Chapter 21

Local and Regional Anesthetic and Analgesic Techniques: Cats

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Introduction

This chapter reviews the use of selective local and regional anesthetic and analgesic techniques in cats as an adjunct to light general anesthesia. The techniques are easily performed for diagnostic and surgical procedures to produce postoperative analgesia. A basic knowledge of the regional anatomy of the area to be desensitized and the pharmacology of drugs used to induce effective local anesthesia is required if the full potential of local anesthetic and analgesic techniques is to be realized.[1,2] Commonly used techniques in cats are topical anesthesia, local infiltration, nerve blocks (e.g., selective blockade of distal branches of nerves about the head, forelimb, and hind limb), brachial plexus block, intravenous regional anesthesia, epidural anesthesia, and epidural analgesia. Because of restraint problems, local and regional anesthetic techniques are typically administered to heavily sedated or anesthetized cats. A number of local anesthetic drugs that vary in potency, toxicity, and cost are available for these purposes. Most commonly, 0.5% to 2.0% lidocaine hydrochloride is used to anesthetize cats for 60 to 120 min, whereas 0.2% to 0.5% ropivacaine hydrochloride or 0.25% to 0.5% bupivacaine hydrochloride produce anesthesia for 240 to 360 min. The applied pharmacology of local anesthetic drugs in animals has been described in Chapter 14. Advantages of using regional anesthetic/analgesic techniques include (a) reduction of the required dose of general anesthetic drugs and thus minimal cardiopulmonary depression, (b) complete blockade of sensory and motor nerve fibers, and (c) prevention of the secondary (central) sensitization to pain. Preemptive analgesia theoretically (a) decreases the severity of pain during surgery, (b) reduces drug requirement for pain control, and (c) provides analgesia after surgery.[3–6]

Topical Anesthesia

Local anesthetics, either as lidocaine spray (10%, 100 mg/mL) or lidocaine hydrochloride solution, can be applied topically. One spray delivers 10 mg of lidocaine, which usually is sufficient to desensitize small areas of oral, nasal, and pharyngeal mucous membranes. Administration of 20 mg of lidocaine to the mucous membrane produces surface anesthesia up to 2 mm deep within 2 min, which lasts for about 15 min. Topical lidocaine (spray or instillation) is useful for minor diagnostic, therapeutic, and surgical procedures (e.g., endoscopy, placement of nasal catheters for tube feeding, foreign-body removal, biopsies, and repair of small mucosal wounds). Instillation of 1.0 mL of lidocaine (20 mg), ropivacaine (2 mg), or bupivacaine (2.5 mg) into the wound of skin incisions or lacerations provides good analgesia in cats (4 kg). These local anesthetics are ineffective when applied topically to intact skin. Sterile lidocaine jelly (2%, 20 mg/mL) provides good analgesia of the urethra during catheter placement, because lidocaine is absorbed across mucous membranes. The eutectic mixture of lidocaine and prilocaine (EMLA cream [lidocaine 2.5% and prilocaine 2.5%]) penetrates the stratum corneum of the skin. Cream is placed on the skin and covered with a clean dressing for at least 20 min to enable painless placement of arterial and venous catheters in nervous cats.[7] Proparacaine 0.5%, tetracaine 0.5%, or butacaine 2% can be applied topically to desensitize the cornea for 10 to 20 min. Repeated doses have been reported to prolong anesthesia up to 2 h without causing harmful effects.[8]

Infiltration Anesthesia

Local infiltration is primarily used for repair of superficial lacerations, cutaneous biopsy, and removal of dermal or subcutaneous tumors. Lidocaine hydrochloride (2 to 5 mg/kg), ropivacaine, or bupivacaine hydrochloride (3 mg/kg) is injected in the form of a subcutaneous bleb, line block, inverted V-block or triangular or rectangular pattern around a small tumor to be surgically removed, using a 25-gauge (G) × 0.6-inch needle or 22-G × 1-inch needle.[9] The dose of the local anesthetic should be carefully calculated to prevent toxicity. The syringe is aspirated before each injection and great care must be taken that the local

