TOOLS FOR COMFORT
As part of a pain management plan for small animals, local anesthetics are used preemptively, postoperatively, and as an adjunct to general anesthesia.

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CONTINUING EDUCATION

PAIN MANAGEMENT

Locoregional Anesthesia for Small Animal Patients

MEET THE AUTHOR

***Heidi Reuss-Lamky**, LVT, VTS (Anesthesia & Analgesia, Surgery), FFCP*
Oakland Veterinary Referral Services, Bloomfield Hills, Mich.

Heidi graduated from Michigan State University's Veterinary Technology Program in 1984. After extensive experience in general practice, she has worked in the surgical department of specialty hospitals since 1993. In 2003, Heidi became certified through the AVTAA. She served as president on the Executive Board of the Michigan Association of Veterinary Technicians from 2007 to 2009. She was a charter member of the Academy of Veterinary Surgical Technicians and currently sits on the executive board. Heidi shares her home with her husband, 3 dogs, 2 cats, an African grey parrot, and pond koi. In her spare time, she enjoys horseback riding, gardening, travel, and quenching her never-ending thirst for knowledge.

Pain management for veterinary patients has evolved tremendously over the past 20 years. Most clients have come to expect pain management from veterinary facilities. Numerous drugs and various routes of administration are available to complete a comprehensive pain management plan.

This article focuses on use of local anesthetic agents as part of a complete pain management plan. The term "local anesthetic" is often used interchangeably with "anesthesia," but from a purely semantic point of view, the meanings of these terms are not the same. Analgesia is associated with attenuating or relieving the perception of pain; and certainly, local anesthetic agents meet this criterion, as do opioids and nonsteroidal anti-inflammatory drugs. Anesthesia may be defined as a condition of controlled, transient loss of sensation or awareness that is induced for medical reasons. It may also include analgesia, paralysis with muscle relaxation, amnesia, and unconsciousness. Although local or regional infiltration of local anesthetic agents does not cause a loss of consciousness, these procedures are uniquely capable of inhibiting 100% of pain perception.[1]

Pain can be defined as an adverse sensory and emotional experience. Negative sequelae of pain may include immobility, inappetence, insomnia, catecholamine release, decreased pulmonary function, and increased myocardial oxygen consumption. It has been proven that veterinary patients provided with adequate analgesia recover more quickly and resume

normal behaviors (e.g., grooming, eating) sooner than patients receiving inadequate analgesia.[2] Moreover, fewer medical problems and deaths have been observed among patients provided with adequate analgesia.[2]

The quality of veterinary pain management has improved with the introduction of preemptive analgesia, an evolving clinical concept. The nervous system encodes and processes noxious stimuli (called nociception, nocioception, or nociperception) (**FIGURE 1**).

Preemptive analgesia is a provision of an analgesic regimen before the onset of noxious stimuli, thereby preventing "wind up" (opening of the pain gates, or sensitization of the central nervous system [CNS]).

Providing balanced analgesia and anesthesia involves using drugs of multiple, synergistic classes combined with a variety of administration routes intended to decrease overall requirements for inhalation anesthesia. Preemptive analgesia regimens may consist of oral and parenteral administration of opiates and/or nonsteroidal anti-inflammatory drugs and infiltration of local anesthetic agents via myriad locoregional anesthetic techniques (e.g., nerve blocks, epidural analgesia), or any combination thereof.

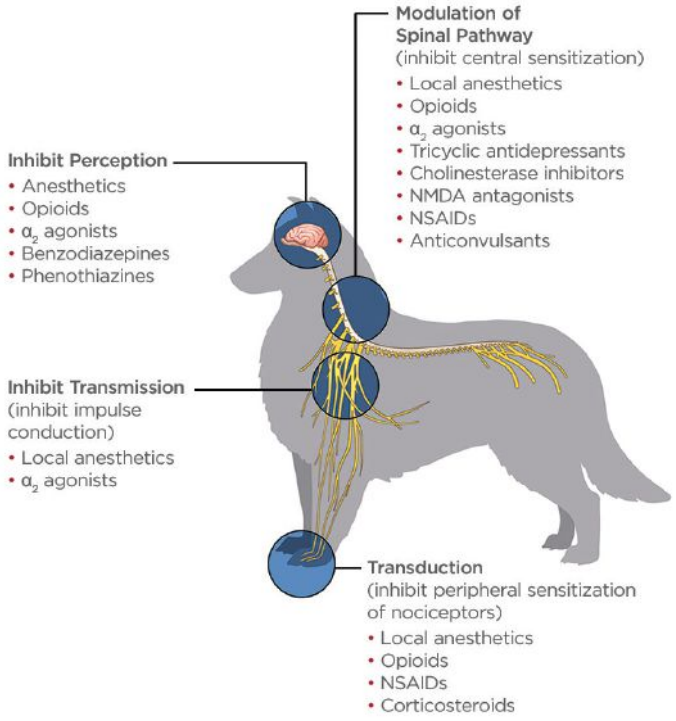


FIGURE 1. Pharmacologic effects of drugs on pain pathways. Nociception occurs via a complex system involving transduction, impulse conduction (transmission), and central nervous system processing (modulation and perception). NMDA=*N*-methyl-D-aspartate; NSAID=nonsteroidal anti-inflammatory drug.

