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Be the pain-attacking offensive midfielder – local anaesthetic blocks every practice can utilise

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ABSTRACT: What is the job of attacking offensive midfielder in soccer? The position will be somewhere between the midfield and the forward line, which means that they'll be able to influence the "attack" high up in the field. Local anaesthetics (LA) are similar. LA used to be the only pain management available to veterinary practitioners, whether small or large animal practice, some 40 years ago. These blocks were used to stop any nerve impulses produced by cutting during surgery. LA are currently used to reduce peri-operative pain, procedural pain and hopefully prevent chronic pain. This article will review a "how to guide" to provide local blocks.

Keywords: local anaesthetics; nerve blocks; guide

Introduction

Local anaesthetic (LA) techniques are the only analgesic techniques that produce a complete blockade of the peripheral nociceptive input. They are, therefore, the most effective way to prevent sensitisation of the central nervous system and development of pathological pain (Barker, 2013a).

Why do we want to use local anaesthetics? Do we have good reasons?

1. Local blockade permits reduction of general anaesthetic requirements, which is safer for patients. The requirements for post-operative pain medications are lowered (MacDougall et al., 2009).
2. The patient can awaken comfortably from anaesthesia. There are fewer unwanted effects from systemic opioids that could cause sedation or respiratory depression (McCarthy, 2010).
3. LA can have anti-inflammatory effects (Cassuto et al., 2006) (reduced production of eicosanoids, thromboxane, leukotriene, histamine, and inflammatory cytokines; and scavenging of oxygen free radicals) and antibacterial, antifungal and antiviral effects (Borgeat & Aguirre, 2010; Epstein, 2017; Epstein & Grubb, 2017; Johnson et al., 2008). The 2015 edition of the AAHA/AAFP Pain Management Guidelines (Epstein et al., 2015) (www.aaha.org/professional/resources/pain_management.aspx) states: "because of their safety and significant benefit, Local Anesthetics (LA) should be utilized, insofar as possible, with every surgical procedure". The International Veterinary Academy of Pain Management has a similar position statement from 2011. The 2013 AAHA Dental Guidelines (Holmstrom et al., 2013) position states: "If oral surgery is planned, the institution of an intraoral local anesthetic is warranted in conjunction with the general anesthesia." (www.aaha.org/public_documents/professional/guidelines/dental_guidelines.pdf)

The World Small Animal Veterinary Association (WSAVA) Global Pain Council, recommends a major role for LA as a preventive for surgical pain in its 2014 Guidelines for Recognition, Assessment

Table 1. Local anaesthetic doses and usage (Epstein, 2010)

Key drug	Drug class	Dose range	Route	Indications
Lidocaine	Local anaesthetic	Dog: 1–5 mg/kg Cat: 2–4 mg/kg	Locoregional	Peri-op blockade
Mepivacaine	Local anaesthetic	Dog: 1–5 mg/kg Cat: 0.5–1 mg/kg	Locoregional	Peri-op blockade
Bupivacaine	Local anaesthetic	Dog: 1–2 mg/kg Cat: 0.5–1 mg/kg	Locoregional	Peri-op blockade
Lidocaine	Local anaesthetic	Dog only: 50 μg/kg/min	Intravenous (IV) constant rate infusion (CRI)	Systemic analgesia, minimise post-op ileus
Ropivacaine	Local anaesthetic	Dog: 1.5–3 mg/k Cat: 1.0–1.5 mg/kg	Locoregional	Peri-op blockade

Figure 1. Nerve locator/stimulator. Courtesy Dr Mark Epstein

Figure 2. Auriculotermporal nerve block. Courtesy Dr Tamara Grubb

and Treatment of Pain (Mathews et al., 2014), www.wsava.org/guidelines/global-pain-council-guidelines.

Pharmacology

Local anaesthetics generally consist of three basic units: an unsaturated aromatic group (benzene ring), an intermediate chain and a tertiary amine ring. The aromatic ring structure affects the lipophilicity and potency of each compound (the more lipid solubility there is, the greater the potency of the drug) (Butterworth & Stichartz, 1990; Duke, 2000; Steffey & Boothe, 1995). Typically, the smaller, lipophilic molecules have a faster onset of action (Butterworth & Stichartz, 1990; Duke, 2000; Steffey & Boothe, 1995). The composition of the intermediate chain classifies LAs as either ester- or amide-linked (Butterworth & Stichartz, 1990; Duke, 2000; Steffey & Boothe, 1995). The most common aminoesters are procaine, chloroprocaine and tetracaine, whereas the most common aminoamides are lidocaine, mepivacaine, bupivacaine and ropivacaine (Wolfe & Muir, 2003) (see **Textbox 1** and **Table 1**).