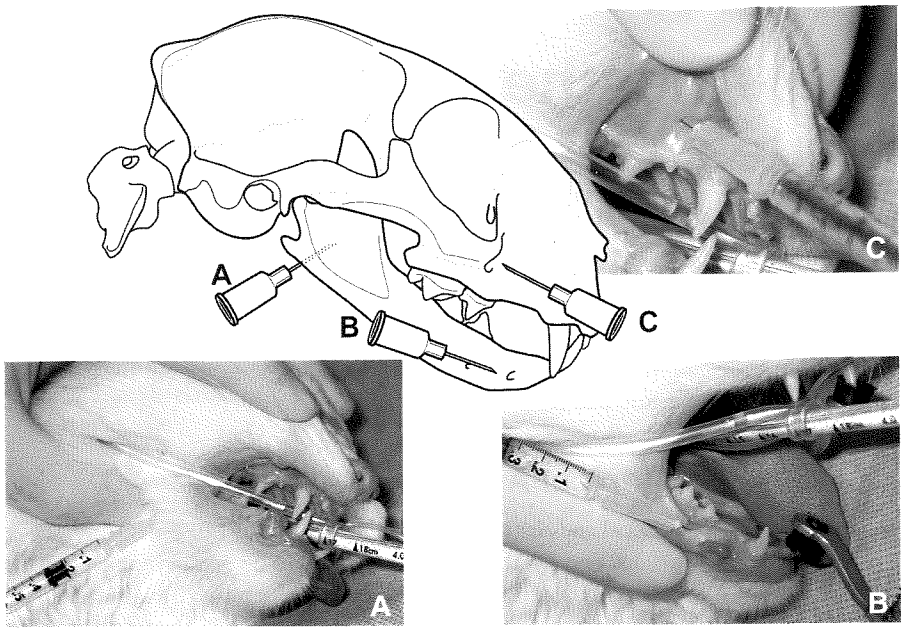

Fig. 21.1. Needle placement for nerve blocks of the head: **(A)** inferior alveolar (mandibular), **(B)** mental, and **(C)** infraorbital.

anesthetic is not inadvertently administered intravenously.[10–12] Sterile saline solution can be used to decrease the concentration and increase the volume of lidocaine (2 mL of a 1% solution instead of 1 mL of a 2% solution) to allow infiltration of a larger lesion. The total dose (20 mg) should be reduced by 30% to 50% in sick cats.

Regional Anesthesia of the Head

Commonly used nerve blocks to manage pain during and after surgical and dental procedures are the infraorbital, inferior alveolar and mental nerves (Fig. 21.1).[2,13,14] These nerves can be desensitized by injecting 0.1 to 0.3 mL of either 1.0% to 2.0% lidocaine, 0.2% to 0.5% ropivacaine, or 0.25% to 0.5% bupivacaine hydrochloride solutions, using a 30-G × 0.5-inch to 22-G × 1-inch needle.

Anesthesia of the Maxilla and Upper Teeth

The upper lip and muzzle, roof of the nasal cavity, soft and hard palates, and teeth in the upper dental arcade are supplied by sensory fibers of the infraorbital nerve. The nerve is blocked at the infraorbital foramen as it emerges from the infraorbital canal, ventral to the eye, approximately 1.0 cm dorsal to the third premolar at the junction of the maxilla and zygomatic arch. Improper identification of the infraorbital foramen and branching of a nerve proximal to the region of local anesthetic may cause failure to produce regional anesthesia.[13] The block is facilitated by angling the needle tip slightly medially. The needle is then advanced approximately 0.5 cm into the infraorbital canal, which is not a true canal in cats (Fig. 21.1C).

Anesthesia of the Mandible and Lower Teeth

The lower dental arcade, including the molars, canines, and incisors, and the skin and mucosa of the chin and lower lip are supplied by sensory fibers of the mandibular nerve. The nerve can be easily blocked at the point of its entry into the mandibular canal at the mandibular foramen. The needle is inserted percutaneously at the ventromedial aspect of the ramus of the mandible, approximately 1.0 cm rostral to the angular process, and for a depth of 0.5 cm (Fig. 21.1A). In an alternative technique, the inferior alveolar nerve can be blocked intraorally, under the buccal fold.

The inferior alveolar nerve branches into the free rostral, middle, and caudal mental nerves, which supply sensory fibers to the lower lip and the medial half of the canine and three incisors. The mental nerve can be blocked at the mental foramina, caudal and ventral to the lower canine (Fig. 21.1B). The extremely small size of the mental foramina precludes the insertion of a needle or catheter into the termination of the mandibular canal.[13]

Anesthesia of the Limbs

Blockade of the distal branches of the radial, median, and ulnar nerves, blockade of cervical and thoracic nerves (brachial plexus block), and intravenous regional anesthesia are cost- and time-effective techniques for providing perioperative anesthesia and managing pain after surgical procedures of the forelimb in cats. In the hind limb, selective blockade of the common peroneal and tibial nerves is easily produced. Injection of the local anesthetic or opioid into the epidural space at the lumbosacral junction provides analgesia of the pelvic limbs and perineum.

Blockade of the Radial, Ulnar, and Median Nerves

Selective blockade of the distal branches of the radial, ulnar, and median nerves produces brief surgical anesthesia and postoperative analgesia after onychectomy or tenectomy. The nerve blocks are easily performed to supplement anesthesia or provide an alternative to wound irrigation with local anesthetic following ony-

