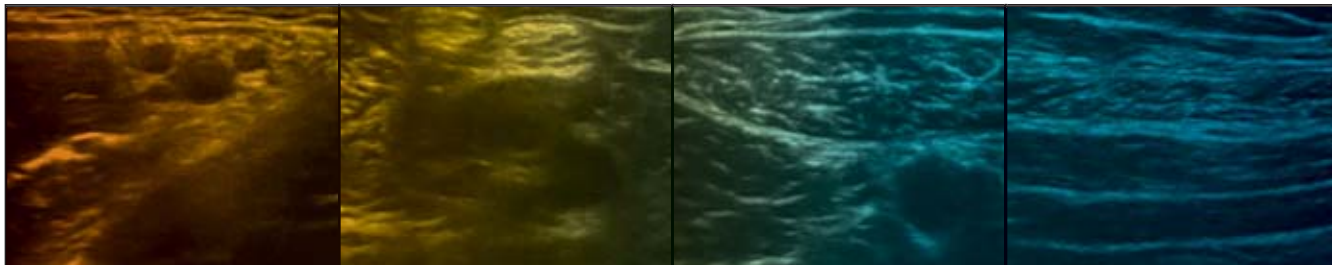




Regional Anesthesia For Ambulatory Surgery: The Ideal Technique for a Growing Practice



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Ambulatory surgery is one of the fastest growing segments of surgery, increasing 67% between 1996 and 2006.^a With the development of minimally invasive techniques and changes in reimbursement, many surgical procedures are shifting from inpatient to ambulatory settings. Proficient ambulatory centers depend on anesthetics that provide quality anesthesia and postoperative analgesia while expediting discharge, minimizing postoperative nausea and vomiting (PONV), and preventing unplanned admission.

^aSource: Ambulatory Surgery in the United States, 2006. Centers for Disease Control and Prevention

Table. Peripheral Nerve Blocks and Associated Surgeries.

Regional Technique	Surgery	Notes
Axillary approach to the brachial plexus	Surgery on the hand, forearm and distal two-thirds of the arm	Superficial and compressible location. Different from axillary nerve block.
Femoral nerve block	Knee arthroscopy ACL repair TKA (CPNB)	Increased risk for fall with quadriceps weakness. Superficial and compressible location.
Infraclavicular approach to the brachial plexus	Surgery on the hand, forearm and distal two-thirds of the arm	Deep location more difficult to visualize by ultrasound guidance.
Interscalene approach to the brachial plexus	Shoulder arthroscopy Rotator cuff repair Total shoulder arthroplasty (CPNB)	Common side effects include Horner syndrome, ipsilateral paresis of phrenic and laryngeal nerves. Ulnar sparing.
Lumbar plexus nerve block	Hip arthroscopy THA (CPNB)	Retroperitoneal hematoma is a possible complication.
PVB	Surgery on the chest or abdominal wall	Pneumothorax is a feared complication.
Saphenous nerve block	Knee arthroscopy	Less quadriceps weakness compared with femoral nerve block.
Sciatic nerve block	Lower leg and ankle surgery Combined with femoral nerve block for ACL and TKA surgery	Foot drop with high concentration blocks.
Supraclavicular approach to the brachial plexus	Surgery on the hand, forearm and distal two-thirds of the arm	Superficial location. Pneumothorax is a feared complication. Ulnar sparing reported.
Suprascapular nerve block	Shoulder surgery	Used when interscalene approach to brachial plexus contraindicated. Often combined with axillary nerve block.
TAP block	Surgery on the lower abdomen	TAP blocks have been used on the upper abdomen with a subcostal approach.

ACL, anterior cruciate ligament; **CPNB**, continuous peripheral nerve block; **PVB**, paravertebral nerve block; **TAP**, transversus abdominis plane; **THA**, total hip arthroplasty; **TKA**, total knee arthroplasty

Postoperative pain management represents a particular challenge in ambulatory surgery. As many as 40% of patients experience severe pain despite conventional treatment.¹ Regional anesthesia (RA) has been shown to improve pain scores, decrease use of narcotics, and lower the incidence of PONV,^{2,3} allowing more patients to be discharged home in less time with high satisfaction.⁴ Consequently, RA has increased in popularity for ambulatory surgery as both the primary anesthetic and as an anesthetic adjunct to improve postoperative analgesia.

