

Epidural anesthesia and analgesia in horses

Epidurale anesthesie en analgesie bij paarden

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A BSTRACT

Epidural anesthesia is a loco-regional anesthesia technique where drugs are injected in the epidural space. In the 19th century, this technique was developed for human medicine, and later found its way into veterinary medicine. It is useful for surgical interventions in the standing horse, as part of a balanced anesthetic protocol or for postoperative pain management. Analgesia and anesthesia involves the pelvis, pelvic limbs, tail, vagina, vulva, anus, perineum and abdomen. However, several contraindications and complications have been reported for epidural anesthesia. In horses, epidural injections can be performed cranially (lumbosacral space) or caudally (sacro-coccygeal or Co1-Co2). While single injections can be performed, the use of epidural catheters allows repeated administration. Depending on the desired effect, different drugs (local anesthetics, alpha2-agonists, opioids, ketamine, tramadol or tiletamine-zolazepam), drug combinations and volumes can be chosen.

SAMENVATTING

Epidurale anesthesie is een loco-regionale anesthesietechniek waarbij medicatie geïnjecteerd wordt in de epidurale ruimte. Deze techniek werd in de humane geneeskunde ontwikkeld in de 19^e eeuw en later ook toegepast in de diergeneeskunde. Enerzijds is epidurale anesthesie nuttig voor staande ingrepen, maar het kan ook gebruikt worden als onderdeel van een gebalanceerde anesthesietechniek of voor postoperatieve pijnbestrijding. Anesthesie en analgesie kunnen bereikt worden voor het bekken, de achterbenen, staart, vagina, vulva, anus of perineum en het abdomen. Hoewel de techniek bij verschillende indicaties gebruikt kan worden, zijn er echter ook enkele tegenindicaties en kunnen er complicaties optreden. Bij paarden kan een epidurale anesthesie craniaal (lumbosacraal) of caudaal (sacro-coccygeaal of Co1-Co2) uitgevoerd worden. Naast enkelvoudige injecties kan ook een epidurale katheter geplaatst worden voor herhaaldelijke toediening. Afhankelijk van het gewenste effect kan er een keuze gemaakt worden uit verschillende types medicatie (lokale anestetica, alfa-2 agonisten, opioïden, ketamine, tramadol, tiletamine-zolazepam), combinaties van medicaties en injectievolumes.

INTRODUCTION: HISTORY OF REGIONAL AND EPIDURAL ANESTHESIA

In ancient Egyptian, Indian and Chinese cultures, a variety of techniques and herbal medicines was used to treat pain (Schroeder, 2013). The characterization and understanding of pain were first described by ancient Greek philosophers and later by Newton (1642-1727) and Hartley (1705-1757). The isolation of morphine by Sertürner in 1803, cocaine by Niemann in 1860 and aspirin by Bayer in 1899 made pain control better

manageable (Schroeder, 2013; Tranquilli and Grimm, 2015). Next to the development of hypodermic needles and syringes, analgesics were also important in the development of regional anesthesia (Schroeder, 2013). Kohler (1884) and Halsted (1885) were the first to apply cocaine as a local anesthetic, which led to the first use of regional anesthesia. Corning (1885) was the first to induce spinal anesthesia in dogs with cocaine. Later, August Bier (1898) performed further research on spinal anesthesia in experiments on dogs and on himself (Schroeder, 2013; Tranquilli and

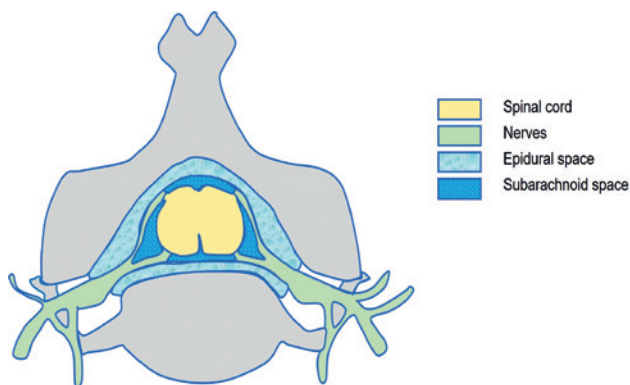


Figure 1. Schematic overview of the epidural and subarachnoid space.