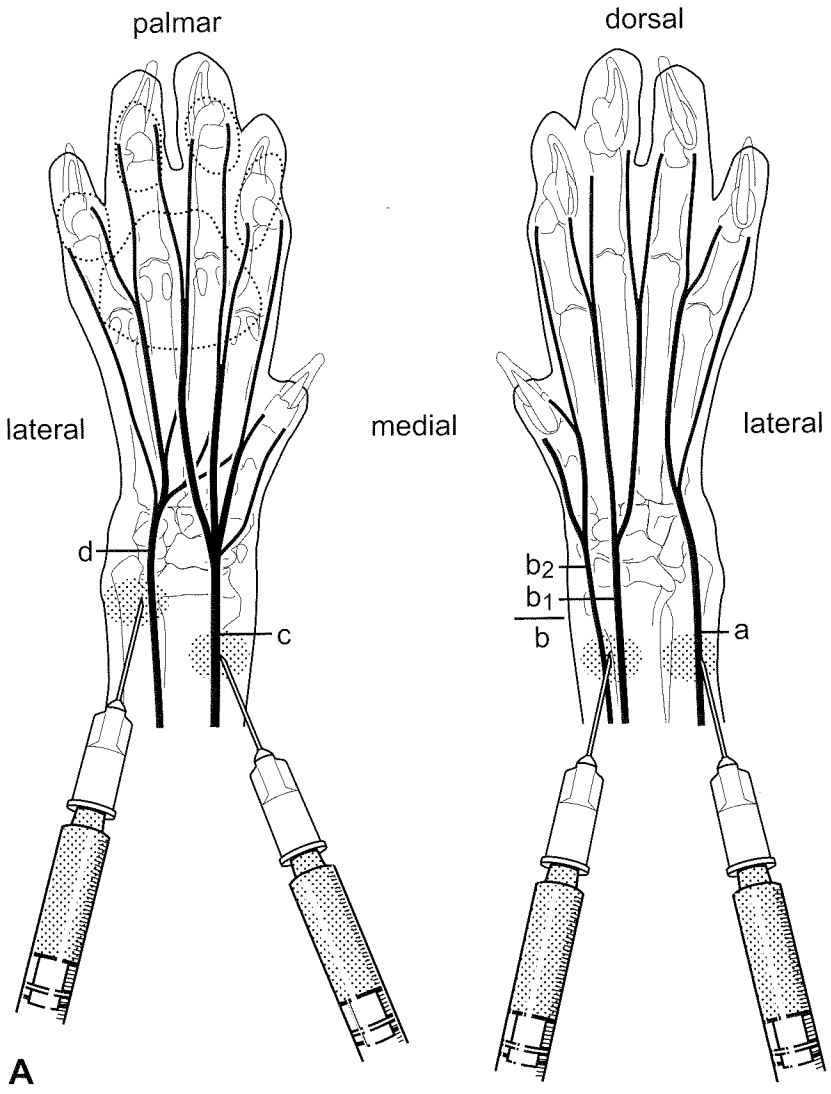

Fig. 21.2. **A:** Needle placement for nerve blocks on the foreleg: (a) dorsal branch of ulnar nerve, (b1) lateral branch and (b2) medial branch of superficial branch of radial nerve, (c) median nerve, and (d) palmar branch of the ulnar nerve.

chectomy.[15–21] The superficial branches of the radial nerve are blocked on the dorsomedial aspect proximal to the carpal joint. The palmar and dorsal cutaneous branches of the ulnar nerve are blocked just proximal and lateral to the accessory carpal bone. The median nerve is blocked proximal to the median carpal pad. A 22-G × 1-inch needle can be used, and approximately 0.3 mL of the anesthetic solution is administered subcutaneously at each site (Fig. 21.2A). In two alternative techniques, the local anesthetic (3 mg/kg body weight) is injected subcutaneously distal to the carpal joint to each of the dorsal and palmar proper digital nerves either as a four-point digital nerve block[22] or ring block.[23]

Blockade of the Common Peroneal and Tibial Nerves

Selective blockade of the distal branches of the common peroneal and tibial nerves produces perioperative and postoperative analgesia in the hind limb for onychectomy or tenectomy. The superficial branches of the common peroneal nerve are easily blocked by subcutaneous infiltration of the local anesthetic on the dorsomedial aspect of the tarsus distal to the tarsal joint. The superficial branches of the tibial nerve are blocked by subcutaneous injection of the local anesthetic ventromedially and distally to the tarsal joint (Fig. 21.2B).

Brachial Plexus Block

Blockade of the ventral branches of the cervical (C6, C7, and C8) and thoracic (T1) spinal nerves can be used to anesthetize the forelimb and manage pain after surgical repair of the radius and ulna in cats.[14] The procedure is performed in well-sedated or anesthetized cats. A needle (22 G × 1 inch) is placed into the axillary space proximal to the shoulder, and approximately 0.5 mL of either 2% lidocaine (10 mg), 0.5% ropivacaine, or 0.5% bupivacaine (2.5 mg) is injected once the needle tip is cranial to the first rib and caudal to the cranial border of the scapula (Fig. 21.3). The same amount of the anesthetic is administered as the needle is withdrawn. The syringe is aspirated prior to each injection to avoid injection into the axillary artery and vein, which are close to the brachial plexus. The brachial plexus should not be