General Principles

Ambulatory surgery constitutes the ideal milieu to demonstrate the potential benefits of RA for accelerated recovery, prevention of PONV, and perioperative pain control. Although the indication for each form of nerve block depends on the type of surgery, RA may be appropriate for anesthesia, postoperative pain management, or both (Table). Two well-studied benefits of regional techniques in the ambulatory setting are less postoperative nausea due to reduced consumption of opioids and improved postoperative analgesia.³

Whether regional techniques reduce total time in the ambulatory facility is unclear. However, both peripheral and neuraxial nerve blocks have been shown to decrease time spent in the postanesthesia care unit (PACU) and use of PACU resources.^{3,5}

Clinicians must consider several factors when choosing a specific block. These include preferences of the surgeon and patient, the duration of surgery, and the surgical and postoperative requirement for motor examination. For example, an interscalene approach to the brachial plexus is indicated for shoulder surgery because it covers the suprascapular and axillary nerves (Figure 1). However, an interscalene block would not be appropriate for hand surgery because it spares the ulnar nerve. In addition, although discharging patients with residual motor block is not a concern in the United States, doing so generally is not the standard of care in other countries, including many in Europe. All patients should have discharge instructions that include phone numbers to contact should concerns arise regarding their nerve block.

Regardless of the regional technique, block location should be above the site of the tourniquet and the surgery. This may assist in causal diagnosis in cases of postoperative nerve injury. If the nerve block is performed above the tourniquet and surgical site, a conduction study may exonerate the block as the cause of injury if the conduction is altered below the site of block insertion and/or at the level of the tourniquet or incision.

The location of block performance largely depends on the anesthesiologist's preference and local environment. Variables include operating room (OR) turnover, available resources, and practice conditions (eg, academic vs private practice; supervised vs physician-only anesthesia). Nerve blocks often are performed before transfer to the OR in an academic or supervision practice. Conversely, private practice or high-turnover facilities may perform nerve blocks in the OR while the room is being arranged.

Neuraxial Anesthesia

One of the oldest regional techniques, spinal anesthesia remains a reasonable option for urologic, gynecologic, abdominal, and lower extremity surgery. Its rapid onset, minimal expense, and easy administration are key advantages in outpatient procedures. Limitations to spinal anesthetics include pain with regression, urinary retention, and the inability to ambulate resulting from weak lower extremities. Given the accessibility of general anesthesia and peripheral nerve blocks, these limitations may be significant.

Local anesthetic (LA) options for outpatient spinals include lidocaine, mepivacaine, chloroprocaine, prilocaine, and low doses of bupivacaine. Short-acting LAs may speed discharge but have some limitations.

Hyperbaric lidocaine was the mainstay for short-duration spinal anesthesia for many years. Its use was

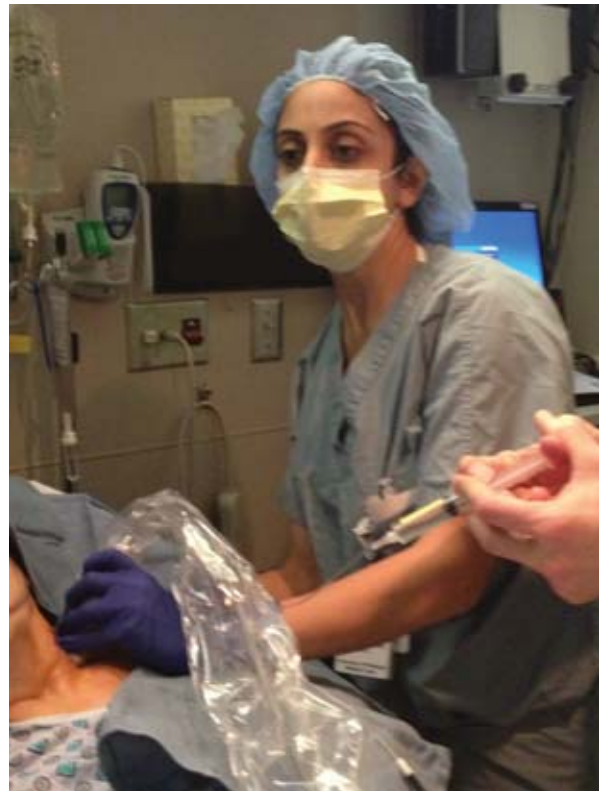


Figure 1. Performing an ultrasound-guided interscalene block.

abandoned when it was associated with 4 times the rate of transient neurologic symptoms (TNS) compared with other LAs.⁶ Mepivacaine, an intermediate-acting LA, was thought to be a hopeful alternative to lidocaine. Its use decreased when TNS was associated with concentrated solutions,⁶ although some studies have not observed TNS with lower-dose mepivacaine spinals.

These events led to renewed interest in chloroprocaine spinals, particularly with the availability of a preservative-free formulation. In one study examining volunteers receiving 40 mg of 2% lidocaine or chloroprocaine, sensory block and tolerance of the tourniquet were adequate for 40 minutes, but patients who received chloroprocaine were able to ambulate and void 30 minutes sooner than those given lidocaine.⁷ Chloroprocaine (40 mg, 2%) produced conditions similar to those seen with 7.5 mg bupivacaine, but patients receiving chloroprocaine were ready for discharge 80 minutes sooner.⁸ These studies, and a retrospective review,⁹ indicate the utility of chloroprocaine for short surgical anesthesia, but unanticipated surgical length may increase the risk for conversion to general anesthesia.

