Clinical Pain Management Techniques for Cats

Bonnie D. Wright, DVM, DACVA

Although pain management is an emerging and popular topic in veterinary medicine, use of analgesics in cats has received little attention relative to their canine counterparts. Some of the difficulty lies in assessment of whether or not a cat is in pain. Simple observation of a cat in a cage relies upon overt expression of pain, and is often inaccurate. Pain scales have been developed that allow a semiquantitative evaluation of the degree of pain an animal may be experiencing. However, treating pain based upon observation of the painful state is less effective than anticipating and preemptively treating pain. This article reviews specific methods for preemptively treating and alleviating pain in the cat. The traditional approach to pain management involves drug administration. Specific categories of agents used in cats include opioids, nonsteroidal anti-inflammatories, or alpha-2 agonists. Other modalities of pain management, which are also reviewed, include use of local anesthetic drugs for local and regional analgesia, as well as acupuncture.

Pain management in animals is a steadily emerging concept that is gaining strong support among veterinary surgeons and practitioners. As the awareness for pain management increases, so does the evidence-based research being conducted to validate treatment modalities. Nevertheless, a significant portion of veterinary analgesia remains experiential. This is especially true for the feline species. This article will present both the evidence-based information available and the clinical experience of professionals who have spent a tremendous amount of time practicing the art of pain alleviation.

In a variety of studies, cats have received relatively less analgesic coverage than their canine counterparts.[1,2] The authors of these studies suggest several possible reasons for this disparity. There is a dearth of scientific evidence behind the practice of feline analgesia. This lack of scientific support for choosing particular analgesic drugs is further complicated by the challenge of finding a safe drug for cats. Because cats have reduced ability to metabolize drugs via hepatic glucuronidation, plasma drug concentrations are often prolonged. Cats are susceptible to toxicity from many drugs, including the popular analgesic nonsteroidal anti-inflammatory drugs (NSAIDs). Opioids are known to cause dose-dependent excitement or dysphoria in cats, which although avoidable with low doses, causes a great deal of concern for many practitioners.[1-3] Last, feline social structure does not facilitate the behavioral expression of pain. In the wild, a painful or injured animal will commonly be attacked by the other animals.[4] Therefore, a cat's expression of pain is often subtle to nonexistent. Unless specific attention is given to assessing a cat's analgesic state, pain is easily overlooked.

Untreated pain generates physiological damage (Table 1). Subjecting animals recovering from disease or surgical intervention to these increased metabolic demands may further compromise their medical condition. Therefore, a modality to anticipate and treat pain is imperative to the most general practice of veterinary medicine.

Assessment of Pain

Diagnosis of pain can be either presumptive or observational. Cats tend to hide when they are sick or in pain and it is unusual for a cat to vocalize when in pain.[5-7] A painful cat may be hunched, less responsive to external stimulus, and may guard the painful area.[5,6] Simple observation of an animal in a cage, however, relies upon overt expression of pain and is often inaccurate. In an attempt to improve pain diagnosis, work has been done to evaluate pain scales for use in domestic animals.[5-8] Pain scales allow a semiquantitative evaluation of the degree of pain an individual may be experiencing, and usually take into account both physiologic signs—such as increased heart rate and respiratory rate—as well as the animal's response to stimulus and manipulation.[8] Although pain scales improve the sensitivity of pain diagnosis, nonverbal animals require an observer for pain rating, and stoically painful animals may still be missed.

Postoperative pain can be very difficult to diagnose because of the blurring of physiologic signs of pain with other physiologic changes. Studies show that heart rate and respiratory rate may not be different between operated-on and unoperated-on cats after anesthesia.[7,8] This is expected because many other physiologic changes can alter heart rate and respiratory rate, as can many pharmacologic manipulations, making these very nonspecific, inaccurate indices of pain. For instance, both stress from the hospital experience and pain tend to cause hyperventilation. Simultaneously, pain and splinting after thoracic surgery may greatly reduce ventilation, as does bronchoconstriction generated by the increased sympathetic tone of the stress response. Ultimately, the most accurate diagnostic indicator of pain may be responses to therapy, such as a more interactive patient or a patient that becomes able to sleep comfortably. Although pain scales may be the most effective way for an observer to diagnose pain in a cat, by the time this assessment has been made, the animal is already in pain.[5-8] Treating pain before initiation of the painful stimulus prevents central sensitization to pain, and is the cornerstone of modern pain medicine.[5-9] For these reasons, having a template for presumptive diagnosis of pain before initiation is important.

From the Department of Clinical Sciences, College of Veterinary Medicine and Biomedical Sciences, Colorado State University, Fort Collins, Colorado.