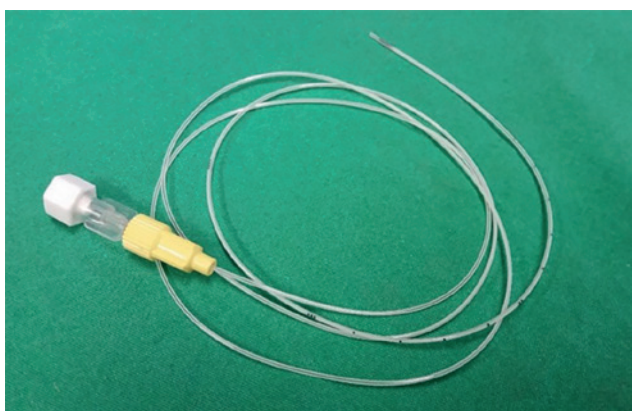


Figure 2. Epidural catheter for horses.



Figure 3. Desensitized subcutaneous area in case of caudal epidural anesthesia depending on volume injected epidurally. With an increase in volume, more spreading of the epidural injection towards cranial can be observed. Injection of 6, 8 and 10 mL of a local anesthetic is depicted in figures A, B and C, respectively (Carpenter and Bryon, 2015).

Grimm, 2015). Because of cocaine's potentially severe side effects, the search for other local anesthetics began. Molecules, such as procaine and later lidocaine, mepivacaine, etc., were developed (Schroeder, 2013). At the beginning of the twentieth century, the use of local anesthesia techniques had found its way into veterinary medicine (Schroeder, 2013). Cuille and Sendrail (1901) performed subarachnoid anesthesia in horses, cattle and dogs. Moreover, Cathelin reported spinal anesthesia in dogs in 1901, but only from 1920, the technique was performed more frequently in large animals (Tranquilli and Grimm, 2015). Nevertheless, it was not until 1950 that epidural anesthesia was being used commonly for surgical procedures in veterinary medicine (Valverde, 2008). With the later development of safer anesthesia techniques and drugs such as nonsteroidal anti-inflammatory drugs (NSAIDs), regional anesthetic techniques were less often used. (Valverde, 2008; Schroeder, 2013). However, in recent years, epidural anesthesia and analgesia have re-emerged as part of balanced anesthetic protocols to provide good intra- and postoperative analgesia (Valverde, 2008).

EPIDURAL ANESTHESIA AND ANALGESIA

Epidural anesthesia is a form of so-called regional anesthesia (Muir and Hubbell, 2009). During regional anesthesia, a specific area of the body, defined by the innervation pattern of the targeted nerve, is desensitized (Tranquilli and Grimm, 2015). Epidural injections are frequently used in veterinary medicine to provide analgesia and anesthesia for procedures involving the pelvis, pelvic limbs, tail, perineum and abdomen (Campoy et al., 2015), through injection of drugs into the extradural space, i.e. outside the dura mater, but underneath the ligamentum flavum (Borer-Weir, 2014) (Figure 1). Epidural anesthesia can be provided by single injection or repeatedly/continuously using an epidural catheter (Figure 2) (Natalini, 2010). In human medicine, intrathecal (spinal, subdural or subarachnoid) analgesia is regularly applied as well. In this case, the drugs are injected into the subarachnoid space, which contains cerebrospinal fluid (CSF) (Figure 1). The diffusion of the drugs is assisted by the CSF (Borer-Weir, 2014).

Anatomy epidural space

The spinal cord is located within the vertebral canal and courses from the brain until the caudal lumbar region (Otero and Campoy, 2013). Vertebral arches and bodies, intervertebral discs and intervertebral ligaments constitute the outer line of the spinal canal (Borer-Weir, 2014). The spinal canal, the spinal cord and the brain are protected by the meninges and CSF (Otero and Campoy, 2013; Borer-Weir, 2014). Three tissue layers form the meninges around the spinal cord, i.e. the pia mater, arachnoid membrane and dura

mater (Otero and Campoy, 2013).

