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Local Anaesthetic Techniques Mini Series

Session 3: Advanced Local Anaesthetic Techniques

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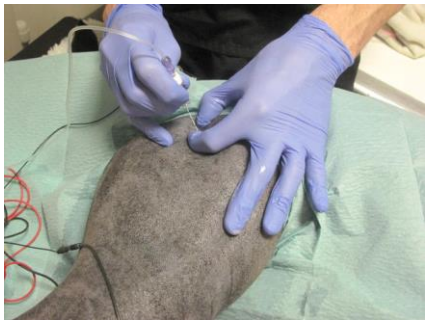


Local Anaesthetic Techniques in Small Animal Practice
Matt Gurney BVSc CertVA DipECVAA MRCVS

Thoracic Limb Blocks

Brachial Plexus

By infiltrating local anaesthetic around the brachial plexus, analgesia is provided to structures distal to the elbow. A spinal needle is a useful length (22G, 2.5") – choose an appropriate size for a dog or cat. These are good blocks to employ a nerve locator for given the spread of nerves within the plexus.

This is inserted at the point of the shoulder and advanced medial to the scapula to the level of the first rib. This is made easier if an assistant can elevate the scapula from the rib cage. Following aspiration local anaesthetic is deposited and the needle withdrawn and the processes repeated at several sites. Risks of this technique are haemorrhage, puncture of the thoracic cavity and damage to the brachial plexus. These are rare and should not dissuade you!

Various approaches for performing a brachial plexus block have been reported (Campoy and others 2010, (Rioja, Sinclair, Chalmers, Foster, & Monteith, 2011). Those evaluated clinically include a nerve locator technique reporting 91% success of providing anaesthesia for a humeral osteotomy in dogs (Futema et al., 2002) and a nerve locator technique in cats demonstrating an isoflurane-sparing effect and reduced post-operative pain (Mosing, Reich, & Moens, 2010).

RUMM – radial, ulnar, musculocutaneous, median

The RUMM block aims to anaesthetise the radial, ulnar, median & musculocutaneous nerves at mid-humeral level to provide anaesthesia distal to the elbow (Trumpatori et al., 2010). Complete anaesthesia of all four nerves was difficult to achieve in this study and the technique warrants investigation using nerve location or ultrasound to improve efficacy. I use a nerve locator technique.

Approach the radial laterally mid humerus – you can flick the radial nerve with you finger - and the UMM medially, proximal to the elbow.
Volume (20-30kg dog)– radial nerve 1-1.5ml, UMM 3ml

Figure 1 Canine thoracic limb; lateral view illustrating the technique for lateral (radial nerve) block. Tm (Lh), lateral head of the triceps muscle; Brm, brachialis muscle, Rn, radial nerve.

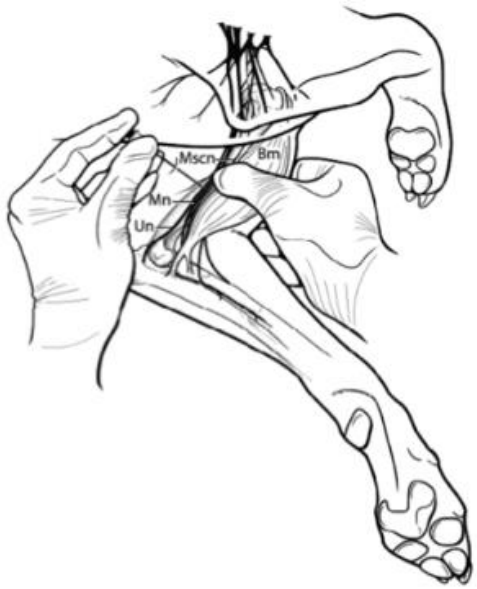


Figure 2 Canine thoracic limb; medial view illustrating the technique for medial (ulnar, musculocutaneous, and median nerve) block. Bm, biceps brachialis muscle; Un, ulnar nerve; Mscn, musculocutaneous nerve; Mn, median nerve.

Blocks applicable to thoracic & pelvic limbs
Intravenous Regional Anaesthesia (IVRA)
Not widely used – limited by tourniquet time of max 90 mins. Excellent technique for short procedures. Advocated for using in sedated patients that you may not want to anaesthetise – my experience is not great doing this (apart from digit amps in sheep!)- the block must work 100% otherwise you need to GA the dog.
Comparable analgesia to a brachial plexus block.
A catheter is placed percutaneously in a peripheral vein distal to the surgical site. A tourniquet is then applied proximal to this following the use of an Esmarch bandage to exsanguinate the limb. Following tourniquet application a pulse should not be palpable. Lidocaine is then injected intravenously at a dose not to exceed the toxic dose of 4mg/kg – use of 3mg/kg is recommended. Onset of analgesia should be around 10 minutes. Note than bupivacaine and ropivacaine are not suitable for this technique due to their increased potential for cardiotoxicity compared to lidocaine. (Ropivacaine for IVRA has been investigated successfully in man, though not in animals). The tourniquet must be tight enough to prevent escape of local anaesthetic into the circulation as this reduces the efficacy of the technique and also increases the risk of systemic side effects. Following intravenous injection the tourniquet should remain in place for at least 30 minutes otherwise there is a risk of systemic release and toxicity. A tourniquet should not be left in place for longer than 90 minutes – beyond this there is a risk of ischaemic damage and reperfusion injury.

Tourniquet pain post-procedure is an issue in man. Limited by adding 0.5µg/kg dexmedetomidine to the lidocaine and by using NSAIDs peri-op.
(A. A. Webb, Cantwell, Duke, & Adkins, 1999)Search for this in pubmed – the pdf is free to access – reviews IVRA in dogs.

Interdigital Nerves
Area Desensitised- selected digit
Indications- digit surgery
Volume to inject- 1-2mL
Needle size 23G 5/8”
Site for injection- nerves run either side of the digit so infiltration must occur in two places interdigitally.