PHARMACOLOGY OF LOCAL ANESTHETIC AGENTS

Local anesthetics prevent transmission of nerve impulses by selectively binding to sodium channels in the nerve membrane at one or more sites and stabilizing excitable tissues during noxious stimulation.

The effects of local anesthetic agents can be local or regional. Local blocks are performed by injecting a small volume (usually less than 1 or 2 mL) of a local anesthetic in close proximity to a nerve whose conductivity is to be interrupted. Regional anesthesia can be divided into 2 types: peripheral and central. Peripheral regional anesthesia causes a temporary loss of sensation in a specific location (e.g., a tooth) or part of the body (e.g., a limb). Central regional anesthesia creates a loss of sensation to a part of the body by impeding sensory nerve conduction between the spinal cord and a particular region (e.g., spinal or epidural anesthesia).

Local anesthetic agents are classified according to chemical structure as either amides or esters. Lidocaine and bupivacaine are amides; procaine and tetracaine are esters. Amides are generally preferred over esters, which can be associated with a higher risk for allergic reactions or systemic toxicities. Commonly used local anesthetic agents include lidocaine, mepivacaine, and bupivacaine (with or without epinephrine).

Many local anesthetics produce vasodilation, which can increase the speed of drug uptake into the bloodstream. This characteristic decreases drug effectiveness at the site of injection and can increase the potential for toxic side effects. As such, many local anesthetics are combined with a vasoconstricting agent such as epinephrine.

TYPES OF BLOCKS

In general, the following blocks are easy to perform and the supplies needed are inexpensive and readily available. These blocks provide rapid onset of analgesia, and their synergism with other analgesic modalities makes them a valuable part of a balanced analgesia and anesthesia plan. Regardless of the type of block being performed, always aspirate before injecting the local anesthetic agent.[3]

Kip Carter. Opposite: Kip Carter.

Local and Incisional Block

Local infiltration, perhaps the safest and most reliable of all analgesic techniques, is accomplished by extravascular placement of the injectable anesthetic agent. Commonly used agents are minute quantities (usually 0.3 to 0.5 mL) of 2% lidocaine or 0.5% bupivacaine, delivered to the desired site via 22- to 25-gauge needles. The amount of agent used will vary with the size of the area to be anesthetized, but local anesthetics can be diluted with 0.9% sodium chloride (NaCl) to create a larger injection volume for multisite injections.

Preliminary studies in humans have demonstrated prolonged duration of analgesia when a local anesthetic agent is combined with an opioid. Suggested combinations for veterinary patients include augmentation of the local anesthetic agent with either morphine (0.1 mg/kg) or buprenorphine (3 µg/kg).[5]

For conscious patients, injection discomfort can be minimized by first creating a small wheal and then slowly proceeding along the periphery of the first wheal site until the block is complete.[6] Potential complications of local and incisional blocks include inadvertent intravenous or intra-articular injection, penetration of internal organs or the body cavity, or excessive bleeding (secondary to vasodilation).[7]

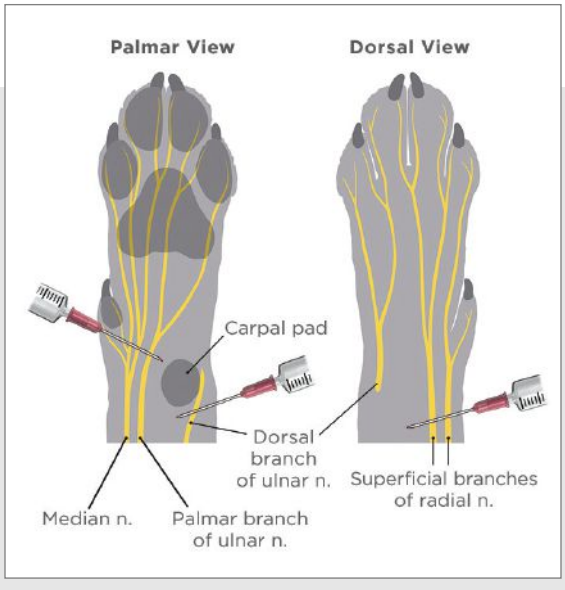


FIGURE 2. Radial-ulnar-median, or ring, block. To perform this block, ensure that the subcutaneous injection sites will incorporate the nerve branches on both the dorsal and ventral aspects of the paw. This technique can be used for dogs and cats.

