Intravenous regional anesthesia (Bier block) in a dog

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Abstract — Intravenous regional anesthesia was used in an adult dog as part of a balanced approach to general anesthesia for amputation of the 4th digit of its right hind limb. It allowed the concentration of isoflurane to be reduced to 0.5%.

Résumé — Anesthésie régionale intraveineuse (bloc de Bier) chez un chien. Une anesthésie régionale intraveineuse a été utilisée chez un chien adulte comme composante d'une anesthésie générale à toxicité dispersée lors de l'amputation du 4e doigt du membre postérieur droit. La concentration d'isoflurane a pu être réduite à 0,5 %.

(Traduit par docteur André Blouin)

Can Vet J 1999; 40: 419–421

Intravenous regional anesthesia (IVRA), also known as the "Bier block," was first described by Bier in 1908; Holmes (1) repopularized the technique in humans in 1963. It has been used in veterinary medicine to provide regional analgesia to extremities undergoing surgery in cattle, small ruminants, buffalo, and swine; however, very little information exists on its use in dogs (2,3). This report describes the technique and clinical use of IVRA in an adult dog that had the 4th digit of its hind limb amputated.

A 5-year-old, 21.6-kg, spayed female boxer was presented to the Western College of Veterinary Medicine Small Animal Clinic with a 10-day-old laceration of the 4th digit of the right hind limb. The dog was lame on the right hind limb due to the 1-cm long laceration on the pad of the 4th digit of the right hind limb. The laceration appeared to be contaminated. After several attempts at treating the wound medically, we decided to amputate the digit.

The dog was fasted for 12 h and without water since morning. An over-the-needle IV catheter (I.D. 0.8 mm × 32 mm; Surflo, Terumo Medical, Elkton, Maryland, USA) was placed in the left cephalic vein, and the dog was administered lactated Ringer's solution (Lactated Ringer's, Abbott Laboratories, Saint-Laurent, Quebec), (10 mL/kg body weight (BW)/h), as part of standard anesthesia protocol. Hydromorphone (Hydromorphone hydrochloride, Sabex, Boucherville, Quebec), 0.15 mg/kg BW, was administered, IV, followed by diazepam (Diazepam, Sabex), 0.2 mg/kg BW, IV.

When a state of neuroleptanalgesia was established, an over-the-needle IV catheter (I.D. 0.8 mm × 32 mm; Surflo, Terumo Medical) was directed proximally in the cranial ramus of the right lateral saphenous vein (Figure 1). The dog became dysphoric and excited, so thiopental (Pentothal, Abbott Laboratories), 15 mg/kg BW, IV, was administered to allow tracheal intubation, and isoflurane (Aerrane, Abbott Laboratories) in 100% oxygen was administered by using a precision vaporizer and a circle rebreathing system. The vaporizer setting ranged from 0.5% to 1.5% throughout the procedure. Systolic blood pressure was indirectly measured by using a Doppler flow probe and sphygmomanometer. Heart rate was obtained by using the Doppler flow probe, stethoscope, and palpable peripheral pulses.

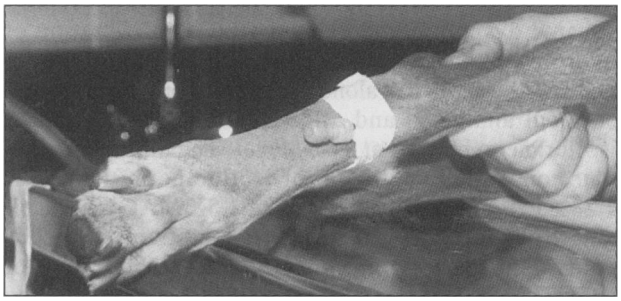

Figure 1. Photograph demonstrating positioning of the over-the-needle catheter in the lateral saphenous vein, prior to exsanguination and tourniquet application, necessary for intravenous regional anesthesia to be performed.

An Esmarch bandage was used to exsanguinate the distal extremity of the right hind limb. A Penrose drain tube (Sherwood Medical, St. Louis, Missouri, USA) was used as a tourniquet, and applied proximal to the catheter preplaced in the saphenous vein. The tourniquet was tightened until a pedal pulse was not palpable, then the Esmarch bandage was removed. Lidocaine without epinephrine (Lidocaine Neat 2%, Ayerst Laboratories, Montreal, Quebec), 3 mg/kg BW, was administered over 1 min through the preplaced saphenous catheter.

