

Role of Regional Anesthesia in the Ambulatory Environment

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KEYWORDS

• Regional anesthesia • Nerve block • Ambulatory • Outpatient

Ambulatory surgery has undergone tremendous growth in the past decade, from 20.8 million procedures in 1996 to 34.7 million in 2006.¹ Several factors have fueled this growth, including less-invasive surgical techniques, changes in practice patterns, and the use of anesthetic agents and techniques associated with fewer postoperative side effects. Postoperative pain management represents a particular challenge with ambulatory surgery because 40% of patients experience severe pain despite treatment.² Studies show that regional anesthesia (RA) improves pain scores, decreases narcotic use, and lowers the incidence of postoperative nausea and vomiting.^{3,4} Thus, more patients can be discharged home in less time with high satisfaction.⁵

ORTHOPEDIC SURGERY

Perhaps more than any other specialty, orthopedic surgery lends itself to the practice of RA. Peripheral nerve or neuraxial blocks may be used as a primary anesthetic or as part of a combined technique to provide postoperative analgesia. For single-injection techniques, benefits generally last 8 to 12 hours, depending on the type of local anesthetic and adjuvants used. These short-term benefits include improved analgesia, fewer opioid-related side effects, and shorter length of stay in the ambulatory setting.^{6–14} To further prolong postoperative analgesia, a continuous infusion of local anesthesia can be delivered through a perineural catheter. The use of continuous regional techniques for promise to broaden the scope of outpatient procedures that can be performed in an outpatient setting such as total shoulder and total hip arthroplasty.^{15,16} These continuous techniques are discussed in detail, see the article by Swenson and colleagues elsewhere in this issue for further exploration of this topic.

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Upper Extremity Surgery

Interscalene blockade (ISB) is a common technique for shoulder surgery. In a prospective study of 50 patients undergoing outpatient rotator cuff repair, patients randomized to receive single-injection ISB (vs general anesthesia [GA]) were more likely to bypass the postanesthesia care unit (PACU), report less pain, ambulate earlier, and meet home discharge criteria sooner.⁸ Not unexpectedly, no difference was observed between groups in pain scores or opioid consumption at 24, 48, and 72 hours. These results support earlier retrospective findings comparing single-injection ISB with GA.^{13,14} Because single-injection techniques can only provide 12 to 24 hours of relief when long-acting local anesthetics are used, patients may experience severe pain after the block resolves.⁶ The addition of a perineural catheter and infusion may sustain analgesia for several days after surgery.^{7,12,17,18} The benefits of catheter-based analgesia after shoulder surgery, however, remain controversial.^{6,19}

Given the high incidence of phrenic nerve blockade during ISB, this technique may be contraindicated in patients who may not tolerate phrenic nerve blockade (eg, severe chronic obstructive pulmonary disease). Suprascapular nerve blockade (SSB) is an alternative technique that may provide analgesia after shoulder surgery. The suprascapular nerve innervates up to 70% of the posterior shoulder joint, the acromioclavicular joint, the subacromial bursa, and the coracoclavicular ligament. Furthermore, the location of blockade (in the supraspinatus fossa) eliminates the risk of inadvertent phrenic nerve blockade commonly encountered during ISB. In a study comparing single-injection ISB, SSB, intra-articular (IA) injection, and parenteral analgesia, SSB patients had lower pain verbal analog scale (VAS) scores with rest and movement up to 24 hours compared with parenteral or IA analgesia.⁹ ISB patients consistently had the lowest pain scores overall, however.

For procedures below the shoulder, RA techniques also provide superior analgesia and shorter time to discharge compared with GA or systemic analgesics. Patients randomized to single-injection axillary brachial plexus block (vs GA) for ambulatory hand surgery were more likely to be fast-track eligible with a shorter duration of stay in the PACU and in the hospital after surgery.¹⁰ In the RA group, pain scores up to 120 minutes after surgery were lower, but again there was no difference in pain, opioid consumption, adverse effects, Pain Disability Index, or satisfaction by postoperative day 1.