For conscious patients, injection discomfort can be minimized by first creating a small wheal and then slowly proceeding along the periphery of the first wheal site until the block is complete.[6]

Radial-Ulnar-Median Nerve or Circumferential Ring Block

The radial-ulnar-median (RUM) nerve block is particularly useful for procedures of the distal forelimb in dogs and cats, such as onychectomy or digit amputation. The superficial branches of the radial and median nerves and the dorsal and ventral branches of the ulnar nerve can be blocked distally by placing 0.1 to 0.3 mL of a local anesthetic agent at each of the 3 locations (**FIGURE 2**).

The median and palmar branches of the ulnar nerve are blocked on either side of the accessory carpal pad on the caudal aspect of the carpus. The superficial branches of the radial nerve are blocked on the dorsal carpus, just proximo-medial to the dewclaw.[7]

Alternatively, a ring block can be performed by placing 2 lines of the local anesthetic agent along the dorsal and ventral aspect of the paw to encompass the anatomic landmarks for the RUM block via 2 subcutaneous injections. A similar administration technique can be used to provide analgesia to the pelvic limb digits.

Drugs commonly used for RUM and ring blocks include 2% lidocaine or 0.5% bupivacaine.[7] Use of epinephrine is contraindicated for these blocks because of its potential to cause profound local vasoconstriction with subsequent tissue necrosis.[3,6]

Intravenous Regional Anesthesia (Bier Block)

This technique provides safe, short-term anesthesia of the extremity. To perform a Bier block, place a catheter distally in an appropriate vein (cephalic or saphenous) in the limb requiring analgesia. Desanguinate the limb by placing an Esmarch bandage, and then place a

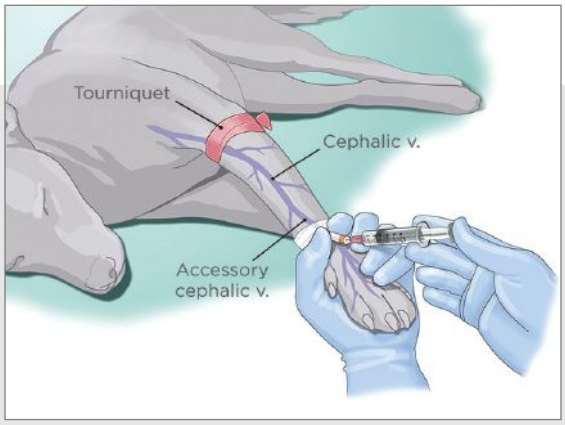


FIGURE 3. Bier block. This block is suitable for short-term anesthesia of the distal extremity. It can be performed with an Esmarch bandage, or substituted with a tourniquet.

tourniquet proximally and tighten it. Remove the Esmarch bandage and inject 2.5 to 5 mg/kg of lidocaine (**FIGURE 3**).

With the tourniquet in place, diluted lidocaine (0.25% or 0.5%) will produce adequate sensory blockade after 5 to 10 minutes. Normal sensation returns to the limb within 5 to 15 minutes, but analgesia remains for up to 30 minutes. *Bupivacaine should never be used for a Bier block.*[6]

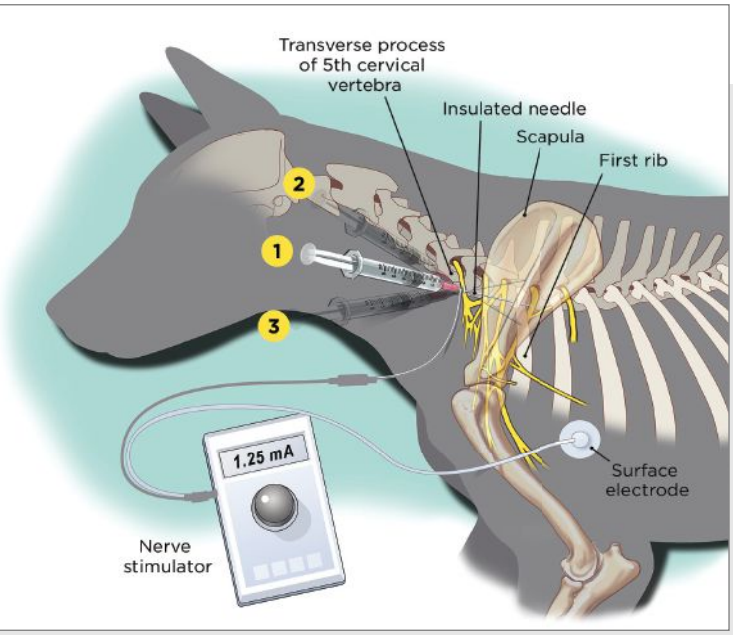
Brachial Plexus Block

Brachial plexus blocks are suitable for forelimb procedures distal to the elbow.[3,7] Appropriate agents are 2% lidocaine or 0.5% bupivacaine. Mixing 2 different local anesthetic agents together in 1 syringe is controversial. To perform this block, after the area has been clipped and scrubbed, place the patient's neck in a natural position to form a straight line with the cervical transverse process. Guide the needle beneath the scapula (and outside the thorax) until the needle tip has been inserted to a depth caudal to the first thoracic rib (**FIGURE 4**). Aspirate and inject one third of the calculated dose as the needle is slowly withdrawn, 1 cm at a time until it is just ready to exit the skin. Repeat this process 2 more times, redirecting the needle 30 degrees above and below the initial injection line and injecting the remainder of the dose. Without the use of electroneural stimulation (nerve locater) or ultrasonography as a guide, effectiveness of this block is difficult to assess until the patient recovers from anesthesia.[7]