Fifteen minutes after injecting lidocaine, the concentration of isoflurane administered according to the dial was reduced from 1.5% to 0.75% while maintaining a nonsurgical level of anesthesia, as defined by the presence of mild jaw tone, a centrally located eye, and palpebral reflexes. Oxygen was administered at a flow rate of 75 mL/kg BW/h. After the dog's digit had been surgically prepared, the isoflurane concentration was reduced to 0.5%. The dog was maintained at this concentration of anesthetic throughout the surgical procedure,

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during which palpebral reflexes and mild jaw tone were present, systolic blood pressure was 110 mmHg, heart rate was consistently 60 beats/min, and respiratory rate was between 12 and 16 breaths/min. The surgical procedure lasted 20 min. The tourniquet was removed at commencement of skin closure; it had been in place for 45 min. No auscultable changes in the rhythm of the heart beat were detected following removal of the tourniquet. The dog recovered uneventfully.

On the day following surgery, the dog walked without difficulty and did not attempt to lick or chew the affected limb. Fourteen days later, the dog was presented for routine suture removal. The surgical site had healed and the dog walked normally.

With balanced anesthesia, multiple drugs are used to attenuate various parts of an anesthetic state, namely, consciousness, analgesia, muscle relaxation, and autonomic reflexes (4). Although the dog, in this report, became dysphoric and excited after administration of hydromorphone and diazepam, and so required general anesthesia, IVRA alone appeared to provide adequate surgical analgesia and allowed the concentration of isoflurane to be kept at a low level. The minimum alveolar concentration (MAC) of isoflurane in the dog is 1.28% (5). It generally takes about 1.5X MAC for an animal to tolerate surgical pain intraoperatively, which is equivalent to an approximately 2% concentration of delivered isoflurane. It has been shown that morphine and oxymorphone will decrease the MAC of isoflurane by 50% and 44.9%, respectively (6,7). Presumably, if hydromorphone induced a similar decrease in the isoflurane MAC in this dog, the dog would have required a minimum of approximately 0.9% concentration of delivered isoflurane to tolerate the surgical pain. Since the dog received only 0.5%, it can be concluded that it was the IVRA that was effective in providing a surgical level of analgesia.

Two previous reports stated that IVRA is a safe and reliable technique for use in dogs (2,3). The site of action whereby the local anesthetic in IVRA produces analgesia is controversial (8,9). Some studies have shown that the local anesthetic agent acts on the smaller nerves and sensory nerve endings, while others have shown that the effects of the local anesthetic are primarily on the main nerve trunks (8,9). Local ischemic effects, including regional acidosis and hypothermia, may also contribute to the analgesia produced by IVRA (9).

Lidocaine is the local anesthetic agent most commonly used in IVRA by medical anesthesiologists; they believe it is safer than other agents, such as bupivacaine. A few anesthesiologists have combined lidocaine with other drugs such as nondepolarizing neuromuscular blockers for enhanced muscle relaxation, potent opioids to potentiate the analgesic effects of the local anesthetic, bicarbonate to decrease injection pain, and heparin to decrease clot formation (10). These combinations have not been reported for IVRA in dogs.

Intravenous regional anesthesia is not without inherent risks. Complications in humans include compartmental syndrome, tourniquet induced paralysis/paresis, seizures, cardiac arrest, incomplete anesthesia, and death (1,10). Many medical anesthesiologists administer systemic benzodiazepine drugs to decrease the frequency of seizures due to sudden release of local anesthetic agents into systemic circulation. Various cuff removal techniques are employed; for example, removal of the tourniquet and its reapplication after 10 s, repeated several times, can reduce the systemic concentration of local anesthetic and thereby reduce toxic effects (11).

In human medicine, pneumatic, rather than rubber or elastic bandage, tourniquets are used because of decreased frequency of neurologic damage. Neurologic damage occurs because of 1) direct pressure, 2) ischemia, 3) hyperemia, and 4) shearing strain and distortion of the nerves underlying the tourniquet. The ideal tourniquet is one whose width is at least 20% wider than the diameter of the limb to which it is applied. Narrower tourniquets will not provide adequate compression of the vessels located deeper within the muscle bed (12).

