Introduction

Anesthesia is defined as reversible loss of pain, unconsciousness, amnesia, muscle relaxation and immobility with low side effects Ukwueze et al. (2014). However, anesthesia may be general or local, while general surgical anesthesia is subdivided into two types such as; (intra-muscular and intra-venous) and inhalant Biswas et al. (2017). Furthermore, local anesthesia is used through infiltration, ring block, field block and epidural administration technique with or without other anesthetic agents like; sedatives, tranquilizing agents, painkillers and muscle relaxants in order reduce the anesthetic dose and overcome the resistance of the animals during examination, maintaining depth of anesthesia and increase safety Omar et al. (2017).
Epidural anaesthesia is defined as injection of anaesthetic agents into epidural space Steagall et al. (2017), because it provides good analgesia in flank, perineal and pelvic region DeRossi et al. (2017). Whereas, epidural anesthesia is the sub-class of local anesthesia. The epidural and extra dural refers to the space outside the dura mater. When sedative and analgesics are directly administered into the epidural space that is called epidural analgesia (Natalini, 2010).

However, it is administered by two methods, high and low epidural anesthesia i.e. Lumbosacral and Sacrococcygeal epidural anaesthesia Figure 1 Silva et al. (2017). Furthermore, high epidural anesthesia is administered in between inter-vertebral space of last lumber and first sacral vertebrae. This type of anesthesia is used for various surgical procedures of hindquarter such as; hysterotomy, celiotomy, rumenotomy, repair of prolapse (vagina, rectum and uterus) hernia and other abdominal affections (Skarda and Tranquilli, 2007). Furthermore, the most common site for administration of epidural injection in small ruminants is space between last lumber and first sacral vertebrae and this space is just above the first layer of meninges (dura mater) and just below the outer layer of vertebrae (periosteum), this area is ideal for injection of anesthetic drugs because this area is very much vascular and very sensitive due to presence of nerves of the cauda equine and in some species, the remaining layers of the spinal cord (the meninges i.e; pia and arachnoid mater) may also be found there Hall et al. (2001). On other hand, the lumbosacral space is difficult to locate in those animals which are suffering from neurological diseases, spinal cord trauma, low-dose heparin therapy and anatomical changes including trauma of the pelvic area and obesity (Jones, 2001). Whereas, low epidural anesthesia is administered in between last sacral and first coccygeal vertebral space or in between first and second coccygeal vertebrae Steagall et al. (2017). This technique is easy to used and performed surgery on standing animals in various surgical procedures of tail, vagina, vulva, anus, rectum, caudal prepuce, scrotum and urethra Molaei et al. (2010).

![Figure 1: Lumbo-sacral epidural space in goats (Skarda and Tranquilli, 2007).](image)

| No. | Name of animal | Xylazine dose (mg) | Lidocaine dose (mg) |
|-----|----------------|--------------------|--------------------|
| 1   | Dog            | 0.75 (Fanì et al., 2008) | 6.0--3.0 (Garcia, 2018) |
| 2   | Cattle         | 0.05 (Grubb et al., 2002) | 0.22 (Ismail et al., 2018) |
| 3   | Buffalo        | 0.05 (Singh et al., 2005) | 2.0 (Singh et al., 2005) |
| 4   | Goat           | 0.1 (DeRossi et al., 2005) | 2.5 (DeRossi et al., 2005) |
| 5   | Rabbit         | 3.0 (Marjani et al., 2014) | 4.0 (Marjani et al., 2014) |

In veterinary practice, usually epidural anesthesia is used to control the pain during surgery (Ismail, 2016). In the intra-operative time pain, inhalation and surgical pain management requirements are reduced by injection of epidural analgesia (Steagall et al., 2017). Epidural anesthesia inhibit the central sensitization and alter the afferent signals to the dorsal horn and serum concentration of cortisol and norepinephrine also decreases up to 48 hours after injection which suppress the stress.

However, spinal needle (22 Gauge and 1-inch long) is inserted through skin, subcutaneous fascia, and the ligamentum flavum, which forms the dorsal wall of the epidural space in order to access the lumbosacral intervertebral space (Skarda and Tranquilli, 2007). When the local anesthetics are injected into lumbosacral epidural space, they block the intra-dural spinal nerve roots and the peripheral layer of the spinal cord in order to produce complete analgesia to the posterior half of the animal body without any life-threatening risk Troncy et al. (2002). Whereas, the lumbosacral junction is the site of lumbosacral epidural anaesthesia in small ruminants Steagall et al. (2017). This junction is easily palpated in thin animals than fatty animals because in fatty animals it is necessary to draw the landmark of lumbosacral space in small ruminants with standing or in lateral recumbency position Hall et al. (2001). The dura mater is above the arachnoid mater and the pia mater. While, cerebrospinal fluid is present in subarachnoid space. Hence, intrathecal or pinal injection is inserted into the subarachnoid space and it is not commonly used in small animals Steagall et al. (2017).