Infraclavicular brachial plexus blockade (INB), an alternative approach to upper extremity blockade for hand and wrist surgery, also provides short-term benefits in an ambulatory setting compared with GA. In a 2004 study by Hadzic and colleagues,¹¹ 52 patients undergoing outpatient hand or wrist surgery were randomized to INB or GA plus wound infiltration with local anesthetic. Compared with patients in the GA group, fewer patients in the INB group had pain (VAS >3) on arrival to the PACU and none requested treatment for pain when in the hospital (vs 48% of GA patients). Patients in the INB group reported less nausea, vomiting, and sore throat than GA patients and were, on average, discharged home approximately 100 minutes sooner than patients randomized to GA.

Lower Extremity Surgery

Hip arthroscopy is a surgical technique growing in popularity for treatment of a variety of painful hip conditions. Like many arthroscopic procedures, hip arthroscopy is commonly performed as outpatient surgery. Postoperative pain intensity may be a limiting factor for dismissing patients home postoperatively. IA bupivacaine injected at the conclusion of surgery lowers average pain scores at rest for 24 hours (18 vs 28

on 100-point scale) and with movement (23 vs 46 on 100-point scale) compared with 0.9% normal saline.²⁰ When 2-level paravertebral blockade (PVB) (L1 and L2) was added to IA bupivacaine, 2 patients experienced analgesia up to 36 and 48 hours, respectively.²¹

Total hip arthroplasty, a procedure that once required 2.5 to 3 weeks of inpatient recovery,²² can now be performed on an ambulatory basis thanks to better pain control with continuous RA techniques. Investigators have described clinical pathways that include the use of 1 or more regional techniques, including lumbar plexus catheter and single-injection sciatic blockade, that enable patients undergoing minimally invasive total hip arthroplasty to be dismissed fewer than 23 hours after surgery.^{16,23}

A variety of anesthetic and analgesic techniques are described for outpatient knee procedures. The most common methods of providing analgesia after knee arthroscopy, particularly with procedures involving ligament reconstruction, include femoral nerve blockade (with or without sciatic nerve blockade), lumbar plexus (ie, psoas) blockade, and IA injection. An ideal technique remains controversial.²⁴ Previous investigations have inconsistently compared the techniques, and variation in results may be due to differences in surgical and patient expectations as well as variations in postoperative nursing management.

Use of IA local anesthesia, often given in combination with an opioid, improves pain scores and early analgesic consumption after outpatient knee arthroscopy, regardless if the IA dose is administered pre- or post surgery.²⁵ Adding tramadol may potentiate the analgesic effects. In a recent study,²⁶ a combination of tramadol and 0.25% bupivacaine resulted in significantly lower pain VAS scores, decreased 24-hour analgesic consumption, prolonged time to first rescue analgesic, and shortened time to discharge compared with IA bupivacaine or tramadol alone. These benefits were seen without any detectable systemic effects. Recent evidence, however, suggests local anesthetics may be harmful to chondrocytes and may cause chondrolysis after IA infusion or even single injection.²⁷⁻³⁰

When used as a primary anesthetic agent, lumbar plexus blockade with or without sciatic nerve blockade provides short-term benefits compared with GA for outpatient knee surgery.^{31,32} Patients who underwent peripheral blockade with 2-chloroprocaine 3% or mepivacaine 1.5% had lower immediate postoperative pain scores, shorter time to hospital dismissal, and higher satisfaction compared with patients who underwent GA.

In patients undergoing surgical procedures of the ankle or foot, several RA techniques exist that can provide anesthesia or analgesia of the operative extremity. Choice of technique largely depends on factors, such as surgical site (eg, hallux vs ankle), type of procedure (eg, hallux valgus correction vs ankle arthrodesis), use of a tourniquet, and the immediate weight-bearing status. A 2003 prospective, randomized study compared the analgesic benefits of a foot blockade (FB) (ie, ankle blockade) with 0.5% bupivacaine (20 mL) to sham blockade for outpatient bony midfoot surgery.³³ Patients who received an FB needed fewer intraoperative opioid supplements and, on average, had a significantly longer time to first perception of pain (12 vs 5.5 hours) compared with sham blockade. Again, the measured benefits were gone by postoperative day 1 with this single-injection technique.