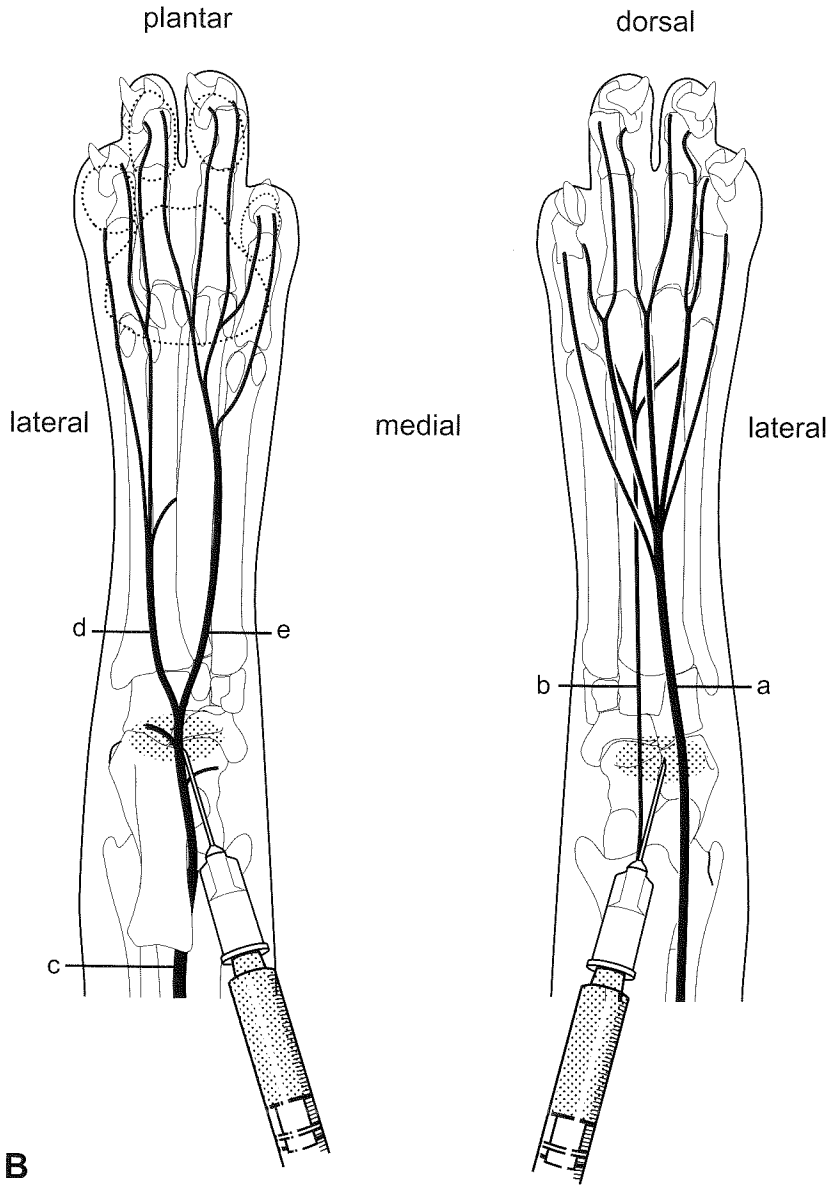

Fig. 21.3 (*continued*). **B:** Needle placement for nerve blocks on the hind leg: (a) superficial peroneal nerve, (b) deep peroneal nerve, (c) tibial nerve, (d) lateral plantar nerve, and (e) medial plantar nerve.

blocked bilaterally because of potential bilateral phrenic nerve blockade and subsequent compromised respiratory function.

Intravenous Regional Anesthesia

Intravenous regional anesthesia (IVRA) may be suitable for anesthetized cats undergoing surgery, including onychectomy, of the distal limbs. First, a 22-G × 1-inch intravenous catheter is inserted into the cephalic vein proximal to the carpus and with the catheter tip pointing distally.[24] Second, an inflatable blood pressure cuff (neonatal no. 2; Criticon, Tampa, FL) is placed proximal to the cephalic catheter and is inflated and maintained at 100 mm Hg greater than systolic pressure. Third, a second tourniquet, 6.25-mm rubber tubing, is tied above the elbow and left in place for 20 min. Lidocaine (1%, 3 mg/kg) is then injected into the distal cephalic venous catheter to anesthetize the entire limb distal to the tourniquet, as determined by lack of response to toe pinch. After the tourniquet has been removed, analgesia still remains for approximately 20 min. No neurotoxicity or adverse hemodynamic or respiratory effects have been reported in cats breathing either a low (1.5%) or high (2.3%) concentration of isoflurane during IVRA. No adverse effects were noted during recovery from anesthesia 20 min after tourniquet removal.[24] The plasma lidocaine concentrations may vary. The reported highest mean lidocaine concentration was 2.8 ± 1.0 μg/mL after the injection of lidocaine (3 mg/kg) and was 3.1 ± 1.1 μg/mL after a second injection of lidocaine (3 mg/kg) 20 min later.[24] The model described simulated a 20-min onychectomy procedure per each front leg of the cat. Significant leakage under the tourniquet may occur, as determined by measurable venous plasma lidocaine concentrations (maximum, 4.42 μg/mL) prior to tourniquet release. Placement of the tourniquet and thus occlusion of blood supply distal to the tourniquet should be limited to 30 min to prevent complications (e.g., lameness or endotoxemia) (Fig. 21.4).

