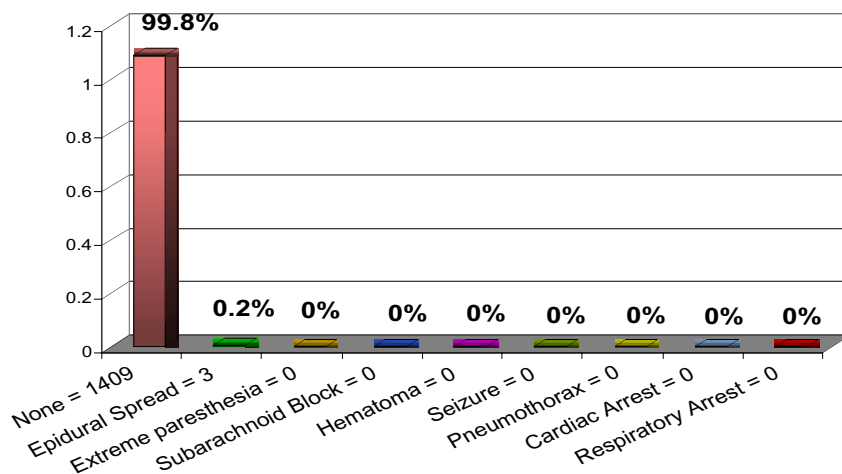


Fig. 7 PAIN at 24 hours
Continuous Peripheral Nerve Blockade Techniques
 (Number of patients = 1556 / Number of catheters = 1715)

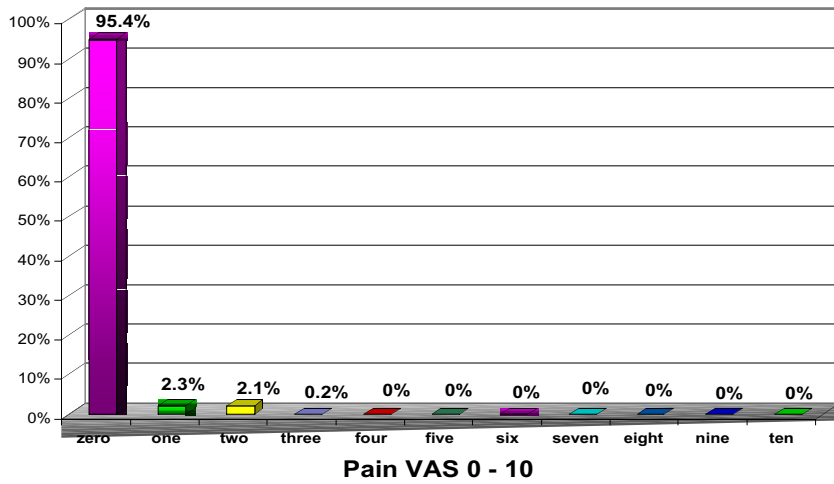


Fig. 8 PAIN at 7 days
Continuous Peripheral Nerve Blockade Techniques
 (Number of patients = 1556 / Number of catheters = 1715)

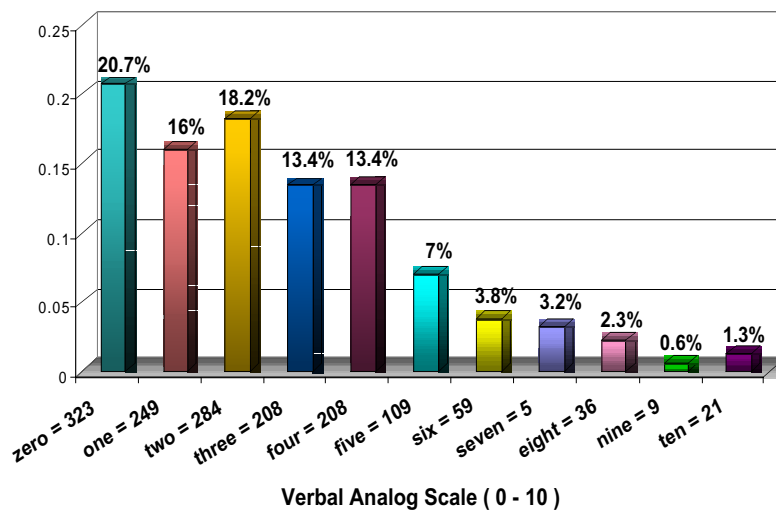


Fig 9 Opioid Requirements
Continuous Peripheral Nerve Blockade Techniques
 (N = 1556)

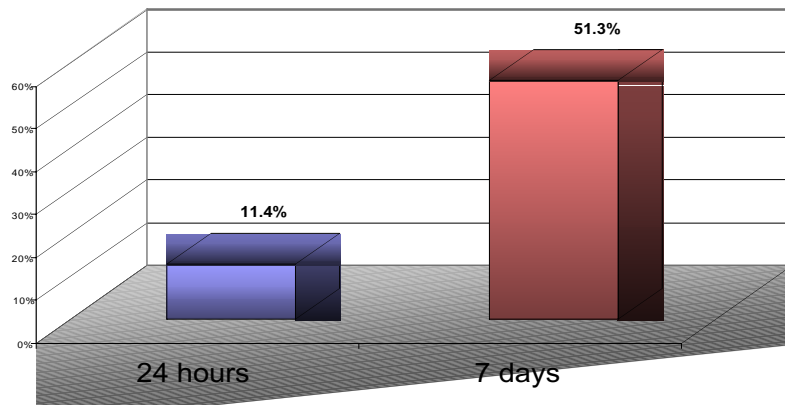
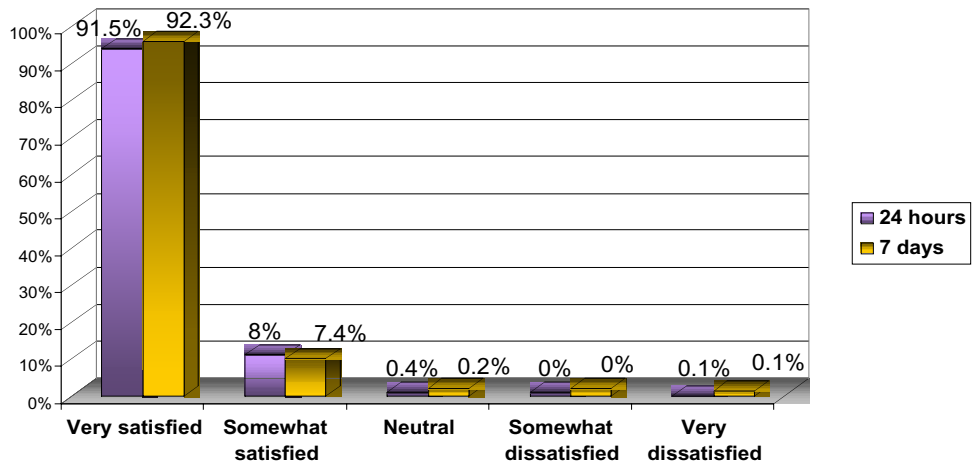


Fig. 10 Patient Satisfaction with CPNB Techniques
 (N = 1556)



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