The terminal branches of the sciatic and femoral nerves anesthetized during an FB can also be blocked more proximally in the popliteal fossa. In a prospective, randomized study comparing the efficacy of FB to popliteal blockade (PB) for outpatient forefoot surgery, Migues and colleagues³⁴ demonstrated equivalency of FBs and PBs. Specifically, both blocks were equally efficacious as primary anesthetic, and both

blocks provided a similar duration of analgesia (FB, 11.0 hours, vs PB, 14.3 hours; $P = .13$) and patient satisfaction. By using a perineural catheter in the popliteal space, improved analgesia for ambulatory foot and ankle surgery can be extended up to 3 days compared with single-injection techniques.^{35–37}

Neuraxial Techniques

A variety of neuraxial techniques have been studied for outpatient lower extremity procedures. With any approach, the anesthetic goals are the same: dense surgical anesthesia with rapid neurologic recovery and avoidance of neurotoxic effects (ie, transient neurologic syndrome). Although many combinations of local anesthetics, doses, additives, and approaches have been studied,^{38–50} no single technique has emerged as the optimal choice. Each neuraxial anesthetic must be tailored to the patient and the procedure.

In the past 5 years, chlorprocaine has regained popularity for intrathecal use in ambulatory surgery. The rapid neurologic recovery (approximately 80–120 minutes) after intrathecal chlorprocaine makes it an attractive option for outpatient spinal anesthesia. At one time, chlorprocaine (or more specifically, the preservative sodium bisulfite) was thought to pose a significant risk of neurotoxicity. Recent animal evidence has disproved this,⁵¹ and, thus far, no cases of neurotoxicity have been reported in several human volunteer and clinical studies.^{43,52–58} Despite the growing body of clinical evidence illustrating the safety of spinal chlorprocaine, its use remains controversial.

An alternative to chlorprocaine for use in ambulatory surgery is low-dose bupivacaine. Many studies have examined a variety of drug doses, use of hyperbaric and isobaric drug preparations, with or without additives, and unilateral or bilateral spread of medication for a variety of surgical procedures.^{39,42,44,55,59–71} Although low (<7.5 mg) and ultralow (2.5–4 mg) doses of spinal bupivacaine are used, these may come at the expense of additional sedation necessary for patient comfort during a procedure. In summary, each spinal anesthetic must be tailored to the patient, the procedure, and the practice style.

GENERAL SURGERY

Pain control after general surgery is challenging, and despite treatment, significant postoperative pain may result in unexpected hospital admission. Local anesthesia is used for subcutaneous injection providing anesthesia and analgesia, but the effects are limited by the short duration. An alternative method of providing prolonged unilateral (or bilateral) somatic and sympathetic nerve blockade is PVB. PVB involves the injection of local anesthetic at the nerve root just lateral to the neuraxial space and can be performed at 1 or more levels to increase the number of anesthetized dermatomes. PVB is commonly used to provide analgesia after procedures on the chest or abdominal wall, including breast surgery, hernia repair, and even laparoscopic procedures (eg, laparoscopic cholecystectomy).

Breast Surgery

PVB is used for major breast surgery. Analgesia for mastectomy, wide local excision, or lumpectomy should include nerve roots T1–T6, whereas procedures involving only sentinel node biopsy or axillary dissection involve nerve roots T1–T3. Injections typically require 3 to 5 mL of local anesthetic at each level (**Fig. 1**) or, alternatively, the entire dermatome coverage divided and a larger volume given at the midpoint. PVB may be used in conjunction with GA or as the primary anesthetic technique with sedation.

Demonstrated advantages of PVB over GA include decreased pain, lower narcotic usage, and earlier hospital discharge compared with patients having GA.⁷² In addition to intraoperative anesthesia and analgesia, PVB using long-acting local anesthetics can prolong analgesia until the next day. This sustained analgesia results in significantly more same-day discharges, decreasing the costs associated with major breast surgery.⁵ PVB also is associated with significantly less pain at 1, 6, and 12 months post procedure and a lower frequency of postmastectomy syndrome.⁷³ Additionally, PVB may inhibit the body's stress response to surgery, potentially limiting suppression of the immune system, including the action of natural killer cells, resulting in a lower recurrence of breast cancer up to 3 years after surgery.⁷⁴

Although the benefits of thoracic PVB are well described, clear consideration must be given to the possibility of procedure-related complications, specifically pneumothorax. The risk of pneumothorax after a multiple injection technique is estimated to be 0.6%, and a postoperative chest radiograph is often ordered.⁷² Although most pneumothoraces are small and asymptomatic, some may require chest tube placement and hospital admission. Ultrasound-guided PVB may be advantageous in that it allows for real-time visualization of the needle, costotransverse ligament, pleura, and spread of local anesthetic. In theory, the risk of complications, such as pneumothorax or intravascular injection, may be less when PVB is performed using ultrasonography, but these potential advantages are not yet proven.

