Research Article

Review on Commonly Used Veterinary Anesthetic Drugs in Small Ruminants

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Abstract | Now a day a variety of drugs are on use for providing anesthesia in animals. Small ruminants, due to their anatomy and physiology, are not suitable for many of the anesthetic drugs. With strict consideration, some drugs are commonly used in these animals. Anesthetic drugs classified based on their action and efficacy. The commonly used local anesthetic agents include procaine, lidocaine and bupivacaine. Understanding the pharmacology of local anesthetics enables the anesthetists to predict the potency, speed of onset, duration of action and safety of a specific drug in a given clinical situation. A local anaesthetic disrupts ion channel function within the neuron cell membrane preventing the transmission of the neuronal action potential while general anesthetics like ketamine disrupt pathways within the cerebrum and stimulates the reticular activating center. Local anaesthetics affect all excitable tissues in the body, so toxicity can occur when sufficient amounts of the drug are absorbed into the circulation. General anesthesia (GA) is not commonly used in small ruminants as its administration results in several side effects such as; ruminal tympany, regurgitation of reticuloruminal contents, aspiration of refluxed material or saliva, hypoventilation, hypotension and fluid and electrolyte imbalances. Ketamine (injectable) is a commonly used general anaesthetic agent in veterinary practice. Injectable anesthetics offer the advantage of requiring less expensive equipment. Isoflurane (inhalant) provides a very rapid and smooth induction and recovery. Pre-anesthetic medications are used to decrease fear and apprehension, aid in restraint, decrease the amount of other anesthetic agents required and decrease side effects of induction drugs. These drugs are metabolized by the liver and excreted by the kidneys. Monitoring vital signs continuously during anesthesia will provide early warning of potential problems and emergencies that may be averted by appropriate and quick corrective actions.

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Introduction

Anesthetic can be defined as any agent that produces a local or general loss of sensation, including pain (Singh, 2014). Anesthesia is defined as a reversible processes induced by a drug or drug combination that depresses activity of nervous tissue peripherally (local and regional anesthesia) or centrally (general anesthesia). Many anesthetic drugs are available to provide this activity (Janycel, 2001). Since pain perception is well developed in small ruminants, anaesthesia is mandatory when performing surgery. Local or regional anaesthesia is a preferred anaesthetic method in sheep and goat (Thurmon *et al*., 1996).

The commonly used local anesthetic agents include lignocaine, lidocaine and bupivacaine. Lignocaine has a relatively rapid onset of action and intermediate duration of about 1 to 2 hours (Lumb and Jones, 1996). Bupivacaine is a long acting local analgesic. It is about 4 times more potent than lignocaine and is used most commonly for regional nerve block. Lidocaine is approved for use in epidural anesthesia (Sarker *et al*., 2012). Local anesthetics disrupt ion channel function within the neuron cell membrane preventing the transmission of the neuronal action potential (Hilary and Graham, 2005). Local anaesthetic drugs are administered to the areas around the nerves to be blocked, which include skin, subcutaneous tissues, intrathecal and epidural spaces (Lagan and McClure, 2004).

General anesthesia is not commonly used in ruminants as its administration results several side effects such as ruminal tympany, regurgitation of reticuloruminal contents, aspiration of material or saliva, hypoventilation, hypotension and fluid and electrolyte imbalances. Ketamine is an example of injectable general anesthetic while isoflurane is inhalant (Mckelvey and Hollingshead, 2003). Alpha-2agonists include xylazine, detomidine and medetomidine that induce sedation and analgesia (Khan *et al*., 2004). The distribution of the drug is influenced by the degree of tissue and plasma protein binding of the drug. The more protein bound the agent, the longer the duration of action as free drug is more slowly made available for metabolism (Plumb, 2005).

The purpose of anesthesia is to provide reversible unconsciousness, amnesia, analgesia, and immobility with minimal risk to the patient. Pre-anesthetic starvation for 18 to 24 hours (or overnight, 12 to 18 hours) should reduce the likelihood of regurgitation by reducing the volume of rumen content. Starvation for very much longer than this may result in a higher liquid component and make regurgitation more likely. Endotracheal intubation with a cuffed tube should be regarded as essential whenever general anaesthesia is induced in a small ruminant (Polly, 1991). Anaesthetic drugs however, compromise patient homeostasis at unpredictable times and unpredictable ways (Haskins, 1996). Therefore, the objective of this paper is to review some anesthetic drugs commonly used in small ruminants

Materials and Methods

History and overview of anesthetic drugs

The term anesthesia, derived from the Greek term anaisthaesia, meaning insensibility, is used to describe the loss of sensation to the entire or any part of the body. Anesthesia is induced by drugs that depress the activity of nervous tissue locally, regionally, or within the central nervous system (Heavner, 1983). Both central nervous stimulants and depressants can be useful general anesthetics. The search for relief of pain would seem to be as long as the history of man. There is evidence of the use of various substances to relieve pain or cause sleep throughout recorded history (Winters *et al*., 1972).