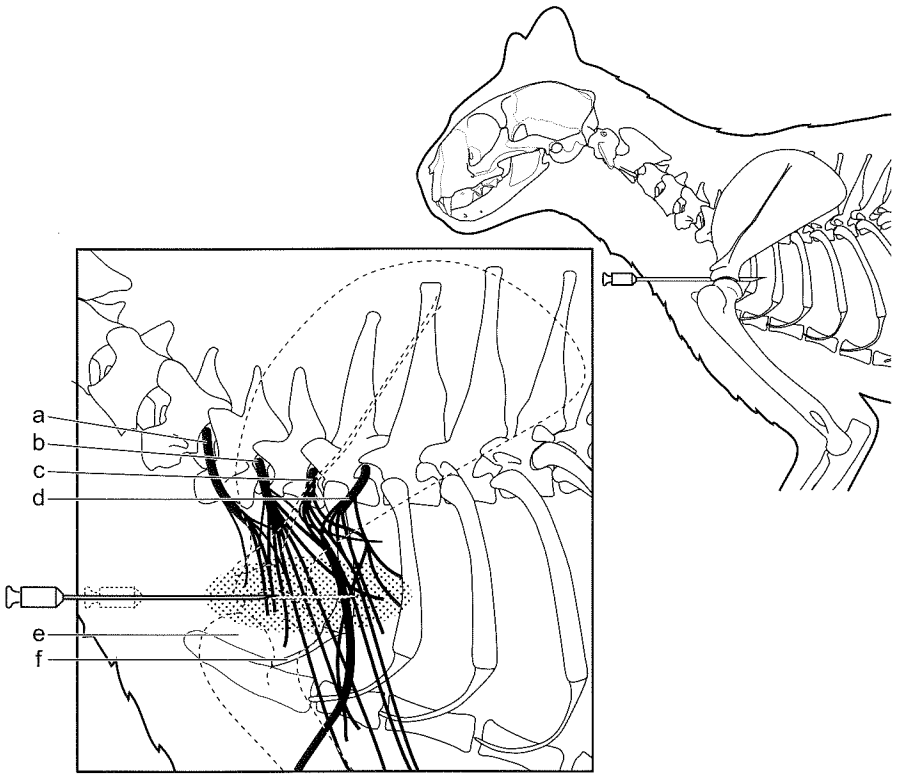

Fig. 21.3. Needle placement for brachial plexus block. **Inset:** ventral branches of (a) sixth, (b) seventh, and (c) eighth cervical, and (d) first thoracic spinal nerve; (e) tuberosity of humerus; and (f) first rib.

Intercostal Nerve Block

This technique is used to control pain following lateral thoracotomy, rib fractures, or pleural drainage. Two adjacent intercostal nerves, cranial and caudal to the incision site or wound (four sites in total), are blocked (Fig. 21.5). A needle (27 G × 1 inch) is inserted into the intercostal muscle close to the insertion of the epaxial muscles. The needle is directed dorsomedially and, using caution not to puncture the lung, its tip is walked off the caudal border of the rib. The syringe is aspirated before each injection of the anesthetic solution (3 mg/kg body weight), which is equally divided among the injection sites. Cats should be observed for development of pneumothorax during the first 30 min after the procedure. Cats with severe lung disease and those that rely on their intercostal muscles for maintaining ventilation and oxygen saturation must be monitored closely.[14]

Lumbosacral Epidural Anesthesia

Lumbosacral epidural anesthesia is safe and inexpensive and provides a reversible loss of sensation to a reasonably well-defined area of the body caudal to the diaphragm. This procedure is relatively easy to perform in heavily sedated or anesthetized cats.[25–27] Epidural injection of a local anesthetic may be used alone in cats that are at high risk of medical complications, that are aged, or that require immediate surgery of the rear quarter. The skin of the lumbosacral area is surgically prepared with an aseptic technique. A needle (22 G × 1 inch) is placed into the skin surface at the midline of the lumbosacral space. Except in obese cats, this space can be easily palpated halfway between the dorsoiliac wings and just caudal to the dorsal spinous process of the seventh lumbar vertebra. The needle is pushed ventrocaudally at a 45° angle to the dorsum to avoid pinching the seventh lumbar spinous process (Fig. 21.6). Resistance is encountered on reaching the ligamentum flavum. A distinct pop is usually felt when the needle is advanced through this ligament. Needle depth to reach the epidural space may vary from 6 to 25 mm (0.25 to 1.0 inch), depending on the cat's size. Further insertion of the needle will meet resistance, indicating the needle tip has encountered the bony floor of the vertebral canal, and thus necessitates the withdrawal of needle for 1 to 2 mm. The hub of the needle is observed for blood and cerebrospinal fluid (CSF). Because the dura sack terminates in the sacral area of cats, CSF may escape from the needle. If CSF is observed or aspirated, either the epidural injection is abandoned or only one-third to one-half of the original calculated dose of the drug is administered. Observation of blood within the needle indicates that the ventral venous sinus has been punctured; therefore, the needle should be removed. Intravascular injection of epidural drugs should be avoided to prevent toxicity. Lidocaine 2%, ropivacaine 0.2%, or bupivacaine 0.25% at the dose of 1.0 mL/4 kg produces analgesia up to the umbilicus area.[1,2,25] Analgesia usually lasts for at least 1 h with the use of lidocaine and 4 to 6 h with ropivacaine or bupivacaine injection. A regular local anesthetic dose (1.0 mL/4 kg) administered subarachnoidally (into the CSF) or a larger dose (>3 mL) administered epidurally produces a more cranial blockade that may be associated with decreased sympathetic activity and direct myocardial depression, and can cause