Intra-articular analgesia
Opioid binding sites have been demonstrated in canine synovial tissue using radio ligand studies in dogs with inflamed joints (Keates, Cramond, & Smith, 1999). Studies by the same authors failed to demonstrate an effect of intra-articular (IA) morphine versus saline and concluded that further work was necessary examining dose. Two previous clinical studies in dogs undergoing surgery for cranial cruciate ligament repair reported beneficial effects of morphine 0.1mg/kg IA (Sammarco and others 1996, Day and others 1995). When force plate analysis was used as an outcome measure in dogs following unilateral elbow arthroscopy no beneficial effect to IA morphine was apparent (Gurney and others, 2012). Evidence from meta-analyses that single dose IA morphine in the human knee produces analgesia for up to 24 hours (Gupta and others 2001, Kalso and others 2002) has subsequently been reversed following consideration of confounding factors (Rosseland and others 2005) such as degree of inflammation, type of surgery, baseline pain and intensity of early post-operative pain.
The peri-operative analgesic effect of IA bupivacaine has been documented in dogs (Gurney and others 2012, Hoelzler and others 2005, Sammarco and others 1996). A series of cases of chondrolysis in people undergoing shoulder arthroscopy where 72-hour bupivacaine infusions were used brought into question the use of IA local anaesthetics (Petty and others 2004). Bupivacaine 0.5% demonstrated greater chondrotoxicity than 0.25% with significant chondrocyte damage occurring after 72 hours of bupivacaine 0.5% (Dragoo and others 2008). The effect of bupivacaine 0.125% on human or bovine chondrocytes was no different to that of 0.9% saline.

A British Journal of Anaesthesia editorial concluded that prolonged infusions of bupivacaine might have adverse clinical effects however single injection of low concentration bupivacaine appears to be safe (S. T. Webb & Ghosh, 2009).

The in vitro effect of mepivacaine on equine chondrocytes demonstrated less chondrotoxicity than lidocaine or bupivacaine (Park, Sutradhar, Hong, Choi, & Kim, 2011) and in dogs IA mepivacaine blunts the haemodynamic response to arthroscopic surgery (Dutton and others 2012).
The above paragraph is taken from my review of peri-operative analgesia. (Gurney, 2012)
Further to these concerns other authors have suggested alternative loco-regional techniques where possible.
For elbow arthroscopy in dogs we use lidocaine 1ml/10kg IA before surgery starts, the infuse 1ml/10kg bupivacaine prior to portal closure. These dogs are comfortable in the recovery period and we have no evidence that this is detrimental to the patient. Buprenorphine is administered 4 hrs after a methadone premed and later that evening is necessary. This protocol would be fine for elbow or stifle arthrotomy as well.

Pelvic Limb Blocks

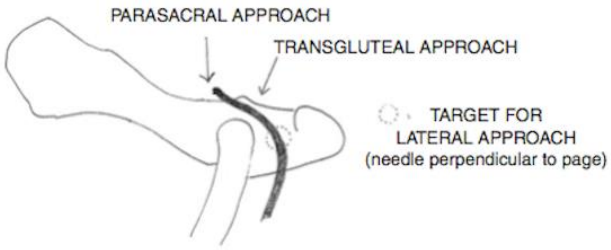


Figure 1 Approaches described for the sciatic nerve blocks.

APPROACHES DESCRIBED FOR SCIATIC NERVE BLOCK

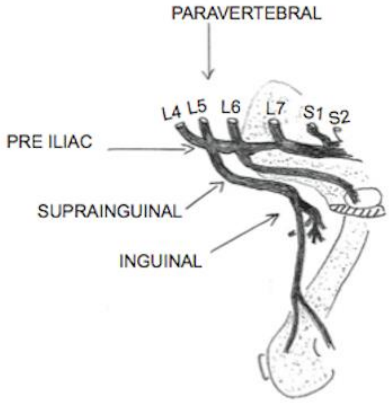


Figure 2 Approaches described for the femoral/lumbar plexus nerve block.

APPROACHES DESCRIBES FOR FEMORAL / LUMBAR PLEXUS NERVE BLOCK

Successful peripheral nerve block (PNB) techniques require thorough anatomical knowledge for the establishment of reliable landmarks, puncture sites, the direction and depth of needle insertion, and relevant structures to be avoided.

The innervation of the canine pelvic limb has been examined in several cadaver studies with the aim of identifying appropriate landmarks and suitable approaches to perform PNBs, specifically the lumbar plexus (LP), the femoral/saphenous nerve (FN/SaN), the sacral plexus (SP) and the sciatic nerve (ScN). The lumbar and sacral plexuses provide the main innervation of the pelvic limb. Anaesthesia of the entire limb can be achieved with perineural administration of local anaesthetic solution in proximity to the main nerves of the lumbosacral plexus (L4-S2) which are the femoral (L4-L6) and the sciatic (L6-S2) nerves plus the lateral femoral cutaneous nerve (LFCN) (L3-L5), obturator (L4-L6) and the caudal cutaneous femoral nerve (L7-S2) (Bailey et al. 1988, Dyce et al. 1996, Portela et al. 2010, Echeverry et al. 2012b, Campoy & Mahler 2013).

The LP is described as six nerves: the ileohypogastric, ileoinguinal, genitofemoral, lateral femoral cutaneous, femoral, and obturator nerve (Evans & de Lahunta 2010). The sacral plexus is composed of the pudendal, caudal cutaneous femoral, gluteal and sciatic nerves (Portela et al. 2010, Evans & de Lahunta 2010).
In dogs the stifle is innervated by the medial articular nerve (SaN in origin), the caudal articular nerve and the lateral articular nerve (both ScN in origin). The medial articular nerve occasionally receives branches from the obturator nerve. In dogs the caudal articular nerve is often absent but by contrast this is the largest of the articular nerves in the cat (O'Connor & Woodbury 1982).
The paths of the FN and ScN have each been described in anatomical studies (Mahler 2008, Echeverry et al. 2010) in the dog as well as guides to dissection (Evans & deLahunta 2010). The FN lies within the iliopsoas muscle then passes into the proximal pelvic limb where it enters the quadriceps femoris between the vastus medialis and the rectus femoris, splitting into branches to innervate quadriceps femoris. Before leaving the iliopsoas muscle, the SaN arises from the cranial side of the FN and a muscular branch splits off to innervate the cranial and caudal bellies of sartorius muscle. The femoral artery and vein run alongside and craniomedial to the FN. The SaN supplies skin on the medial side of the thigh, stifle, tarsus and paw as well as fibres to the medial articular nerve (O'Connor & Woodbury 1982).
The ScN exits the pelvis through the greater ischiatic notch and runs caudally towards the coxofemoral joint, passing caudal to the greater trochanter of the femur. It passes over the gluteus profundus muscle, deep to gluteus medius and gluteus superficialis muscles. It then travels distally between biceps femoris and the adductor muscles. With biceps femoris laterally and semitendinosus medially it divides into terminal branches, the tibial and peroneal nerves. The level at which this division occurs varies (Dyce et al. 1996).