Longer-acting agents, such as ropivacaine and bupivacaine, continue to provide excellent anesthesia but

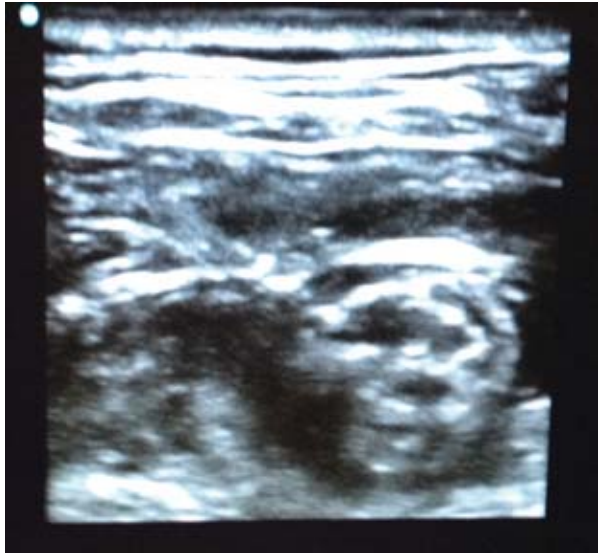


Figure 2. Ultrasound-guided interscalene block.

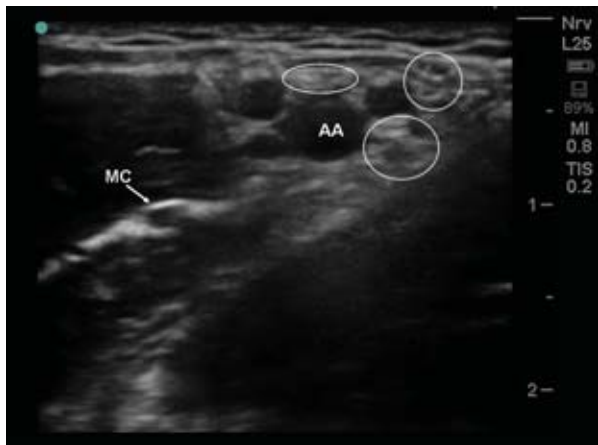


Figure 3. Axillary block.

may delay discharge from the PACU. Decreasing the dose of these anesthetics permits expedited recovery, but at the possible expense of block efficacy.¹⁰ Adding intrathecal fentanyl and/or clonidine^{11,12} to low-dose bupivacaine spinals has been shown to improve block quality and success without prolonging recovery.

Peripheral Nerve Blocks

ORTHOPEDIC

Patients undergoing ambulatory orthopedic surgery often experience severe pain that is aggravated

with mobilization.¹³ Orthopedic surgery is exceptionally suited for RA as peripheral nerve blocks allow for the surgical limb to be anesthetized without affecting other extremities. Depending on the LA used, single-injection blocks may last from 2 to 24 hours, providing surgical anesthesia, postoperative analgesia, or both. Continuous perineural catheters permit prolonged pain control. Optimal pain control improves patient satisfaction and early rehabilitation.¹⁴

Safety is always a concern when anesthetizing an extremity in outpatients. Given the sensitive structures in proximity to the brachial plexus, it was theorized that ultrasound guidance would improve safety with block placement. Although motor- and sensory-onset times are improved with ultrasound guidance, increased safety compared with nerve stimulation techniques has not been proven. Patients also will need to care for their insensate limb with discharge to home. Blockade of the brachial plexus requires arm immobilization for the duration of nerve blockade to protect the anesthetized extremity. Patients should be discharged home in a sling or other secure immobilizer and with knowledge of how to care for the insensate limb to prevent injury. Patients undergoing the anesthetization of a lower extremity should receive crutches and be taught how to use them to prevent falls.¹⁵ All patients should be given instructions, as well as the phone numbers of their clinicians, should concerns arise regarding their nerve block.