Textbox 1. (Epstein, 2017)

Commonly used LA drugs in veterinary medicine include:

Lidocaine

- Onset of action: rapid (less than 5 min), duration of action: 60–120 min
- 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 min after injection (up to 20 min), duration of action: 4–6 h

Figure 3. Greater auricular nerve block. Courtesy Dr Tamara Grubb

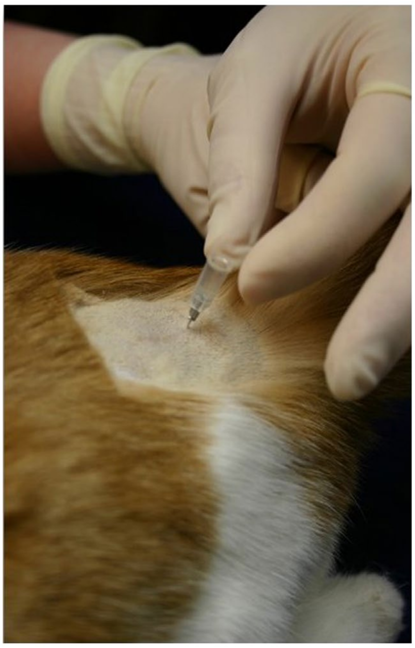

Figure 4. Sacrococcygeal block. Courtesy Dr Bonnie Wright

Figure 5. Sacrococcygeal block 2. Courtesy Dr Bonnie Wright

- 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 are 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 – toxicity reactions (see Textbox 2)

- Central nervous system, which usually occurs first, and can result in either depression and sedation or seizure-like activity, depending on the dose that reaches the brain (Borer, 2006).
- Cardiovascular, which is probably the most significant and occurs at a higher dose than central nervous system toxicity. Cardiovascular side effects occur due to the LA's direct action on the myocardium, which decreases cardiac output and blood pressure, and its indirect actions on sympathetic nerves, which are blocked by LAs (Borer, 2006).
- Methaemoglobinaemia, which may occur in response to some LAs, particularly prilocaine. Fe^{2+} in haem in erythrocytes is oxidised to Fe^{3+} by these drugs; this form of haemoglobin is unable to transport oxygen, thus resulting in cyanosis (Borer, 2006).

Textbox 2. (Epstein, 2017)

Adverse events caused by LA drugs:

- Local tissue effects – swelling, bleeding, inflammation
- Anaphylaxis – rare, more common with esters (but still rare)
- Central nervous system – muscle tremors, seizure, coma
- Cardiovascular system – the myocardial conduction system is sensitive to LAs and IV boluses can result in cardiovascular collapse. ONLY LIDOCAINE CAN BE ADMINISTERED IV.
- Methaemoglobinaemia – rare, but can occur in cats.

Types of LA block placement

There are four main modalities used to administer LA in proximity of a nerve to block it: blind, electrolocation, ultrasound guidance and combined ultrasound guidance and electrolocation (Schroeder, 2013a).

"Blind" approaches require identification of anatomical landmarks to guide the direction and depth of needle placement to reach the target nerve. This modality requires no special equipment or training, so is often utilised for superficial nerve blocks (Gracis, 2013). The blind technique can also be employed to block deeper nerves; however, the efficacy of the block may be reduced compared to other techniques and a larger volume of LA is generally required (Trimble & Leece, 2016).

In 1984, specially designed needles became available for electrostimulation of nerves. These needles had electrically insulated shafts but naked metal tips that served as electrodes during nerve stimulation (Ford et al., 1984). Nerve stimulation for nerve localisation was found to be associated with a decreased incidence of nerve trauma (Dillane & Tsui 2012).

Ultrasound guidance has become popular as a nerve localisation tool in people, and its use during regional anaesthesia has recently been called the "new gold standard" (Schroeder, 2013b). As target nerves can be "seen", they can more effectively be located with a needle tip prior to injection of the LA solution. Compared with the use of nerve stimulation alone, ultrasound guidance has been shown to result in a higher rate of successful peripheral nerve blockade, decreased block set-up times and longer block durations (Orebaugh, Williams, & Kentor, 2007; Orebaugh, Williams, Vallejo, & Kentor, 2009). Ultrasound guidance can improve speed

Figure 6. Testicular block cat. Courtesy Dr Tamara Grubb

and overall completeness of nerve blocks when used on its own or in combination with nerve location, particularly for nerves in deeper tissues (Williams et al., 2003).

A word about nerve locators/stimulators

A nerve locator is a hand-held device that supplies direct electrical current to a sheathed needle. The needle's tip is uninsulated, concentrating the current at this point. Electrical stimulation of a nerve causes a predictable gross muscle movement. Veterinary patients usually require general anaesthesia. Superficial landmarks must be identified and sterile technique is used with a needle of appropriate length being advanced through the skin in the direction of the target nerve. A grounding electrode (anode) is placed on the patient's skin to complete the circuit. An initial current around 2–3 milliamperes (mA) is selected with a frequency between 1 and 2 Hz and a duration of 0.1–0.2 ms (Love & Egger, 2009). When the appropriate muscle twitch is generated, the current intensity is decreased in a stepwise fashion to a level that indicates nerve proximity without penetration of the nerve sheath. A successful nerve blockade depends on the identification of the correct gross muscle movement. The desired muscle response is usually present at 0.4–0.6 mA and absent at 0.2 mA. There should be no resistance to injection of the LA as this may indicate that the needle is within a nerve fascicle (Raw et al., 2013) (see **Figure 1**).

Figure 7. Testicular block dog. Courtesy Dr Tamara Grubb

Once the lowest possible current required to elicit a twitch has been determined, LA is injected through the needle via tubing. Injection of LA pushes the needle a little further away from the nerve, so twitches are usually diminished or lost immediately after injection (Lerch, 2016b).