Inguinal Hernia Repair

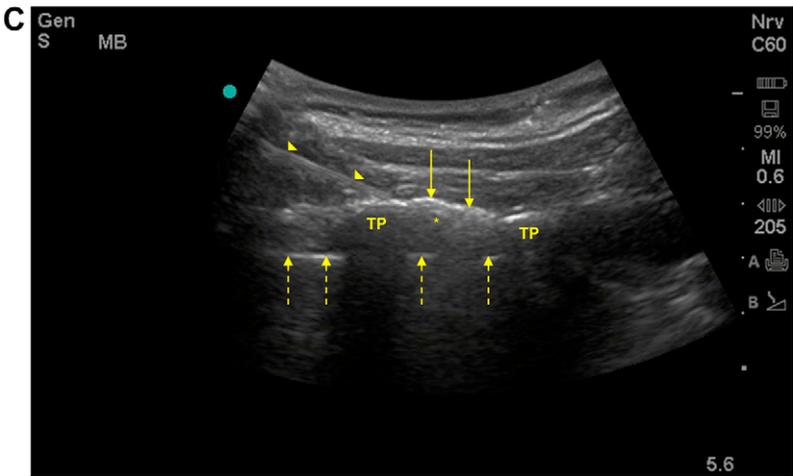
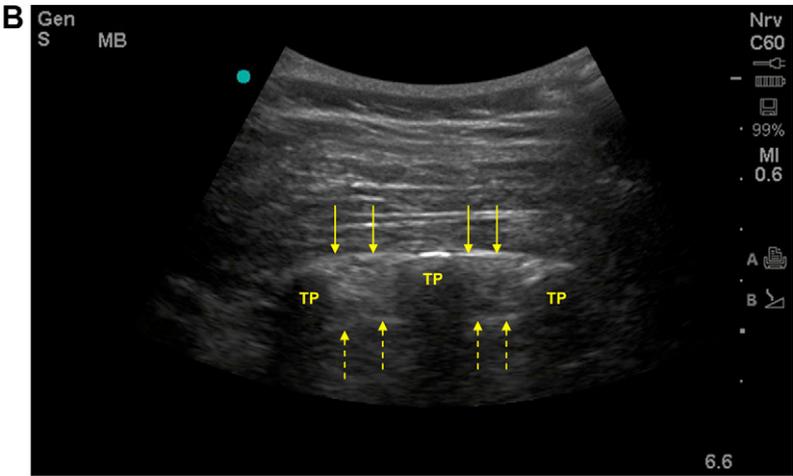
Analgesia after open inguinal herniorrhaphy is managed in many ways, although the use of local anesthesia is used increasingly due to superior outcomes. Simple wound infiltration is used commonly, and it is associated with an efficient recovery because side effects, such as urine retention, are uncommon (<0.5%).⁷⁵ The analgesic effects are limited by the brief duration of the local anesthetic used, but analgesia may be extended by placing a catheter in the wound. A continuous infusion for 2 days results in significantly lowered pain scores at 2 and 5 days postoperatively.⁷⁶

PVB is an ideal perioperative technique for inguinal herniorrhaphy and lacks some of the risks (eg, pneumothorax) associated with thoracic-level paravertebral injections. For inguinal hernia surgery, blockade of T11-L2 nerve roots is required for adequate dermatomal analgesia. PVB for inguinal hernia repair is associated with less pain, less nausea, lower opioid requirements, and earlier home readiness compared with GA with local infiltration.⁷⁷ In addition, patients were able to urinate significantly sooner in the PVB group (128 vs 213 minutes).

An alternative technique that may be used to provide analgesia after hernia surgery is the transverse abdominus plane (TAP) block. Like PVB, TAP blocks may be unilateral or bilateral and involve injecting local anesthetic between the internal oblique and transverse abdominus muscle planes, resulting in blockade of T10-L3 segmental nerves and possibly the ilioinguinal and iliohypogastric nerves (**Fig. 2**).