The anesthesia plan for outpatient shoulder surgery commonly includes interscalene or suprascapular nerve blocks. The interscalene approach to the brachial plexus covers cervical roots 5 through 7 and often serves as both an anesthetic and analgesic block (Figure 2). Single-injection techniques may last 12 to 24 hours and decrease both pain and time to meet discharge criteria.¹⁶ However, interscalene blockade is associated with paresis of the ipsilateral phrenic and laryngeal nerves. As a result, some patients may be inappropriate candidates for this RA option. For this population, a suprascapular nerve block is superior to systemic medications and intra-articular injections but inferior to interscalene nerve blocks.¹⁷ Because the majority of the innervation to the shoulder joint arises from the suprascapular and axillary nerves, blockade of the suprascapular and axillary nerves, blockade of the suprascapular will improve analgesia; however, patients will require additional parenteral medications. Other alternatives, such as subacromial and intra-articular LA injections, were popular in the recent past. Yet, these techniques have been nearly abandoned over concerns about the risk for chondrolysis.¹⁸

Studies have investigated the feasibility of performing shoulder arthroplasty as an outpatient procedure with ambulatory, interscalene perineural catheters.^{19,20} Patients in these trials were relatively healthy, motivated individuals and reported minimal pain and opioid requirements.

Supraclavicular, infraclavicular, and axillary approaches to brachial plexus blockade provide excellent anesthesia and analgesia for operations affecting the distal two-thirds of the arm, forearm, and hand. In addition to the surgical procedure, the choice of approach should be decided based on patient factors. For example, an axillary block would not be appropriate on a patient unwilling to move the arm and a supraclavicular approach would be contraindicated in a patient with contralateral recurrent laryngeal or phrenic nerve injury. Interscalene blocks do not anesthetize the nerve root supplying the ulnar nerve (C8, T1), making it an inappropriate option for these surgeries.

Once feared due to the increased risk for pneumothorax, the supraclavicular approach has experienced renewed interest with the increasing use of ultrasound. The superficial location and compact arrangement of the brachial plexus in this region result in a short onset time for the block and have led many to call the supraclavicular block the “spinal of the arm.” However, ulnar nerve sparing has been reported with this procedure.

The infraclavicular approach also is reliable and has an onset time comparable to that for supraclavicular blockade.²¹ The deeper location of the brachial plexus cords with the infraclavicular approach may make ultrasound visualization more difficult than the supraclavicular and axillary methods for practitioners less experienced with ultrasonography or in more obese patients.

The axillary approach was preferred for many years given its distance from the lungs (Figure 3). It continues to be a common technique with similar onset times to supra- and infraclavicular blockade.²¹ Placement of an axillary block may require more time because musculocutaneous, median, radial, and ulnar nerves all must be anesthetized, and the musculocutaneous nerve in particular is usually not near the axillary artery. However, the extremely superficial location in a compressible area makes this approach particularly appealing if anticoagulation is a concern.

Arthroscopic knee procedures, including repair of the anterior cruciate ligament, routinely are performed as outpatient surgeries. Compared with administration of intra-articular or IV opioids, femoral nerve blockade to anesthetize the anterior knee improves postoperative pain and early mobilization while reducing side effects from narcotics.^{22,23} Once the mainstay for arthroscopic analgesia, intra-articular injection is declining as a result of animal studies and case reports showing chondrotoxicity.¹⁸

Because falling is a concern in outpatients with lower extremity nerve blockade, saphenous nerve blocks have experienced increased popularity (Figure 4). Saphenous blockade improves analgesia with rest and movement after knee arthroscopy but without increased quadriceps weakness.²⁴ Saphenous nerve blocks also often

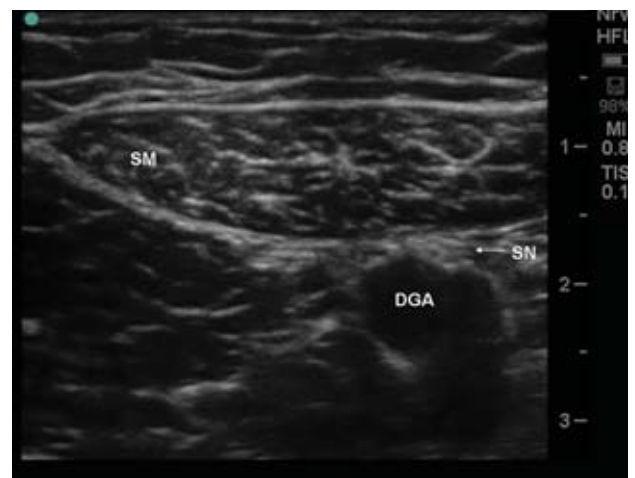


Figure 4. Saphenous block.