An overview of PNB approaches
The ScN nerve can motor blockade and work flow factors such as time to perform the technique and equipment required will be important in future evaluations to determine the long term adoption of each approach.
A measure of success in cadaver studies is the length to which the target nerve is stained with dye. The desired stain length of more than 2cm stems from an original study by Raymond et al. (1989) who concluded that exposure length is critical to blockade success. Only when local anaesthetic concentration is very high is a length of three nodes of Ranvier (intermodal distance 1mm) adequate. At any given concentration of lidocaine there is a direct relationship between the incidence of block in a fibre population and the length of nerve exposed to LA, with the concentration of local anaesthetic required to block 50% of fibres decreasing by half as length was increased from 6mm to 25-30mm.
The sciatic nerve
Several approaches to anaesthetise the ScN have been described at various locations along its course from its origin to the division into common peroneal and tibial nerves. These are illustrated in Fig. 1 and summarised in Table 1.
The proximal ScN block, also described as the lateral approach, whereby the ScN is targeted between the greater trochanter and the ischiatic tuberosity and the needle advanced perpendicular to the skin has been described in laboratory and clinical studies (Campoy et al. 2008a, Campoy et al. 2008b, Vettorato et al. 2012). Under ENL, more than 2cm of nerve was stained with dye (Campoy et al., 2008; Portela et al., 2010). When combined with a FN or LP block an overall success rate, judged by intra-operative rescue analgesic be approached between the greater trochanter of the femur and the ischiatic tuberosity (Campoy et al. 2008), in the gluteal region (Mahler & Adogwa 2008) or through a parasacral approach (Portela et al (2010). The FN can be blocked inguinally at the femoral triangle (Mahler & Adogwa 2008); through a single paramedian injection at the psoas compartment in the L5–L6 intervertebral space (Campoy et al. 2008); by three paravertebral injections aiming at the spinal lumbar nerves (L4, L5 and L6) (Portela et al. 2010), via a pre-iliac approach (Portela et al. 2012) or using a suprainguinal approach (Echeverry et al. 2012a). These approaches are represented in the above figures. At the current time the reader will appreciate that this is an area of discovery, with the bulk of literature examining new approaches to these nerves. To date there are no veterinary studies directly comparing one approach versus another, and therefore one is unable to draw conclusions of superiority.

Patient factors such as risk of vascular puncture, duration of consumption, of 77% was reported in dogs undergoing stifle surgery (Echeverry et al., 2012; Vettorato et al., 2012). Mahler and Adogwa (2008) document that ENL of the ScN is possible with an approach through the superficial gluteal muscle in a location more dorsal than the proximal sciatic approach described by Campoy et al. (2008a).
This approach is named the transgluteal approach by Campoy & Mahler (2013). No further work has been conducted using this approach.

With the parasacral approach (Portela et al. 2010) the ScN is blocked at its origin from L7, S1 and S2. A line drawn from the cranial dorsal iliac crest to the ischiatic tuberosity is divided into thirds with the injection site at the junction of the cranial and middle third. The needle is advanced perpendicular to the skin under ENL guidance. A reported success rate of 60% is attributed to the volume of injectate used ($0.05ml^{-1}kg^{-1}$), therefore an increased volume is recommended but the ideal volume is yet to be determined. The parasacral technique is reported in humans in combination with a paravertebral LP block for anaesthesia of the entire pelvic limb (Ho & Karmakar, 2002; Mahler & Adogwa, 2007), and advocated by Campoy (2013) for femoral head osteotomy in the dog, although yet to be formally studied in both dogs and humans.

Ultrasound guidance has been employed in blockade of the ScN in dogs (Campoy et al. 2010, Echeverry et al. 2010 Shilo et al. 2010, Costa Farre et al. 2011) and cats (Haro et al 2012). Campoy et al. (2010) describe the transducer positioned immediately distal to the ischiatic tuberosity and greater trochanter with an in-plane approach directing the needle from the caudal thigh. In seven of eight nerves staining was mean 2.8 ± SD 0.3cm, thus judged successful. In the failed block only the muscular branch of the ScN was stained. In this case a foot twitch was not achieved with ENL, but caudal thigh contraction highlighting the importance of good ENL technique and the benefit of using ENL with USG. This technique was employed in clinical cases by the authors to good effect (Campoy et al. 2012a). Lower success is reported when using an out-of-plane needle-transducer relationship; the tibial component was only partially blocked in all five dogs, which was attributed to incomplete spread of injectate around the nerve (Costa-Farré, Blanch, Cruz, & Franch, 2011; Portela et al., 2013). Echeverry et al. (2010) took an USG ENL midfemoral approach, having identified this as the optimal acoustic window, using an in-plane transducer-needle relationship. Upon dissection they reported successful ScN staining, but do not specify a definition of this. This approach has not received evaluation in surgical subjects. Work conducted in cats used an USG mid-femoral approach with the needle in-plane. Lidocaine 2 mg kg^{-1} diluted to 1mL produced complete sensory and motor block of the ScN in all six cats studied (Haro et al. 2012). Studies by Shilo et al. (Shilo et al., 2010) target the ScN as it crosses the ilium using an USG in-plane technique with a long axis view of the nerve. Injectate volumes used were 0.03, 0.06 and 0.12mL kg^{-1}. Success rates of 67% were attributed to a lack of circumferential spread of local anaesthetic around the nerves leading the authors to conclude that either the technique or injectate volume requires further attention before widespread clinical use.
In a cadaver study Rasmussen et al. (2006a) assessed a caudal mid-thigh approach to the common peroneal and tibial nerves using a blind injection technique, reporting good visual staining of nerves upon dissection (although failed to define the meaning of 'good visual staining'). The success rate of this block when combined with a blind, mid-thigh SaN block in a clinical study of stifle surgery was low with dogs in the treatment group requiring more opioids in the post-operative period (Rasmussen, Lipowitz, & Graham, 2006). The authors correctly conclude that these blocks failed to incorporate the lateral cutaneous femoral and the obturator nerve.