The pia mater is the inner membrane and is attached to the spinal cord. The arachnoid is the central layer and its outer surface is attached to the dura mater, which forms a firm outer surface of the meninges (Otero and Campoy, 2013; Borer-Weir, 2014). The subarachnoid space is located between the pia mater and the arachnoid membrane and contains CSF (Otero and Campoy, 2013) (Figure 1). Between the dura mater and the wall of the vertebral canal, a potential space is formed, which is called the epidural space (Otero and Campoy, 2013; Borer-Weir, 2014) (Figure 1). The epidural space contains blood vessels, nerves, fat and lymphatics. Each nerve root with its associated dorsal and ventral roots is initially covered with an extension of the dura mater and arachnoid membrane. More distally, the meninges in combination with connective tissue form the nerve sheets around the peripheral nerves (Otero and Campoy, 2013). The spinal nerves exit from the spinal canal through the intervertebral foramina. After epidural injection, diffusion of drugs into neural tissue is necessary to achieve a good epidural anesthesia (Borer-Weir, 2014) (Figure 1).

Indications

The aim of epidural anesthesia is usually to desensitize the caudal and last sacral nerves, providing sen-

sory loss of their innervation regions as well as parasympathetic blockage, causing relaxation and dilatation of the anus, bladder and genital organs (Skarda et al., 2009). A caudal epidural injection can provide anesthesia for standing surgery of the rectum, anus, perineum, tail, urethra, bladder, vulva or vagina of sedated horses (Doherty and Valverde, 2006; Skarda et al., 2009; Vigani and Garcia-Pereira, 2014; Carpenter and Bryon, 2015) (Figures 3 and 4). Examples of such procedures are correction of a rectum prolapse, rectovaginal fistula or uterine torsion, laparoscopic cryptorchidectomy and fetotomy (Robinson and Natalini, 2010). Epidural anesthesia can also be used under general anesthesia for the same anatomical regions (Doherty and Valverde 2006), as part of a multimodal analgesic plan (Borer-Weir, 2014) or for postoperative analgesia, e.g. for painful conditions of the hind legs (Doherty and Valverde, 2006; Carpenter and Bryon, 2015) with or without the use of an epidural catheter for continuous analgesia (Natalini, 2010).

Contraindications

Untreated hypovolemia, septicemia, bacteremia, skin trauma/ infection or neoplasia are absolute contraindications for performing epidural anesthesia (Doherty and Valverde, 2006; Dugdale, 2010a; Love, 2012; Campoy et al., 2015, Steagall et al., 2017). Al-



Figure 4. Identification of the caudal epidural injection site between Co1 and Co2. The first coccygeal interspace between Co1 and Co2 can be identified by lowering and raising the tail from its base (A and B) as the first movable joint, since the first coccygeal vertebrae Co1 is usually fused with the sacrum. However, in obese patients, the palpation of the interspace can be quite challenging. By alternating the angle of the bent of the tail, a depression in the midline caudal to the sacrum can be palpated (C), identifying the first coccygeal interspace. The needle is inserted in this interspace between Co1 and Co2 (Skarda et al., 2009).

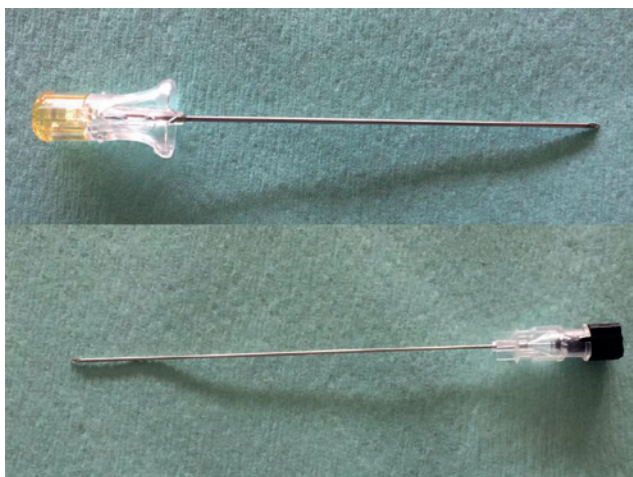


Figure 5. Examples of different brands of spinal needles.