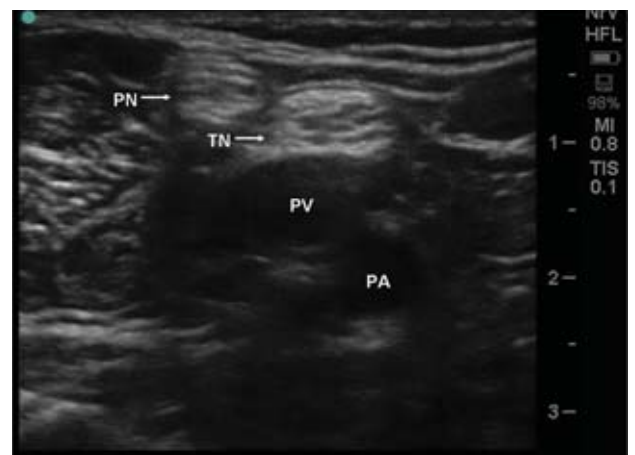


Figure 5. Popliteal block.

are combined with a sciatic nerve block for medial leg or ankle anesthesia in surgery on the lower leg.

Surgical procedures of the foot and ankle may be associated with pain that is difficult to control. Sciatic nerve blockade decreases opioid consumption and postoperative pain while improving patient satisfaction and facilitating discharge.²⁵ Although clinicians anesthetize the sciatic nerve via several routes, the popliteal fossa is amenable to both single injections and catheter placement (Figure 5).

JOINT REPLACEMENT

An estimated 3.5 million joint replacements will be performed by 2030 in the United States, representing an increase of nearly 700% over the current figure. In the past 10 years, the development of minimally



Figure 6. Ultrasound-guided paravertebral block using a sagittal approach.

invasive techniques, the creation of specific anesthesia protocols, and improved postoperative pain control with RA and multimodal analgesia have helped shorten hospital stays from 5 to 7 days to 1 to 2 days, and same-day surgery is even possible in some cases.²⁶⁻²⁸

However, many institutions have been hesitant to allow joint replacements as ambulatory procedures because of the lack of an approved billing code. Most insurers, including Medicare, require patients to spend at least 1 night in the hospital for reimbursement, and some states have created significant penalties for discharging patients before postoperative day 5.

Patients considered for ambulatory total joint replacement must meet certain preoperative requirements. The hospital environment also must be suited for the procedure, and hospital staff must educate patients and families on proper preoperative surgical preparation as well as provide postoperative tools and education before surgery. Patient selection is critical. Patients should be in optimal preoperative physical condition, as myocardial infarction and pulmonary embolism are still postoperative risks.

Intraoperatively, anesthesia technique is chosen based on the preferences of the surgeon, anesthesiologist, and patient. General, epidural, and spinal anesthesia have been used with success. Irrespective of the

technique, patients must be able to recover quickly from anesthesia, remain hemodynamically and thermodynamically stable, and not experience PONV. To allow proper recovery, the duration of surgery should be relatively short—less than 1 hour—with minimum blood loss in order to avoid postoperative transfusions. Finally, physical therapists capable of assisting in functional recovery must be well trained and available within hours following surgery.

Effective postoperative pain protocols are essential to enable early mobilization. Most of these protocols are based on the use of RA techniques: continuous femoral perineural catheters, with or without a sciatic block, for total knee arthroplasty (TKA), and lumbar plexus for total hip arthroplasty.^{4,26,27} In all cases, preservation of motor function is essential to permit full weight-bearing physical therapy, independent ambulation with crutches or a walker, and practice walking up and down steps.

Mobility is best achieved with low concentrations of LAs, without additives. For example, in patients undergoing TKA, a femoral catheter initially may be bolused with 20 mL of 0.2% ropivacaine before surgery and an infusion of 0.1% ropivacaine or 0.0625% of bupivacaine started postoperatively. A gluteal sciatic catheter also may be placed preoperatively without LA bolus to allow surgeons to diagnose any nerve injury related to surgery.

Postoperatively, the catheter may be bolused (5 mL) with 0.05% ropivacaine or 0.03% bupivacaine, followed by an infusion (3-5 mL per hour). These low concentrations of LA will permit physical therapy while providing patients with adequate analgesia.

Regardless which surgical, intraoperative anesthetic and postoperative analgesia technique, the same considerations required for successful ambulatory procedures are pertinent here: Avoid PONV, improve alertness, and optimize motor function. Clinician attention to these factors allows the patient undergoing ambulatory joint replacement to undergo active physical therapy within hours after surgery and facilitate recovery.

GENERAL SURGERY

Pain control after general surgery can be difficult, and inadequate analgesia can result in unplanned admission. Subcutaneous infiltration of LA may ameliorate postoperative pain but is limited by a brief duration of action. Therefore, regional techniques to anesthetize the thorax and abdomen that are amenable to discharge to home have become prevalent.