Step-by-step process for LA blocks

Ear block – auriculotemporal and greater auricular nerve blocks

These nerve blocks provide analgesia to the external ear canal and the auricular cartilage making it a useful nerve block for dogs undergoing total ear canal ablation and bulla osteotomy surgery whose pain is often difficult to control. These blocks may also be useful to provide a stable plane of anaesthesia during ear flushes in dogs with chronic or extreme pain. The auriculotemporal nerve is blocked by inserting a needle between the rostral aspect of the vertical ear canal and the caudal aspect of the zygomatic arch. To block the greater auricular nerve, place the needle caudal to the vertical ear canal and cranially and ventrally to the wing of the atlas, keeping the needle parallel to the vertical ear canal.

Technique

Auriculotemporal nerve block (see Figure 2)

1. Palpate the external ear canal (it is conical in shape and very hard when inflamed)
2. Locate the caudal aspect of the zygomatic arch
3. Introduce the needle perpendicular to the skin in the palpable depression between the zygomatic arch and the external ear canal
4. Advance the needle as far as possible until the tip is touching bone (the temporomandibular joint)
5. Knowing the total depth of the tissues, withdraw the needle approximately halfway

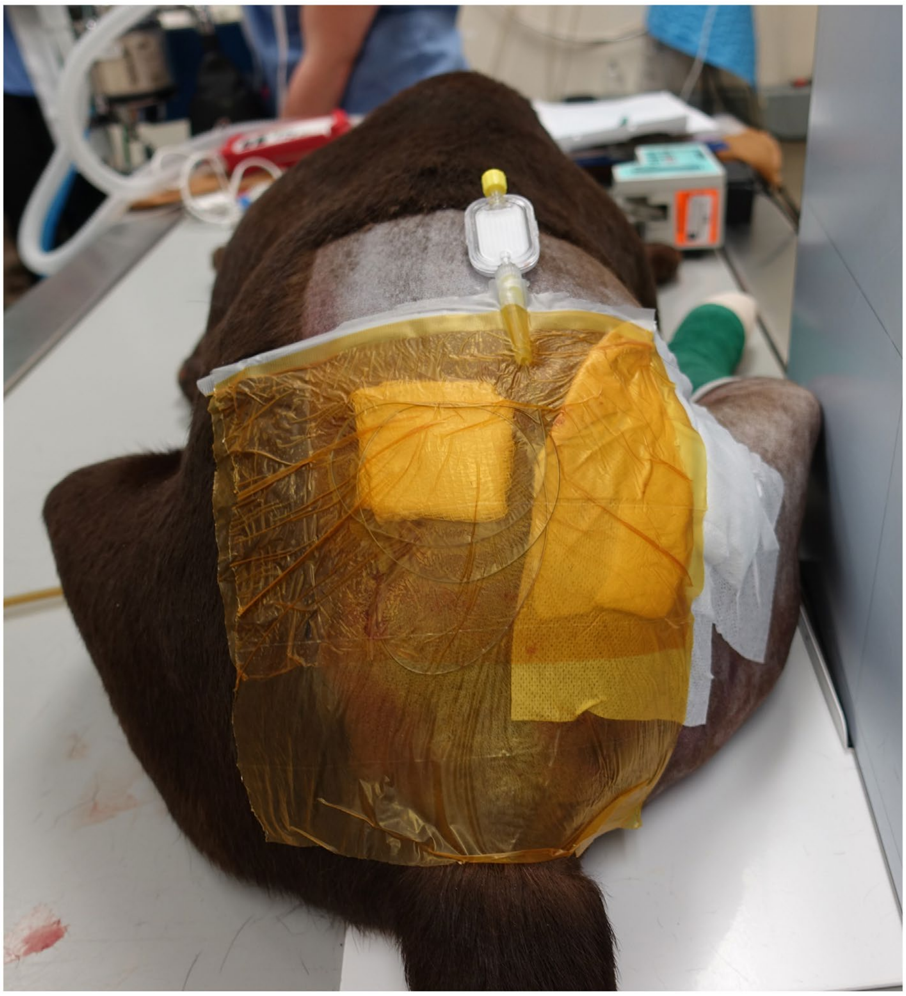

Figure 8. Canine epidural catheter. Courtesy Dr Sheilah Robertson

6. Aspirate to prevent intravascular injection
7. Inject 0.5–1.5 ml of anaesthetic solution or combination (e.g. 0.25–0.5% bupivacaine) (Taboada, 2016)

Great auricular nerve (see Figure 3)

1. Palpate the external ear canal
2. Locate the most cranial point of the transverse process of the atlas vertebra
3. Introduce the needle parallel to the transverse process
4. Direct the tip of the needle ventral to the most cranial part of the process
5. The nerve is very superficial and it is better to maintain the needle at a very shallow angle to the skin (Taboada, 2016)
6. Aspirate to prevent intravascular injection
7. Inject 0.5–1.5 ml of anaesthetic solution or combination (e.g. 0.25–0.5% bupivacaine)

Caution

Paralysis of the facial and/or temporopalpebral nerves preventing the animal from blinking (recommended to lubricate the eye every 2–4 h) (Taboada, 2016).