The femoral nerve
The SaN is a branch of the FN and provides sensory input from the medial thigh and stifle, but lacks a motor component. Approaches to the FN are illustrated in Fig. 2 and summarised in Table 2. Although the SaN is the target for local anaesthetic deposition, when using ENL the FN is used as a surrogate for the SaN because it contains both sensory and motor fibres. This introduces a degree of variability and may affect success of PNB. To eliminate this variability the FN can be targeted closer to the spinal cord in the LP. The combined blockade of the FN and ScN has been associated in humans with incomplete analgesia during some surgical procedures carried out on the knee (Sakura et al. 2010) and hip (Murray et al. 2010).

As a result, blockade of the lumbar plexus (LP) and ScN is suggested in man when analgesia of the entire pelvic limb is required (Murray et al. 2010; Sakura et al. 2010). The inguinal approach to the FN, under the guidance of ENL has been used in several clinical studies of dogs undergoing stifle surgery, in combination with a ScN block.

Two studies have compared an inguinal FN block combined with a ScN block to extradural local anaesthetic. Campoy et al. (2012a) compared extradural morphine-bupivacaine to PNB bupivacaine and Caniglia et al. (2012) used a lidocaine bupivacaine combination either as a PNB or administered extradurally. Each reported a comparable degree of analgesia to the same combinations used extradurally, with Campoy et al. reporting duration of analgesia of 10 hours with a femoral and sciatic nerve block (FSNB). Each of these studies used a small population of subjects and these promising results should be validated by larger studies.

Mahler (Mahler & Adogwa, 2007) reported a lack of reliable anatomical landmarks to suggest the depth to which the needle should be advanced to block the FN when an inguinal approach is used, and therefore techniques such as ENL and USG have been investigated. With the aim of improving the chances of success, several investigators have examined the use of USG in performance of the FN block. When imaged from the medial side of the limb in the inguinal area, Shilo et al. (2010) were unable to observe the saphenous nerve (SaN) directly prior to injection. With an injectate volume of 0.4mL kg^{-1} a success rate of 83% was reported by Echeverry et al (Echeverry et al., 2010; Rasmussen et al., 2006) who describe only one acoustic window possible in which to locate the FN inguinally. The FN was located in only 50% (four of eight) with staining produced in 62.5% (five of eight) of cadavers. However Campoy et al. (2010) report a much higher success in observing the FN ultrasonographically, perhaps due to the positioning of the dog. Both Echeverry et al. and Shilo et al. positioned dogs in lateral recumbency with the limb to be imaged and blocked down. With dogs in the same recumbency, Campoy targeted the uppermost limb, abducting it 90^{o} and extended caudally. With a volume of 0.4ml kg^{-1} more than 4cm of nerve staining was achieved in all cases.

Campoy et al. (Campoy et al., 2008) describe a paravertebral approach to the LP at the level of the 5th lumbar vertebra. Based on dye staining studies a volume of 0.4mL kg^{-1} is recommended, although this volume produced epidural staining in 8.7% of cases. Such an approach is described in cats under USG between L6 and L7 transverse processes. A 1mL volume produced FN staining of 3-6.4cm in a cadaver study (Haro et al. 2013). Portela et al. (Portela et al., 2010) describe a similar paravertebral style approach, using a three injection technique and 0.2-0.4 mL kg^{-1}. Basing their outcomes on loss of proprioception, the ability to walk and pressure from a Halsted clamp to the medial thigh, these investigators report a success rate of 87.5%. No complications were encountered during the study nor during a 3-month follow up period. Cadavers were not specifically examined for extradural staining. In a pre-iliac approach to FN within the psoas compartment using a combination of lidocaine and new methylene blue Portela et al. (Portela et al., 2013) evaluated the degree of nerve staining, cardiovascular response to surgery and analgesia requirements during a two hour period post-surgery. Successful nerve staining was documented (more than 7cm) and no cardiovascular response was recorded in 13 of 15 dogs. Pain scores were low for dogs in which the block was successful.

In order to achieve better ultrasonographic observation of the FN, a suprainguinal approach is described (Echeverry et al., 2012; Shilo et al., 2010). With the animal in dorsal recumbency and the pelvic limb extended, the ultrasound transducer is applied across the iliopsoas muscle at the level of the inguinal nipple. The FN was easily located and with 0.3mL kg^{-1} injectate volume a donut sign was identifiable upon injection. (The ‘donut sign’ refers to the ultrasonographic appearance of injectate surrounding the target nerve). The FN stained an average length of 6.2 cm and all dogs demonstrated proprioceptive deficits and an inability to bear weight. The same authors further examined the optimal injectate volume with this approach and concluded 0.2mL kg^{-1} produces successful staining of more than 2cm of both femoral and obturator nerve. With this approach the LFCN was stained, but not by as much as 2cm. The advantages of this approach whereby the FN, ON and LFCN are targeted shows promise and requires evaluation in clinical subjects. With the inguinal approach to the FN, vascular puncture and potential intravascular injection is a risk, which is negated by the suprainguinal approach.