The earliest records of the use of natural substances such as *opium* and alcohol to relieve pain date back to thousands of years BC. In the 800's, the use of a "*Soporific sponge*" is described. This was a sponge soaked in a mixture of substances egopium, hyoscyamus, mulberry juice, hemlock, madragora and ivy. The sponge was applied to the nose of the patient prior to surgery. With the ability to extract and identify the compounds in these plants, we can now provide justification for the inclusion of most of these substances in such recipes (Tranquilli *et al*., 2007).

By 1866 local anaesthesia by ether spray had been described. Cocaine was first introduced clinically in 1884. Its toxicity and addictive properties lead to its use being discontinued except in surgery of the nasal cavity when its ability to produce intense vasoconstriction is useful. Procaine was the next drug on the scene, in 1905. It is very slow in onset. Research and development are directed towards producing a local anesthetic that is longer acting and less toxic than those already available (Jones, 2002).

In 1943, an alternative class of anesthetics was discovered when Lofgren developed lidocaine. This agent is an amide derivative of diethylaminoacetic acid, not PABA; therefore, it has the benefit of a low allergic potential. Since then, multiple amide-type anesthetic shave been introduced into clinical use. Slight chemical alterations to the compounds have imparted beneficial characteristics, including increased duration and potency, to each. These compounds offer the surgeon more choices, and anesthetics can be appropriately matched to different procedures (Stafford *et al.*, 2002).

Types of anesthetic drugs

Local anesthetics: Local anesthetics are drugs, which reversibly prevents transmission of the nerve impulse in the region to which they are applied, without affecting consciousness. Local anesthesia induces loss of sensation by reversibly blocking transmission of nerve impulses along the nerves in a small part of the body, which is to be operated (Harjai, 2013; Lauretti, 2014). Local and regional anesthesia are commonly used in farm animals, as they are considered both safe and effective. Local anesthetics generally have a lipid-soluble hydrophobic aromatic group and a charged, hydrophilic amide group. The bond between these two groups determines the class of the drug, and may be amide or ester. Examples of amides include lidocaine, bupivacaine and prilocaine. Examples of esters include cocaine and procaine (Hilary and Graham, 2005).

Lidocaine: Lidocaine induces an intense, faster, and more extensive anesthesia than procaine, another amide type local anesthetic. The lidocaine is the most widely used general-purpose local anesthetic in veterinary use. It possesses reasonably rapid onset of action, with good spreading properties. It may cause some local irritation and swelling. It is available in a variety of concentrations or injection; with and without epinephrine; and in the form of solutions, creams, jellies, sprays etc. Duration of action is variable (depending on uptake) but will be around one hour without epinephrine, and two hours with epinephrine. Lidocaine, a local-regional anaesthetic agent, is currently recommended to be used for local-regional anaesthesia in food producing animals (Orlando *et al.*, 2003).

The bupivacaine has a prolonged duration of action: Up to eight hours when combined with epinephrine. It is therefore used whenever long action is required. The prilocaine has slower onset of action, and spreads less well compared to lidocaine. The unique ability of prilocaine to cause dose-dependent methemoglobinemia limits its clinical usefulness (Stewart *et al.*, 2009). Procaine (p-aminobenzoyl-diethylaminoethanol) is a water-soluble local anaesthetic, which was previously used in veterinary medicine.

Table 1: *Local Anesthetic drugs approved for small ruminants (Stoelting and Mikhail, 2006).*

Agent	Molecular weight	Pka (25°C)	Speed onset	Potency	Protein binding (%)
Cocaine	303	8.7	Slow	High	6
Procaine	236	9	Slow	Low	-
Lidocaine	234	7.7	Fast	intermediate	64
Bupvacaine	288	8.1	Slow	High	95
Prilocaine	220	7.9	Fast	intermediate	55

Regional anesthetics: This term is used where specific nerves to the area concerned are blocked. Examples include specific nerve blocks to the limbs; paravertebral blocks; cornual block (for dehorning) and many others. Paravertebral anesthesia refers to the perineural injection of local anesthesia about the spinal nerves as they emerge from the vertebral canal through the intervertebral foraminae (Stafford *et al.*, 2002). Local anesthetic drugs, such as lidocaine, used to block painful sensations in a certain part of animal body. The anesthesia (or loss of sensation) is often accompanied by a lack of motor control or relaxation of the muscles. Regional nerve block analgesia is of obvious advantage in ruminants and various methods are available. In small ruminants, these methods are less easily applied than in their larger counterpart, obviously because of small size (Babalola and Oke, 2011).