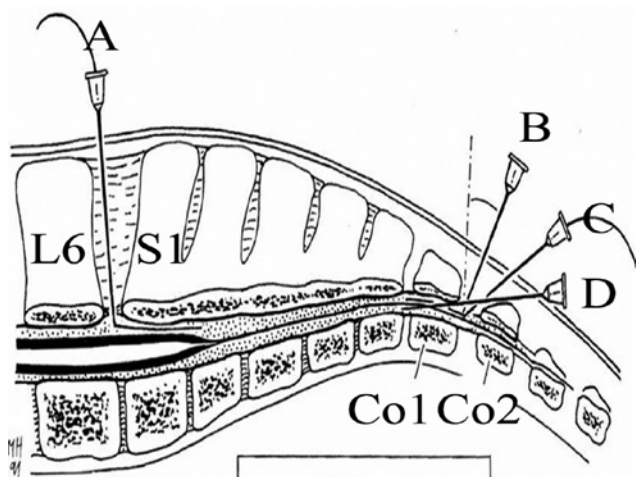


Figure 6. L6: sixth lumbar vertebrae, S1: first sacral dorsal spinous process, Co1 and Co2: first and second coccygeal vertebrae. A: cranial epidural anesthesia between L6 and S1: catheter placement for continuous caudal epidural anesthesia (technically demanding, infrequently performed). B: needle placement for caudal anesthesia perpendicular direction. C: needle introduction under 45° approximately. Once the needle is inserted, the catheter can be introduced over a distance of 10 to 30 cm into the epidural space. After placement of the catheter, the needle can be removed and the catheter can be secured to the skin. D: needle placement in the caudal part of the Co1-2 interspace under an angle of approximately 30° for caudal anesthesia (Skarda et al., 2009; Carpenter and Bryon, 2015). Figure adapted from Carpenter and Bryon (2015).

ternatives should be considered to provide analgesia in these patients, but also in patients with ataxia or bleeding disorders caused by coagulation disorders or thrombocytopenia to avoid uncontrollable hemorrhage (Dugdale, 2010; Love, 2012; Campoy et al., 2015; Steagall et al., 2017). In obese or trauma patients with pelvic or lumbar spine injury, locating the correct anatomical landmarks may be quite chal-

lenging due to a distorted anatomy (Dugdale, 2010; Steagall et al., 2017). In patients with increased intracranial pressure, epidural anesthesia is not advised due to the possible risk of brain herniation in case of inadvertent intrathecal injection.

Complications

Several complications have been reported related to epidural injection. Failure to achieve a good anesthesia and analgesia is often related to a poor technique, anatomical anomalies or fibrous scar tissue formation at the site of injection due to previous epidural injection (Doherty and Valverde, 2006; Skarda et al., 2009; Carpenter and Bryon, 2015). Severe ataxia or recumbency may occur in case of an overdose (Doherty and Valverde, 2006; Skarda et al., 2009; Natalini, 2010; Carpenter and Bryon, 2015). Injection of a large volume or a rapid injection may also cause ataxia or general discomfort in the horse. In case of recumbency and motor blockage, sedation or light anesthesia of the horse may be necessary until the motor blockage of the hind limbs wears off (Doherty and Valverde, 2006; Skarda et al., 2009; Natalini, 2010). The risk of breaking needles is quite low, but can be further reduced by proper restraint and sedation of the horse prior to injection. The use of flexible needles with a stylet can further reduce the risk (Skarda et al., 2009) (Figure 5). Systemic uptake of drugs, especially with the use of an alpha2-agonist, may cause sedation and cardiovascular depression (Doherty and Valverde, 2006; Skarda et al., 2009). Infection at the injection site may occur in case of failure of an aseptic technique (Otero and Campoy, 2013). Systemic uptake or accidental subarachnoid injection of opioids may cause central excitation (Natalini, 2010). Inaccurate placement of the epidural catheter or the presence of congenital membranes or adhesions in the epidural space may cause unilateral blockage (Natalini, 2010). Epidural administration of opioids may cause systemic pruritus (Doherty and Valverde, 2006; Carpenter and Bryon, 2015). Other side effects observed after epidural anesthesia with lidocaine or xylazine are local sweating in the affected regions or perineal edema. Due to a local histamine release, edematous skin wheels can be observed after epidural administration of morphine (Natalini, 2010). Neurotoxicity remains controversial though (Robinson and Natalini, 2010). Drugs without preservatives should be used to avoid any neurotoxicity (Borer-Weir, 2014).