Intercostal Block

Intercostal nerve blocks are indicated for patients with rib fractures, after thoracotomy, or to achieve pleural drainage. Intercostal nerve blocks eliminate input from and paralyze tissues innervated by the intercostal nerves located between each rib, providing analgesia without respiratory depression.[3] Because of the overlap of innervation, a minimum of 3 consecutive ribs must be blocked. The intercostal nerves and vessels lie adjacent to the caudal border of each rib. Inject small quantities

FIGURE 4. Brachial plexus block. Ensure that the needle is beneath the scapula and beyond the first thoracic rib.



Illustrations: Kip Carter (2). Illustration opposite: Kip Carter.

(less than 0.5 mL) of the local anesthetic distal to the angle of the rib, near the insertions of the epaxial muscles. Direct the needle dorsally and medially, and "walk" the needle off the caudal border of each rib (**FIGURE 5**).[3] The preferred agent is bupivacaine (up to 2 mg/kg) because of its prolonged duration of action.[3]

Intercostal blocks are not recommended for dogs with pulmonary diseases impairing blood gas exchange or for patients unable to be observed for several hours after injection.[3,6]

Intercostal nerve blocks are indicated for patients with rib fractures, after thoracotomy, or to achieve pleural drainage.

Epidural Block

Neuraxial anesthesia includes the administration of regional anesthetic drugs into the epidural or subarachnoid (spinal) space. Epidural anesthesia blocks the motor, sensory, and autonomic systems; decreases inhalant requirements; and greatly reduces postoperative analgesic requirements.[7,8] Almost any patient undergoing a hindquarter surgical procedure involving the pelvic limbs, pelvis, or tail can benefit from the analgesia provided by neuraxial anesthesia.[4,7]

To perform an epidural block, clip an adequate area over the proposed insertion site, aseptically prepare the site, drape it, and don sterile gloves. Sterile technique must be used while performing an epidural to avoid epidural abscess or lumbosacral diskospondylitis.[4] After the patient is profoundly sedated or anesthetized and positioned in sternal recumbency with the head elevated and the pelvic limbs pulled forward, palpate the cranial edge of the iliac wings. An imaginary line connecting these 2 points typically overlies the L7 vertebral body, and the palpable depression just caudal to this point corresponds with the lumbosacral junction. In adult dogs, the spinal cord usually ends at the L6 vertebral body; but in puppies and cats, the spinal cord and dural sac may extend further caudally (up to S1) (**FIGURE 6**).[4,7]

To perform the hanging drop technique, place the spinal needle (Quincke or Huber point, 22- to 18-gauge, 1.5- to 3.5-inch) perpendicularly over the depression indicating the lumbosacral junction. Be sure that the stylet of the needle is fully seated to avoid transplanting skin into the epidural space. After the skin has been penetrated, remove the stylet and place it on the sterile glove liner paper.

Place a few drops of 0.9% NaCl into the hub of the spinal needle until it forms a meniscus. Slowly advance the needle until the ligamentum flavum is punctured and the needle tip enters the epidural space, at which point the bubble of sterile saline will be drawn into the needle/epidural space (**FIGURE 6**).[7]

Carefully attach the syringe containing the analgesic agent and approximately 1 mL of air onto the spinal needle. Needle placement is correct if you encounter