Epidural anesthetics

An injection of local anesthetics and analgesics into the space of the spine that surrounds the actual spinal cord. This technique often involves placement of an epidural catheter (a small plastic tube) that can also be used for postoperative pain relief. Lidocaine is approved for use in small ruminants for epidural anesthesia (Puente and Josephy, 2001). In both sheep and goats, anterior epidural anesthesia, induced by injection at the lumbosacral junction is easily performed and provides excellent analgesia and muscle relaxation for abdominal surgery. As in cattle, there is a risk of subarachnoid injection (McMeekan *et al.*, 1998).

General anesthetics: Drugs used to induce complete loss of consciousness, intended to block the physiologic and conscious response to any painful or unpleasant stimulus. General anesthetics are of two category injectable and inhalant. Injectable anesthetics can be used to produce short-term anesthesia for minor diagnostic and surgical procedures, or they can be used for induction of general anesthesia followed by maintenance of inhalation anesthesia for longer procedures (Smith and Sherman, 2009).

Common injectable agents include barbiturates (pentobarbitone, thiopental, thiamylal sodium, methohexitone, etc.) and dissociatives (ketamine) (Lyon, 2006). Ketamine is a commonly used general anaesthetic agent in veterinary practice that has recently gained greater popularity because of its suitability for use as an analgesic agent to prevent development of chronic pain when administered at sub-anaesthetic doses by continuous infusion (Valverde and Gunkel, 2005). Ketamine should be administered in combination with xylazine or diazepam to induce surgical anesthesia (Lin, 2007). Ketamine can be used for anaesthesia in sheep and goats without fear of convulsions. Muscle relaxation is poor, but is improved by sedatives such as diazepam or xylazine (Grant and Upton, 2001).

Common inhalation agents include isoflurane, sevoflurane and nitrous oxide. From these isoflurane provides a very rapid and smooth induction and recovery. May cause some slight respiratory depression. It undergoes very little biotransformation and is almost totally eliminated in exhaled air. It can only be used in a vaporizer (with or without induction chamber). It provides no post-operative analgesia (Swindle *et al*., 2002). Alpha-2 agonists include xylazine, detomidine, and medetomidine that induce sedation and analgesia. While xylazine and detomidine are commonly used in farm animals and small ruminants are very sensitive to the effects of xylazine. For systemic administration of xylazine, typical doses range from 0.05 to 0.2 mg/kg in small ruminants (Khan *et al*., 2004).

Mechanism of action of anesthetic drugs

The mechanism of action local anesthetics is the blockade of fast voltage-gated Na+ channels of neuronal membranes, thus preventing signal transduction. They disrupt ion channel function within the neuron cell membrane preventing the transmission of the neuronal action potential. These anesthetic agent (in their ionized form) bind to sodium channels, holding them in an inactive state so that no further depolarisation can occur. This effect is mediated from within the cell; therefore, the local anaesthetic must cross the cell membrane before it can exert its effect. Another mechanism is they involve in the disruption of ion channel function by the incorporation of local anaesthetic molecules into the cell membrane (the membrane expansion theory (Hilary and Graham, 2005).

Table 2: *General anesthetics of small ruminants (Scott, 2001).*

Anesthetics	Dose	Route
Isoflurane	3-4% induction 1-2% maintenance	Inhalation
Diazepam+ Ketamine	0.1mg/kg+4.5mg/kg	IV
Medetomidine + Ketamine	0.5-1mg/kg+0.00020.00025mg/kg	IM
Ketamine + Xylazine	0.05mg/kg+4.5mg/kg 0.2mg/kg+10-15mg/kg	IV IM
Xylazine	0.02-0.15mg/kg 0.05-0.2mg/kg	IV IM, SC
Detomidine	0.01-0.2mg/kg	IM, IV

Injectable general anesthetics like ketamine disrupt pathways within the cerebrum and stimulates the reticular activating center (Chan *et al*., 2005) and diazepam effects release of endogenous GABA, an inhibitory neurotransmitter. Inhalant anesthetics (isoflurane) induce unconsciousness, amnesia, muscle relaxation, blunting of autonomic reflexes and immobility. Ketamine does not produce muscular relaxation (Shmaa and Baradey, 2014). The mechanism of action is uncharacterized (Afshar *et al*., 2005). Alpha-2 adrenoreceptor agonists-stimulation of these receptors causes a decrease in the level of norepinephrine released in the brain resulting in sedation and analgesia (Scoggins *et al*., 2009). The alpha2 agonists are non-irritant so it could be administered intravenously (IV), intramuscularly (IM) or sub-cutaneously (SC). Alpha2 agonists facilitate the restraint of animals for minor surgical and diagnostic procedures as well as reduced the requirements of injectable and inhalant agents (Adams, 2001).

