Randomized controlled studies in people suggest that in comparison with systemic opioids, regional techniques provide superior pain relief, faster postoperative recovery, and reduced hospital stay. Until very recently, regional techniques have been confined to neuraxial (epidural/spinal) approaches. However, peripheral nerve blockades have been shown to provide effective analgesia with potentially less morbidity than neuraxial techniques.

Multimodal analgesic techniques are becoming increasingly popular for treating pain in animals. Local anesthetic drugs can be used in a variety of ways, including topical administration into surgical wounds (“splash blocks”), infiltration into target tissues (“field blocks”), specific nerve blocks, epidural administration, and intra-articular injection.

**Primary Benefits of Regional Anesthesia**
- Better pain control
- Earlier mobilization, improved rehabilitation

The key features of regional anesthesia, combined with new surgical techniques and ward routines (encouraging early nutrition, increased mobility), may make it possible to reduce the incidence and severity of complications, speed recovery, and thus reduce hospital stay.

**Complications**
The incidence of serious complications in veterinary patients is not known, and as we continue to develop these techniques for clinical use, prospective studies should be performed so that we will be better able to identify the risks to our patients. With proper training and equipment, complications of using locoregional anesthetic techniques for pain control should be rare. Potential complications must be fully understood by the clinician, and strategies to minimize its incidence, including good recordkeeping, should be implemented.

**Splash/Infiltration Blocks**
Wound infiltration involves the direct injection of a local anesthetic into the surgical field. It is popular in human and veterinary medicine due to its relative simplicity, safety, and low cost (Moiniche et al. 1998; Carpenter et al. 2004; Savvas et al. 2008).

In a systematic review, Moiniche et al. (1998) reported the results of 26 randomized, controlled trials. The authors of the review reported that the location of infiltration played an important role in the success of the intervention. In addition, there was a significant dose-response relationship observed in these studies, with larger doses (highest concentration) of local anesthetics causing the most pronounced pain relief. The authors also reported that the beneficial effects of most studies were short-lived (2–7 hours).

Recently, three studies have reported the results of using incisional infiltration of local anesthesia for provision of preemptive and postoperative analgesia for a variety of abdominal surgeries in dogs (Carpenter et al. 2004; Savvas et al. 2008; Fitzpatrick et al. 2010).

In the first study, immediately prior to closure of the linea alba, Carpenter et al. (2004) randomly administered either 0.88 mL kg⁻¹ of 0.9% saline, 8.8 mg kg⁻¹ 2% lidocaine with epinephrine (1:200 000), or 4.4 mg kg⁻¹ 0.75% bupivacaine into the intraperitoneal space immediately prior to closure of the skin of each dog. The blinded investigators found that intraperitoneal and incisional bupivacaine provided effective analgesia following ovariohysterectomy in their dogs.

Savvas et al. (2008) compared saline and bupivacaine 0.25% (2 mg kg⁻¹) for preoperative or postoperative incisional use. They injected the respective solution in a fan-like fashion both subcutaneously and intramuscularly at the proposed incision site either just before the start of the incision or at the end of surgery following subcutaneous tissue closure. Preoperative administration of bupivacaine to dogs resulted in significantly lower pain scores and less frequent use of additional postoperative analgesia compared to the other three groups. In that study, none of the preoperative bupivacaine dogs required additional postoperative analgesics.
Most recently, Fitzpatrick et al. (2010) reported the results of a study that used infiltration of local anesthetics as part of a multimodal approach to managing pain following ovariohysterectomy in dogs. The authors randomly assigned 92 dogs to one of four different treatment groups: no perioperative incisional injections, preoperative infiltration with saline, preoperative infiltration using 2 mg kg$^{-1}$ bupivacaine, or postoperative infiltration using 2 mg kg$^{-1}$ bupivacaine. The respective solutions were infiltrated along the superficial and deep tissues of the incision site. The authors found no significant differences in pain scores, doses of rescue analgesics, and responses to von Frey filaments.

**Soaker Catheters**

A promising new modality is placing a multifenestrated catheter into the surgical wound at the end of the procedure. This technique can be used to provide analgesia following a variety of surgical procedures, is technically very simple to perform, offers the potential for complete analgesia, and has the added benefit of permitting repeated or continuous infusion of local anesthetics into the wound for a prolonged period of time postoperatively.