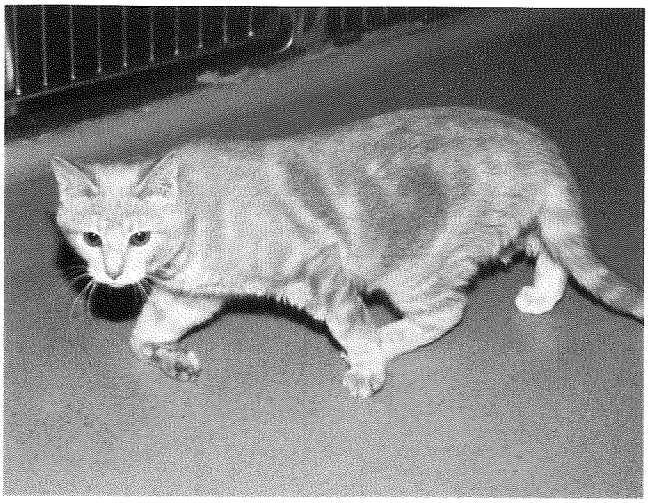

Fig. 21.4. Severe 18-h lameness of a cat, which had a rubber tourniquet in place above the right carpus during onychectomy for approximately 40 min.

hypotension, respiratory insufficiency, respiratory paralysis, and convulsions.

Epidural Opioid Analgesia

Preservative-free morphine (Astramorph/PF, 0.5 or 1.0 mg morphine/mL; or Duramorph, 0.5 or 1.0 mg morphine/mL) can be administered through a sterile needle or indwelling epidural catheter into the epidural space of cats to provide moderate to excellent intraoperative analgesia and postoperative pain control. An aseptic technique, as described for epidural injection of local anesthetic drugs, must be used. Placement of a vascular access device (access port model SLA-3.5H; Access Technologies, Division of Norfolk Medical Products, Skokie, IL) used as an indwelling epidural catheter in cats has been described (Fig. 21.6A).[28–30] In contrast to the administration of a local anesthetic drug by the epidural route, epidural morphine provides more prolonged analgesia (>6 h) with no effect on motor and sympathetic pathways.[31] The dose of morphine (0.1 mg/kg) must be calculated carefully and, to avoid inadvertent intravascular administration, the syringe should be aspirated before injection. A cat weighing 4 kg can be administered 0.4 mg morphine, which is 0.8 mL of Astramorph (0.5 mg/mL). If the needle tip has entered the intrathecal (subarachnoid) space, as recognized by free flow