EPIDURAL ANESTHESIA AND ANALGESIA IN HORSES

Epidural injections can be performed cranially (lumbosacral space) or caudally (sacro-coccygeal or Co1-Co2,) in horses (Robinson and Natalini, 2010; Natalini, 2010; Love, 2012) (Figure 6).

Location

Cranial epidural injection

Cranial epidural injection in horses performed in the lumbosacral space is less common and is substantially more difficult than caudal epidural injection (Skarda et al., 2009; Love, 2012). In horses, the spinal cord ends at the level of the caudal half of the second sacral vertebrae (Carpenter and Bryon, 2015). This means that injection at the lumbosacral space carries a potential risk of puncture of the dura and accidental injection into the subarachnoid space, besides an increased risk for motor blockage and ataxia (Doherty and Valverde, 2006; Carpenter and Bryon, 2015).

The lumbosacral intervertebral space is located 1 to 2 cm caudal to an imaginary line between the cranial aspects of each tuber coxae and the dorsal midline (Skarda et al., 2009; Carpenter and Bryon, 2015). By applying digital pressure, a depression can be palpated between the dorsal spinous process of L6 and S1 (Skarda et al., 2009). Rectal palpation may also be useful to locate the L6-S1 intervertebral space (Skarda et al., 2009). Although this technique has its disadvantages, it only requires a small volume, has a rapid onset of anesthesia and there are minimal physiological disturbances (Skarda et al., 2009; Carpenter and Bryon, 2015). The desensitized areas are comparable with those where paravertebral thoracolumbar anesthesia is applied (Figure 7). If an epidural catheter is placed in caudal direction, caudal epidural anesthesia will be achieved (Carpenter and Bryon, 2015) (Figure 6 (A)).

Caudal epidural injection

Caudal epidural injection is performed at the first coccygeal interspace (Co1-Co2). This is the preferred, simple, inexpensive and most commonly used technique (Skarda et al., 2009; Carpenter and Bryon, 2015). At this level, there is no risk of a spinal injection (Natalini, 2010; Carpenter and Bryon, 2015) and it is less likely to cause a motor blockage to the pelvic limbs (Love, 2012).

By raising and lowering the tail, the Co1-Co2 interspace can be palpated as the first movable joint caudal to the sacrum (Figures 4 A and B). A depression in the midline caudal to the sacrum can be palpated (Doherty and Valverde, 2006; Skarda et al., 2009; Carpenter and Bryon, 2015) (Figure 4C).

Technique and equipment

A good restraint and preparation of the horse are mandatory when performing epidural anesthesia (Doherty and Valverde, 2006; Skarda et al., 2009; Love, 2012). If possible, the horse should be bearing equal weight on the pelvic limbs (Love, 2012), so oversedation may be avoided (Doherty and Valverde, 2006). Regardless of whether a single injection will

be performed or an epidural catheter will be placed, a strictly aseptic technique is necessary (Doherty and Valverde, 2006). Hypodermic needles (22, 20 or 18 standard wire gauge (SWG)) or spinal needles (depending on the size of the horse) can be used for a single injection (Figure 5). An injection of local anesthetic around the injection site may be useful to minimize the pain of the procedure (Skarda et al., 2009).

