LocoRegional Anesthesia: Principals and Applications 1 of 2

Mark E. Epstein, DVM, Dipl. ABVP C/F, CVPP
TotalBond Veterinary Hospitals
Gastonia, Charlotte NC
International Veterinary Academy of Pain Management

Local anesthetics were once a mainstay of pain management in veterinary medicine, and may now be one of the most under-utilized modalities. Administered locally or regionally, they are the only modality that renders complete anesthesia to a site, i.e. no transmission of nociceptive impulses as long as the drug exerts its effect. Initially used as a means of desensitizing tissues in order to "invade" tissues with scalpels; local anesthetics are enjoying a rebirth as powerful tools to prevent or reduce perioperative pain (as well as procedural and even chronic pain). There is no longer a reason to hold an "either-or" position; "for surgery either I use local anesthetics *or* I use general anesthesia", in fact, there are many reasons to combine general and local anesthetic for surgical pain relief.[1] Secondly

Local anesthetic drugs are extremely effective, inexpensive and easy to use. When local anesthetic drugs are administered, pain impulses originating in the periphery are blocked and prevented from reaching the central nervous system. This blockade has several positive consequences:

- The sensation of pain is alleviated or even eliminated for the duration of the block. Local anesthetic drugs work by blocking sodium channels in nerve membranes. Decreased permeability to sodium slows the rate of depolarization so that the threshold potential is not achieved and an action potential is not propagated, thus the pain impulse is not propagated. Local anesthetics bind more readily to 'open' channels, thus rapidly firing nerves are more susceptible to blockade.
- The likelihood that 'wind-up' or hypersensitization will occur is greatly decreased because the portion of the pain pathway called 'transmission' is blocked. Transmission involves the conductance of pain impulses from the peripheral nociceptors to the dorsal horn neurons in the spinal cord. The neurons in the dorsal horn are responsible for central sensitization. By blocking input to these neurons, central sensitization (or 'wind up') is less likely to occur.
- The analgesia allows the patient to be maintained under a lighter plane of anesthesia and this makes the anesthetic episode safer for the patient. In fact, local anesthetic drugs decrease the minimum alveolar concentration (MAC) of all anesthetic gases.

- Local anesthesia to a surgical site permits comfortable awakening from anesthesia, creating a sparing effect of other analgesic medications (thus decreasing the likelihood of their adverse drug effects
- Local anesthetics have been associated with fewer exaggerated, sustained (i.e. maladaptive, neuropathic) pain states.
- Lastly, local anesthetics are recognized to have many beneficial effects beyond blocking nerve conduction; broad anti-inflammatory effects (reduced production of eicosanoids, thromboxane, leukotriene, histamine, and inflammatory cytokines; and scavenging of oxygen free radicals) and even antimicrobial, antifungal and antiviral affects.[2].[3]

Furthermore, local anesthetic blocks are extremely cost effective and can increase profits to the clinic.

Commonly used local anesthetic drugs in veterinary medicine include

- Lidocaine
  - Onset of action: rapid (less than 5 minutes)
  - Duration of action: 60-120 minutes
  - Dose 2-6 mg/kg (use the lower end of the dose in cats)
  - Convulsive dose in dogs: 11-20 mg/kg
  - Lethal dose in dogs: 16-28 mg/kg
  - 'Toxic dose' in cats reported as 6-10 mg/kg
  - The general recommendation for clinical use is ≤ 6 mg/kg in the dog and ≤ 3-4 mg/kg in the cat.
- Bupivacaine
  - Onset of action: approximately 5-10 minutes after injection (up to 20 minutes)
  - Duration of action: 4 to 6 hours
  - Dose 1-2 –(4) mg/kg (use the lower end of the dose in cats)
  - Toxic dose in dogs: 5-11 mg/kg or potentially any amount given IV
  - Data is mostly anecdotal in the cat but the general feeling is that 3 mg/kg is the toxic dose.
  - The general recommendation for clinical use is ≤ 2 mg/kg in the dog and ≤ 1 mg/kg in the cat.