Address reprint requests to Bonnie D. Wright, DVM, Diplomate ACV, Department of Clinical Sciences, College of Veterinary Medicine and Biomedical Sciences, Colorado State University, Fort Collins, CO 80523.

1096-2867/02/1704-0008$35.00/0
doi:10.1053/svms.2002.36609

TABLE 1. Sequelae of Untreated Pain[31]*

Spinal Reflexes	Endocrine Responses	Metabolic Responses	Brainstem Responses	Cortical Responses
↑↑Sympathetic tone	↑↑Corticotropin, cortisol	Catabolic state	Increased respiration	Anxiety
Vasoconstriction, bronchoconstriction	↑↑Glucagon	Hyperglycemia	↑↑Sympathetic tone	Fear
↑↑Peripheral resistance	↑↑ADH	↑↑Protein catabolism		↑↑Sympathetic tone
↑↑Heart rate and stroke volume	↑↑Growth hormone	↑↑Lipolysis		↑↑Blood viscosity
↑↑Myocardial workload	↑↑cAMP, interleukin-1	↑↑Renal Na^+ retention		↑↑Clotting time
↑↑Oxygen consumption	↑↑Renin	↑↑Water retention		Fibrinolysis
↑↑Skeletal muscle tone	↑↑Catecholamines	↓↓Potassium		Platelet aggregation
↓↓Gastrointestinal motility and tone	↑↑Angiotensin/aldosterone	Delayed healing		
↓↓Urinary tone	↓↓Insulin	↓↓GFR		

*Pain exerts physiologic effects independent of the underlying disease process that delay healing and increase metabolic demands. This is an incomplete list of the results of pain upon the physiologic state.

For presumptive diagnosis of a painful state, analogies with other species may be helpful. Nociceptive physiology is well preserved between species, justifying this extrapolation.[10] If a procedure elicits a predictable amount of pain in people, dogs, or other species studied, it likely does the same in cats. Presumptive diagnosis promotes analgesic administration before the painful stimulus, maximizing the preemptive facilitation of analgesia. Treating pain based upon observation of the painful state is therefore less effective than anticipating and preemptively treating pain.

Anticipated levels of pain for illness and injury have been formulated (Table 2). These are presumptive only, and may be affected by severity, additional inflammation or infection, individual pain threshold, surgical technique, and concomitant sources of pain (e.g., osteoarthritis). Young animals tend to be less pain-tolerant and more demonstrative of pain, whereas geriatric animals will often hide their pain.[10] Treatment standards established for the presumptive level of pain for a given procedure facilitate a multimodal approach to analgesia. If appropriate analgesics for the anticipated level of pain are insufficient for an individual, further analgesic therapy can be initiated. It is important to note that even relatively noninvasive procedures are likely to cause some degree of pain, and many preexisting diseases are extremely painful. These sources of pain need to be considered in addition to the analgesic techniques established for surgical patients.

Summary

- Untreated pain is detrimental
- Cats exhibit pain through subtle signs that may vary between individuals
- The degree of pain elicited by a procedure can be estimated, but may vary by individual
- Breed, age, and temperament affect pain demonstration
- Preemptive treatment of pain before noxious stimulus is more effective than reactive treatment
- Response to treatment is the most effective diagnostic technique
- Trauma, surgery, and many diagnostic interventions and illnesses require analgesics

Analgesic Drugs for Use in Cats

Opioids

Opioids are drugs that bind to a class of receptors in the central nervous system, and may bind to sites in peripheral nervous

TABLE 2. Average Presumptive, Relative Pain Based on Disease or Surgical Technique

Excruciating	Severe	Moderate	Mild
Disk herniation	Osteoarthritis	Simple laparotomy	Castration
Neuritis, meningitis	Intra-articular orthopedic surgery	Hernia repair	Lump removal (small)
Extensive inflammation anywhere	Fracture repair or amputation	Simple, extra-articular orthopedic procedures	Laryngeal inflammation (intubation)
Postsurgical pain with extensive inflammation	Thrombosis or ischemia (saddle thrombus)	Mass removals (unless extensive)	Esophagitis (endoscopy)
Multiple fracture and soft-tissue injury	Peritonitis (especially bile; also urine and septic)	Complicated ovariohysterectomy (old or obese)	Myositis (mild) (uncomfortable positioning)
Necrotizing pancreatitis	Organomegaly (capsular pain)	Declaw (onychectomy)	Multiple needle punctures
Necrotizing cholecystitis	Moderate distention of hollow viscous	Most lacerations	Early or resolving conditions
Severe bowel distention	Torsions (gastrointestinal, uterine, testicular)	Cystitis	
Pathologic fractures	Urethral obstruction	Otitis	
Osteosarcoma (especially postbiopsy	Ophthalmologic conditions (ulcer, glaucoma, uveitis)	Chest drains	
Implants impinging on neural tissue	Laparotomy (involved), thoracotomy	Dental extractions	
Total ear canal ablation	Parturition Trauma Cancer pain	Resolving conditions	

*Pain tolerance varies by individual, and degree of pain may be increased by surgical technique or inflammation, but this relative pain scale provides a baseline for preemptive analgesic administration.