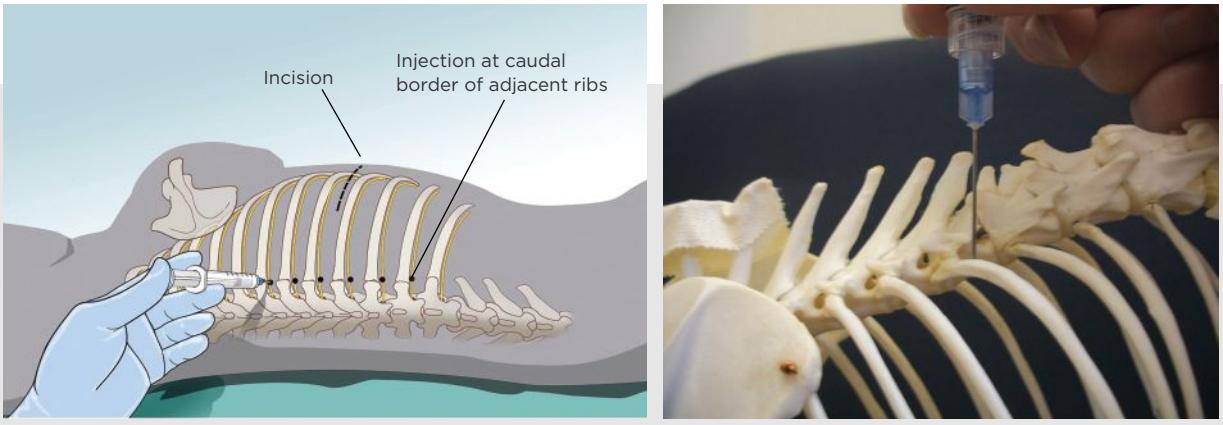


FIGURE 5. Intercostal nerve block. This block must incorporate 3 rib spaces cranial and caudal to the targeted region.

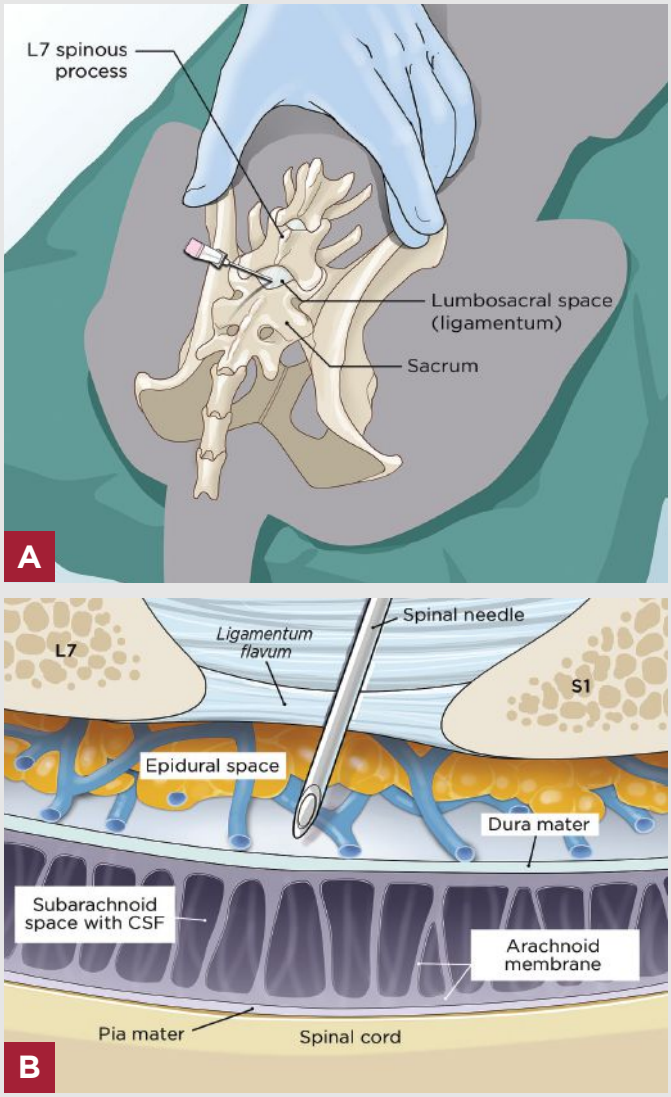


FIGURE 6. Epidural block. **(A)** Identify the L7 lumbosacral junction by visualizing an imaginary line between the cranial edge of the iliac wings and palpating the depression caudal to this landmark. **(B)** Identify pertinent anatomic landmarks associated with neuraxial anesthesia. CSF=cerebrospinal fluid.

lack of resistance and if the air bubble does not become compressed during the injection. To avoid uneven coverage, inject the epidural solution slowly (over approximately 1 minute) (**FIGURE 6**).

Effects of an epidural block peak within 5 to 20 minutes after injection, depending on the agent used. Unless bilateral effects are desired, the patient should be placed with the dependent side down to maximize the local anesthetic effects.[4]

Epidural catheters can be used in patients with multiple traumatic injuries to a pelvic limb, in patients with pancreatitis, or at any time when multiple epidural injections would be beneficial. Epidural catheters must be carefully inserted to ensure proper placement within the epidural space and can remain in place for up to several days; maintenance of sterile conditions throughout their use is crucial.

Preservative-free morphine sulfate solution is commonly incorporated into epidural analgesia protocols. A standard epidural dose is 0.1 mg/kg, which should be based on the patient's lean or ideal body weight.[7] Single-agent morphine epidurals can provide analgesia for 6 to 12 hours.