Adverse events caused by local anesthetic drugs: extremely rare but can include any of the following:

- Local tissue effects – swelling, bleeding, inflammation, 'tingling'? (unknown if this occurs in animals). A commonly held misconception is that local anesthetics impair wound healing – although they can powerfully inhibit the inflammatory component of cellular tissue influx, there is no evidence to support impaired wound healing. Both bupivacaine and ropivacaine have been implicated in myotoxicity, although it appears that this has not been listed as a complication in most human studies where these drugs were infused for 24 – 36 hours postoperatively into a wound bed. With proper technique and avoidance of needle induced trauma, local anesthetics can be used without the fear of negative effects on healing.
- Anaphylaxis – rare, more common with esters (but still rare)
- Central nervous system – muscle tremors, seizure, coma
    - At lower concentrations, depression of inhibitory neurons occurs and can cause cerebral excitation, which may lead to seizures. At higher concentrations, profound CNS depression with subsequent coma, respiratory arrest and death can occur. The latter is more likely following IV boluses of large doses.
- Cardiovascular system – the myocardial conduction system is sensitive to local anesthetics and IV boluses can result in cardiovascular collapse. ONLY LIDOCAINE CAN BE ADMINISTERED IV (and never with epinephrine).
- Methemoglobinemia – rare, but can occur in cats.
- Motor and autonomic nerves are also blocked by local anesthetics, and so motor weakness and vasodilation may occur with certain techniques. Blockade of essential nerve function, like that of phrenic nerve, or high epidural blocks, should be avoided. Motor weakness or paralysis of limbs, from spinal or major nerve trunk blockade is transient and as long as the patient is protected from injury and undue stress, should not be of consequence.

LOCOREGIONAL APPLICATIONS

The locality of administration is often limited only by the clinician's ability to learn various utilities and anatomic landmarks; few are outside the scope of any clinician to master. They include, but are not limited to local line or paraincisional blocks[4], regional blocks such as carpal ring, dental nerve, and intercostal blocks, subcutaneous diffusion blocks, testicular blocks, intra-articular blocks, and epidurals. Facet blocks are commonly used in humans though not yet

described in veterinary medicine, although recently a paravertebral block was described for dogs.[5]

Commonly used local anesthetic blocks in veterinary medicine

For many of the blocks listed below, a suggested volume of drug is listed based on the amount of drug that can physically be injected into the site. However, with all blocks, the total dose that the patient can receive should be calculated and the cumulative dose (add up the dose or volume injected for each block) should not exceed this total dose.

1. **Transdermal/cutaneous**
    a. Commercial transdermal products are extremely useful in facilitating catheter placement and for minor procedures involving the dermis and epidermis. A lidocaine/prilocaine ointment formulation (EMLA®, also comes as a generic) is placed on a shaved area and covered with a non-porous wrap (foil or cellophane). In humans it is recommended to have the product in place for 45 minutes to achieve full affect, but in the author's experience 15-20 minutes appears sufficient in dogs and cats. Penetration depth of analgesia has been reported to be time dependent and from 2-6 mm.[6]
    b. Commercial 5% lidocaine patches (Lidoderm®) provides post-operative wound paraincisional analgesia.[7] However, Lidoderm® patches in fact are manufactured and labeled for post-herpetic neuralgia (Shingles), a very common form of chronic, neuropathic pain in humans. The pharmacokinetics of this product has been investigated in dogs and cats, with minimal systemic absorption noted.[8],[9] The adhesive patches can be cut formed to the desired size and shape, for example on either side of an incision. One cautionary note is that an entire patch contains 700 mg of lidocaine, obviously a dose that would be toxic if ingested; therefore adequate precautions need to be taken to ensure the patient is unable to access the patch.
    c. Studies in humans with moderate-severe stifle osteoarthritis reveal significant reduction in pain intensity after 2-week use of Lidoderm® patches[10], and pain relief similar to that achieved by oral NSAID.[11] Their potential for use in animals for chronic pain conditions (e.g. osteoarthritis, osteomyelitis, osteosarcoma) remains plausible but no applications are described in the veterinary literature.