After preparation and identification of the correct injection site, the needle can be introduced in the center of the palpated space, perpendicular to the skin (Figures 6 (A and B)) (Natalini, 2010; Carpenter and Bryon, 2015). A popping sensation may be observed when passing through the ligamentum flavum (Natalini, 2010; Love, 2012; Carpenter and Bryon, 2015). To avoid injection in the intervertebral disc, the needle is slightly withdrawn with 5 mm, when the needle touches the bone (Natalini, 2010; Love, 2012). For cranial and caudal epidural injections, the perpendicular approach can be used (Natalini, 2010; Carpenter and Bryon, 2015). Another technique for caudal epidural anesthesia is the insertion of the needle under an angle of 30° to the horizontal plane (Skarda et al., 2009; Natalini, 2010; Carpenter and Bryon, 2015) (Figure 6 (D)). In adult horses, the needle can be inserted approximately 3.5 to 8 cm to reach the intervertebral space (Carpenter and Bryon, 2015).

Correct needle placement can be verified by several methods. Firstly, with the hanging drop technique, a drop of fluid is aspirated from the hub of the needle immediately after penetration of the ligamentum flavum. This aspiration occurs due to the negative pressure in the epidural space (Doherty and Valverde, 2006; Love, 2012; Otero and Campoy, 2013; Carpenter and Bryon, 2015). A second method is the loss of resistance while injecting air or fluids (Doherty and Valverde, 2006; Otero and Campoy, 2013; Carpenter and Bryon, 2015). In small animals, the needle placement can be confirmed by ultrasonography or electrolocation (Otero and Campoy, 2013). Clinical effects such as loss of tail or anus tone can be observed after performing a successful epidural injection (Doherty and Valverde, 2006). To ensure there is no intravascular injection, aspiration should be performed prior to a slow injection (Natalini, 2010).

Continuous epidural analgesia

In some cases, repeated epidural drug administration may be necessary to provide prolonged analgesia. Patients with several clinical symptoms such as painful conditions on the hind limbs (fracture, wounds or lacerations) or continuous tenesmus with prolapse of the rectum or uterus as a consequence, may benefit from epidural analgesia (Carpenter and Bryon, 2015). Epidural catheters can remain in place for periods of up to twenty days (Martin et al., 2003) (Figures 2 and 6 (A and C)). For insertion of a 19 or 20 SWG epidural catheter, a 17 or 18 SWG, 17.5 cm Huber point Tuohy needle (Figures 8 and 9) can be used (Doherty and

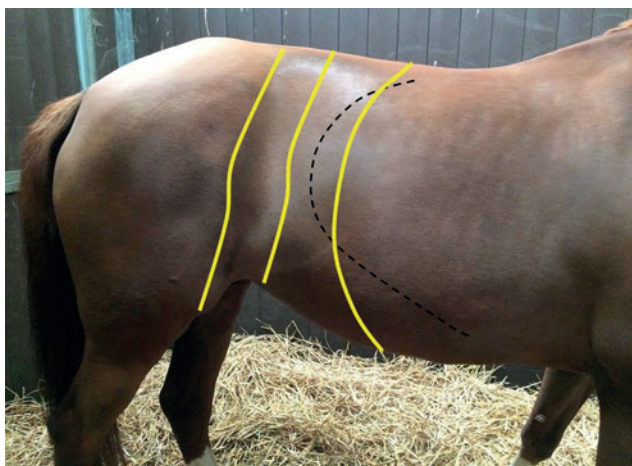


Figure 7. Desensitized area after cranial epidural injection with segmental blockade.



Figure 8. Huber Tuohy needle. This type of needle is especially used while placing an epidural catheter.



Figure 9. Tuohy needle tip. The tip of the Tuohy needle is slightly curved and blunt at the end. In this way, it helps directing the catheter and because of the blunt end, damage to the catheter during placement is prevented (Natalini, 2010).