Sacro-coccygeal block

Indicated for perineal and tail procedures including: relief of urinary obstruction, perineal urethrostomy, anal sacculectomy, peri-anal mass removal and tail amputation (see **Figures 4** and **5**). Additional applications in the cat may include: vaginal delivery of kittens during dystocia, tail amputations or degloving injuries and other perineal procedures (O'Hearn & Wright, 2011).

Technique (O'Hearn & Wright, 2011)

1. The patient is placed in sternal recumbency, palpate the space between the sacrum and the 1st coccygeal vertebra while dorso-flexing tail (between coccygeal vertebrae 1 and 2 is also acceptable)
2. Clip and sterilely prepare the area
3. Use a 25-gauage 1′′ needle to penetrate the skin at midline
4. Direct the needle at a 30–45° angle and continue through the interarcuate ligament
5. There may be a palpable "pop" when the ligament is penetrated; as the needle is advanced, there is no resistance upon entering the epidural space
6. If bone is encountered, keep the needle in the skin and slightly angle the needle cranially or caudally off the bone until the space is entered
7. The needle feels more firmly seated once the ligament is penetrated than it does in the subcutaneous tissues
8. Inject 0.5 ml of 2% lidocaine or 0.5% bupivacaine; there should be no resistance

Intratesticular block

Intratesticular block is extremely easy to perform and provides up to 8 h of post-operative pain relief for patients undergoing castration by anaesthetising the spermatic cord. The addition of opioids to local blocking agents will extend the duration of pain relief (Bazin, 1997; Candido et al., 2002).

Technique (Goldberg et al., 2015a)

1. This is a very effective, low-cost application of LA agents
2. Mix 1.0 mg/kg (0.5 mg/lb) bupivacaine with 1.0 mg/kg (0.5 mg/lb) lidocaine and:
3. Either 0.075 mg/kg (0.035 mg/lb) morphine or 0.003 mg/kg (0.0015 mg/lb) buprenorphine to effectively double the duration of analgesia
4. Use a 25 g or 27 g 5/8′′ needle for most cats (see **Figure 6**) and a 22 g 1–1.5′′ needle for dogs (see **Figure 7**)
5. Place the needle through the testicle starting from the caudal pole aiming for the spermatic cord
6. It is acceptable, even desirable, for the needle to exit the testicle proximally as it is the spermatic cord that will receive the direct clamp stimulation
7. ASPIRATE BEFORE INJECTING
8. Inject, expecting firm backpressure, while withdrawing the needle
9. Expect to use about one-third to one-half of the drug volume per testicle leaving the organ firmly turgid
10. Repeat for another testicle
11. The total time for this procedure should be 1–2 min

Epidural catheter placement

Sterilised kits for placing epidural catheters are available commercially. They typically include a Tuohy needle, a loss of resistance syringe, a radiopaque catheter with guidewire, a connector and an antibacterial filter. Some kits also include a sterile pen, which is used to mark on the catheter the distance it should be advanced through the Tuohy needle

Figure 9. Epidural catheter injection. Courtesy Dr Sheilah Robertson

(Lerch, 2016a). Veterinary nurses can support the use of these by understanding the techniques used and by being confident in monitoring for complications (Barker, 2014b), as currently they are not allowed to undertake epidural catheter placement.

Technique (Goldberg et al., 2015b) (see Figures 8 and 9)

1. It is advisable to broaden the sterile field and to use sterile drapes so that inadvertent contamination of the catheter does not occur during handling and manipulation
2. The epidural tray should be opened sterilely and all its component parts identified.

   The stylet of the Tuohy needle should be removed and the catheter advanced into the needle. This ensures that it will pass into the needle when the needle is in the patient. The markings on the catheter should be used to identify when the catheter is near the tip of the needle, giving the anaesthetist more information about how far to advance the catheter into the needle when it is in place. Once this measurement is taken, the catheter should be carefully removed from the needle and the stylet replaced into the needle for use.
3. If the patient is sedated rather than anaesthetized, infiltrate the puncture site as well as the supra- and interspinous ligaments with 2% lidocaine to increase patient tolerance to the procedure.
4. Place the Tuohy needle into the epidural space using standard techniques. Make sure to direct the needle bevel (curve) cranially to assist with placement of the catheter. Once it is in place, tipping the needle hub caudally will further facilitate catheter exit from the needle tip and will assist with its advancement into the epidural space.
5. After confirming correct needle placement (using Loss of Resistance glass or plastic syringe, hanging drop, etc.), a small volume of the initial dose of LA is injected through the needle into the epidural space. This will facilitate insertion and advancement of the catheter.
6. An adapter can be attached to the needle hub (threading aid) to provide rigidity to the catheter.
7. While the needle is held firmly in position using the non-dominant hand, the catheter is coiled and held by the dominant hand to prevent it from falling outside the sterile area.
8. The needle stylet is removed and the epidural catheter is threaded through the needle, paying attention to the previously identified depth markings on the catheter. Once the catheter is determined to be at the needle tip, slight pressure is sometimes required to advance the catheter around the "corner" of the Tuohy needle. At this point, the second distance marker on the catheter will be visible at the needle hub.
9. The catheter should be advanced out of the needle several centimetres to the desired level of the blockade.
10. Once the catheter is advanced into the epidural space to the desired level, the needle can be carefully withdrawn over the catheter. To withdraw the needle, the catheter is held at its point of entry between the thumb and index fingers, while the needle is removed.
11. The catheter should now be secured in place. Subcutaneous tunnelling of the catheter several centimetres away from its point of entry provides additional fixation while at the same time minimising the potential for catheter site contamination.
12. After confirming the absence of spontaneous flow of cerebrospinal fluid (CSF) or blood from the catheter by