2. **'Field' block**

a. Blocking the 'field' of surgery. Local anesthetic drugs can be administered around the incision or directly into the incision. It is not true that lidocaine in an incision causes a delay in healing.
b. Savvas et al (2008) reported that a subcutaneous incisional midline block prior to celiotomy provided superior pain relief, compared with postoperative bupivcacaine or saline infiltration in dogs having a variety of abdominal surgeries.[12] These authors used a dose of 2 mg/kg of 0.25% bupivacaine. Carpenter et al (2004) compared the effects of intraperitoneal bupivacaine with that of saline and lidocaine in dogs having ovariohysterectomy and found that the bupivacaine treated dogs received less supplemental analgesia and had improved pain scores.[13] These authors used a higher than commonly recommended dose of bupivacaine (4.4 mg kg^{-1} 0.75% bupivacaine diluted with saline to a volume of 0.88 ml/kg), in the cranial intraperitoneal space with an additional 2 ml of 0.75% bupivacaine on the incision prior to closure. Tobias et al 2006 did not find a benefit to a preoperative subcutaneous infiltration of 1.1 mg/kg bupivacaine in cats having ovariohysterectomy, but this dose is low compared to other studies;[14] Fitzpatrick (2010) also failed to detect a difference in pain scores with incisional bupivacaine in dogs undergoing OHE, but technique errors and the use of a strong multi-modal protocol may have prevented the detection of diminished pain attributable to the local block.[15] The overwhelming volume of literature in humans strongly supports the use of this technique.

3. **IntraCavity Blocks**.
    a. Bupivacaine is infused through a catheter, or in the case of the abdomen, added to the final lavage. Useful for any laparotomy, thoracotomy, thoracic trauma, or chest tube; has also been utilized in humans for pancreatitis, peritonitis. Results of multiple human and veterinary studies support that peritoneal use of local anesthetics can spare opioid requirements and improve pain scores.
    b. In addition to the studies above, Campagnol (2012) found that IP bupivacaine in dogs lowered post-OHE pain scores and was in fact superior to incisional bupivacaine.[16] Kim (2012) found similar results in dogs undergoing laparoscopic OHE.[17]

4. **Indwelling diffusion/wound catheter block (sort of a long term field block)**
    a. A relatively new strategy to extend the duration of local anesthesia may markedly help patients with moderate to severe surgical injury. Implantation of a catheter into the surgical wound site prior to closure allows repeated or continuous infusion of local anesthetics into the affected area. Indwelling, or 'soaker', catheters should be considered for large wounds or incisions that may be difficult to block or that may require continuous or intermittent delivery of drug for several days.
        i. The catheters can be buried in or near incisions and local anesthetic infused through the catheter to provide more long-term analgesia.
        ii. Very useful for surgeries with large incisions, e.g: amputations, mastectomies, etc…
        iii. Local anesthetic drugs can be infused via a pump or administered by intermittent injection (e.g., q 6-8 hour injections of bupivacaine).
        iv. The catheter is generally removed in 48-96 hours.
    b. In humans, relatively costly FDA approved catheters[a] are used. For veterinary use, two moderately priced types are commercially available[b,c]. The basic form is a soft pliable catheter with tiny holes along the end that is implanted; functioning somewhat like a garden "soaker hose". Delivery of local anesthetic by continuous infusion of lidocaine, or intermittent bolus dose of bupivacaine can be used. An elastomeric balloon pump is a modestly priced option for ambulatory patients. A recent review of wound incision catheters for surgery in humans, concluded that the overall: "Continuous wound catheters consistently demonstrated analgesic efficacy in terms of reduced pain scores or opioid use for all surgical subgroups, despite heterogeneity in type of surgical procedure, location of wound catheter, mode of delivery of local anesthetic, dose of local anesthetic, and analgesic mixture" (Liu et al, 2006). In most cases, duration was approximately 2 days. Beneficial outcomes included reduction of pain scores at rest and with activity, reduction of daily consumption of opioids, and trends towards better patient satisfaction and length of hospital stay. Veterinary clinical studies have been reported involving the use of continuous wound infusion of local anesthetics. The most studied surgical indication was total ear canal ablation, but use for extensive soft tissue resection in cats (fibrosarcoma

resection) is also reported.[18] Studies reported to date have used either bupivacaine or lidocaine infusion, and, as with human studies, pain was generally perceived to be adequately managed with the infusion, and complication rates low and not perceived to be problematic. Currently, anecdotal reports are that practitioners are using such wound infusion catheters for limb amputation, ear canal ablation, intercostal and sternal thoracotomy, celiotomy, and major soft tissue tumor excision, with excellent results and few complications. [19]

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