Valverde, 2006; Skarda et al., 2009; Natalini, 2010). An epidural catheter is normally inserted into the epidural space over a distance of 10 to 30 cm beyond the tip of the needle (Natalini, 2010; Carpenter and Bryon, 2015). The catheter mustn't be introduced further than 30 cm, since kinking of the catheter may occur.

A bacterial filter can be connected and the site of the catheter insertion must be covered (Natalini, 2010).

With each injection through the epidural catheter, a strictly aseptic technique is required (Doherty and Valverde, 2006; Love, 2012). The catheter is preferably flushed with sterile saline after each drug administration (Natalini, 2010).

Drugs

The ideal drugs used in the application of epidural analgesia should provide analgesia or anesthesia with minimal systemic effects and minimal motor blockade (Valverde, 2008). Drugs or drug combinations are chosen depending on the desired effect and duration of their action. Drugs that can be administered epidurally are alpha2-agonist, local anesthetics, opioids, ketamine, tramadol or tiletamine-zolazepam (Doherty and Valverde, 2006; Skarda et al., 2009; Carpenter and Bryon, 2015) (Table 1). With higher, epidurally injected volumes of (un)diluted drugs or drug combinations, a more rostral spread may occur, resulting in a more cranial epidural block (Doherty and Valverde, 2006) (Figure 3). The choice of drugs depends on the indication for which the epidural anesthesia or analgesia is used.

Local anesthetics prevent depolarization of the nerves and thus prevent the conduction of any sensory input, including the pain stimulus (Carpenter and Bryon, 2015). However, besides sensory blockage, motor blockage can result from epidural administration of local anesthetics (Robinson and Natalini, 2002). Sensory blockage of anus, perineum, rectum, vagina and vulva can be useful in cases of surgery on the vagina or vulva, for instance the correction of a recto-vaginal fistula (Figure 3). Fetotomy or reducing a prolapse of the rectum, vagina or bladder to avoid continued tenesmus are other indications to use local anesthetics in epidural injections (Carpenter and Bryon, 2015). The addition of epinephrine to local anesthetic solutions can provide a faster time of onset and a prolonged effect (Carpenter and Bryon, 2015).

Most -if not all- other drugs for epidural use produce analgesia, but no complete anesthesia. This includes alpha-2 agonists, which bind to their receptors in the spinal cord after epidural injection, thus providing analgesia (Robinson and Natalini, 2002; Carpenter and Bryon, 2015). Motor blockage will not occur, but ataxia and recumbency are still possible (Robinson and Natalini, 2002). Opioids are potent analgesics (Robinson and Natalini, 2002). They provide analgesia for longer periods and can be used alone or in combination with local anesthetics or alpha-2 agonists for acute or chronic pain (Carpenter and Bryon, 2015). Epidural analgesia but no complete anesthesia is achieved by sole administration of an opioid (Doherty and Valverde, 2006). Tramadol, ketamine and tiletamine-zolazepam can also be injected into the epidural space, but further studies are needed before their epidural use can be recommended in

Table 1. Literature overview of drugs dosages for epidural injection. Drugs that can be administered epidurally are alpha2-agonist, local anesthetics, opioids, ketamine, tramadol and tiletamine-zolazepam.