TABLE 3. Opioid Drugs for Use in Cats[9,11,12-15,32,33]

Opioid/type	Dose mg/kg	Duration	Comments
Morphine μ agonist	0.05-0.2 IV (slowly) 0.1-0.5 IM, SQ 0.5-1.5 oral 0.1 epidural	2-4 hr 3-4 hr 6-8 hr 12-18 hr	Systemic administration: sedation, bradycardia, profound analgesia, respiratory depression, vomiting, dysphoria at high doses, histamine release with rapid IV infusion Epidural: urinary retention
Methadone μ agonist	0.05-0.2 IV 0.1-0.5 IM, SQ	2-4 hr 3-6 hr	Similar to morphine, no histamine release; less sedation, vomiting, and dysphoria
Hydromorphone μ agonist	0.05-0.1 IV 0.1-0.4 IM, SQ IV CRI rate: 0.0125-0.025 mg/kg/hr	2-3 hr 2-4 hr	Similar to morphine, no histamine release, less vomiting Clinical impression: smoother, more predictable μ agonist in cats than other drugs
Oxymorphone μ agonist	0.03-0.08 IV 0.05-0.2 IM, SQ	1-3 hr 2-4 hr	Similar to morphine, no histamine release, increased panting
Meperidine μ agonist	3-5 IM, SQ (not IV)	0.5-2 hr	Similar to morphine; profound histamine release—no IV use! Short duration of action
Fentanyl μ agonist	0.002-0.01 IV 0.05-0.1 IM, SQ IV CRI: Loading: 0.002-0.005 then 0.002-0.005 mg/kg/hr	15-20 min 15-30 min	Profound analgesia, **very** short duration; bradycardia and hypoventilation Recommend use as an IV infusion with monitoring; titrate to avoid dysphoria
Fentanyl patch μ agonist	0.025-0.05 mg/hr transdermal	3-6 days	Onset 0-12 hr, duration variable; variable efficacy, may require additional parenteral analgesics—use only μ agonists to avoid reversal
Codeine μ agonist	0.1-1 PO only	4-8 hr	**Do not use** in combination with acetaminophen
Butorphanol κ agonist μ antagonist	0.05-0.1 IV 0.2-0.8 SQ, IM To treat mild pain or partially reverse pure μ	1-1.5 hr 1-2 hr	Antagonist properties may reverse agonist properties at higher doses, causing a ceiling effect of analgesia; fewer side effects than μ agonist drugs, may be used to reverse μ agonist effects yet retain analgesia
Nalbuphine μ partial agonist/ antagonist	0.03-0.1 IV, IM, SQ For mild pain		Similar to butorphanol, more pronounced antagonist; minimal sedation; good for μ reversal
Buprenorphine Partial μ agonist	0.005-0.01 IV 0.01-0.02 IM, SQ Sublingual	6-8 hr	Slow onset—1 hour; long duration, difficult to reverse; Excellent IM and sublingual bioavailability; mild pain (ceiling effect)
Naloxone μ, κ, δ antagonist	0.001-0.025 IV, IM, SQ	1-2 hr	Reverse opioid overdose or side effects; no analgesia, if animal is in pain, use partial antagonist or microdoses titrated to effect

Abbreviations: IV, intravenous; IM, intramuscular; SQ, subcutaneous; CRI, constant rate infusion; PO, by mouth.

system and the joint capsules in some species. Drugs that competitively bind to opioid receptors can do one of three things: completely activate the receptor (agonists), causing full expression of receptor function; partially bind to the receptor, causing partial expression of the receptors function (or partially blocking the receptor if it is already functional); or fully antagonize the receptor, completely eliminating the function of the receptor during the duration of action of the drug. Agonists and partial agonists are useful to produce varying degrees of analgesia. Opioids do not modulate nerve conduction, but inhibit release of excitatory neurotransmitters at the level of the brain and spinal cord. Consequently, opioids reduce the pain from a stimulus, but do not obliterate the stimulus or interfere with motor function. Common opioid side effects are bradycardia, sedation, urinary retention, respiratory depression, gastrointestinal (GI) stasis, vomiting and nausea (less common postoperatively or in painful patients), and occasional dysphoria or excitement. Opioids have minimal effects on cardiac function (aside from the effects of histamine release with morphine and meperidine), and are considered safe in compromised patients and animals with heart conditions.[11]

There are three currently recognized opioid receptors, μ, δ, and κ. All three receptors mediate analgesia although the quality of analgesia varies, as does the severity of side effects. In general, μ and κ receptors are the primary target in veterinary practice with the drugs currently available. μ receptor agonists provide more profound analgesia in many species, although this is controversial in cats. μ agonists are generally accompanied by more pronounced side effects than κ agonists (Table 3).