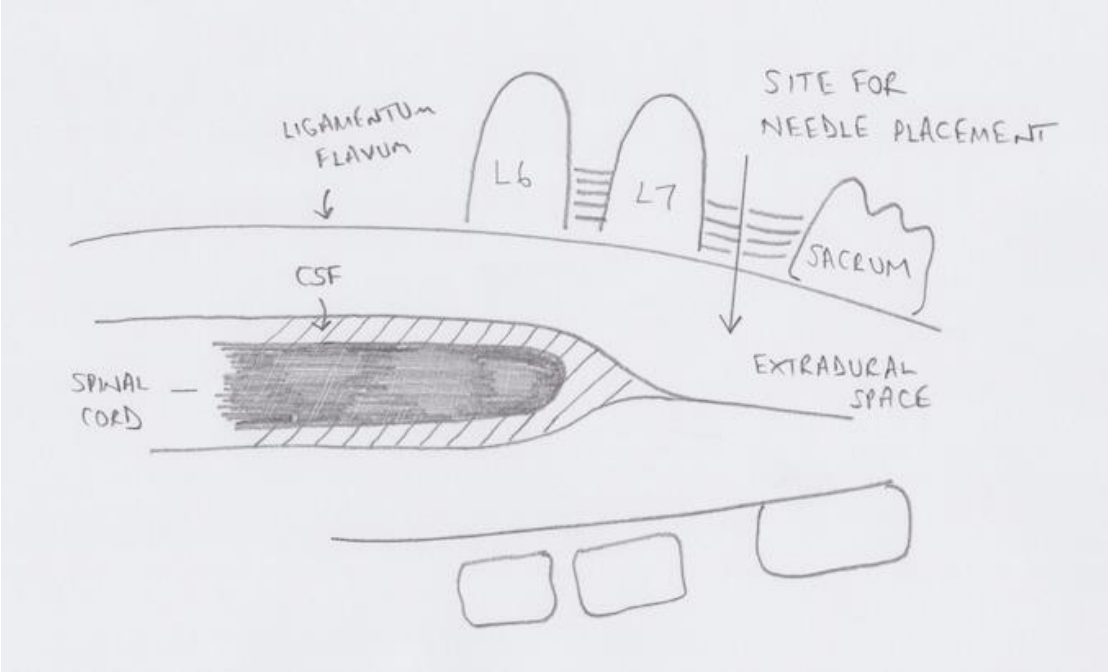
Epidural analgesia

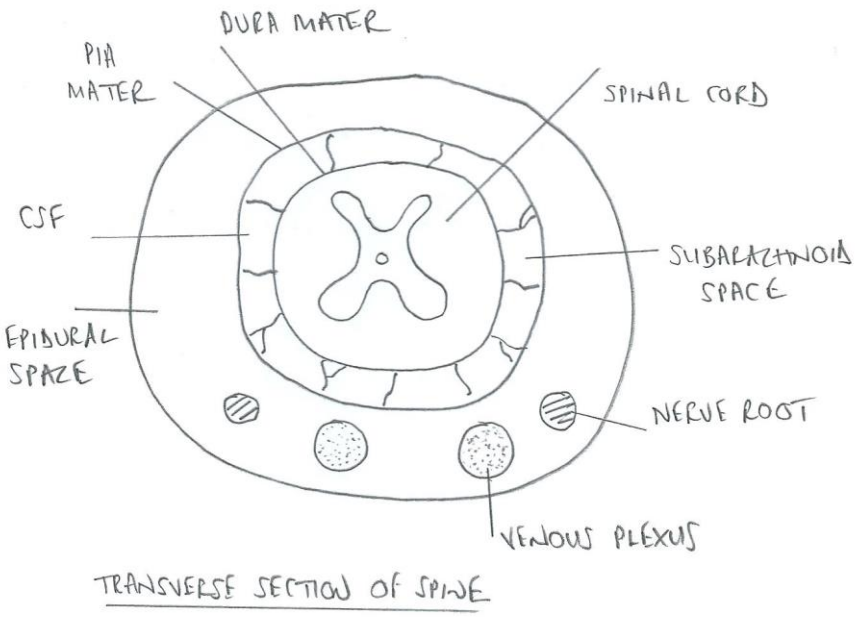
Note – nurses are not permitted to perform epidurals as this constitutes entering a body cavity.

Epidural analgesia (or more anatomically, extradural) is used to provide analgesia to the hind limbs but will also afford analgesia to the caudal abdomen, perineal region and at appropriate doses, the thoracic region.

The technique described is that adopted by the author. There are several techniques and these are widely described in the literature.

The transverse section below is at the level of L5. In the sagittal section the spinal cord actually ends a little further forward – you can perform an epidural between L6/L7 without danger of hitting the spinal cord in an adult animal. Note that in young animals the spinal cord can extend to the sacrum. It is therefore often more likely to perform an intrathecal injection in younger animals (or if you aspirate CSF redirect (withdraw) the needle to inject extradurally.)





TRANSVERSE SECTION OF SPINE

Site of action of epidurally administered drugs
For local anaesthetics the site of action is the spinal nerves. For pelvic limb blockade the area from L3 to S1 must be covered. For the abdominal wall, this extends forwards to T11-L3. Solutions injected at L7 flow primarily cephalad but there is some loss of solution through intervertebral foraminae.

What affects spread?
Volume & concentration
Actual mass (dose) of drug is the most important factor influencing spread rather that absolute volume.
Injection speed/pressure
Administer slowly over 1-2mins. Rapid injection can cause bradycardia/apnoea/asystole thought to be due to changes in CSF pressure.
Site of injection
More cranial injection gives more cranial spread. Drug volumes quoted given assume lumbosacral injection.
Direction of needle bevel
Most relevant when a Tuohy needle is used – less concern with a Quinke needle.
Patient position
Most local solutions are hypobaric so a head up position encourages cranial spread. Hyperbaric bupivacaine is used in man (spinals are performed seated) to encourage the local to 'sit' at the base of the spine where its effects are desired. The solution is made 'heavy' (hyperbaric) by addition of glucose 8%. This is only relevant with spinal injections, not epidurals.
Fat in the epidural space
May affect spread giving a patchy block.
Venous plexuses
Venous engorgement is reported to affect spread by decreasing the epidural space. This is the case in pregnant patients plus those with increased intra-abdo pressure. During pregnancy in animals it is reported that onset of blockade is more rapid – use lower volumes in these cases.
Age
The dura mater is more permeable to local anaesthetics in old age – use lower doses – there are more arachnoid villi in the dura. Decreased numbers of myelinated fibres may allow local to penetrate the nerves more readily.

What to use for epidural analgesia

Local anaesthetics will provide total sensory (and motor) blockade. Opioids used epidurally reduce sensation however do not totally block sensation. The combination of local anaesthetics and opioids provides the advantage of excellent analgesia during the procedure with a long lasting effect.

