Specific nerve blocks: an update

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Recently there has been a considerable increase in interest in regional anesthesia and neural blockade. Many traditional nerve block techniques have been significantly modified to better fit the realm of both inpatient and outpatient surgery. The introduction of long acting local anesthetics with better safety profile as well as better equipment for continuous neuronal blockade has further increased the utility of peripheral nerve blocks. A significant effort has also been invested in studying and improving the safety of various techniques. These developments, coupled with an increased emphasis on teaching of regional blocks by organized anesthesia societies are likely to result in a wider use of these techniques in years to come. Curr Opin Anaesthesiol 13:549–555. © 2000 Lippincott Williams & Wilkins.

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Introduction

After a relatively dormant period of several decades, there has recently been a significant resurgence of interest in regional anesthesia and peripheral nerve blockade. This has been accompanied and facilitated by an explosion of research, new information and availability of better equipment for regional anesthesia. The present review provides an update on the recent developments in this field.

Upper extremity blocks

Block of the brachial plexus can be approached at several levels from its origin at C4-T1. Recently there have been substantial efforts to increase the success rate of the existing techniques using modified approaches, multiple injection techniques or adding various additives to local anesthetic solution.

Interscalene block

Since its popularization by Winnie [1], interscalene block has been a frequently utilized regional anesthesia technique for upper extremity and shoulder surgery [2,3]. Recently, the block technique was evaluated by Wong *et al.* [4] using magnetic resonance imaging. Those investigators examined the angle of the needle insertion in reference to the saggital plane. They suggested that the needle should be inserted at a 60° angle relative to the saggital plane, rather than more perpendicular as previously described. They concluded that this may decrease the number of needle insertions necessary to contact the brachial plexus.

The introduction of the intersternocleidomastoid muscle approach to brachial plexus block by Pham-Dang *et al.* [5] addressed some problems encountered in the traditional approaches, especially problems with catheter placement and their accidental dislodgment. In their detailed report of the technique, those authors also emphasized that the technique is relatively easy to master and teach because the surface landmarks of the triangle formed by the sternocleidomastoid heads are readily identified. Although this approach has attracted considerable interest in the regional anesthesia community, it has also been criticized by some because of the higher likelihood of lung injury [6].

Parascalene block is a technique of blocking the brachial plexus at the lateral border of the anterior scalene muscle superior to the clavicle. In a study by Vongvises and Beokhaimook [7] the analysis of computed tomography images revealed that the level of needle insertion was superior to the dome of the pleura. The distances from the skin to the interscalene groove and from the interscalene groove to the first rib at the level of the needle insertion or the marker in both groups were measured to be 17 ± 4 mm and 15 ± 3 mm, respectively [4]. This suggests that the incidence of pneumothorax should be small using this approach.

The introduction of long-acting local anesthetics with an increased safety profile and relatively fast onset of action has also contributed to a greater interest in the interscalene block technique. For example, in a study by Casati *et al.* [8] in patients undergoing elective shoulder surgery, 20 ml of 1.0% ropivacaine resulted in faster readiness for surgery than did the same volume of 2% mepivacaine. Interscalene block using ropivacaine also provided postoperative analgesia that was twice as long as compared with mepivacaine. Promising results were reported with continuous interscalene brachial plexus analgesia using a basal infusion of 5 ml/h local anesthetic mixture (0.125% bupivacaine with sufentanyl 0.1 μgl/ml and clonidine 1 μg/ml) with patient-controlled analgesia boluses (2.5 ml/30 min) [9•]. Those authors concluded that continuous interscalene analgesia with a background infusion after open shoulder surgery reduces local anesthetic consumption and allows patients to rapidly reinforce the block shortly before physiotherapy.

Interscalene block is a potentially useful technique in high-risk patients because of its unique advantages over general anesthesia, such as avoidance of airway manipulation and excellent pain control. However, the high incidence of diaphragmatic paralysis [10] and its consequent impact on pulmonary function may actually contraindicate its use in patients with significant respiratory disease [11]. It appears that block of the phrenic nerve is unavoidable even with smaller volumes of local anesthetics (e.g. 20 ml) and with proximal digital pressure applied during injection of the local anesthetic [12•]. Similarly, interscalene block through the posterior approach is not devoid of pulmonary side effects, because the method was reported to result in hemidiaphragmatic paresis and a reduction in pulmonary function tests similar to those seen with the anterior approach [13].