Laparoscopic Surgery

Minimally invasive surgery using laparoscopy has dramatically expanded the number and type of cases that can be performed on an ambulatory basis. Cholecystectomy is a prime example. Although there is significantly less pain associated with the laparoscopic approach, pain is still the most common reason for admission to the hospital, with rates as high as 41%. The laparoscopic cholecystectomy pain state is unique even among other laparoscopic procedures with incisional somatic pain, abdominal visceral pain, and referred visceral pain to the shoulder. This complex pain state suggests



a role for multimodal analgesia. Acetaminophen and celecoxib are efficacious, and local anesthetic is applied in many ways to the postoperative pain with varying results.

Injecting the portholes with local anesthesia is efficacious although limited by the duration of local anesthesia. Ropivacaine injected to the portholes provides a median duration of analgesia of 2 to 3 hours, after which pain scores were similar to control patients.⁷⁸ Local anesthesia may also be applied to the intraperitoneal space for analgesia. The results have been excellent with an even greater efficacy resulting from injection of local anesthetic at the beginning of the procedure. Analgesia may last up to 4 hours.⁷⁹

Bilateral PVB also seems efficacious after cholecystectomy, with the added benefit of longer duration. A combination of lidocaine and bupivacaine results in significantly less pain at 6, 12, and 24 hours postoperatively.⁸⁰

TAP may be useful during cholecystectomy because it has an opioid-sparing effect perioperatively.⁸¹ PVB and TAP blocks show some promise in managing pain after cholecystectomy, but incisional local combined with oral multimodal medications based on outcome data are the only regimen that demonstrate efficacy.

Many gynecologic procedures are done laparoscopically with GA, and local anesthesia is used to provide postoperative analgesia. When levobupivacaine is injected preoperatively in the port sites, laparoscopy patients experience significantly less pain, require fewer pain treatments, and ambulate earlier than patients not receiving local anesthesia.⁸²

Postoperative pain control also is provided with local anesthetics applied to peritoneal surfaces intraoperatively. The efficacy of intraperitoneal local analgesia is conflicting in gynecologic surgery, and there is no compelling evidence to support its routine use as exists after laparoscopic cholecystectomy. The laparoscopic approach is similar in gynecologic and general surgery, but the procedures and pain states seem unique.

PLASTIC SURGERY

Local anesthesia has long been used in cosmetic surgery as much for its anesthetic potential as its vasoconstrictive properties when combined with epinephrine. Surgery may be conducted with the addition of light sedation, and this is preferred in rhytidectomy and blepharoplasty due to superior recovery compared with GA. In rhinoplasty, the local anesthetic cocaine is used for its anesthetic and vasoconstrictive properties, although there is concern for its arrhythmogenicity. Adrenalized lidocaine is also effective and combined with sedation or GA depending on the procedure. Liposuction uses the same lidocaine and epinephrine mixture in a different manner. Tumescence anesthesia, normal saline mixed with lidocaine 0.05% and epinephrine 1:1,000,000, is injected subdermally, so fluid distends adipocytes permitting thin cannula suctioning of the adipose tissue. Considerable amounts may be injected during liposuction raising concerns about hypervolemia and local anesthetic systemic toxicity. The maximum dose of adrenalized lidocaine is 7 mg/kg, but doses as high as 55 mg/kg have been used safely during liposuction, resulting in subtoxic serum lidocaine levels

Fig. 1. Ultrasound-guided thoracic PVB: (A) patient position, machine location, and hand position; (B) ultrasound anatomy: paraspinous tendon (*solid arrows*), parietal pleura (*dashed arrows*); TP, transverse process; and (C) ultrasound image showing needle approach and spread of local anesthetic in paravertebral space: paraspinous tendon (*solid arrows*); parietal pleura (*dashed arrows*); needle image with tip just below paraspinous tendon (*arrowheads*); final position of needle tip (*asterisk*); TP, transverse process.