Agent	Dose	Onset	Duration	Remarks
Lidocaine	4mg/kg	5 mins	1-2hrs	Risk of motor blockade Care not to exceed toxic dose
Bupivacaine or Levobupi	1mg/kg	10-20mins	4-8hrs	Risk of motor blockade Care not to exceed toxic dose
Ropivacaine	1mg/kg	10-20mins	4-8hrs	Risk of motor blockade Care not to exceed toxic dose
Morphine	0.1mg/kg Use 0.2mg/kg for thoracic spread	30-60mins	6-24hrs	Onset slow Risk of urinary retention – monitor post op – express bladder before recovery.
Morphine + bupivacaine/levobupi	0.1mg/kg + 1mg/kg	10-15mins	16-24hrs	Rapid onset, long duration
Morphine + lidocaine	0.1mg/kg + 4mg/kg	5-10mins	16-24hrs	Rapid onset for surgical benefit without longer term motor blockade
Methadone	0.3mg/kg	20-30mins	4hrs	

Some authors advocate using a limited volume (1ml/5kg) whilst others use the calculated dose. Doses may be reduced with older (fibrous tissue in epidural space), pregnant(engorged vasculature in epidural space) and obese(more fat in epidural space) patients. Preparations should be **preservative-free and local anaesthetics adrenaline-free.**

Doses ml/kg for dogs – injection site lumbosacral

Drug	Dermatome	Volume ml/kg
Bupi 0.25%	L3	0.2 (pelvic limb sx)
Bupi 0.5%	T10-L1	0.3
Bupi 0.25%	T9	0.4 (for abdo sx)

Doses ml/kg for cats – lumbosacral injection

Drug	Dermatome	Volume ml/kg
This study used methylene blue to test spread – likely that 0.5% bupi produces similar spread	L1-L2	0.2
	T7	0.3
	T6-10	0.4

A common volume for injection is 0.2ml/kg and we can expect lumbar spread. Therefore if using an epidural for analgesia during abdominal surgery we should use a greater volume such as 0.4ml/kg. We must still remain within our safe dose.

Duration of sensory blockade w local anaesthetics in dogs

Drug	Duration of sensory blockade (mins)
Lido 2% 4.4mg/kg	120
Ropi 0.75% 0.14mg/kg**	100
Levobupi 0.5% 1mg/kg	180 – shorter than expected

** note very low dose

Sensory blockade tends to last longer than motor blockade. The lidocaine and levobupivacaine doses are clinical doses and therefore we can expect our epidural to last these lengths if local alone is used. Duration of action can be extended by incorporating morphine.

Another method of calculating the volume used is occiput-coccygeal length (L_{oc}) (crown rump length). The epidural anaesthetic volume for ropivacaine or bupivacaine can be calculated as follows;
0.05mL/cm L_{oc} will block 30-35% L_{oc}
0.1mL/cm L_{oc} will block 55-60% L_{oc}
0.15mL/cm L_{oc} will block 70-75% L_{oc}

Technique-
The area should be aseptically prepared, the operator gloved and the site draped. Animal positioned in sternal with the limbs drawn forwards. A spinal needle is be used, which is advanced perpendicular to the skin until a popping sensation is felt as the ligamentum flavum is penetrated. The stylet is then removed and a 2mL syringe is attached to aspirate and check for inadvertent intra-thecal injection (denoted by the presence of CSF). A test injectate of saline (Irripods – from your supplier) is injected. The solution to be injected is attached and with very gentle pressure the injection begins. Administration should be over 2 minutes. The needle is then withdrawn.
You may prefer to position the animal in lateral recumbency.

Confirming correct needle placement-

- No CSF aspirated
- Popping sensation felt once ligamentum flavum is penetrated
- Lack of resistance to injection (a test injectate of saline may be used)
- Hanging drop technique (epidural space is under slight negative pressure). Only works in sternal.
- Loss of resistance (LOR) technique. A low resistance syringe is attached to the spinal needle. Pressure is applied as the needle is advanced. LOR is noted when the needle enters the epidural space. LOR may occur (false positive) if the needle is in fat. If the needle is blocked false negatives can occur.
- Electrolocation
- **If you aspirate CSF reduce dose by 1/5-1/2 this is therefore an intrathecal technique.**

Contraindications
Absolute

- Infection at injection site
- Coagulopathies
- Hypovolaemia/hypotension – avoid local anaesthetics – opioids ok.

Relative

- Distortion of anatomy- ie pelvic fractures
- Obesity – unable to locate landmarks

Risks of epidurals

- hypotension
- motor blockade (only w local, not opioids)
- urinary retention – always express bladder post sx)
- slow hair regrowth (11%)

Cardiovascular Effects

Negative CV effects usually the result of preganglionic SNS blockade.
Vasodilation produces hypotension. These fibres maintain vascular tone in blood vessels and blocking them causes vasodilation. Blood pools in the venous circulation, reduces venous return, this cardiac output, hence hypotension. Fluid therapy should be provided to counteract this. Some authors advocate a bolus of 10ml/kg Hartmann's when performing an epidural.
Secondly, a vasoconstrictor such as ephedrine 0.2mg/kg IV may be required.
If cardioaccelerator fibres serving the heart (T1-T4) are blocked bradycardia can occur.
Treatment is with atropine 0.01mg/kg IV or glycopyrrolate 0.01mg/kg IV (slower onset than atropine though).