Clinical investigations of this technique in people following a variety of surgical procedures have demonstrated not only improved pain control, but also decreased postoperative opioid use and its associated side effects in people such as nausea, vomiting, and urine retention.

In animals, use of wound catheters has been reported for procedures such as total ear canal ablation, amputation, oncologic surgery, or closure of large wounds (Radlinsky et al. 2005; Wolfe et al. 2006; Davis et al. 2007a, 2007b; Abelson et al. 2009).

**Total Ear-Canal Ablation and Bulla Osteotomy in Dogs**

In the study by Radlinsky et al. (2005), 16 dogs were enrolled. At the end of surgery, treated dogs had wound soaker catheters placed in the tissues lateral to the bulla and received either 0.5% or 0.75% bupivacaine from an elastomeric pump via the catheter. Wound catheters were removed after 48 hours. In the study by Wolfe et al., 20 dogs had wound catheters placed at the end of their surgeries. Ten treated dogs received 2% lidocaine infusions (25–50 ug kg$^{-1}$ minute$^{-1}$) administered by elastomeric pumps via the wound catheters and saline infusions administered intravenously by syringe pump. In all dogs, catheters were placed prior to surgical wound closure, and the use of local anesthesia administered via wound catheters was subsequently compared to the use of systemically administered morphine, either boluses or infusions. Both of these studies reported no significant differences between their two treatment groups. Low pain scores were obtained in general (Radlinsky et al. 2005).

**Feline Oncologic Surgery**

Davis et al. (2007a, 2007b) described the use of wound soaker catheters for providing analgesia to cats following major oncologic surgeries. Wound catheters were placed prior to wound closure. These authors reported that, compared to cats not receiving a wound catheter, cats receiving local anesthetic infused through wound catheters spent significantly less time in hospital than those cats that did not receive a local anesthetic infusion (Davis et al. 2007b).

**Amputation**

Abelson et al. (2009) reported their experiences of using wound soaker catheters for providing analgesia to a variety of surgical patients in a veterinary teaching hospital over a two-year period. The majority of the cases described in their report were dogs that underwent amputation of their thoracic or pelvic limbs (46 of 56 cases). Catheters remained in place between 12 hours and 3 days. Their patients received either bupivacaine administered as intermittent boluses or lidocaine administered as continuous infusions. The authors suggested that those patients that received a local anesthetic through a wound soaker catheter received less systemically administered opioids than dogs that did not have a wound soaker catheter placed. This resulted in less sedation and a more rapid return to mobility, eating, and urination and led to a shortened period of overall hospitalization for the wound catheter patients.

**Epidural**

The administration of agents with analgesic properties via the epidural route has been used for many years to provide highly effective, localized anesthesia and analgesia.

**Technique**

- The patient is positioned in lateral or sternal (preferable) recumbency.
• The puncture site is located between the spinous processes of L7 and S1 (medial sacral crest) on the dorsal midline of the patient.
• The patient’s hair should be clipped over the planned site, and the skin should be prepared according to accepted standards.
• The needle is inserted on the dorsal midline, caudal to the spinous process of L7.
• The needle is advanced through the skin and into the subcutaneous tissue. Usually there is no palpable resistance to needle advancement in these tissues.
• The needle is then advanced through the interspinous ligament until it is thought to be embedded in the ligament. Resistance will be appreciated as the needle penetrates this ligament.
• LOR or hanging drop techniques can be used to identify when the needle enters the epidural space.
• If during any of these manipulations the needle comes into contact with bony structures, it should be withdrawn slightly and redirected caudally or cranially as applicable. “Walking” the needle off the adjacent bones will help to identify the intervertebral space. Movements should be gentle and controlled so as to minimize the risks of causing tissue trauma.
• After the epidural space is correctly identified, the needle hub should be checked for the presence of cerebrospinal fluid (CSF) or blood. If either fluid is observed, the needle should be removed from the patient and the procedure should be repeated.

Clinical Pearl
Since the dural sac extends further caudally in cats than in dogs, the clinician should concentrate on stopping needle advancement as soon as the epidural space is entered.