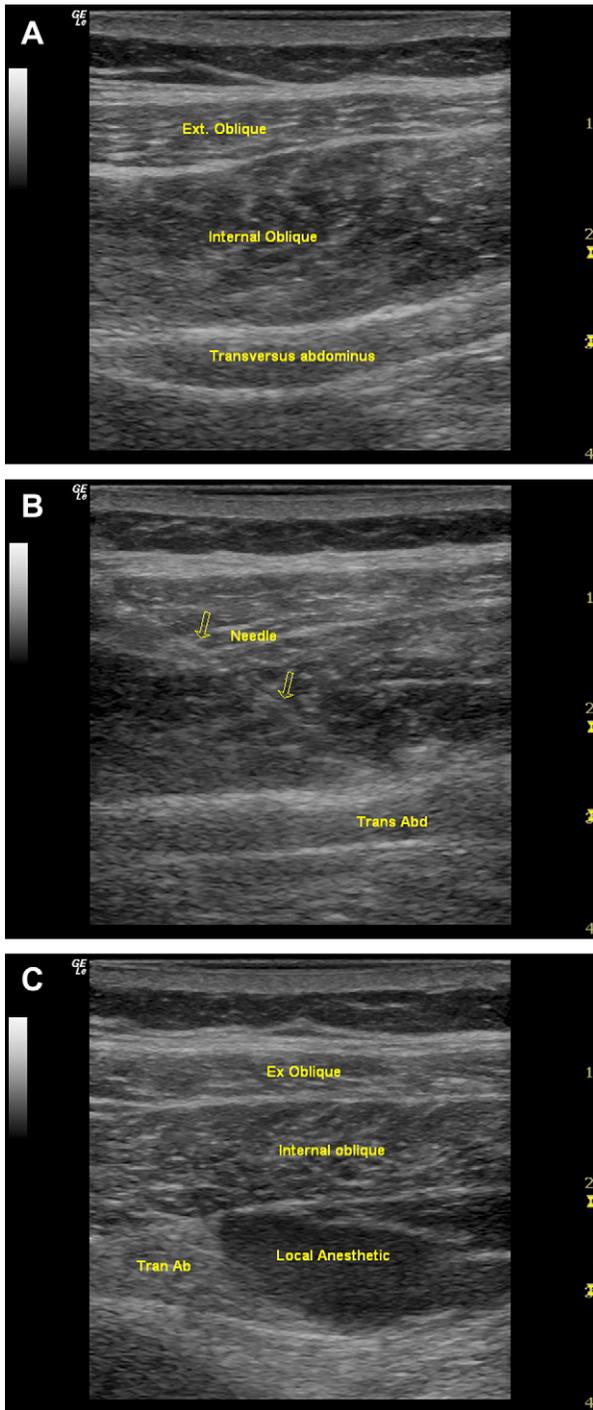


Fig. 2. Ultrasound-guided transversus abdominis plane blockade: (A) ultrasound anatomy, (B) ultrasound image showing needle (arrows) approach, and (C) ultrasound image showing injection of local anesthetic deep to fascial plane between transversus abdominis and internal oblique muscles.

(<5 µg/mL).⁸³ These doses of epinephrine do not cause tachycardia, arrhythmias, or hypertension. Cosmetic procedures use local anesthesia with epinephrine to provide anesthesia and limit bleeding, thus improving the surgical field conditions.

Breast surgery was discussed previously but bears mention because augmentation and reduction mammoplasty are unique. Paravertebral blocks also are used in the setting of plastic surgery. During submuscular breast augmentation, PVB provides intraoperative anesthesia and postoperative pain management, so patients may be discharged efficiently with minimal side effects.⁸⁴ Another analgesia technique in this setting involves a surgeon implanting catheters in the wound. Local anesthesia is infused providing prolonged analgesia.⁸⁵ Patients have significantly better analgesia, require less pain medication, and are more likely to be discharged on the same day compared with patients not receiving continuous wound infiltration.⁸⁶ This technique may have an advantage over PVB because analgesia is extended, no special training is required to place, and there is no risk of pneumothorax.

OFFICE-BASED SURGERY

Most of the growth in ambulatory surgery has taken place in offices or freestanding surgery centers. Although these smaller venues are usually associated with minor and less-invasive procedures, trends favor expansion of larger cases into smaller venues. All of the regional techniques (described previously) can (and eventually probably will) be done in offices as long as sufficient personnel and resources are available. Two examples of common office-based procedures are transrectal prostate biopsy and intrauterine surgery.