Breast surgery is associated with high rates of acute and chronic pain. Although paravertebral nerve blocks (PVBs) often are used to control pain following mastectomy, they also provide effective analgesia for lumpectomy, wide local excision, and breast reduction and augmentation (Figure 6). PVBs may serve as the

primary anesthetic with sedation or in conjunction with general anesthesia. They provide superior pain control to surgical LA infiltration and reduce analgesic requirements.^{29,30} PVBs also may inhibit the stress response to surgery. This may limit immune suppression and reduce the risk for cancer recurrence.³¹ However, PVBs may be complicated by pneumothoraces. Ultrasound-guided PVBs may be preferable to landmark techniques to prevent this complication, but this benefit has not been conclusively demonstrated.

Although inguinal herniorrhaphy is a common outpatient procedure, more than 60% of patients rate their postoperative pain as moderate to severe.¹³ As with breast surgeries, PVBs can provide excellent surgical anesthesia or postoperative analgesia for umbilical and inguinal hernia repairs. PVB is associated with reductions in pain, opioid consumption, and nausea, with earlier micturition and ambulation than general anesthesia with infiltration of LA.^{32,33}

Transversus abdominis plane (TAP) blocks are another alternative for postoperative analgesia following abdominal surgery (Figure 7).³⁴ Insertion of LA between the internal oblique and transversus abdominis muscles results in analgesia of T10-L2 dermatomes and the ilioinguinal and iliohypogastric nerves. TAP blocks, like PVBs, provide prolonged postoperative analgesia with decreased use of parenteral analgesics,³⁵ but they are simpler to place and are not associated with pneumothoraces.

LAPAROSCOPIC AND MINIMALLY INVASIVE SURGERY

The growth of minimally invasive surgery has triggered a surge in the variety of ambulatory procedures. Although minimally invasive techniques are associated with less pain than open procedures, inadequate pain control remains the most common cause for postoperative admission. Laparoscopic cholecystectomies, which produce somatic incisional pain, discomfort in abdominal viscera, and referred shoulder pain, are among the more painful of such surgeries. Whereas periportal and intraperitoneal infiltration of LAs provide short-duration (2-4 hours) analgesia,³⁶ PVBs and TAP blocks improve analgesia and decrease opiate consumption up to 24 hours postoperatively (Figure 8).³⁷ Similar findings also have been noted in gynecologic laparoscopic surgery and urologic procedures such as lithotripsy.^{38,39} A subcostal TAP block may be warranted if port sites are above the umbilicus. Preoperative LA application is superior analgesia to postoperative placement in all situations.

OPHTHALMIC NERVE BLOCKS

Before the 1990s, RA for ophthalmic procedures was performed mainly by the operating surgeon as retrobulbar anesthesia (RBA). Due its intraconal injection location, small volumes (2-5 mL) of LA can effectively

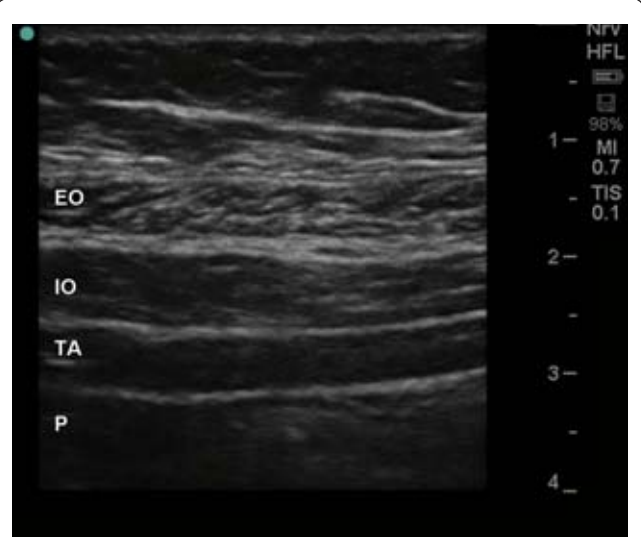


Figure 7. Transversus abdominis plane block.

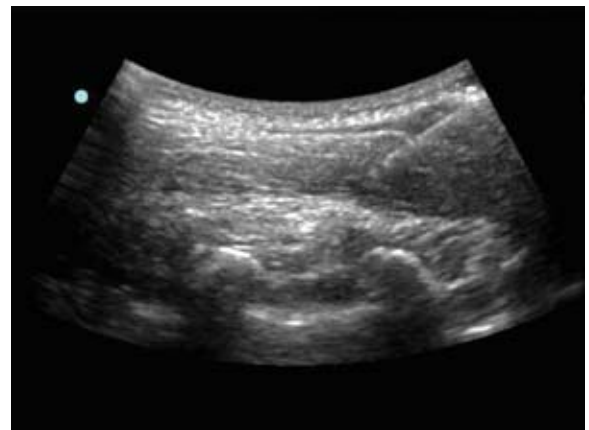


Figure 8. Paravertebral block.