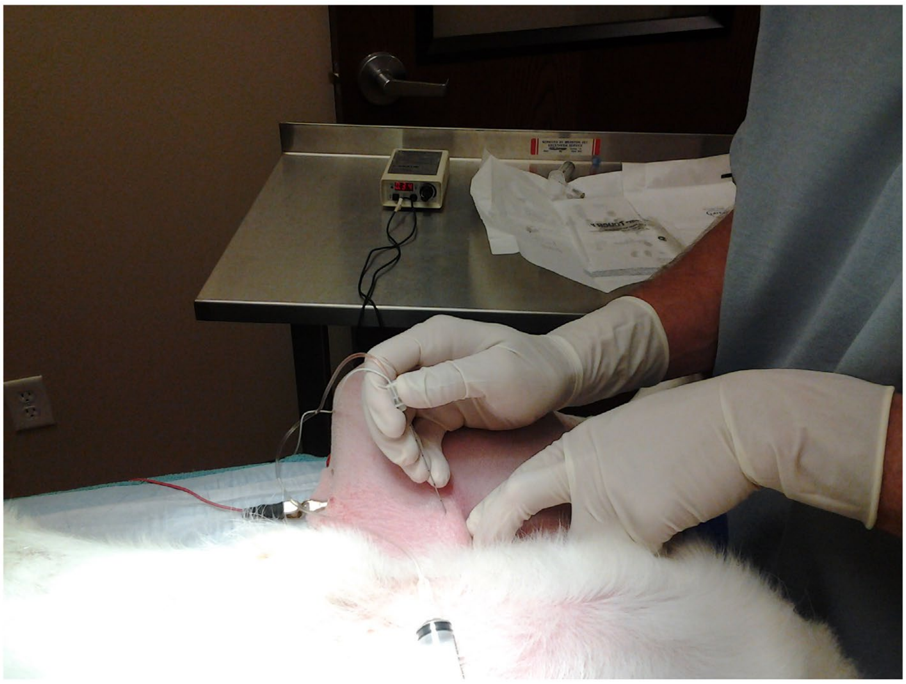

Figure 10. Femoral nerve block. Courtesy Dr Bonnie Wright

Figure 11. Femoral nerve block. Courtesy Dr Douglas Stramel

holding the end of the catheter in a dependent position, an adapter is attached to the end of the catheter. An aspiration test for CSF or blood is attempted with a 3-ml syringe.

13. Next, a bacterial filter is connected to the adapter. To avoid excessive amounts of air being injected into the epidural space, the filter should be primed with the LA solution before connecting it to the adapter.
14. The catheter can now be secured in place using one of a variety of transparent dressings and adhesive devices.
15. Following a negative aspiration, the remainder of the initial bolus of LA can be administered into the epidural space through the catheter.

Caution. The procedure is for catheter placement in dogs. A high incidence of catheter failure in cats (27%) is reported. The skill level for this procedure is high. Therefore, only those technicians or nurses with advanced training should attempt this procedure under supervision.

Femoral nerve block

This block is excellent for surgery of distal femur, stifle and distal limb in combination with sciatic nerve block. The advantages over an epidural are elimination of some epidural side effects such as in ability to walk, trauma to the cord, infection or no hair regrowth (see **Figures 10** and **11**).

Technique (Covey-Crump, 2016b)

1. With patient in lateral recumbency, hindlimb to treat uppermost
2. Abduct limb caudally, palpate femoral artery
3. Direct needle dorsomedially towards nerve which lies cranial to femoral artery
4. With nerve stimulator at 2 mA and gradually reducing, observe responses to nerve stimulation including quadriceps twitch, patellar twitch, stifle extension (reducing to 0.2 mA to avoid intrafascicular injection prior to injection) (sartorius twitch = needle too superficial)
5. Aspirate to avoid intra-arterial injection
6. Inject 0.2 ml/kg 0.5% bupivacaine or 0.75% ropivacaine

Cautions. Haematoma, intravascular injection, nerve damage

Sciatic nerve block

This block will result in anaesthesia of the stifle (partial) and the structures distal to it. The patient is positioned in lateral recumbency. The uppermost limb should be the one intended to be blocked. Identify the greater trochanter (GT) and ischiatic tuberosity (IT). Draw a line between these two points (GT–IT line). The puncture site is located at the point between the cranial and the middle thirds (Campoy & Mahler, 2013b) (see **Figures 12**, **13** and **14**).