Axillary block

Brachial plexus block at the axilla is one of the most widely used regional anesthesia techniques [2]. It can be used as a sole anesthetic technique for surgical procedures involving the hand, forearm and elbow. The most commonly used technique, the transarterial approach, has been reported to result in an unusually high failure rate (10–20%). Traditionally, the spread of local anesthetic solution in axillary brachial plexus block is believed to be influenced by the position of the arm and the use of compression maneuvers. However, a recent study [14] reported that the central spread of the local anesthetic is facilitated by injection without abduction of the arm. In that study, traditionally taught compression at the injection site did not enhance the spread of the local anesthetic. Of note, neither abduction nor compression during injection had other significant effects on the quality of the block, except that the radial nerve block was achieved more often in the neutral position.

Recently in Europe, in an attempt to increase the reliability of the block, a multiple injection technique has been introduced. With this technique nerve stimulation of specific nerves (ulnar, radial, musculocutaneous and medianus) is performed before injecting local anesthetic. Lavoie *et al.* [15] injected local anesthetic after stimulation of the musculocutaneous nerve and the nerve innervating the surgical site. They found the technique easy to use and reported a high success rate. Inberg *et al.* [16•] also found that a double-stimulation technique was as effective as the transarterial technique, and there was less need for supplemental nerve blocks when a volume of 35 ml local anesthetic was used. Similarly, Dupré [17] earlier suggested an approach at the level of mid humerus that involved stimulation of four nerves. In a prospective, randomized study comparing the success rate, time required to perform the blocks, and onset and quality of the block [18], the mid humeral approach proved to be superior to the two-nerve stimulation approach at the level of the axilla. In another prospective study, however, the same approach yielded a failure to achieve anesthesia in 17.9% of blocks [19]. In yet another study that compared the transarterial approach with the mid humeral nerve stimulator technique [20], the latter required fewer supplementary blocks and resulted in a faster patient readiness for surgery than the transarterial technique. However, the mid humeral technique took longer to perform and the patients received more intraoperative sedatives.

On the basis of the available data, the mid humeral technique seems to hold promise for a faster onset and possibly higher success rate with smaller doses of local anesthetic. However, more clinical experience and data from other centers is needed before these techniques can be recommended over traditional approaches.

Another area of research has concentrated on improving the success rate using newer local anesthetics and local anesthetic additives. The introduction of ropivacaine, an amide-type local anesthetic of long duration holds promise for increased safety with long-acting local anesthetics. Ropivacaine has been shown in experimental models to be less cardiotoxic than bupivacaine. Using an identical technique and 32 ml local anesthetic, Bertini *et al.* [21•] found that 0.5% ropivacaine resulted in a faster onset of blockade and higher quality of anesthesia than did 0.5% bupivacaine. Of note, those authors emphasized that they found that increasing the concentration of ropivacaine from 0.5 to 0.75% did not enhance either the onset or quality of blockade. Although the duration of sensory block was similar (11 h), however, the patients who received bupivacaine had motor block lasting 2 h longer than those who received ropivacaine. It is possible that the faster resolution of the motor block might have contributed to the better patient satisfaction reported in the ropivacaine group.

Similar results were reported in a study performed at five Norwegian centers [22]. Again, ropivacaine 0.5% resulted in a better quality of anesthesia than did 0.5% bupivacaine when volumes of 40 ml were used, as evaluated by surgeons and anesthesiologists, although there were no differences in the time to onset and duration of the block. Of note, one patient developed toxicity shortly after injection of 40 ml 0.5% ropivacaine, indicating an accidental intravenous injection. With ropivacaine blood levels of 2.7 mg/l, this patient apparently had central nervous system involvement, resulting in convulsions, and eventually recovered uneventfully.