provide the anesthesia with akinesia of the globe and extraocular muscles required for an open eye or complex ophthalmic procedure.⁴⁰ RBA may be considered analogous to spinal anesthesia for the eye. Many major structures are located within the muscular conus and may be injured by inadvertent direct needle penetration. These include the optic nerve with meningeal sheaths; arteries of the orbit; and the autonomic, sensory, and motor innervation of the globe. The risk for direct needle trauma on injection is substantial and complications may include globe perforation, intra-arterial injection (seizures), and inadvertent dural sheath injection (brainstem anesthesia).⁴¹

For less invasive and closed intraocular surgeries (ie, phacoemulsification and anterior vitrectomy), operating times are reduced and ocular manipulations limited. Although anesthesia is needed, complete akinesia may not be required.⁴⁰ In these situations, peribulbar anesthesia (PBA), low-volume sub-Tenon's anesthesia or topical anesthesia are options.

PBA may be considered analogous to epidural anesthesia for the eye. A large volume (up to 12 mL) of LA is deposited outside the muscular cone and diffuses to the extraconal corpus adiposum of the orbit, including the intraconal space, and the eyelid anesthetizing the orbicularis muscle. Repeated supplementation with additional injections is common, especially if akinesia of the globe is required. Poor operating conditions and lack of block consistency are the main drawbacks to using PBA. Increased needle depth (>25 mm) effectively converts a PBA to an RBA. For a similar anatomic reason, a highly myopic eye (longer globe) is a major risk factor for inadvertent globe perforation. Axial length more than 26 mm is the classic described contraindication to PBA.⁴⁰

Tenon's capsule is a fibroelastic layer that surrounds the entire scleral portion of the globe. Sub-Tenon's or episcleral space is a potential space into which LA solution can be introduced. Two anesthetic techniques are used at this location: blunt cannula and needle injection. Blunt cannula involves operative placement of a cannula during the ocular procedure and usually supplements RBA. Needle injection involves LA placement between the conjunctiva and globe. This enables diffuse spread of the LA around the scleral portion of the globe, achieving dense analgesia of the globe with the low volumes typically used for RBA (2-5 mL). There is a substantially high rate of minor complications with this technique compared with either RBA or PBA.⁴¹

Topical anesthesia is the use of LA eye drops placed onto the cornea. It avoids all of the potential hazards of the other needle injection eye blocks and has become very popular for phacoemulsification cataract procedures. Drawbacks include incomplete analgesia, complete motor sparing of the globe and eyelids, and increased procedural pain.

OUTPATIENT PERINEURAL CATHETERS

With the trend toward performing more complex ambulatory surgical and orthopedic procedures, continuous peripheral nerve blocks (CPNBs) can be safely adapted to home use. Single-injection nerve blocks (SINBs) can provide effective post-discharge analgesia. However, dense sensory and motor blockade inherent to SINB can lead to limb neglect, pressure injuries, and falls. CPNB can provide effective prolonged analgesia by using dilute, low-volume continuous infusions,^{4,19,28} which can enable significant cost savings compared with hospitalization for post-procedure CPNB infusions.⁴²

A major impediment to initiating ambulatory CPNB infusions is the perception among anesthesiologists of a subsequent increased need for frequent patient calls, monitoring, and interventions after normal hours. On the contrary, a retrospective review of more than 600 patients with ambulatory interscalene, popliteal sciatic, and femoral perineural catheters revealed that only 4% required interventions.⁴³ The most common call was a need for a catheter bolus of LA. Only 1% of these interventions occurred after normal duty hours and only one patient was unable to remove the indwelling catheter at home.

The 2 most commonly used LAs are bupivacaine and ropivacaine. Both provide adequate analgesia and there are no reports of LA toxicity with prolonged infusions. Common infusion rates in the literature vary from 5 to 12 mL per hour with either 0.2% ropivacaine or 0.125% bupivacaine.⁴³ Simple basal infusion rates provide significant pain relief and opioid reduction,^{43,25} whereas indications for the use of basal-bolus or bolus-only infusion regimens are less clear.

A variety of devices are available for at-home use. Available at all price points, these range from disposable, fixed-rate elastomeric pumps to electronically programmable disposable or returnable models. Although electronic, programmable pumps are more accurate in dispensing preset hourly rates than elastomeric pumps, a significant difference in analgesia or risk for adverse events has not been found for the different devices.

Reported complications associated with outpatient CPNBs are rare. Cited infection rates are less than 1%.^{43,44} Specific infection risk factors include catheter duration of more than 2 days, no antibiotic prophylaxis, catheter insertion site in the axilla or groin, and CPNB pump not filled under sterile conditions.^{44,45} One case report identified deep, severe cellulitis attributed to a CPNB filled under unsterile conditions.⁴³ Therefore, full sterile precautions should be used when filling pumps. Catheter tunneling has not been shown to prevent infection. Neurologic complications are rare, with pressure injury the most likely etiology.⁷ Casts, splints, and dressings should be applied with care and checked frequently. Falls are another area of concern and occur despite instructions not to stand on the affected leg.¹⁵ LA toxicity has not been reported with low infusion rates of dilute LA.