Spinal Analgesia

-onset more rapid than epidural
-placement confirmation more obvious – CSF issues from the needle hub
-profound anaesthesia
-risk of cardioaccelerator blockade much higher than epidural administration

Doses

Morphine 0.01-0.03mg/kg
Bupi 0.5% 0.05ml/kg blocks up to L3 dermatome

Inadvertent spinal injection of an epidural dose can have profound, fatal consequences so care with confirmation of needle placement and dose calculation is advised

References

Abelson, A. L., McCobb, E. C., Shaw, S., Armitage-Chan, E., Wetmore, L. A., Karas, A. Z., & Blaze, C. (2009). Use of wound soaker catheters for the administration of local anesthetic for post-operative analgesia: 56 cases. *Veterinary Anaesthesia and Analgesia*, *36*(6), 597–602. doi:10.1111/j.1467-2995.2009.00487.x

Calvo, G., Holden, E., Reid, J., Scott, E. M., Firth, A., Bell, A., et al. (2014). Development of a behaviour-based measurement tool with defined intervention level for assessing acute pain in cats. *Journal of Small Animal Practice*, *55*(12), 622–629. doi:10.1111/jsap.12280

Campoy, L., Bezuidenhout, A. J., Gleed, R. D., Martin-Flores, M., Raw, R. M., Santare, C. L., et al. (2010). Ultrasound-guided approach for axillary brachial plexus, femoral nerve, and sciatic nerve blocks in dogs. *Veterinary Anaesthesia and Analgesia*, *37*(2), 144–153. doi:10.1111/j.1467-2995.2009.00518.x

Campoy, L., Martin-Flores, M., Looney, A. L., Erb, H. N., Ludders, J. W., Stewart, J. E., et al. (2008). Distribution of a lidocaine-methylene blue solution staining in brachial plexus, lumbar plexus and sciatic nerve blocks in the dog. *Veterinary Anaesthesia and Analgesia*, *35*(4), 348–354. doi:10.1111/j.1467-2995.2007.00390.x

Campoy, L., Martin-Flores, M., Ludders, J. W., Erb, H. N., & Gleed, R. D. (2012). Comparison of bupivacaine femoral and sciatic nerve block versus bupivacaine and morphine epidural for stifle surgery in dogs. *Veterinary Anaesthesia and Analgesia*, *39*(1), 91–98. doi:10.1111/j.1467-2995.2011.00673.x

Costa-Farré, C., Blanch, X. S., Cruz, J. I., & Franch, J. (2011). Ultrasound guidance for the performance of sciatic and saphenous nerve blocks in dogs. *The Veterinary Journal*, *187*(2), 221–224. doi:10.1016/j.tvjl.2009.10.016

Dahl, J. B. (2004). Pre-emptive analgesia. *British Medical Bulletin*, *71*(1), 13–27. doi:10.1093/bmb/ldh030

Davis, K., Hardie, E., Martin, F., Zhu, J., & Brownie, C. (2007). Correlation between perioperative factors and successful outcome in fibrosarcoma resection in cats. *Veterinary Record*, *161*(6), 199.

Denny, N. M., & Harrop-Griffiths, W. (2005). Location, location, location! Ultrasound imaging in regional anaesthesia. *British Journal of Anaesthesia*, *94*(1), 1–3. doi:10.1093/bja/aei001

Dravid, R. M., & Paul, R. E. (2007). Interpleural block – part 1. *Anaesthesia*, *62*(10), 1039–1049. doi:10.1111/j.1365-2044.2007.05183.x

Echeverry, D. F., Gil, F., Laredo, F., Ayala, M. D., Belda, E., Soler, M., & Agut, A. (2010). Ultrasound-guided block of the sciatic and femoral nerves in dogs: A descriptive study. *The Veterinary Journal*, *186*(2), 210–215. doi:10.1016/j.tvjl.2009.08.005

Echeverry, D. F., Laredo, F. G., Gil, F., Belda, E., Soler, M., & Agut, A. (2012). Ventral ultrasound-guided suprainguinal approach to block the femoral nerve in the dog. *The Veterinary Journal*, *192*(3), 333–337. doi:10.1016/j.tvjl.2011.06.043

Futema, F., Fantoni, D. T., Auler, J. O. C., Jr, Cortopassi, S. R. G., Acaui, A., & Stopiglia, A. J. (2002). A new brachial plexus block technique in dogs. *Veterinary Anaesthesia and Analgesia*, *29*(3), 133–139.

Grimm, K. A., Tranquilli, W. J., Thurmon, J. C., & Benson, G. J. (2000). Duration of nonresponse to noxious stimulation after intramuscular administration of butorphanol, medetomidine, or a butorphanol-medetomidine combination during isoflurane administration in dogs. *American Journal of Veterinary Research*, *61*(1), 42–47.

Gurney, M. A. (2012). Pharmacological options for intra-operative and early postoperative analgesia: an update. *Journal of Small Animal Practice*, *53*(7), 377–386. doi:10.1111/j.1748-5827.2012.01243.x

Ho, A. M. H., & Karmakar, M. K. (2002). Combined paravertebral lumbar plexus and parasacral sciatic nerve block for reduction of hip fracture in a patient with severe aortic stenosis. *Canadian Journal of Anaesthesia = Journal Canadien D'anesthésie*, *49*(9), 946–950. doi:10.1007/BF03016880

Kamata, M., King, J., Seewald, W., Sakakibara, N., & al, E. (2012). Comparison of injectable robenacoxib versus meloxicam for peri-operative use in cats: Results of a randomised clinical trial. *The Veterinary …*.

Katz, J., Clarke, H., & Seltzer, Z. (2011). Preventive Analgesia. *Anesthesia & Analgesia*, *113*(5), 1242–1253. doi:10.1213/ANE.0b013e31822c9a59

Keates, H. L., Cramond, T., & Smith, M. T. (1999). Intraarticular and periarticular opioid