Peripheral Nerve Blocks
Mastery of these techniques offers veterinarians a powerful tool to augment intra- and postoperative analgesia and therefore decrease the time between surgery and the return to normal patient behavior. A number of recent studies have been conducted to help refine the procedure in veterinary patients. Although locoregional anesthesia is relatively new to veterinary medicine, we hope that this lecture will allow more veterinarians to achieve consistent proficiency in performing these two nerve blocks.

Fundamentals of Peripheral Nerve Localization
The success of a nerve block is dependent on placing local anesthetic solution in close proximity to the appropriate nerve. Techniques for peripheral nerve localization vary. Electrostimulation has been considered the “gold standard” technique for peripheral nerve localization (Marhofer and Chan 2007). However, ultrasound-guided techniques, used in conjunction with electrostimulation, are gaining in popularity. The advantages of ultrasound include the ability to visualize and manipulate the needle under direct observation and the ability to monitor the spread of the local anesthetic solution as it is being injected.

In electrolocation, an insulated stimulating needle is advanced through the tissue toward the target nerve. The needle is connected to a peripheral nerve stimulator. The stimulator emits a low output, pulsatile, electrical current. These electrical impulses are conducted down the insulated needle and emitted from the tip of the needle. Impulses reaching a nearby nerve are transmitted along the nerve fibers. If the nerve contains motor fibers, the electrical current will result in contractions of the effector muscle. These muscle twitches, obtained at low current output, indicate that the stimulating needle is in close proximity to the nerve. Once the target nerve is localized in this manner, local anesthetic solution is injected through the needle. As the anesthetic solution surrounds the nerve, it inhibits axon depolarization, thereby blocking sensory and motor functions to the structures innervated by the nerve.

A wide range of surgical procedures can be performed after pelvic limb nerve blocks, including fracture repairs and articular procedures (for example, femoral head osteotomies, knee arthroscopy, anterior cruciate ligament repair, and foot and ankle surgery).

Intra-articular (IA) Injections
The IA injection of local anesthetics will provide blockade of intra-articular structures only, and analgesia of extra-articular structures and the skin is not achieved. Using this technique does not replace the requirement for supplemental analgesics in cases of open surgical procedures; however, it may reduce the dose and interval for administrating supplemental analgesic therapy (Day et al. 1995).
Choice and Dosing of Local Anesthetics
The drugs most commonly used for diagnostic and therapeutic purposes in human and small animal practice include lidocaine, mepivacaine, bupivacaine, or ropivacaine. When injected preoperatively, the addition of epinephrine (1:100,000) to the local anesthetic solution helps to minimize hemorrhage during the surgical procedure. The addition of buprenorphine (3 μg kg⁻¹) or morphine (0.1 mg kg⁻¹) to the local anesthetic solution will extend the total analgesic duration of the intra-articular block. Intra-articular use of clonidine (Reuben and Connelly 1999) or dexmedetomidine (Al-Metwalli et al. 2008) also enhances analgesia after arthroscopic knee surgery in people. Corticosteroids (i.e., betamethasone and methylprednisolone) and hyaluronic acid are also used as intra-articular therapies in cases of osteoarthritis. Stem cell therapy is currently being investigated as part of the treatment of osteoarthritis (Black et al. 2008).

Toxicity of Intra-articular Local Anesthetics
Recently, attention has been drawn to the possible toxic effects of local anesthetics on chondrocytes. Bogatch et al. (2010) studied the effects of lidocaine and bupivacaine on bovine articular chondrocytes in a suspension culture. Their results suggest potential chemical incompatibility of the drugs producing formation of needle-like crystals in synovial fluid and chondrocyte death. The chondrotoxicity of local anesthetics appears to be dose and time-dependent. Prolonged, intra-articular administration of high concentrations of local anesthetic solutions may result in adverse clinical effects (chondrolysis) (Karpie and Chu 2007). A single IA injection of 0.5% bupivacaine led to reduced chondrocyte density without chondrolysis six months after injection (Chu et al. 2010). In other studies, a single injection of low-concentration bupivacaine appears to be safe (Webb and Ghosh 2009). Incidentally, most clinical case reports of IA complications in people describe chondrolysis following continuous bupivacaine infusions (Anderson et al. 2010). Ropivacaine has been shown to be less chondrototoxic than bupivacaine (Piper and Kim 2008). Evidence relating to the effects of epinephrine and preservative agents found in local anesthetic solutions on intra-articular surfaces has yet to be elucidated (Webb and Ghosh 2009).

References