Pharmacokinetics of anesthetic drugs

Pharmacokinetics of local anaesthetics: Local anaesthetic drugs are administered to the areas around the nerves to be blocked, which include skin, subcutaneous tissues, and intrathecal and epidural spaces. Some of the drug will be absorbed into the systemic circulation: How much will depend on the vascularity of the area to which the drug has been applied and intrinsic effects of the drug or its additives on vessel diameter. Cocaine, in contrast, has a vasoconstrictive effect. The distribution of the drug is influenced by the degree of tissue and plasma protein binding of the drug. The more protein bound the agent, the longer the duration of action as free drug is more slowly made available for metabolism (Plumb, 2005).

Ester and amide anaesthetics differ in their metabolism. Esters (except cocaine) are broken down rapidly by plasma esterases to inactive compounds and consequently have a short half-life. Cocaine is hydrolysed in the liver. Ester metabolite excretion is renal. Amides are metabolized hepatically by amidases. This is a slower process, hence their half-life is longer and they can accumulate if given in repeated doses or by infusion. Prilocaine is also metabolised extra-hepatic ally (Lagan and Mcclure, 2004).

Pharmacokinetics of general anesthetics: Injectable anesthetics are, in general, metabolized by the liver and excreted by the kidneys. Animals with liver or kidney disease should not be anesthetized with these agents. Inhalation anesthetics are safer for use in sick or debilitated animals, because there is minimal metabolism, the amount of anesthetic administered can be controlled and one can cease administration as the situation dictates. Injectable anesthetics offer the advantage of requiring less expensive equipment (Plumb, 2005).

Inhalation agents are vapors or gases that are administered directly into the respiratory system, absorbed into the bloodstream, and passed into the brain. Many of these agents are not dependent on detoxification or metabolism in the body, but rather are removed on exhalation. Some however are metabolized and will cause elevation of the liver micro enzymes (Lyon, 2006). Xylazine is rapidly metabolized to inactive compounds, and elimination occurs mainly by urinary excretion of these metabolites (Afshar *et al*., 2005).

Route, dose and duration of action of anesthetics

Local anaesthetic agents have a wide variety of applications. In veterinary practice, intravenous anaesthetic drugs are commonly used as induction agents to facilitate endotracheal intubation, whilst inhalation anaesthetic agents form the foundation for maintenance of general anaesthesia (McKenzie, 2008). Although local areas of anaesthesia can be produced by subcutaneous injection of local anaesthetics, the process of injection may itself cause pain. Inhalation anaesthesia may not be applicable in all situations where anaesthesia is required. Intravenous drugs in those situations (Hofer *et al*., 2003) can then maintain general anaesthesia. Intravenous anaesthesia (IVA), instead of inhalation anaesthesia, could soon become an established means of anaesthetic provision for both induction and maintenance of anaesthesia in veterinary practice (Mckelvey and Hollingshead, 2003). The alpha2 agonists are non-irritant so it could be administered intravenously (IV), intramuscularly (IM) or sub-cutaneously (SC). Alpha2 agonists facilitate the restraint of animals for minor surgical and diagnostic procedures as well as reduced the requirements of injectable and inhalant agents (Adetunji *et al*., 2002).

Local anaesthetics are available as solutions for injection, sprays, creams and gels. Most local anaesthetic preparations contain a preservative agent such as 0.1% sodium metabisulphite, with or without a fungicide. Multidose vials contain 1mg/ml of the preservative methyl parahydroxybenzoate (Lagan, 2004). Usually local anesthesia (lidocaine, bupivicaine, xylocaine) is used in topical applications (e.g. desensitize the cornea for manipulations,

Table 3: *Dosage, route, and withdrawal time of anesthetic drugs of small ruminants (Seyedmehdi, 2004).*

Anesthetics and tranquilizer	Brand name	Dosage	Route	Withdrawal time	
				Meat	Milk
Ketamine	Ketaset	5-10mg/kg	IV or IM	3 days	48 hours
Lidocaine	Lidocaine	1% (variable in goat)	-	-	-
Xylazine	Rompun	0.05-0.1mg/kg	IV or IM	5 days	72 hours
Thiamylal Na	Biotal	10-20 mg/kg	IV	1 day	24 hours
Yohimbine	Yobin	0.25mg/kg	IV	7 days	72 hours

larynx for intubation, or skin incision sites) or to desensitize regional tissues and structures (Hadi and Alireza, 2008).