Management of RA in Ambulatory Surgery

The benefits of RA are abundant and clear, but its implementation in ambulatory settings is far from straightforward and requires both agreement and support from anesthesiologists, surgeons, and administrative staff. Acceptance by anesthesiologists unfamiliar with RA may be a challenge. They must be willing either to learn regional techniques or assist with patient care

while a colleague is placing nerve blocks. Clinicians who choose to practice RA require adequate education and ongoing training to master various techniques and associated technology. On the logistical level, anesthesiologists who perform RA must have a pager or call center to handle outpatient concerns.

Surgeons must agree with the decision to use RA. They must concur with their patients receiving nerve blocks, and whatever method of RA the anesthesiologist chooses should be appropriate for both the planned surgery and postoperative care. Patient education regarding RA by the surgeon at a preoperative office visit may expedite the preoperative process on the day of surgery.

Administration must provide adequate resources. Physicians placing nerve blocks may require certain institutional credentialing or certification. Nerve block equipment and supplies need to be purchased, managed, and maintained. Medical documentation for block placement requires institutional standardization to improve record keeping, coding, and billing of regional techniques. Additionally, coding and billing staff may benefit from further education to ensure appropriate charges and reimbursement.

Finally, the surgical facility must be able to accommodate the placement of nerve blocks and patient recovery from the procedures. Communication with OR management is essential to optimize patient scheduling. Earlier patient arrival facilitates RA without impeding OR flow. Nurses should receive training to assist with patient preparation, recovery, and discharge instructions, and scheduling adjustments may be necessary to match patient flow. For example, early patient preparation may demand increased nurse staffing, whereas fewer nurses may be needed for recovery due to shorter stays in the PACU or bypassing of the unit entirely.⁵ Pharmacy should be equipped to prepare ambulatory pumps and daily medications. Also critical are emergency plans and equipment for block-specific resuscitation, such as Intralipid (Bayer Healthcare), and plans for transport to a facility with cardiopulmonary bypass capability in cases of systemic LA toxicity.

Economic Implications

Favorable reimbursement strategies and opportunities to cut costs associated with ambulatory surgery have driven much of the caseload to the outpatient setting. However, economic implications for these associated procedures often are overlooked. Continuous nerve blocks can provide outstanding postoperative analgesia, yet physicians have had an economic

disincentive to provide outpatient nerve blocks since the unbundling in 2009 of perineural catheters from follow-up care. Because follow-up is precluded in the outpatient setting, this unbundling resulted in a 46% decrease in reimbursement for these procedures between 2008 and 2010. Coupled with the extra time cost associated with catheter placement, the result has been a reluctance to perform continuous nerve blocks in the outpatient setting.

Although diagnostic methodology prevents hospitals from claiming additional revenue for inpatients, additional revenue for outpatients is available under the Hospital Outpatient Prospective Payment System (HOPPS) for nerve blocks and acute interventional perioperative pain techniques. Medicare uses Ambulatory Pay Classification (APC) codes to reimburse facilities for the technical component of procedures under the HOPPS. The HOPPS APC codes available for outpatients present significant reimbursement opportunities for hospitals and can add significantly to a facility's profit margin.⁴⁶ These codes currently bundle the nerve block and the use of ultrasound to perform the procedure. Rate setting by the Centers for Medicare & Medicaid Services relies on accurate documentation of the effort associated with any procedural code. Therefore, although ultrasound is bundled within the APC code for outpatient nerve blocks, it is vital to continue to report the use of ultrasound to maintain appropriate reimbursement for these procedures. Furthermore, future reimbursement models using bundled payments will require accurate accounting of costs and complete documentation of resources, and physician effort.

Future Directions

The FDA in 2010 approved a new formulation of bupivacaine formulation (Exparel, Pacira) for wound administration. This new formulation contains bupivacaine in a suspension of multivesicular liposomes (DepoFoam drug delivery system). Infiltration of the drug at the surgical site has been shown to provide more effective analgesia than placebo and results in measurable plasma levels of bupivacaine that persist for 96 hours. A single injection of Exparel has been reported to decrease postsurgical pain and delay the use of opioids for between 48 and 72 hours in patients undergoing bunionectomy or hemorrhoidectomy.^{47,48} The long-lasting effects may represent an interesting alternative to the continuous infusion into wounds of LAs. The role that this formulation can play in RA, particularly when performing peripheral nerve blocks, remains to be established.

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