Drug	Dosage (mg kg ⁻¹)	Volume mL (500 kg horse)	Onset (minutes)	Duration (minutes)	Remarks	References
Local anesthetics						
Lidocaine (20 mg mL ⁻¹)	0.2 – 0.25	5 – 6.5	5 - 20	60- 120	Careful with re-dosing since overdose can cause ataxia, recumbency and hypotension.	Doherty and Valverde, 2006; Dugdale, 2010; Love, 2012; Carpenter and Bryon, 2015
Ropivacaine (5 mg mL ⁻¹)	0.02 – 0.1	2 – 10	10	180	Minimal ataxia and cardiorespiratory effects.	Doherty and Valverde, 2006; Carpenter and Bryon, 2015
Mepivacaine (20 mg mL ⁻¹)	0.2 – 0.25	5 – 6.5	20	80		Doherty and Valverde, 2006; Carpenter and Bryon, 2015
Bupivacaine (5 mg mL ⁻¹)	0.06	6	< 6	>300	Rapid onset and long duration.	Carpenter and Bryon, 2015
Opioids						
Morphine (10 mg mL ⁻¹)	0.1	5	30 – 180	>300	Mild systemic effects.	Doherty and Valverde, 2006; Dugdale, 2010; Love, 2012; Carpenter and Bryon, 2015
Methadone (10 mg mL ⁻¹)	0.1	5	15	300	Rapid onset but intermediate time of action. Can be diluted in 10mL 0.9% sterile saline for a horse of 500 kg.	Doherty and Valverde, 2006; Dugdale, 2010; Love, 2012; Carpenter and Bryon, 2015
Tramadol (50 mg mL ⁻¹)	1	10	< 30	240 – 300	Can be diluted in 10 – 20 mL 0.9% sterile saline for a horse of 500 kg.	Doherty and Valverde, 2006; Love, 2012; Carpenter and Bryon, 2015
Alpha-2 agonist						
Xylazine (20 mg mL ⁻¹)	0.17 – 0.22	4.3 – 5.5	15-30	150 - 210	Minimal sedative effects. Can be diluted in 10mL 0.9% sterile saline for a horse of 500 kg for perineal analgesic/ anesthetic effects or in 20 -30 mL for a more rostral spread and analgesic effect. Preferred alpha-2 agonist for epidural use since a more potent antinociceptive effect is observed with minimal sedative and cardiovascular side effects.	Doherty and Valverde, 2006; Dugdale, 2010; Love, 2012;
Detomidine (10 mg mL ⁻¹)	(0.01) – 0.03 – 0.06	0.5 – 3	10 – 15	120 - 160	Minimal to excessive sedative effects. Can be diluted in maximal 10mL 0.9% sterile saline for a horse of 500 kg to limit rostral spread and its side effects.	Doherty and Valverde, 2006; Dugdale, 2010; Love, 2012; Carpenter and Bryon, 2015
Other						
Ketamine (100 mg mL ⁻¹)	0.5 – 2	2.5 – 10	5 – 10	30 - 80	Systemic effects can occur with higher dosages. Dilution of ketamine in 10 to 30 mL 0.9% sterile saline for a horse of 500 kg.	Doherty and Valverde, 2006; Dugdale, 2010; Love, 2012; Carpenter and Bryon, 2015
Tiletamine-zolazepam (Telazol 50 mg and 50 mg mL ⁻¹)	1	10	< 30	240 - 300	Can be diluted in 10 – 20 mL 0.9% sterile saline for a horse of 500 kg. Increase in noxious pressure stimulus by epidural administration but further studies should be conducted.	Doherty and Valverde, 2006; Dugdale, 2010;

horses (Carpenter and Bryon, 2015).

Combinations of drugs can increase the duration of analgesia. However, careful dosage is required to avoid adverse effects (Doherty and Valverde, 2006; Carpenter and Bryon, 2015). Opioids combined with alpha-2 agonists can be useful for long term pain management in cases of hind limb pathology with extreme lameness. The combination of alpha-2 agonists with local anesthetics may give a prolonged effect compared to the local anesthetic alone (Doherty-Valverde, 2006).

CONCLUSION

Epidural anesthesia and analgesia are effective techniques in horses as part of a balanced anesthesia and for postoperative pain management. Caudal epidural anesthesia is a simple, inexpensive and effective method that can be conducted in equine practice for different indications. Surgical procedures in the perineal and sacral regions can be performed in combination with sedation to avoid general anesthesia. Different drugs or their combinations may provide a different onset and duration of their effect. Providing longer-term analgesia in pain management is possible due to the availability of epidural catheters. Complications can occur, but they outweigh the benefits.

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