Morphine can also be combined with a local anesthetic, which can provide neuraxial analgesic effects lasting up to 24 hours.[4,7] Alternate epidural drug options include 1) preservative-free fentanyl, 2% lidocaine, or 0.25% to 0.5% bupivacaine or 2) ketamine (0.1 to 0.3 mg/kg), dexmedetomidine (0.1 µg/kg), and preservative-free buprenorphine (5 µg/kg).[1,7]

When diluting epidural drugs with saline or local anesthetics, keep the total injection volume less than 0.25 mL/kg.[7] Moreover, for pregnant animals, decrease the injection volumes by as much as 75%. The safest suggested volume of epidural drugs for pregnant patients is 1 mL/5 kg (based on lean or nonpregnant body weight).[4]

Complications

Neurotoxicity has been associated with parenteral morphine formulations containing preservatives deposited directly onto the spinal cord, especially after repeated injections.[1] Other rare complications of epidural blocks include pelvic limb paresis and hyperalgesia. Ventilatory impairment may occur secondary to excessive cranial migration of the drug, resulting in motor blockade of the phrenic nerve at C3–C5.[4,9] Because epidural injection of local anesthetics and opioids commonly leads to urinary retention, careful postoperative monitoring is required.[4,7]

Contraindications

Epidurals are contraindicated for patients with septicemia, infection, spinal trauma, bleeding disorders, spinal deformity, and pre-existing spinal neurologic disease.[4,10] Avoid epidurals in patients with infection of the tissues overlying the lumbosacral space.[3] Local anesthetic agents

Kip Carter (2)

should not be administered to patients at risk for hypotension because inhibition of sympathetic efferent activity may cause a sympathetic blockade.[7]

Sacrococcygeal Epidural Block

A sacrococcygeal epidural block combined with low-dose sedation is an effective way to facilitate catheterization of male cats with urethral obstructions while providing analgesia to the penis and urethra. A single preservative-free lidocaine injection results in anesthesia within 5 minutes, while effects may last up to 1 hour. While performing this block, as with epidural anesthesia, wear sterile gloves and use aseptic technique. Inject a low volume (0.1 to 0.2 mL/kg) of 2% lidocaine (average 0.5 mL/cat), without inserting air, in the first movable space at the caudal end of the sacrum (sacrococcygeal or intercoccygeal space). Complications are rare but may include pelvic limb weakness, infection or abscessation at the injection site, ineffective block, or inadvertent systemic absorption of lidocaine. Contraindications for sacrococcygeal epidural blocks are similar to those for epidural blocks.[11]

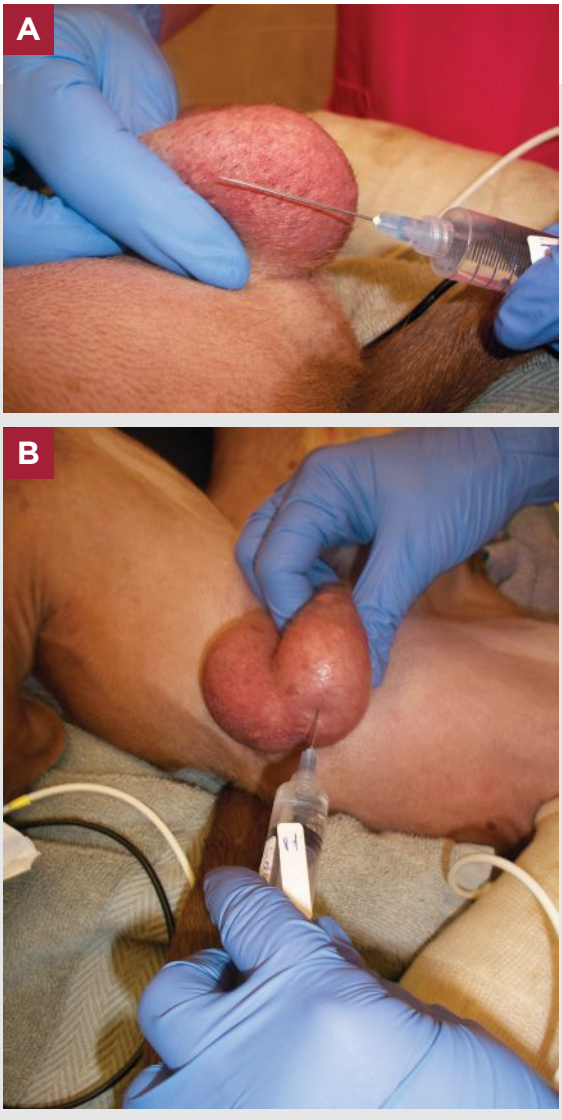


FIGURE 7. Correct needle advancement for the intratesticular block in the dog. Intratesticular blocks can be very effective during dog or cat castration procedures.