For patients undergoing complex, prolonged or particularly painful upper extremity surgery, continuous brachial plexus block through the axillary approach has become the norm since its popularization by Selander [23]. Using this method, Mezzatesta *et al.* [24] found that both the continuous infusion and intermittent bolus administration of bupivacaine provided safe and effective postoperative analgesia. However, intermittent bolus administration provided lower plasma bupivacaine levels.

Local anesthetic infusion through nerve sheath catheters placed under direct vision is an alternative analgesic technique in patients undergoing upper extremity amputations. In a recent clinical report [25], infusion of bupivacaine 0.25% administered through catheters as a bolus and then as a continuous infusion for at least 72 h after surgery resulted in a complete analgesia in all six patients evaluated in the report. Unfortunately, three out of six patients reported phantom limb pain during follow-up evaluation.

Another area of investigation focused on using various additives to local anesthetics to prolong the duration of analgesia without unwanted accompanying motor blockade. Bernard and Macaire [26] found that clonidine added to lidocaine for brachial plexus enhances the quality of axillary plexus block. These effects appeared to be dose-related, and the authors recommended doses of 30 to 60 μgl as optimal. Addition of 100 mg tramadol (an analgesic and possibly α_2-adrenoreceptor agonist) to 1% mepivacaine in axillary plexus block also prolonged the duration of sensory blockade by 100 min without side effects. However, the tramadol had no effects on the onset of sensory or motor blockade. On the basis of these data it appears that these additives produce effects similar to those of epinephrine, except that their use for this purpose is largely devoid of significant cardiovascular and sedative side effects [27]. Their advantages with long-acting local anesthetic, however, is less clear. Bone *et al.* [28] suggested that axillary plexus block analgesia can also be enhanced by addition of neostigmine. Those investigators based their recommendation on a study in which patients receiving 500 μg neostigmine as an adjunct to local anesthetic had significantly lower pain ratings and a lower need for analgesics 24 h after surgery.

Supraclavicular and infraclavicular blocks

Supraclavicular and infraclavicular blocks refer to the block of the brachial plexus at the level of divisions and cords, respectively. Because the blocks are placed above the axilla and below the level of the roots, the potential advantages include better anesthesia for arm tourniquet, fewer failures to anesthetize the musculocutaneous nerve, and possibly a lower incidence of diaphragmatic paralysis. Similarly to other regional block techniques, this technique has seen some modifications to the original approach. Salazar and Espinosa [29] described their experience in 360 cases in which they employed an infraclavicular approach with the needle directed medially, rather than laterally. This approach resulted in a high success rate (95%) and no complications in patients undergoing upper extremity surgery. However, the medial direction of the needle is unlikely to make this approach the first choice for those who are less experienced in regional blocks because it may carry a higher risk of pneumothorax.

Brachial plexus block by the coracoid approach has an advantage over the axillary approach because it does not require arm abduction. However, in a randomized observer-blinded study that compared success rates and onset of block, Koscielnak *et al.* [30] found that the axillary approach to the brachial plexus using four injections of ropivacaine yielded a faster onset of block and a better spread of analgesia than in the coracoid approach using a two-injection technique. Unfortunately, those authors do not describe the responses to nerve stimulation obtained during the coracoid approach, which makes it difficult to place their results in clinical perspective. In contrast, Kapral *et al.* [31] obtained a 100% success rate using 40 ml 1.5% mepivacaine in their infraclavicular block when the motor response of the distal muscles was obtained after lateral cord stimulation.

In a study by Neal *et al.* [32] supraclavicular block resulted in hemidiaphragmatic paresis in 50% of cases, which is a 50% reduction compared with the interscalene block. Although in their study on healthy volunteers pulmonary function was not affected, such effects in patients with pulmonary disease are likely to be more pronounced. Their use of a rather small volume of local anesthetic (30 ml) makes it difficult to apply their results universally to clinical practice, because significantly larger volumes of local anesthetics are used by many clinicians. On the other hand, infraclavicular block does not seem to affect respiratory function, even in the elderly when a mixture of 40 ml local anesthetic is used [33].

Somatic blocks

Several somatic block techniques which seemed to have long been forgotten have been recently re-introduced and modified to fit the realm of modern surgery and anesthesia. Thoracic and lumbar paravertebral blocks have especially been found as useful and promising anesthesia techniques in patients undergoing ambulatory surgery.