**Scope of epidural anaesthesia**

Generally epidural anaesthetic technique is frequently used in goats and sheep to perform hindquarter operations (Skarda and Tranquilli, 2007). This procedure is also used for analgesia in animals. In addition, the hysterotomy, bone operations and other caudle laparotomy procedures are commonly performed through this analgesia Hewitt.
et al. (2007). Because of regurgitation problems during general anesthesia in ruminants, the epidural anesthesia is performed (Ismail, 2016). Moreover, epidural anaesthesia is also beneficial for surgery due to its uniform desensitization of all the laparotomical layers including skin, muscles and peritoneal layer and also helpful for embryo transfer in animals Khajuria et al. (2014).

However, xylazine and lidocaine are being used epidurally in many animals like equines, bovines, ovines, caprines and camels Molaei et al. (2010). But, alpha agonist (Xylazine) is frequently injected into the epidural space of the ruminants, because it enhances the analgesic effect and decline in motor function of rare quarter Singh et al. (2005). Whereas, in donkeys and horses prolonged analgesia of caudle region is achieved by injecting alpha agonist drug into epidural space Mpanduji et al. (1999). While, the scrotal herniorrhaphy in pig is performed under epidural anesthesia Ekstrand et al. (2015). The ropivacaine do not produce any adverse effect of overdose in rabbit epidural anesthesia (Derossi et al., 2005). The epidural anesthesia decreases the side-effects and increase the safety of animal Singh et al. (2005).

Practical use of epidural anaesthesia in ruminants

In veterinary practice for treatment of different surgical and obstetrical interventions of pelvic region, reproductive, renal system and hind quarters of domestic animals epidural anaesthesia is commonly used Dehkordi et al. (2012). While, general anesthesia may produce undesirable results in ruminants Habibian et al. (2011), because during general anesthesia animal may take food particle, saliva or other material into the respiratory tract due to its regurgitating ability Azari et al. (2014).

However, in ruminants epidural anesthesia is comparatively uncomplicated method for diagnostic procedures and regional surgery Khajuria et al. (2014). Such as, hysterotomy, celiotomy, rumenotomy, repair of prolapse (vagina, rectum and uterus) hernia and other abdominal affections and surgery of the prepuce, penis or hind limbs (Skarda and Tranquilli, 2007). This type of anesthesia is comparatively safe. Therefore, it is used frequently prior to diagnostic, obstetrical and surgical procedures in small ruminants Khajuria et al. (2014). These drugs are cheap, easily available and having good analgesia Hall et al. (2001). Dissimilar to local infiltration, epidural anaesthesia desensitize all the layers of abdomen including the peritoneum and also increase intra-abdominal space in laproscopy procedures for easy manipulations Khajuria et al. (2014).

Dystocia and prolapse of uterus are significant problems and have been encountered in small ruminants Bigham et al. (2009). Whereas, both conditions could be solved by surgical manipulation (Ismail, 2016). Therefore, anesthesia play an important role to control the animal by using safe anesthetic agents. Meanwhile, ruminants are at high risk for anesthesia, due to number of anesthetic complication have been observed during surgery such as tympany, regurgitation and muscular structure damage Habibian et al. (2011). Therefore, alternate method such as; epidural anesthesia is preferred in small ruminants to perform many different surgical procedures. Though, dystocia, prolapse of rectum, prolapse of uterus and posterior udder surgery in female animal, problems would be easier to save when using epidural anesthesia. But epidural anesthesia is also best for castration in buck through surgical method (Ismail, 2016). However, epidural anaesthesia is used in ruminants for the treatment of other obstetrical and surgical interventions of hind limb area such as; surgery of anus, vulva, perineum, caudal udder, and scrotum (Ismail, 2016).

Commonly used drugs in epidural anesthesia

The bupivacaine, lidocaine, tremadol and xylazine are more frequently used drugs for induction of high epidural anesthesia in ruminants (Ismail, 2016).

Xylazine HCL

The use of alpha adrenergic agonists in domestic animals has become famous for good analgesia Kalhoro (2006). However, it is more frequently used in veterinary science by noxious stimuli produces analgesia by inhibiting the spinal substance release and nociceptive neuron firing produced by noxious stimuli and produces analgesia and also stimulates the alpha, adrenergic receptors of the spinal cord for sedation. (Ismail, 2016). However, it causes the sedation, hypotension, bradycardia, and respiratory depression in goats and horses Molaei et al. (2010); Kalhoro (2006). These drugs are more effective for epidural or subarachnoid analgesia in domestic animals (Ismail, 2016). The alpha agonists are superior to anaesthetic agents because it produces the duration of action and reduced disruption of the motor function of the hind limbs in cattle Molaei et al. (2010).

Xylazine is used for epidural anesthesia in sheep, goat, cows, buffalos, horses and camels Singh et al. (2005). While, epidurally administered alpha agonists produces analgesia by activating presynaptic alpha adrenergic receptors located on primary afferent fibres terminating in the dorsal horn of the spinal cord, as well as postsynaptic alpha receptors located on wide dynamic range projection neurons in the dorsal horn Schug et al. (2006).