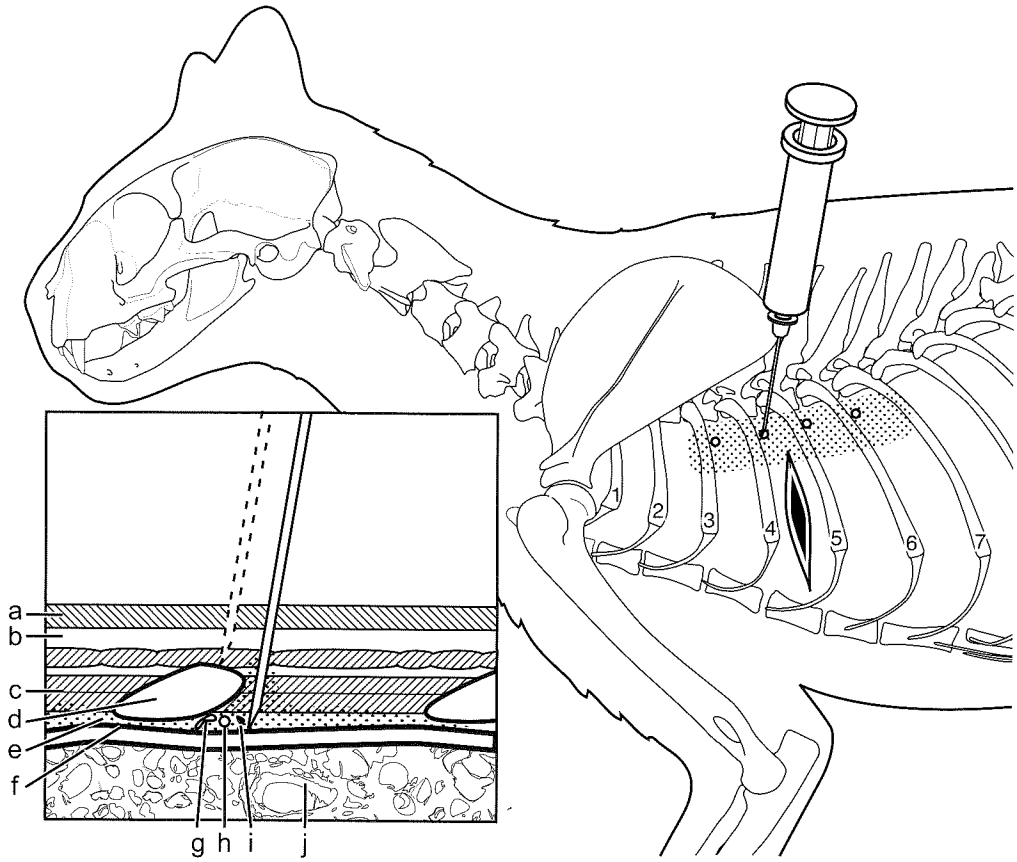

Fig. 21.5. Needle placement for inducing intercostal nerve blocks, showing the lateral aspect and the sagittal section **[inset]**: (a) skin, (b) subcutaneous tissue, (c) intercostal muscles, (d) rib, (e) subcostal space, (f) pleura costalis and fascia, (g) intercostal vein, (h) intercostal artery, (i) intercostal nerve, and (j) lung.

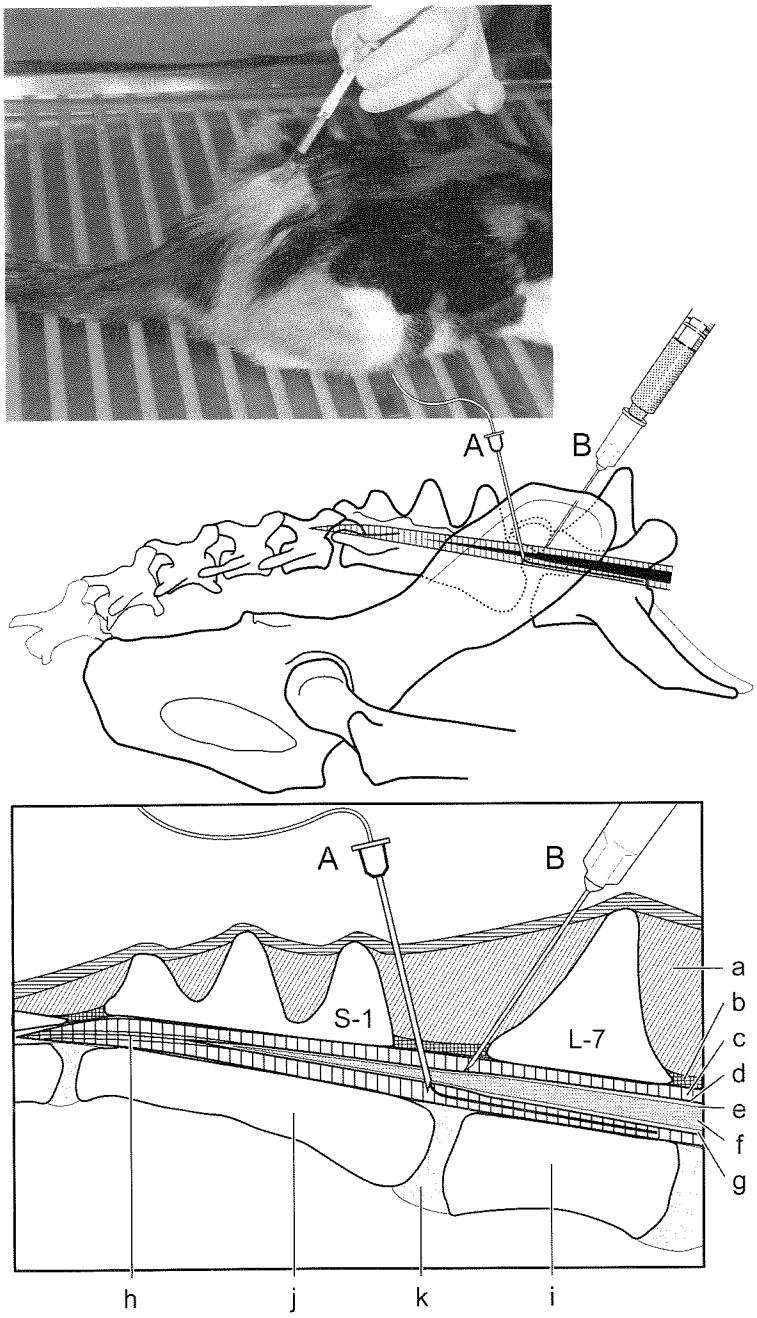

Fig. 21.6. Needle placement into the lumbosacral epidural space of the cat (B) and catheter placement for continuous epidural anesthesia by using a local anesthetic and/or analgesia by using an opioid (A). **Inset:** (a) interspinous ligament, (b) interarcuate ligament (ligamentum flavum), (c) epidural space with fat and connective tissue, (d) dura mater, (e) arachnoid membrane, (f) spinal cord, (g) cerebrospinal fluid, (h) cauda equina, (i) seventh lumbar (L7) vertebra, (j) first sacral (S1) vertebra, and (k) intervertebral disk.