Maximum venous pressure (MVP) is the highest venous pressure achieved when administering an IV solution to an individual with a given cuff size and cuff pressure and is an important consideration in IVRA. The MVP does not change, regardless of the force or speed of injection. When a wide tourniquet is utilized, the cuff pressure approximates the MVP. The smaller the cuff width, the greater the cuff pressure that is required to be effective (12,13). It has been suggested that, in adult humans, 4- to 6-cm-wide pneumatic cuffs should be inflated to an intracuff pressure of 300 mm Hg and that the IV local anesthetic agent be given over approximately 90 s (12). If the local anesthetic agent is injected too rapidly, the venous pressure reaches MVP. As the venous pressure reaches MVP, leakage of local anesthetic around the cuff occurs, thereby increasing the risk of systemic toxic effects (12,13). However, most medical anesthesiologists simply tighten the tourniquet to a point where pulse pressure is no longer palpable in the distal extremity (10). No information exists regarding cuff size or optimal pressure for pneumatic tourniquets in dogs, but similar principles probably apply.

The length of time a tourniquet should be applied is an important factor in IVRA. Studies performed on humans demonstrate that tourniquets should not be applied for longer than 2 h, otherwise local metabolic changes occur. These include hypoxia, hypercapnea, acidosis, hyperkalemia, and increased lactate concentration (12). Some authors believe that tourniquet time should be limited to 90 min to avoid ischemic muscle injury (13).

Sensation and return to function of a limb following tourniquet removal is rapid. Studies in dogs, where bupivacaine was used for IVRA, found that return of sensation was approximately 4 min, and that the dogs were able to bear weight approximately 12 min after tourniquet removal (3).

Further studies in dogs are warranted to investigate the uptake of local anesthetic agents into the systemic circulation and the influence of cuff width and inflation and deflation techniques. We conclude that IVRA can be used effectively to provide a balanced anesthetic technique for relatively short surgical procedures involving the distal extremity of limbs. The technique is not without its adverse effects, and dogs should be monitored appropriately. CVJ

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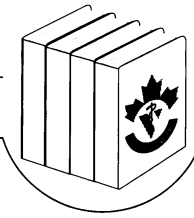
BOOK REVIEW



COMPTE RENDU DE LIVRE

Greene CE. ***Infectious Diseases of the Dog and Cat, 2nd ed.*** WB Saunders Company, Toronto, Ontario, 1998. 934 pp. ISBN 0-7216-2737-4. $188.00.

In the 8 years since the original version of this text was published, a wide variety of changes have occurred in the infectious disease field. The discovery of new disease agents, new testing modalities, and new treatment options are just a few of the areas addressed in this edition. New to this text, for example, are discussions on canine parvovirus infections in cats, *Helicobacter* infections, and *Toxoplasma*-like infections in cats. The text is intended for small animal practitioners, veterinary students, and teachers, and it is well suited to all of these groups.

The book is divided into 5 sections: 1) Viral, Rickettsial, Chlamydial, and Mycoplasmal Diseases, 2) Bacterial Diseases, 3) Fungal Diseases, 4) Protozoal Diseases, and 5) Clinical Problems. Each section begins with a subsection on laboratory diagnosis and follows with a discussion on drugs used to treat that set of infectious diseases. It is also useful that the author has included in each section a discussion of potential public health considerations, in an effort to aid us in our role as public health officials. In the section on Clinical Problems, the approach to common, clinical infectious processes according to body systems (integumentary, genitourinary, etc.) is discussed in a very concise and accessible format.

Anyone familiar with the 1st edition of this text will also appreciate the improvements made to the appendices. While some information that was in the previous version has been omitted (staining and microscopic techniques, biocidal agents), the expanded drug formulary and current vaccination protocol recommendations are well worth the loss. Also, the author has once again provided a concise list of infectious disease rule-outs for common medical problems, which most practitioners will find extremely useful. One of the best new additions to the text is a section on immunocompromised humans and pets that provides both the practitioner and the client with practical information regarding zoonoses and disease prevention, as well as helpful guidelines regarding veterinary care, hygiene, nutrition, etc.

The overall format of the book is excellent. It is easy to go to either the table of contents or the index to find the subject of interest. There are clear diagrams and helpful photos and tables throughout the text that make the information easily accessible. While all of the broad-spectrum of disease agents discussed in this edition may not be of importance to the Canadian practitioner, it is still a very well-rounded and improved version of the original.

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