Technique (Covey-Crump, 2016c)

1. With patient in lateral recumbency, hindlimb to treat uppermost on a line between GT and IT, puncture site is 1/3 distance from GT
2. Direct needle perpendicular to skin
3. With nerve stimulator at 2 mA and gradually reducing, observe responses to nerve stimulation – dorsiflexion of tarsus (peroneal nerve),

Figure 12. Sciatic nerve block. Courtesy Dr Douglas Stramel

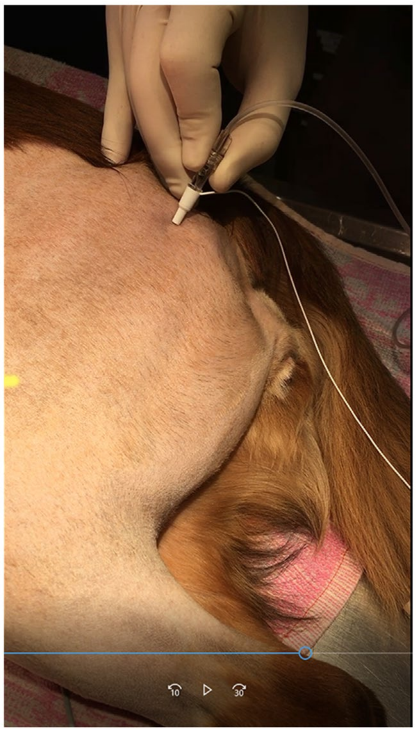

Figure 13. Sciatic nerve block 2. Courtesy Dr Mark Epstein

Figure 14. Sciatic nerve block. Courtesy Dr Bonnie Wright

plantarflexion (tibial nerve) (reducing to 0.2 mA to avoid intrafascicular injection prior to injection)

4. Aspirate to avoid intra-arterial injection
5. Inject 0.05–0.1 ml/kg 0.25–0.5% bupivacaine or 0.75% ropivacaine

Cautions. Risk of intravascular injection, nerve damage

Brachial plexus block

This technique is described to provide anaesthesia for structures distal to the elbow. However, using nerve stimulation to guide the block, investigators have been successful blocking structures from the mid-humerus distally (Covey-Crump, 2016a) (see **Figures 15**, **16** and **17**).

Technique (Campoy & Read, 2013; Mahler & Adogwa, 2008)

1. Identify first rib by axillary palpation. Pre-measure needle depth to a point where a line extending the course of the jugular vein crosses the first rib. The brachial plexus is just cranial to this point.
2. Insert needle craniomedial to the acromion in a caudoventral direction parallel to the jugular vein and in a strictly sagittal plane.
3. With nerve stimulator at 2 mA and gradually reducing, observe responses to nerve stimulation (reducing to 0.2 mA to avoid intrafascicular injection prior to injection).
4. At point of radial nerve stimulation (and no further than premeasured depth), aspirate to avoid intravascular (blood) or interpleural (air) injection.
5. Inject 0.1 ml/kg 0.5% bupivacaine or 0.75% ropivacaine.
6. Withdraw needle 0.5–1 cm, aspirate, then inject further 0.1 ml/kg.
7. Repeat step 6, injecting a final 0.1 ml/kg beneath the point of the shoulder.

Cautions. Intravascular, interpleural injection, haematoma. Nerve damage.

Conclusion

Local anaesthetic blocks, even those that require intermediate skill and training, are achievable for the veterinary nurse. Local analgesic and anaesthetic techniques can be mastered and contribute to multimodal analgesic therapy and balanced anaesthesia, thereby decreasing the side effects

Figure 15. Brachial plexus landmark. Courtesy Dr Tamara Grubb

Figure 16. Brachial plexus nerve block – needle insertion. Courtesy Dr Tamara Grubb

Figure 17. Brachial plexus first injection. Courtesy Dr Tamara Grubb

of any individual drug. These techniques are associated with little morbidity and mortality. When used pre-emptively, these techniques obtund or prevent wind up. As a result, patient comfort is increased and the intra-operative and post-operative requirement of analgesics is decreased. The incorporation of these techniques in your practice is relatively inexpensive. While the veterinary nurse may not be permitted to perform all the listed blocks, it is wise to understand the procedure to aid the veterinary surgeon.

References

Barker, M. (2013a). Local anaesthesia – Part 1 regional anaesthesia of the head. *Veterinary Nursing Journal, 28*, 396–399.

Barker, M. (2014b). Local anaesthesia – Part 2: Regional anaesthesia of the thoracic limb. *Veterinary Nursing Journal, 29*, 47–50.

Bazin, J. E., Massoni, C., Bruelle, P., Fenies, V., Groslier, D., & Schoeffler, P. (1997, September). The addition of opioids to local anaesthetics in brachial plexus block: The comparative effects of morphine, buprenorphine and sufentanil. *Anaesthesia, 52*, 858–862.

Borer, K. (2006, April). Local analgesic techniques in small animals. *In Practice, 28*, 200–207.

Borgeat, A., & Aguirre, J. (2010). Update on local anesthetics. *Current Opinion in Anaesthesiology, 23*, 466–471.

Butterworth, J. F., & Strichartz, G. R. (1990). Molecular mechanisms of local anesthesia: A review. *Anesthesiology, 72*, 711–734.

Campoy, L., & Mahler, S. (2013). The pelvic limb. In L. Campoy & M. Read (Eds.), *Small animal regional anesthesia and analgesia* (pp. 215–217). Ames, IA: John Wiley & Sons.

Campoy, L., & Read, M. R. (2013). The thoracic limb. In *Small animal regional anesthesia and analgesia* (pp. 146–147). Ames, IA: Wiley-Blackwell.

Candido, K. D., Winnie, A. P., Ghaleb, A. H., Fattouh, M. W., & Franco, C. D. (2002). Buprenorphine added to the local anesthetic for axillary brachial plexus block prolongs postoperative analgesia. *Regional Anesthesia and Pain Medicine, 27*, 162–167.