Thoracic paravertebral block

Paravertebral block is a regional block technique that has recently been reintroduced. It has been shown to be particularly useful as an anesthetic technique in patients undergoing the surgical treatment of breast cancer. Paravertebral block markedly improves the quality of recovery after breast cancer surgery, and provides the patient with the option of ambulatory discharge. Coveney *et al.* [34] reported that 96% of patients having paravertebral block anesthesia were discharged within the day of surgery. Similarly, cosmetic and reconstructive breast surgery is frequently associated with significant postoperative nausea and pain. However, the use of paravertebral block in these patients has been reported to result in significantly fewer complications and greater patient comfort postoperatively when compared with general anesthesia [35].

Lumbar paravertebral block

Very favorable results were reported when paravertebral somatic nerve block was used for outpatient inguinal herniorrhaphy [36]. Surgical anesthesia occurred 15–30 min after injection of 5 ml local anesthetic (0.5% bupivacaine with 1 : 400 000 epinephrine) paravertebrally from T10 to L2. The authors reported that more than 75% of patients had no incisional discomfort for at least 10 h after surgery. However, an epidural spread occurred in 15%, suggesting that the same precautions with regard to hemodynamic monitoring should be employed with lumbar paravertebral block as are used in epidural anesthesia. In another study that compared lumbar paravertebral block with the field block in patients undergoing inguinal herniorrhaphy [37], the former was reported to result in better anesthesia with fewer needle insertions, less local anesthetic used and a high patient satisfaction. Paravertebral lumbar plexus (sympathetic) block has also been reported as another useful technique to alleviate labor pain in parturients with spine pathology [38,39]. Although those authors used a single-shot technique at L2 level on each side, a catheter could also be inserted for continuous infusion of local anesthetic [40].

Lower extremity blocks

Lower extremity blocks are among the least frequently used regional anesthesia techniques. However, the wider use of nerve stimulators and introduction of better techniques have led to a significant resurgence of interest for these techniques in clinical practice.

Femoral nerve block

There has been a recent interest in using ultrasound for the purpose of more precise placement of the needle in femoral nerve blockade. Marhofer *et al.* [41] demonstrated that the use of ultrasound improved the onset time and the quality of sensory block in a ‘three-in-one’ technique compared with conventional nerve stimulator techniques. Since its introduction by Winnie in 1973, the ability of the 3-in-1 technique to provide consistent blocks of femoral, obturator and lateral cutaneous nerve of the thigh nerves through a single injection of local anesthetic (thus, 3-in-1) ‘has been a subject of controversy.’ However, it remains unclear how the ultrasound technique may influence the time efficiency to accomplish the blocks, and how these results translate into achieving surgical anesthesia. In contrast, precise localization of the femoral nerve by employing the very predictable relationship of the femoral nerve to the femoral artery at the inguinal (femoral) crease level was reported with a 100% success rate for surgical anesthesia using a nerve stimulator technique [42•]. The key to this high success rate was insertion of the needle at the inguinal crease level and immediately adjacent to the lateral border of the femoral artery, which resulted in a high rate of needle–femoral nerve contacts. Additionally, low current intensity nerve stimulation and injection of a larger volume of local anesthetic of high potency are also essential to the high reliability of the technique [42•].

Both three-in-one block and femoral block (the former of which remain a subject of controversy) have also been very successfully used for postoperative analgesia after various femur and knee surgeries. The use of combined sciatic and femoral blocks with bupivacaine preoperatively resulted in superior analgesia and reduced morphine consumption during the first 24 postoperative hours, as reported by several investigators [43,44]. Of note, Allen *et al.* [44] also found that the addition of sciatic nerve block to femoral nerve block did not further improve analgesic efficacy, a result that diverges from our experience [45] that a good proportion of patients still need a popliteal or sciatic block in addition to femoral block, especially when the patients are treated postoperatively with passive continuous motion devices.