of CSF from the needle hub or aspiration by the syringe,[32] the dose is reduced by 50% to 0.2 mg of morphine (0.4 mL of Astramorph). Administration of 0.05, 1.0, and 2.0 mg of epidural morphine per kilogram of body weight decreased the minimum alveolar isoflurane concentration requirements in cats by 21.4% ± 9.7%, 30.8% ± 9.6%, and 30.2% ± 6.8%, respectively.[33] Increasing the dose of morphine was not found to be significant, probably because of a saturation of opioid receptors with increasing doses of morphine. These cats demonstrated a significant decrease in systolic, mean and diastolic blood pressure, heart and respiratory rates, and arterial pH, whereas the arterial carbon dioxide tension increased with epidural morphine administration.[33] Mild hind-limb ataxia, but no excitement, licking, retching, or vomiting, was observed up to 60 min into recovery. Such side effects can be observed in nonanesthetized cats receiving epidural administration of morphine. Analgesia generally develops first, lasts longer, and is more profound in somatic areas of spinal cord segments, which are presumably exposed to the highest concentration of morphine.[34] The depressant effects of epidural morphine on the hemodynamic and respiratory centers are likely the result of interaction with opioid receptors in the central nervous system (general analgesia) after diffusion to the brain via the blood and CSF.

Analgesia and behavioral effects of epidural oxymorphone (0.025, 0.05, and 0.1 mg/kg mixed in 0.13 mL saline/kg) and saline placebo have been evaluated in four cats.[35] A spinal nee-

dle (22 G × 1.5 inches) was inserted into the epidural space at the lumbosacral junction, and the doses were given randomly to each cat anesthetized with isoflurane at 7-day intervals. Isoflurane was discontinued, and scores for pain, behavior, and sedation were recorded along with indirect blood pressure and respiratory rate at 30 and 60 min and hourly thereafter to 480 min. A noncrushing clamp was briefly placed 5 cm from the tail base to produce nociception at each time interval. No significant changes were observed in blood pressure, respiratory rate, behavior, or sedation of healthy cats. Analgesic effects were present for 52 ± 22 min in nontreated cats but increased to 332 ± 111 min with the highest oxymorphone dose (0.1 mg/kg).

Lumbosacral epidural injection of fentanyl (4 μg/kg) diluted to a total volume of 1 mL with physiological saline reportedly increases the pain threshold of the hind limb for up to 245 min after injection. No visible side effects or behavioral changes were observed, nor was analgesia detected in the forelimbs of these cats.[29] Epidural fentanyl injection was associated with a decrease in heart and respiratory rates and mean arterial blood pressure.[30] Epidural fentanyl also increased arterial PCO_2 and decreased arterial pH from 15 to 120 min after injection.[30] In these same studies, medetomidine (10 μg/kg) in 1 mL of saline significantly increased the pain threshold up to 245 min (hind limb) and 120 min (forelimb), respectively. Epidural medetomidine was associated with mild sedation and emesis in 12 of the 15 cats studied.[29] The hemodynamic profile during isoflurane (2.4%) anesthesia was a biphasic blood pressure response: first a significant increase (5 to 20 min after injection) and then a significant decrease (30 to 120 min after injection). Arterial PCO_2 and blood bicarbonate concentration were significantly increased, while arterial pH was significantly decreased for up to 2 h after epidural medetomidine administration.[30]

The *N*-methyl-D-aspartate (NMDA) receptor antagonistic action of ketamine may be useful in patients with chronic pathological pain states refractory to opioids, anticonvulsants, or antidepressants.[36] However, the safety of neuraxially administered ketamine remains unclear. No inflammatory reactions have been reported in animal studies when preservative-free ketamine has been used. Ketamine with benzethonium chloride preservative administered intrathecally has caused radicular demyelinization in rats.[37] Subpial vacuolar myelopathy[38] and focal lymphocytic vasculitis have been observed adjacent to the catheter tip in humans, but no neurological deficit or other histological changes were evident.[39]

Based on the observations to date, the epidural use of α_2-receptor agonists (xylazine and medetomidine), dissociative anesthetics (ketamine and tiletamine-zolazepam), and anti-inflammatory drugs (ketoprofen) cannot be advocated for routine epidural use in cats.[40]

Conclusion

Local and regional anesthetic techniques can safely be used in heavily sedated or anesthetized cats. The local and regional anesthetic and analgesic techniques described are compatible with systemically administered opioids (e.g., morphine, butorphanol, and fentanyl patch), α_2-receptor agonists (e.g., xylazine and medetomidine), dissociative anesthetics (e.g., ketamine and tiletamine-zolazepam), anti-inflammatory drugs (e.g., ketoprofen), and/or inhalation anesthetic drugs (e.g., halothane, isoflurane, and sevoflurane). These techniques are both practical and effective when applying a multimodal pain-management strategy in cats.

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