Cassuto, J., Sinclair, R., & Bonderovic, M. (2006). Anti-inflammatory properties of local anesthetics and their present and potential clinical implications. *Acta Anaesthesiologica Scandinavica, 50*, 265–282.

Covey-Crump, G. (2016a). Regional anesthetic blocks of the limbs. In P. Lerche, T. K. Aarnes, G. Covey-Crump, & F. M. Taboada (Eds.), *Handbook of small animal regional anesthesia and analgesia techniques* (p. 56). Oxford: John Wiley & Sons.

Covey-Crump, G. (2016b). Regional anesthetic blocks of the limbs. In P. Lerche, T. K. Aarnes, G. Covey-Crump, & F. M. Taboada (Eds.), *Handbook of small animal regional anesthesia and analgesia techniques* (p. 66). Oxford: John Wiley & Sons.

Covey-Crump, G. (2016c) Regional anesthetic blocks of the limbs. In P. Lerche, T. K. Aarnes, G. Covey-Crump, & F. M. Taboada (Eds.), *Handbook of small animal regional anesthesia and analgesia techniques* (p. 70). Oxford: John Wiley & Sons.

Dillane, D., & Tsui, B. (2012). Is there still a place for the use of nerve stimulation? *Pediatric Anesthesia, 22*, 102–108.

Duke, T. (2000). Local and regional anesthetic and analgesic techniques in the dog and cat: Part I. Pharmacology of local anesthetics and topical anesthesia. *Canadian Veterinary Journal, 41*, 883–884.

Epstein, M. (2010). *Novel uses of local anesthetics for perioperative pain control*. Proceedings 82nd Western Veterinary Conference, February 14–18, Las Vegas, NV, pp. 1–7.

Epstein, M. (2017). Ketamine and local anesthetics review. *VIN IVAPM core review week 2 neuropharmacology 1*. Retrieved June 29, 2017 from www.vin.com/Members/CMS/Project/DefaultAdv1.aspx?pId=18482&catId=98940&id=8077032

Epstein, M., & Grubb, T. (2017). *Concept to clinic: New rules of local anesthetics*. Proceedings Western Veterinary Conference, 89th Annual Conference, Las Vegas, NV, March 5–9, S27FP.

Epstein, M. E., Rodan, I., Griffenhagen, G., Kadrlik, J., Petty, M. C., Robertson S.A., & Simpson, W. (2015). 2015 AAHA/AAFP pain management guidelines for dogs and cats. *Journal of the American Animal Hospital Association, 51*, 67–84.

Ford, D. J., Pither, C., & Raj, P. P. (1984). Comparison of insulated and uninsulated needles for locating peripheral nerves with a peripheral nerve stimulator. *Anesthesia & Analgesia, 63*, 925–928.

Goldberg, M. E., Shaffran, N., Spelts, K., Liss, D., McNerney, T., Farry, T., ... Dupre, J. L. (2015a). Locoregional analgesic blocking techniques. In M. E. Goldberg, & N. Shaffran (Eds.), *Pain management for veterinary technicians and nurses* (1st ed., pp. 75–76). Ames, IA: John Wiley & Sons.

Goldberg, M. E., Shaffran, N., Spelts, K., Liss, D., McNerney, T., Farry, T., Rowland, S., & Dupre, J. L. (2015b). Locoregional analgesic blocking techniques. In M. E. Goldberg, & N. Shaffran (Eds.), *Pain management for veterinary technicians and nurses* (1st ed., pp. 80–81). Ames, IA: John Wiley & Sons.

Gracis, M. (2013). The oral cavity. In L. Campoy, & M. R. Read (Eds.), *Small animal regional anesthesia and analgesia* (pp. 119–140). Ames, IA: Wiley-Blackwell.

Holmstrom, S., Bellows, J., Juriga, S., Knutson, K., Niemiec, B. A., & Perrone, J. (2013). American veterinary dental college. 2013 AAHA dental care guidelines for dogs and cats. *Journal of the American Animal Hospital Association, 49*, 75–82.

Johnson, S. M., Saint John, B. E., & Dine, A. P. (2008, April). Local anesthetics as antimicrobial agents: A review. *Surgical Infections*, 9, 205–213.

Lerch, P. (2016a). Introduction. In P. Lerche, T. K. Aarnes, & G. Covey-Crump, F. M. Taboada (Eds.), *Handbook of small animal regional anesthesia and analgesia techniques* (p. 8). Oxford: John Wiley & Sons.

Lerch, P. (2016b). Introduction. In P. Lerche, T. K. Aarnes, G. Covey-Crump, & F. M. Taboada (Eds.), *Handbook of small animal regional anesthesia and analgesia techniques* (p. 9). Oxford: John Wiley & Sons.

Love, L., & Egger, C. (2009, February 28) Nerve location through electrical nerve stimulation. *Veterinary Medicine*. Retrieved July 14, 2017 from https://veterinarymedicine.dvm360.com/nerve-location-through-electrical-nerve-stimulation

MacDougall, L. M., Hethey, J. A., Livingston A., Clark, C., Shmon, C. L., Duke-Novakovski, T. (2009, September). Antinociceptive, cardiopulmonary, and sedative effects of five intravenous infusion rates of lidocaine in conscious dogs. *Veterinary Anaesthesia and Analgesia, 36*, 512–522.