In studies examining the analgesic usage in veterinary medicine, a reluctance of practitioners to use potent opioids in cats is apparent. Concern about drug side effects, as well as the need for record keeping for use of these controlled substances are cited as reasons for this disparity.[1,2] Although an occasional cat may become dysphoric on opioids, it is uncommon at efficacious doses, and not limited to cats.[3] Dysphoria can often be avoided by staying within the recommended dose range (cats have a lower dose range than dogs), and can also be greatly reduced by concurrent use of a tranquilizer.[3,5-9] When an individual exhibits dysphoria, adjunctive analgesic techniques such as α-2 agonists can ameliorate the excitement while providing necessary analgesia. Respiratory depression from opioids is a significant problem in human medicine, but far less pronounced in domestic animals at clinical doses.[11] Finally, the legal records required for opioid use are no longer restricted to opioids, and include many other commonly used anesthetic drugs.

Emerging concepts in feline analgesia with opioids include the use of transmucosal buprenorphine, which has been shown to have remarkably predictable, rapid, and effective uptake when sprayed onto the mucous membranes, facilitating home administration.[12] Current clinical impression is that hydromor-

TABLE 4. Nonsteroidal Anti-Inflammatory Drugs for Use in Healthy Cats[24-26,34-36]

Drug	Dose	Frequency	
Ketoprofen COX1, COX2	2 mg/kg SQ then 0.5-1 mg/kg PO, SQ	One dose 3-5 days only	Increases bleeding time, use postoperatively only
Carprofen COX 2>>>COX 1	4 mg/kg SQ	One dose (off label—repeat once after 24 hours)	Chronic pain: 1-2 mg/kg PO daily for 4 days, then every 2-3 days as needed
Meloxicam COX 2>>>COX 1	0.1-0.2 mg/kg SQ, PO (oral suspension)	One dose 3-4 days	Validated for chronic pain: 0.025 mg/kg PO every 2-3 days (not to exceed 0.1 mg/cat)[19]
Flunixin meglumine COX 1, COX 2	0.25 mg/kg SQ	Once	Less safe than newer NSAIDs
Aspirin COX1, COX2	Chronic pain only 10-20 mg/kg PO	Every 2-3 days	Antithrombotic, antiplatelet effects

Abbreviations: SQ, subcutaneously; PO, by mouth.

phone appears to be more effective than other opioids for long-term analgesia, especially when administered as a constant rate infusion. Fentanyl patches have contributed to longer duration of analgesia, but must be monitored closely because of extreme variability in individual uptake and efficacy in cats.[13-15]

Additional applications for opioids include local and regional techniques. Opioid receptors have been isolated on nociceptive nerve terminals in inflamed synovial tissue, although work has not been done to verify their presence in cats.[16] Intra-articular administration of opioids may be beneficial, especially when combined with a local anesthetic. A dose of 0.1 mg/kg morphine diluted to the appropriate volume for the joint being explored with saline or local anesthetics is recommended.[17] Additionally, epidural or intrathecal administration of opioids has been described as excellent anesthesia adjuncts.[18] The technique for epidurals has been well described in a number of texts.[17-21] With the addition of local anesthetics there is further potentiation of analgesia with a loss or reduction of motor function. Low-dose local anesthetics preferentially block sensory fibers in the spinal cord and may have minimal effect on motor function.[18,19] α-2 agonists administered added to epidural morphine dramatically augment analgesia via synergistic action of α-2 and opioid receptors in the spine. For long-term pain relief, placement of an epidural catheter can facilitate repeat injections or constant epidural infusion of analgesic drugs.[18,19,22]

Summary

- Opioids are efficacious analgesics in cats
- Opioids rarely cause excitement at clinical doses in cats
- Systemic and regional use of opioids are possible
- Opioids and opioid combinations are ideal for epidural administration

NSAIDs

NSAIDs provide analgesia peripherally by reducing inflammation, decreasing release of substances involved in pain recognition and, in some cases (carprofen), centrally by reducing pain perception and reducing central hypersensitivity.[23] NSAIDs provide a cornerstone of pain management in people and act synergistically with opioids. However, dogs and cats are far more susceptible to toxicity from these drugs, so they must be used with caution.[24] NSAIDs function through inhibition of cyclo-oxygenase (COX), reducing the production of prostaglandins. Two forms of COX have been isolated, COX-1 and COX-2. COX-1 is associated with normal metabolic function (constitutive), balancing blood flow to organs such as the GI tract, kidney, and liver. COX-2 appears to be produced in response to tissue injury (inducible). For safety and analgesic efficacy, drugs that preferentially block the COX-2 receptor are preferred. These drugs include meloxicam, carprofen and etodolac (Table 4).