Ilioinguinal and lateral femoral cutaneous nerve of the thigh blocks

The blockade of specific, sensory components of lumbar plexus also has a role in clinical management of anesthesia. The use of ropivacaine proved to be effective for pain relief after hernia repair in ilioinguinal blocks [46]. In that study the plasma concentrations of ropivacaine peaked after 30–45 min, and were within safe limits after administration of 0.25 ml/kg ropivacaine. It should be remembered that femoral nerve block can occur after ilioinguinal field infiltration for inguinal herniorrhaphy [47]. The mechanism could involve tracking of local anesthetics between the fascial planes of transversus abdominis muscle and the transversalis fascia deeper to the iliacus fascia that contains the femoral nerve. This has important implications for the performance of a percutaneous ilioinguinal field block, particularly in the day surgery environment and when long-acting local anesthetics are used.

Lateral femoral cutaneous nerve block is also a very effective analgesic/anesthetic technique for skin grafts that are harvesting from the lateral thigh [48]. This technique is also very well tolerated and devoid of significant side effects.

Sciatic nerve block

Sciatic nerve block has long been used to provide analgesia and anesthesia of the lower extremity. More recently Mansour [49] and Morris *et al.* [50] reported that the parasacral approach to sciatic block results in a high success rate of anesthesia of the entire sacral plexus. Of special interest is that these authors also reported a motor block of the obturator nerve with this technique. Both the parasacral and posterior approaches to sciatic nerve blocks can be used to reliably provide continuous analgesia through a continuous infusion catheter. Using an approach modified for the purpose of catheter placement and using firmer stimulating catheters, Sutherland [51] reported a success rate of 95%.

The anterior approach to the sciatic nerve block has several advantages over the posterior or lithotomy approaches [52,53]. With the anterior approach, the block can be performed with the patient in the supine position, the limb need not be flexed in order to place the block [54,55], and both sciatic and femoral blocks can be placed with the patient in the same position. In the anterior approach, the needle is inserted through the anteromedial thigh, inferior to the inguinal ligament, and advanced posteriorly towards the sciatic nerve that lies directly behind the femur. Chelly and Delauney [55] have recently described a modification of the Beck's anterior approach to sciatic nerve block using simplified landmarks. The authors emphasized the more practical landmarks that may significantly facilitate nerve localization. In the anterior approach, the needle passes just medial to the femur and contacts the sciatic nerve, but the needle frequently encounters the femur before reaching the sciatic nerve. Although the classical description of the block suggests that the needle simply should be 'walked off' the bone in the event of needle–femur contact, this maneuver results in displacement of the tip of the needle too medially, and thus away from the nerve. However, internal rotation of the leg in the hip joint may significantly help in reaching the sciatic nerve [56].

Popliteal block

The popliteal block or block of the sciatic nerve in the popliteal fossa has also seen modifications and improvements. A study that compared the posterior with the lateral approach to the popliteal block [57] confirmed the comparable efficacy of both techniques in patients undergoing lower extremity surgery [58]. Although the lateral approach appeared to be technically more demanding, the advantage of the lateral technique is more convenient patient positioning and ease of catheter placement when continuous popliteal block is indicated. Paqueron *et al.* [59] reported that a double stimulation technique may result in better success rate when smaller volumes of local anesthetic (e.g. 20 ml) are used. The technique consists of localizing both components of the sciatic nerve using a nerve stimulator (common peroneal and tibial nerves) and injecting 10 ml local anesthetic after stimulation of each component. Further, larger scale clinical studies are needed to identify the subpopulation or surgical indications in which one technique may be advantageous to another. Similarly to continuous sciatic nerve block, popliteal block also lends itself to placement of continuous catheters and continuous infusion of local anesthetics [60].

Conclusion

A number of highly efficacious peripheral nerve block techniques can be used to provide excellent surgical anesthesia and good postoperative analgesia in patients undergoing a wide variety of surgical procedures. It is almost universally accepted that these techniques offer numerous advantages, and it is very likely that a trend toward increased interest in peripheral nerve blocks will continue to take place in the near future [2]. Judiciously and skillfully performed nerve blocks can facilitate pain management and fast tracking, allow early mobilization, decrease the duration of hospital stay, reduce unanticipated hospital admission, and reduce health care costs.

With the development of better block techniques and equipment, and more flexible local anesthetics, nerve blocks are rapidly becoming the anesthetic of choice for many surgical procedures.

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