Mahler, S. P., & Adogwa, A. O. (2008). Anatomical and experimental studies of brachial plexus, sciatic, and femoral nerve-location using peripheral nerve stimulation in the dog. *Veterinary Anaesthesia and Analgesia, 35*, 80–89.

Mathews, K., Kronen, P. W., Lascelles, D., Nolan, A., Robertson, S., Steagall, P. V. M., ... Yamashita, K. (2014). Guidelines for recognition, assessment and treatment of pain: WSAVA global pain council. *Journal of Small Animal Practice, 55*(6), E10–E68.

McCarthy, G. C., & Megalla S. A. Habib, A. S. (2010, June 18). Impact of intravenous lidocaine infusion on postoperative analgesia and recovery from surgery: A systematic review of randomized controlled trials. *Drugs, 70*, 1149–1163.

O'Hearn, A. K., & Wright, B. D. (2011). Coccygeal epidural with local anesthetic for catheterization and pain management in the treatment of feline urethral obstruction. *Journal of Veterinary Emergency and Critical Care, 21*, 50–52.

Orebaugh, S. L., Williams, B. A., & Kentor, M. L. (2007). Ultrasound guidance with nerve stimulation reduces the time necessary for resident peripheral nerve blockade. *Regional Anesthesia and Pain Medicine, 32*, 448–454.

Orebaugh, S. L., Williams, B. A., Vallejo, M., & Kentor, M. L. (2009). Adverse outcomes associated with stimulator-based peripheral nerve blocks with versus without ultrasound visualization. *Regional Anesthesia and Pain Medicine, 34*, 251–255.

Raw, R. M., Read, M. R., & Campoy, L. (2013). Peripheral nerve stimulators. In L. Campoy, & M. R. Read (Eds.), *Small animal regional anesthesia and analgesia* (1st ed., pp. 65–76). Ames, IA: John Wiley& Sons.

Schroeder, K. (2013a). History of regional anesthesia. In L. Campoy, & M. R. Read (Eds.), *Small animal regional anesthesia and analgesia* (pp. 1–9). Ames, IA: Wiley-Blackwell.

Schroeder, K. (2013b) History of regional anesthesia. In L. Campoy & M. R. Read (Eds.), *Small animal regional anesthesia and analgesia* (1st ed., pp. 3–9). Ames, IA: John Wiley & Sons.

Steffey, E. P., & Booth, N. H. (1995). Local anesthetics. In H. R. Adams (Ed.), *Veterinary pharmacology and therapeutics* (7th ed., pp. 358–371). Ames, IA: Iowa State University Press.

Taboada, F. M. (2016). Blocks of the head. In P. Lerche, T. K. Aarnes, G. Covey-Crump, & F. M. Taboada (Eds.), *Handbook of small animal regional anesthesia and analgesia techniques*(p. 50). Oxford: John Wiley & Sons, Ltd.

Trimble, T., & Leece, E. A. (2016). Essential local anaesthetic blocks for small animal practice: The limbs. *Companion Animal, 21*, 496–503.

Williams, S. R., Chouinard, P., Arcand, G., Harris P., Ruel, M., Boudreault, D., & Girard, F. (2003). Ultrasound guidance speeds execution and improves the quality of supraclavicular block. *Anesthesia & Analgesia, 97*, 1518–1523.

Wolfe, T. M., & Muir, W. (2003). Local anesthetics: Pharmacology and novel applications. *Compendium, 25*(12), 916–927.

Multiple Choice Questions

1. Which of the following would NOT be a good reason for utilising a local anaesthetic (LA) technique?

(a) LA can have anti-inflammatory effects
(b) LA permits reduction of general anaesthetic requirements
(c) Requirements for post-operative pain management are lowered
(d) LA can have pro-inflammatory effects

2. The 2015 edition of the AAHA/AAFP Pain Management Guidelines states: "because of their safety and significant benefit, Local Anesthetics (LA) should be utilized, insofar as possible, with every surgical procedure".

(a) True
(b) False

3. Which of the following drugs is commonly used for LA techniques?

(a) Butorphanol
(b) Carprofen
(c) Lidocaine
(d) Methadone

4. Which LA technique would be most suitable for a patient undergoing a total ear canal ablation?

(a) Epidural
(b) Auriculotemporal block
(c) Brachial plexus block
(d) Sciatic nerve block

5. Which of the following is a rare side effect of some LAs in cats:

(a) Salivation
(b) Methaemoglobinaemia
(c) Excitation
(d) Agression

6. Which type of LA block placement may have reduced efficacy of the block and require a larger volume of LA compared to other techniques?

(a) Blind
(b) Electrolocation
(c) Ultrasound guidance
(d) Combined ultrasound guidance and electrolocation

7. Which LA technique would be most suitable for a patient undergoing surgery below the elbow?

(a) Epidural
(b) Auriculotemporal block
(c) Brachial plexus block
(d) Sciatic nerve block

8. What percentage of epidural catheter failure in cats is reported?

(a) 55%
(b) 38%
(c) 75%
(d) 27%

For the answers to the MCQs, please go to: http://www.bvna.org.uk/publications/veterinary-nursing-journal