Because of a cat's susceptibility to NSAID toxicity and aggravated by the lack of glucuronide metabolism in this species, NSAID use must be practiced with caution. Despite some reports of side effects, carprofen has been safely administered to cats after surgery, and appears equally efficacious with other NSAIDs.[25,26] Absolute contraindications to the use of NSAIDs include renal or hepatic insufficiency, dehydration, hypotension, heart failure, coagulopathies, concurrent use of other NSAIDs or corticosteroids, or signs of GI ulceration. Geriatric animals should be fully evaluated before and during use. NSAIDs can contribute to bleeding and, although this risk is greatly reduced with COX-2 drugs, many surgeons prefer to administer these drugs postoperatively. Preemptive analgesia is recommended, so opioid administration preoperatively and immediately postoperatively to provide analgesia during the NSAID onset is recommended.[24]

Summary

- Cats are highly susceptible to toxicity from use of NSAIDS
- Unlike opioids there are absolute contraindications to the use of NSAIDs
- Used with caution NSAIDS are extremely effective analgesics
- NSAIDs are safest given postoperatively, so adjunct use with opioids for preemptive analgesia is recommended

α-two Agonists

α-2 receptors are located peripherally in both presynaptic and postsynaptic sympathetic terminals as well as centrally in the brain and spinal cord near opioid receptors. Activation of central α-2 receptors decreases excitatory activity, which provides profound sedation and analgesia. Undesirable central effects include decreased heart rate and contractility. Activation of peripheral receptors causes the undesirable effects of vasoconstriction, bradycardia, arrhythmias, and decreased stroke volume. α-2 agonists have synergistic effects with opioids and other anesthetic drugs, and do not lead to dysphoria or excitement. Xylazine (.05-0.1 mg/kg intravenously [IV] and .1-.2 mg/kg intramuscularly [IM] or subcutaneously [SQ]) and medetomidine (.001-.01 mg/kg IV and 0.005-0.2 mg/kg IM or SQ) are the most common drugs of this class used in cats. Profound

TABLE 5. Local Anesthetic Dosages for Cats[19-21]*

Drug	Dose/Route	Duration	Comments
Lidocaine	2-4 mg/kg perineural	1-2 hr	Rapid onset: 10-15 min.
	0.1-0.5 mg/kg epidural with opioid	1-3 hr	Low dose may offer a "differential block," retaining motor function while augmenting analgesia
Bupivacaine	1-2 mg/kg perineural	2-4 hr	Slow onset: 20-30 min. For rapid effect, cut dose in half and mix with lidocaine half-dose.
	0.1-0.5 mg/kg Epidural with opioid	2-6 hr	Cardiotoxicity may result from overdose
Mepivacaine	2 mg/kg perineural	2-3 hr	Less risk of local toxicity than bupivacaine, intermediate duration

*Total dosages may be diluted in saline to provide a lower concentration and adequate volume for all sites being blocked.

cardiovascular depression and arrhythmias accompany use of these drugs, so careful patient selection is important. Individuals in which opioid therapy is not possible because of tolerance or dysphoria and animals experiencing a rough recovery can be greatly improved with surprisingly small doses of α-2 agonists.[27] Atipamezole and yohimbine are available for reversal, but also must be used with caution in compromised patients as the reversal drugs also exert cardiovascular changes such as increased peripheral resistance and arrhythmias. Analgesia will be reversed as well as the undesirable effects of these drugs, so adequate analgesia should be established by some other method before reversal.

Adjuncts to Analgesia Therapy

Other sedatives and tranquilizers can augment analgesia via reduction of anxiety. Although having no analgesic efficacy alone, benzodiazepines and phenothiazines can affect the anxiety-dependent component of pain and reduce opioid-induced excitement. Care should be taken, however, not to use tranquilizers in place of appropriate analgesic therapy in painful animals.