Local anesthetic agents should not be administered to patients at risk for hypotension because inhibition of sympathetic efferent activity may cause a sympathetic blockade.[7]

Intratesticular Block

Intratesticular infusion of local anesthetics can provide a quick, simple, and inexpensive analgesic option for surgical castration of dogs and cats. Insert a 22-gauge needle beginning at the caudal pole of the epididymis, while aiming for the spermatic cord at the proximal end of the testicle (**FIGURE 7**). Since mixing local anesthetic agents is controversial and no longer recommended, inject half of the calculated volume of lidocaine (1 mg/kg) or 0.5% bupivacaine (1 mg/kg) until the first testicle becomes turgid. Repeat the injection on the other testicle. A video and full instructions on how to perform intratesticular blocks in dogs and cats are available at **vasg.org/intratesticular_blocks.htm**.[12]

Splash Block

Local pain control can also be achieved by placing a local anesthetic directly into a surgical site or injecting it into a closed space where the agent can diffuse.[13] For maximum effect, the analgesic agent should be applied to dry tissues and remain in contact for 15 to 20 minutes, negating the need for further tissue blotting. Splash blocks are best used as an adjunct for particularly painful surgeries (e.g., ear crops, lateral ear resections, and ablations).[3]

Minimize toxic effects by always using the minimal amount of agent necessary to obtain the desired effect. For geriatric (>8 years), sick, or cachectic patients, reduce dosages by 30% to 40%.[6]

LOCAL ANESTHETIC AGENTS

Liposome-Encapsulated Bupivacaine

In 2016, Aratana Therapeutics released a liposome-encapsulated form of bupivacaine, called Nocita (now manufactured by Elanco; **elanco.com**). This injectable suspension is used as a local postoperative analgesic agent. The U.S. Food and Drug Administration initially approved Nocita for cranial cruciate ligament surgery in dogs and in 2018 approved it for use in cats undergoing onychectomy. In clinical settings, it has been used off label for various procedures, including incision blocks and limb amputations. After Nocita has been deposited into the tissue, the local anesthetic effect can last 72 hours or more after surgery, which is relevant in that postoperative pain is most severe during the first 24 to 72 hours.[14] Nocita is currently available in 10- and 20-mL bottles.

Transdermal Local Anesthetic Preparations

For humans, lidocaine patches are used to provide pain relief for patients with peripheral neuropathies, such as shingles. In veterinary patients, they have been used to manage chronic neuropathic and mastectomy pain, as well as post-thoracotomy or ear canal ablation pain.[7] Other indications include postoperative use after laparotomy, spinal cord decompression, cruciate repair and amputation, as well as longer-term use for osteoarthritis.[1] Further studies are needed to evaluate their effectiveness for trauma, bruising, and wounds in dogs and cats.[10]

Standard lidocaine patches are relatively inexpensive. To apply, cut the patch to the length of the surgical incision and apply 1 patch to each side of the incision after skin closure. Lidocaine patches may take up to 12 hours to become fully effective.[10]

Lidocaine patches offer the following advantages: 1) they can be cut to almost any shape without affecting drug delivery; 2) lidocaine is not a controlled substance; 3) systemic side effects are minimal because activity is local; 4) they provide incomplete sensory blockade beneath the patch; and 5) they provide a physical barrier against mechanical stimulation.

Topical Local Anesthetic Preparations

Topical local anesthetic creams usually contain a 1:1 ratio by weight of lidocaine and prilocaine, which can penetrate human skin within 1 hour of topical application without untoward effects. The cream can be used as an analgesic before superficial minor surgical procedures and percutaneous catheter placements. Apply cream 1 to 2 hours before desired analgesic effect, which will last an additional 1 to 2 hours. Do not apply to broken or inflamed skin. Prevent veterinary patients from licking or ingesting the cream because the effects on mucous membranes may be greater than those on the skin.[7]

TABLE 1 General Dosing Information for Commonly Used Local Anesthetic Agents

Always verify doses and never exceed toxic doses.

AGENT	MAXIMUM TOTAL INFILTRATION DOSE, MG/KG		ONSET, MIN	DURATION, HR	TOXIC DOSE, MG/KG
	DOG	CAT			
Lidocaine 2%	5	2.5	5–10	1–2	10
Mepivacaine 1%–2%	5	2.5	5–10	2–3	30
Bupivacaine 0.5%	2	1	10	3-6	4

Table provided courtesy of Dr. Stephen A. Greene, Washington State University, Pullman, Wash.

GENERAL PRECAUTIONS

Never use local anesthetics containing epinephrine in tissues supplied by end arteries (e.g., ear tips, distal limbs, individual digits, or tails) or in thin or dark-skinned dogs (e.g., poodles) due to epinephrine possibly leading to severe vasoconstriction, local ischemia, and necrosis.[6] Other contraindications for epinephrine use include uncontrolled hyperthyroidism, cardiac dysrhythmias, and asthma.[14]

Minimize toxic effects by always using the minimal amount of agent necessary to obtain the desired effect (**TABLE 1**). For geriatric (>8 years), sick, or cachectic patients, reduce dosages by 30% to 40%.[6] When blocking multiple locations in smaller patients, *use extreme caution to ensure that toxic doses are not exceeded.*

If dilution of local anesthetic agents is necessary to provide additional volume and avoid toxicity, use 0.9% NaCl (*not* sterile water).[6]

TOXICITY AND COMPLICATIONS OF LOCAL ANESTHETICS

Systemic toxicity from local anesthetics is rare but can result in CNS signs such as muscle twitching, seizures, depression, unconsciousness, coma, and respiratory arrest. Note that these signs can be masked in the anesthetized patient.