While, Xylazine is used at 0.025mg/kg to 0.5 mg/kg body weight in ruminants (Ismail, 2016) whereas, the dose rate of xylazine is different in different animals as mentioned in Table 1. When the lowest possible dose of xylazine and lidocaine is used in epidural space, the onset of epidural anesthesia is commonly occurs within 10 minutes and
duration of sedation remains for 3–4 hours. Time may be increased up to 5 minutes and 6 hours, when xylazine given at dose rate of 0.03–0.05 mg/kg body weight and also combined with lidocaine (Ismail, 2016). Meanwhile, the onset of action of xylazine is delayed, but duration of action is longer by epidural anaesthesia in many animal species (Ismail, 2016).

Xylazine induces a state of drowsiness with a high dose-dependent degree of analgesia, generalized muscle relaxation of central origin and cardiopulmonary depression. Xylazine can even have local anaesthetic effects (Ismail, 2003). Xylazine may produce sedation with a high dose-dependent degree of analgesia, generalized muscle relaxation of central origin, cardiovascular and respiratory depression when administered parentally into the domesticated animals (Molaei et al., 2010). While, it produces analgesia of the perineal region without the adverse effects such as hypotension, neuro-toxicosis, severe ataxia of other locally administered anesthetics, when used epidurally in rams, ponies, cattle, horses and llamas. While, cardio-pulmonary effect of xylazine is very less when epidural route is used as compare to intramuscular route (DeRossi et al., 2003).

Presently, alpha₂ agonists such as xylazine is frequently administered into the epidural space in many domestic animals but contraindicated in cardiovascular patients because it may cause bradycardia, hypotension and vomiting (Molaei et al., 2010).

**Lidocaine HCL**

Lidocaine hydrochloride 2% is the local analgesic drug composed of amino-amide class, which is most commonly used for epidural analgesia in cattle, camel, buffalo, sheep and goat (Ismail, 2016). This analgesic alters the fast voltage-gated by blocking signal conduction in sodium channel of the neuronal cell membrane (Skarda and Tranquilli, 2007). In ruminants lidocaine hydrochloride 2–5 mg/kg bodyweight is administered epidurally whereas, the epidural dose rate of lidocaine is different in different animals as mentioned in Table 1. However, it is used with or without other anesthetic agents to produce good analgesia at tail, anus and perineum in ruminants (Ismail, 2016). The time of analgesia may be prolonged when lidocaine is mixed with epinephrine (Rostami and Vesal, 2012).

The time of onset of analgesia with lidocaine as epidural anaesthesia is 3–5 minutes after administration and effect remains for 2.5 hours and depending on the dose. Usually 2–8 mg/kg body weight is recommended. While, lidocaine produces rapid onset but its effect lasts earlier than xylazine in horses, ponies and cattle (Ismail, 2016). Furthermore, analgesia is produced by lidocaine is relatively short duration and incremental dose will allow completion of the surgical procedure (Atiba et al., 2015). In addition, local anaesthetic agents indiscriminately block motor, sensory and sympathetic fibers causing ataxia, hind limb weakness and occasionally recumbency (Ismail, 2016). Lidocaine blocks the sensory, motor and sympathetic nerve by axonal depression of nerves (Derossi et al., 2005). The drugs with greater duration of action injected in epidural space for those surgical procedures which requires long duration analgesia (Molaei et al., 2010). While, sympathetic blockade due to epidural injection of local anaesthetics may results in the vasodilatation. However, vasodilatation reduces the period of anaesthesia and produces the hypotension (Derossi et al., 2005).

General anesthesia may produce undesirable results in ruminants (Habibian et al., 2011), because during general anesthesia animal may take food particle, saliva or other material into the respiratory tract due to its regurgitating ability (Azari et al., 2014). However, in ruminants epidural anesthesia is comparatively uncomplicated method for diagnostic procedures and regional surgeries (Khajuria et al., 2014). Such as, like hysterotomy, celiotomy, rumenotomy, repair of prolapse (vagina, rectum and uterus) hernia and other abdominal affections and surgery of the prepuce, penis or hind limbs (Skarda and Tranquilli, 2007).

**Conclusions and Recommendations**

The high epidural anesthesia is safe as compared to general anesthesia in ruminants because during general anesthesia animal may take food particle, saliva or other material into the respiratory tract due to its regurgitating ability. The xylazine alone produced good sedative effects as compared to lidocaine alone when administered in lumbosacral space. Furthermore, xylazine alone produced slow onset of analgesia but it produces more sedative and analgesic effects as compared to lidocaine alone. This agent may be used in clinical practice for complete and safe regional sedative and analgesic effects for obstetrical and surgical interventions. Finally, xylazine is recommended for epidural analgesia in small ruminants. However, further studies require investigating the optimum dose for particular obstetrical and surgical intervention.

**Conflict of interest**

The authors have declared no conflict of interest.

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M.Y. Jakhrai et al.