binding in inflamed tissue in experimental canine arthritis. *Anesthesia & Analgesia*, *89*(2), 409–415.
Kelly, D. J., Ahmad, M., & Brull, S. J. (2001). Preemptive analgesia II: recent advances and current trends. *Canadian Journal of Anaesthesia = Journal Canadien D'anesthésie*, *48*(11), 1091–1101. doi:10.1007/BF03020375
Lascelles, B. D. X., Cripps, P. J., Jones, A., & WATERMAN PEARSON, A. E. (1998). Efficacy and kinetics of carprofen, administered preoperatively or postoperatively, for the prevention of pain in dogs undergoing ovariohysterectomy. *Veterinary Surgery*, *27*(6), 568–582.
Lascelles, B. D. X., & Kirkby Shaw, K. (2016). An extended release local anaesthetic: potential for future use in veterinary surgical patients? *Veterinary Medicine and Science*, *2*(4), 229–238. http://doi.org/10.1002/vms3.43
Mahler, S. P., & Adogwa, A. O. (2007). Anatomical and experimental studies of brachial plexus, sciatic, and femoral nerve-location using peripheral nerve stimulation in the dog. *Veterinary Anaesthesia and Analgesia*, *0*(0), 070816104446004–??? doi:10.1111/j.1467-2995.2007.00356.x
McMillan, M. W., Seymour, C. J., & Brearley, J. C. (2012). Effect of intratesticular lidocaine on isoflurane requirements in dogs undergoing routine castration. *Journal of Small Animal Practice*, *53*(7), 393–397. doi:10.1111/j.1748-5827.2012.01233.x
Mosing, M., Reich, H., & Moens, Y. (2010). Clinical evaluation of the anaesthetic sparing effect of brachial plexus block in cats. *Veterinary Anaesthesia and Analgesia*, *37*(2), 154–161. doi:10.1111/j.1467-2995.2009.00509.x
Park, J., Sutradhar, B. C., Hong, G., Choi, S. H., & Kim, G. (2011). Comparison of the cytotoxic effects of bupivacaine, lidocaine, and mepivacaine in equine articular chondrocytes. *Veterinary Anaesthesia and Analgesia*, *38*(2), 127–133. doi:10.1111/j.1467-2995.2010.00590.x
Portela, D. A., Otero, P. E., Briganti, A., Romano, M., Corletto, F., & Breghi, G. (2013). Femoral nerve block: a novel psoas compartment lateral pre-iliac approach in dogs. *Veterinary Anaesthesia and Analgesia*, *40*(2), 194–204. doi:10.1111/j.1467-2995.2012.00765.x
Portela, D. A., Otero, P. E., Tarragona, L., Briganti, A., Breghi, G., & Melanie, P. (2010). Combined paravertebral plexus block and parasacral sciatic block in healthy dogs. *Veterinary Anaesthesia and Analgesia*, *37*(6), 531–541. doi:10.1111/j.1467-2995.2010.00572.x
Rasmussen, L. M., Lipowitz, A. J., & Graham, L. F. (2006). Controlled, clinical trial assessing saphenous, tibial and common peroneal nerve blocks for the control of perioperative pain following femoro-tibial joint surgery in the nonchondrodystrophoid dog. *Veterinary Anaesthesia and Analgesia*, *33*(1), 49–61. doi:10.1111/j.1467-2995.2005.00235.x
Rioja, E., Sinclair, M., Chalmers, H., Foster, R. A., & Monteith, G. (2011). Comparison of three techniques for paravertebral brachial plexus blockade in dogs. *Veterinary Anaesthesia and Analgesia*, no–no. doi:10.1111/j.1467-2995.2011.00677.x
Shih, A. C., Robertson, S., Isaza, N., Pablo, L., & Davies, W. (2008). Comparison between analgesic effects of buprenorphine, carprofen, and buprenorphine with carprofen for canine ovariohysterectomy. *Veterinary Anaesthesia and Analgesia*, *35*(1), 69–79. doi:10.1111/j.1467-2995.2007.00352.x
Shilo, Y., Pascoe, P. J., Cissell, D., Johnson, E. G., Kass, P. H., & Wisner, E. R. (2010). RESEARCH PAPER: Ultrasound-guided nerve blocks of the pelvic limb in dogs. *Veterinary Anaesthesia and Analgesia*, *37*(5), 460–470. doi:10.1111/j.1467-2995.2010.00560.x
Slingsby, L. S., & WATERMAN PEARSON, A. E. (2001). Analgesic effects in dogs of carprofen and pethidine together compared with the effects of either drug alone. *The Veterinary Record*, *148*(14), 441–444.
Slingsby, L. S., Murrell, J. C., & Taylor, P. M. (2010). Combination of dexmedetomidine with buprenorphine enhances the antinociceptive effect to a thermal stimulus in the cat compared with either agent alone. *Veterinary Anaesthesia and Analgesia*, *37*(2), 162–170. doi:10.1111/j.1467-2995.2009.00519.x
Slingsby, L. S., Taylor, P. M., & Murrell, J. C. (2011). A study to evaluate buprenorphine at 40 μg kg−1 compared to 20 μg kg−1 as a post-operative analgesic in the dog. *Veterinary Anaesthesia and Analgesia*, *38*(6), 584–593. doi:10.1111/j.1467-2995.2011.00656.x

STEAGALL, P. V. M., Taylor, P. M., Rodrigues, L. C. C., FERREIRA, T. H., Minto, B. W., & Aguiar, A. J. A. (2009). Analgesia for cats after ovariohysterectomy with either buprenorphine or carprofen alone or in combination. *The Veterinary Record*, *164*(12), 359–363.

Stevens, B. J., Posner, L.P., Jones, C. A., & Lascelles, B. D. (2013). Comparison of the effect of intratesticular lidocaine/bupivacaine vs. saline placebo on pain scores and incision site reactions in dogs undergoing routine castration. *The Veterinary Journal*, *196*(3), 499–503. doi:10.1016/j.tvjl.2012.11.019

Trumpatori, B. J., Carter, J. E., Hash, J., Davidson, G. S., Mathews, K. G., Roe, S. C., & Lascelles, B. D. X. (2010). Evaluation of a Midhumeral Block of the Radial, Ulnar, Musculocutaneous and Median (RUMM Block) Nerves for Analgesia of the Distal Aspect of the Thoracic Limb in Dogs. *Veterinary Surgery*, *39*(7), 785–796. doi:10.1111/j.1532-950X.2010.00712.x

Vettorato, E., Bradbrook, C., Gurney, M., Aprea, F., Clark, L., & Corletto, F. (2012). Peripheral nerve blocks of the pelvic limb in dogs: A retrospective clinical study. *Veterinary and Comparative Orthopaedics and Traumatology*, *25*(4), 314–320. doi:10.3415/VCOT-11-08-0111

Webb, A. A., Cantwell, S. L., Duke, T., & Adkins, E. (1999). Intravenous regional anesthesia (Bier block) in a dog. *The Canadian Veterinary Journal. La Revue Vétérinaire Canadienne*, *40*(6), 419–421.

Webb, S. T., & Ghosh, S. (2009). Intra-articular bupivacaine: potentially chondrotoxic? *British Journal of Anaesthesia*, *102*(4), 439–441. doi:10.1093/bja/aep036