Risk for cardiotoxicity is greater with use of bupivacaine than lidocaine or mepivacaine because bupivacaine dissociates slowly from sodium ion channels. Bupivacaine-induced toxicity results in decreased cardiac output and hypotension, leading to cardiovascular arrest. Prompt treatment is imperative and consists of supportive care such as IV fluids, positive inotropes, and vasopressors. Addition of epinephrine to bupivacaine may result in tachycardia, bronchospasm, or dysrhythmia.[6]

Local anesthetic metabolites or preservatives can cause rare allergic-type reactions.[15] The most common types of anaphylaxis are cutaneous and respiratory reactions, secondary to accidental IV injection or administration of excessive doses.

Because local anesthetic agents are avoided in human patients prone to malignant hyperthermia, it may be prudent to also avoid their use in veterinary patients prone to this condition.[16]

SUMMARY

Pain management has become an integral part of small animal veterinary care. As part of an overall pain management plan, local anesthetics may be used preemptively, postoperatively, and as an adjunct to general anesthesia. Commonly used local anesthetic agents include lidocaine, mepivacaine, and bupivacaine (with or without epinephrine). The techniques for administering local or regional blocks are easy to perform, and the supplies needed are inexpensive and readily available. Synergism of local anesthetic agents with other analgesic modalities makes them a valuable part of a balanced analgesia and anesthesia plan. **TVN**

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CONTINUING EDUCATION

Locoregional Anesthesia for Small Animal Patients

TOPIC OVERVIEW

This article focuses on local anesthetic agents as part of pain management. As part of an overall pain management plan, local anesthetics are used preemptively, postoperatively, and as an adjunct to general anesthesia; they can be administered through several situation-dependent techniques.

LEARNING OBJECTIVES

- Understand pain's physiologic effects and the value of pain management
- Understand basic pharmacology associated with local anesthetic agents
- Understand the difference between the terms "anesthesia" and "analgesia"
- Be familiar with techniques used to provide local and regional anesthesia
- Know the indications and contraindications associated with each local anesthesia technique

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1. **Another way to describe "wind up" is**
   a. Sensitization of the central nervous system
   b. Preemptive analgesia, as an evolving clinical concept
   c. A combination of analgesic regimens working on various pain pathways
   d. Systemic toxicity associated with local anesthetic overdose

2. **Which of the following is an example of central regional anesthesia?**
   a. Epidural or spinal anesthesia
   b. Ring block
   c. Brachial plexus block
   d. Incisional block

3. **Bupivacaine should never be used to perform which type of block?**
   a. Bier
   b. Radial-ulnar-median nerve
   c. Intratesticular
   d. Intercostal

4. **Which of the following are contraindications to performing epidurals?**
   a. Septicemia, hypertension, hypothyroidism
   b. Hypotension, bleeding disorders, dermatitis
   c. Preexisting spinal deformity, Chiari malformation, achondroplasia
   d. Infections, buphthalmos, asthma

5. **According to the manufacturer, the duration of action of liposome-encapsulated bupivacaine is how many hours?**
   a. 24
   b. 12
   c. 36
   d. 72

6. **Which of the following local anesthetic drugs are effective topically?**
   a. Lidocaine/prilocaine cream and lidocaine patches
   b. Nocita and proparacaine
   c. Mepivacaine and articaine
   d. Septocaine and cocaine

7. **Local anesthetics containing epinephrine are contraindicated in tissues supplied by end arteries because**
   a. They can cause cardiac dysrhythmias.
   b. They are associated with anaphylaxis in dark-skinned dogs.
   c. They can cause local ischemia and necrosis.
   d. They are ineffective at labeled doses.

8. **Systemic toxicity of local anesthetics may include which of the following?**
   a. Seizures, alopecia, and Heinz bodies
   b. CNS depression, hypotension, and respiratory arrest
   c. Methemoglobinemia, bronchodilation, and malignant hyperthermia
   d. Pulmonary edema, shock, and acute renal failure

9. **Which of the following analgesic drugs prevent transmission of nerve impulses by selectively binding to sodium channels?**
   a. Nonsteroidal anti-inflammatories
   b. Opioids
   c. α-Adrenoreceptor antagonists
   d. Local anesthetics

10. **Neuraxial anesthesia may also be referred to as**
    a. Bier block
    b. Brachial plexus block
    c. Neuroleptanalgesic
    d. Spinal or epidural block