Ketamine has been shown to be an effective drug for inhibiting the facilitation of pain that occurs after a painful stimulus (wind-up). For extremely painful conditions, a constant rate infusion of ketamine in addition to opioids can dramatically improve analgesia, especially when initiated before the painful stimulus.[28,29] A loading dose of 0.5 mg/kg followed by an infusion of .01 mg/kg/min during surgery augments analgesia and reduces requirements for inhalant anesthetics.[28,29] The infusion rate is decreased to .002 mg/kg/min during recovery for 24 to 48 hours. This therapy is best combined with opioids, either via constant rate infusion of the opioid or with intermittent boluses. At these doses, behavioral changes are not usually observed, and people undergoing this therapy do not report changes in consciousness or hallucinations.

Tricyclic antidepressants can be used at low doses to treat chronic pain conditions, although this is not validated in animals, and may be primarily a result of the antidepressive effects of these drugs.[19] Amitriptyline 0.5-1.0 mg/kg by mouth (PO) daily may given with primary analgesics, such as opioids or NSAIDs, or with imipramine 0.5-1 mg/kg PO twice per day to improve analgesia.[27]

Acupuncture has been successfully employed to treat acute and chronic pain conditions with minimal systemic side effects.[30] There is growing popularity for nonpharmacologic treatments of pain such as acupuncture, and many clients are searching for such options.

Local Anesthetic Drugs and Techniques

Local anesthetic drugs work by blocking nerve transmission via sodium channel blockade. These drugs, therefore, do not just decrease pain transmission as do all previously mentioned drugs, but completely obliterate the pain stimulus before it reaches the spinal column. This can be an extremely helpful facet of multimodal analgesic therapy because pain sensitization can be blocked before it ever begins. Traditionally, veterinarians have considered local techniques as a substitute for general anesthesia, and the concept of using local techniques in addition to general anesthesia for surgical procedures is a reemerging concept that provides low-cost multimodal analgesia.

As with many other drugs, local anesthetic drugs seem to

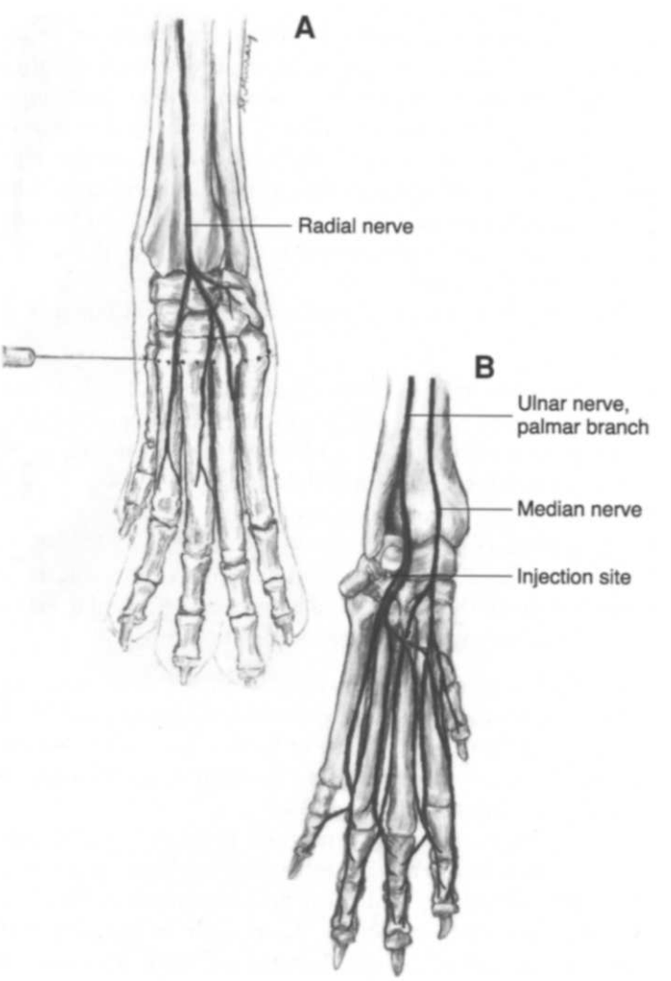

Fig 1. Local block for feline declaw using lidocaine, mepivacaine, or bupivacaine. Reprinted with permission.[21]