Transrectal prostate biopsy is a procedure commonly performed as an office-based procedure or in an ambulatory center. At one time, this procedure was thought well tolerated by most patients. Recent reviews have estimated, however, that 65% to 90% of patients experience discomfort and up to 30% may have significant pain. Many studies, including a recent meta-analysis, have compared the use of periprostatic nerve block to intrarectal local anesthesia or no local anesthesia during transrectal prostate biopsy. Periprostatic nerve block around the neurovascular bundles provided superior analgesia compared with intrarectal local anesthesia or no anesthesia with no increase in procedure-related complications.⁸⁷

Intrauterine procedures, including dilation and curettage, diagnostic and operative hysteroscopy, oocyte retrieval, polypectomy, endometrial ablation, and sterilization, are often performed under GA or RA with sedation. Paracervical blockade, injection of local anesthetic around the cervix, is often used because anesthesia personnel are not present. The paracervical block seems of little value as a primary anesthetic or analgesic technique.⁸⁸ Patients anesthetized with paracervical block have equivalent intraoperative and postoperative pain compared with patients who receive no anesthesia at all. Therefore, intrauterine procedures should be done with deep sedation and there is no clear role for local analgesia.

Laparoscopy may be done in an office with only local anesthesia, and the laparoscopes are usually smaller with lower insufflation pressures in this setting. Laparoscopy is typically performed for diagnosis or treatment (eg, sterilization), and performing the procedure in this manner is associated with lower costs.⁸⁹ The gynecologic laparoscopic procedure may be done with local anesthesia or analgesia depending on the approach.

REGIONAL ANESTHESIA AND EFFICIENCY

Painful stimuli are initiated by tissue injury and transmitted by A δ -fiber and C-fiber nociceptors to the spinal cord dorsal horn neurons. In response to this injury, a variety

of neurotransmitters, such as prostaglandin, bradykinin, serotonin, and substance P, are released, which leads to increased activity of the dorsal horn neurons. If this input remains unmodulated, the result may be central sensitization. Preemptive analgesia is a pain control strategy implemented before a painful stimulus and in sufficient duration to limit or prevent sensitization of the central nervous system. This should result in less intense pain of shorter duration. Preemptive analgesia has been demonstrated in several animal models. In human studies by Moiniche and colleagues and Dahl and Moiniche and in the most recent meta-analysis by Ong and colleagues, preemptive analgesia could not be proved.^{90–92} Their findings demonstrate it is unnecessary to provide analgesia before a painful stimulus, but it is critical to provide effective analgesia of sufficient duration. Local anesthesia inhibits the transmission of noxious afferent stimuli from the operative site to the spinal cord and brain, and it is desirable to maintain this effect well into the postoperative period. This sustained postoperative analgesia decreases the risks of hyperalgesia, allodynia, and increased pain.

The merits of local anesthetic-based analgesia are well established, and it is clear these techniques facilitate an earlier facility discharge with superior pain control. There is bias against RA because of the time commitment and possible delays associated with it. RA techniques may require additional time to perform, and this may have an impact on operating room efficiency and increase costs. Use of regional techniques result in an overall lower cost due to earlier discharge and fewer unplanned admissions.⁹³ More advanced techniques (eg, ultrasound-guided PVB) take time to administer and are best done in a time-neutral environment outside the operating room (eg, dedicated block room or PACU). Dedicated block rooms are time effective and contribute to an efficient outpatient practice while preserving analgesic outcomes.^{94,95} This same level of efficiency and patient care has also been demonstrated in private practice settings.⁹⁶ These are barriers that must be overcome to use RA in any practice.^{97,98}

SUMMARY

The use of local anesthetics in ambulatory surgery offers multiple benefits in line with the goals of modern-day outpatient surgery. A variety of regional techniques can be used for a wide spectrum of procedures; all are shown to reduce postprocedural pain; reduce the short-term need for opiate medications; reduce adverse effects, such as nausea and vomiting; and reduce the time to dismissal compared with patients who do not receive regional techniques. It is likely that the growth in ambulatory procedures will continue to rise with future advances in surgical techniques, changes in reimbursement, and the evolution of clinical pathways that include superior, sustained postoperative analgesia. Anticipating these changes in practice, the role of and demand for RA in outpatient surgery will continue to grow.

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