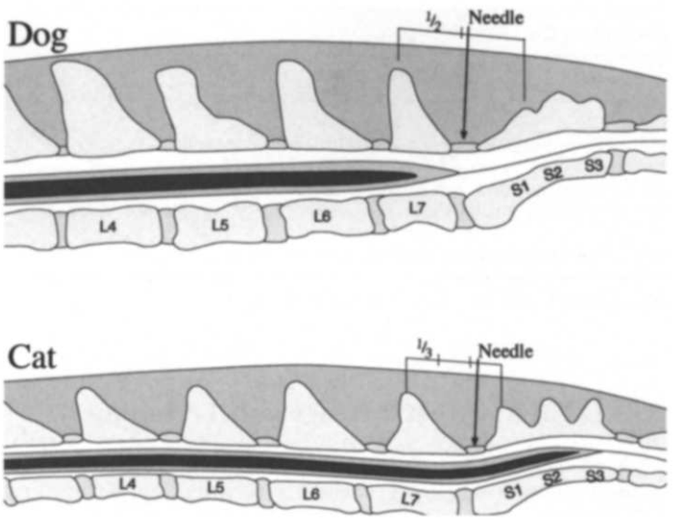

Fig 2. Epidural technique in cats involves placement of a 22 gauge 1½-inch spinal needle in the epidural space and administration of 0.1 mg/kg morphine alone or in combination with local anesthetics or α-two agonists. Reprinted with permission.[19]

have more pronounced toxicity in cats than other species. Careful attention to local anesthetic doses in cats is important to avoid toxicity because of their small size and reduced metabolic capability. Within appropriate dose ranges, local anesthetics are quite safe (Table 5).[19,20] Seizures can occur at excessive doses, and eventually cardiotoxicity may occur, especially with bupivacaine, which occasionally shows cardiotoxicity before seizures. Local damage to nerves can occur with local anesthetics, but is uncommon with isolated administration. Addition of epinephrine to local anesthetics will extend the duration of action, but it also increases the likelihood of local tissue damage. Epinephrine should only be added to locals in areas with adequate collateral circulation; it is contraindicated if the area being blocked is a distal extremity because it may cause necrosis from hypoperfusion.

Common sites for local anesthetic administration in cats include:

- Incisional blocks before skin closure: Dilute calculated dose of drug to the volume needed to block the area. The drug should be injected 1 to 2 cm beyond the suture line on all sides so as not to interfere with healing
- Declaw blocks for onychectomy (Fig 1)
- Dental blocks for extractions/repairs
- Epidurals for abdominal or hind limb procedures (Fig 2)
- Brachial plexus block for forelimb procedures distal to elbow
- Intercostal or intrapleural blocks for thoracotomy

Regional techniques are described in greater detail in several texts.[19-22] Use caution when performing more than one block that the overall maximum dose of local anesthetics is not exceeded. Dilute the maximum dose in saline or sterile water as needed to distribute between all sites.

In conclusion, providing analgesia through a multimodal approach including adequate preemptive coverage, postoperative supplementation, and local and regional techniques is medically beneficial. Although cats provide heightened challenges to providing adequate analgesia, with a variety of drugs and techniques a pain-free patient can be achieved. Increasing awareness and scientific research is widening the options for treating pain in cats. Patient, client, and practitioner will all be rewarded by the exploration and advancements in this area.

Acknowledgment

The author would like to thank Dr. Khursheed Mama for her assistance with this manuscript.

References

1. Lascelles BDX, Capner CA, Waterman-Pearson AE: Current British veterinary attitudes to perioperative analgesia for cats and small mammals. Vet Rec 145:601-604, 1999
2. Hansen B, Hardie W: Prescription and use of analgesics in dogs and cats in a veterinary teaching hospital: 258 cases (1983-1989). J Am Vet Med Assoc 202:1485-1494, 1993
3. Fertziger AP, Stein EA, Lunch JJ: Suppression of morphine-induced mania in cats. Psychopharmacology 36:185-187, 1973
4. Sedgewick Charles: Inhalant anesthesia for captured wild mammals, birds and reptiles, in Fowler ME (ed): Zoo and Wild Animal Medicine (ed 2). Philadelphia, PA, W.B. Saunders, 1986.
5. Johnson JM: The veterinarian's responsibility: assessing and managing acute pain in dogs and cats. Part I. Comp Cont Ed Pract Vet 13:804-807, 1991
6. Sanford J, Ewbank R, Molony V, et al: Guidelines for the recognition and assessment of pain in animals. Vet Rec 118:334-338, 1986
7. Cambridge AJ, Tobias KM, Newberry RC, et al: Subjective and objective measurements of postoperative pain in cats. J Am Vet Med Assoc 217:685-689, 2000
8. Smith JD, Jallen SW, Quandt JE, et al: Indicators of postoperative pain in cats and correlation with clinical criteria. Am J Vet Res 57:1674-1678, 1996
9. Lascelles BDX, Cripps PJ, Jones A, et al: Post-operative central hypersensitivity and pain: the pre-emptive value of pethidine for ovariohysterectomy. Pain 73:461-471, 1997
10. Short CE, Van Poznak A (eds): Animal Pain. New York, Churchill Livingstone, 1992.
11. Pascoe PJ: Opioid analgesics. Vet Clin North Am (Sm Anim Pract) 30:757-772, 2000
12. Robertsons SA, Taylor PM, Bloomfield M, et al: Buprenorphine disposition after buccal administration in cats: preliminary observations. Vet Anaesth Analg 28:206-207, 2001
13. Glerum LE, Egger CM, Allen SW, et al: Analgesic effect of the transdermal fentanyl patch during and after feline ovariohysterectomy. Vet Surg 30:351-358, 2001
14. Scherk-Nixon M: A study of the use of a transdermal fentanyl patch in cats. J Am Anim Hosp Assoc 32:19-24, 1996
15. Lee DD, Papich MG, Hardie EM: Comparison of pharmacokinetics of fentanyl after intravenous and transdermal administration in cats. Am J Vet Res 61:672-677, 2000
16. Stein C: Peripheral mechanisms of opioid analgesia. Anesth Analg 76:182-187, 1993
17. Harvey RC, Paddleford RR, Popilskis SJ, et al: Anesthesia and analgesia in dogs, cats, and ferrets, in Kohn DF, Wixson SK, White WJ, et al (eds): Anesthesia and Analgesia in Laboratory Animals. San Diego, Academic Press, 1997, pp 257-279
18. Jones RS: Epidural analgesia in the dog and cat. Vet J 161: 123-131, 2001
19. Flecknell P, Waterman-Pearson A (eds): Pain Management in Animals. New York, Saunders, 2000
20. Thurmon JC, Tranquilli WJ, Benson GJ (eds) Lumb and Jones' Veterinary Anesthesia. Baltimore, Williams & Wilkins, 1996
21. Gaynor JG, Mama K: Local and regional anesthetic techniques for alleviation of peri-operative pain. In Gaynor JG, Muir WW (eds): Handbook of veterinary pain management. St. Louis, Mosby, 2002
22. Hall LW, Taylor PM. Anaesthesia of the Cat. London, Bailliere Tindall, 1994
23. Livingston A: Mechanism of action of nonsteroidal anti-inflammatory drugs. Vet Clin North Am (Sm Anim Pract) 30:773-781, 2000

24. Mathews KA: Nonsteroidal anti-inflammatory analgesics, indications and contraindications for pain management in dogs and cats. Vet Clin North Am (Sm Anim Pract) 30:783-804, 2000
25. Slingsby LS, Waterman-Pearson EA: Comparison between meloxicam and carprofen for postoperative analgesia after feline ovariohysterectomy. J Small Anim Pract 7:286-289, 2002
26. Taylor PM, Delatour P, Landoni FM, et al: Pharmacodynamics and enantioselective pharmacokinetics of carprofen in the cat. Res Vet Sci 60(2):144-151, 1996
27. Lamont LA, Tranquilli WJ, Mathews KA: Adjunctive analgesic therapy. Vet Clin North Am (Sm Anim Pract) 30:805-813, 2000
28. Ilkiw JE, Pascoe PJ, Craig CA, et al: The effect of ketamine infusions on the minimum alveolar concentration of isoflurane in cats. Vet Anaesth Analg 28:210-211, 2001
29. Wagner AE, Walton JA, Hellyer PW, et al: Use of low doses of ketamine administered by constant rate infusion as an adjunct for postoperative analgesia in dogs. J Am Vet Med Assoc 221:72-75, 2002
30. Gaynor JG: Acupuncture for management of pain. Vet Clin North Am (Sm Anim Pract) 30:875-884, 2000
31. Lamont LA, Tranquilli WJ, Grimm KA: Physiology of pain. Vet Clin North Am (Sm Anim Pract) 30:703-728, 2000
32. Balmer TV, Irvine D, Jones RS, et al: Comparison of carprofen and pethidine as postoperative analgesics in the cat. J Sm Anim Pract 39:158-164, 1998
33. Slingsby LS, Waterman-Pearson AE: Comparison of pethidine, buprenorphine and ketoprofen for postoperative analgesia after ovariohysterectomy in the cat. Vet Rec 143:185-189, 1998
34. Lascelles BD, Cripps P, Mirchandani S, et al: Carprofen as an analgesic for postoperative pain in cats: dose titration and assessment of efficacy in comparison to pethidine hydrochloride. J Small Anim Pract 35:535-541, 1995
35. Parton K, Balmer TV, Boyle J, et al: The pharmacokinetics and effects of intravenously administered carprofen and salicylate on gastrointestinal mucosa and selected biochemical measurements in healthy cats. J Vet Pharmacol Ther 23:73-79, 2000
36. Taylor PM, Delatour P, Landoni FM, et al: Pharmacodynamics and enantioselective pharmacokinetics of carprofen in the cat. Res Vet Sci 60:144-151, 1996