Purpose of using anesthetics in small ruminants

The purpose of anaesthesia is to provide reversible unconsciousness, amnesia, analgesia and immobility with minimal risk to the patient (Ben and Smith, 2008). In veterinary practice, anaesthesia has to satisfy two requirements: (i) the humane handling of animals and (ii) technical efficiency. Humanitarian considerations dictate that gentle handling and restraint should always be employed; these minimize apprehension and protect the struggling animal from possible injury (Hall *et al*., 2000).

To produce a convenient and safe means of restraint so that clinical or experimental procedures may be performed with a minimum amount of pain, discomfort, and toxic side effects to both the patient and the anesthetist. Local anaesthetic agents are used as the backbone ingredients for local and regional anaesthetic techniques, in the treatment of acute pain during labour, and for analgesia in the operative and postoperative period (Singh *et al*., 2007). They are also used in the management of chronic pain where local anaesthetic injections may have a prolonged effect, and are used to aid diagnosis and management prior to neurolytic procedures (Mclure and Rubin, 2005). GA is preferable to sedation and local infiltration in goats, as they do not tolerate sedation and physical restraint as well as sheep (Mueller, 2009).

The ideal general anesthetic state is characterized by a loss of all sensations and includes analgesia and muscle relaxation. For anesthesia in the domestic goat, single-drug protocols or a combination of drugs from two anaesthetic groups have been used (Afshar *et al*., 2005; Mahmood and Mohammad, 2008). To minimize the risk of injury to animals and people (e.g., dehorning); to reduce aggressive behavior and make male animals easier to handle (e.g., castrating oxen); to prevent carcass damage such as bruising (e.g., dehorning); to enhance carcass quality (e.g. castration); to prevent damage to the environment (e.g., nose ringing in pigs); to aid in identification (e.g., ear marking or notching, branding). The most common painful husbandry procedures used in sheep are castration, tail docking and ear tagging or notching. Local anaesthetic injected into the scrotum and testicles eliminates the plasma cortisol response and by inference the acute pain caused by rubber ring castration (Dinniss *et al*., 1997).

Stages of general anesthesia in small ruminants

Premedication: Pre-anesthetic medications are used to decrease fear and apprehension, aid in restraint, decrease the amount of other anesthetic agents required and decrease side effects of induction drugs. Commonly used pre-anesthetics are tranquilizers and sedatives (chlorpromazine, diazepam and xylazine), Narcotic analgesics (Morphine, Butorphanol) and anticholinergics (atropine, glycopyrrolate). These drugs are usually given to decrease salivation and to minimize the vaso-vagal reflex (Swindle *et al*., 2002).

Induction

In small ruminants and calves, general anesthesia can be induced by administering isoflurane, halothane, sevoflurane, or desflurane with a facemask. For faster induction and less exposure to anesthetic gases, these agents can also be administered through nasotracheal intubation. Combination of alpha 2 agonists with dissociatives IM or IV can be administered. Ketamine for induction diazepam may have to be readministered following catheterization and before ketamine administration (Hadi and Alireza, 2008). Xylzine-Ketamine, Medetomidine-Ketamine combination can also be used for induction (Hall *et al*., 2001). Analgesics are together administered with general anesthetics to minimize hemodynamic changes and side effects. Nonsteroid antiinflammatory drugs (COX inhibitors) or acetaminophen could provide adequate analgesia for minor surgical procedures. However, opioids are the primary analgesics used before the induction of general anesthetics for surgery (Riviere and Papich, 2009).

Maintenance

During the maintenance period, the anesthetist has two responsibilities. First is to monitor the patient closely to ensure that the animal's vital signs remain within acceptable limits. Second, is to maintain the animal at an appropriate anesthetic depth. The key to effective and safe anesthesia is patient monitoring. The anesthetist who closely monitors the animal under anesthesia will receive ample warning of potential problems as they arise (Hedenqvist and Hellebrekers, 2002). Any of the commonly used inhalation anaesthetics in veterinary practice including isoflurane, and sevoflurane are suitable for maintenance of anaesthesia. The anaesthetic agent of choice is isoflurane (Scoggins *et al*., 2009).

Recovery

The anesthetic period does not end when the surgery ends. Perioperative support and monitoring continues through the recovery period. The anesthetist is responsible for informing the recovery team of any anesthetic or surgical complications that occurred and any special needs before leaving the patient. Vital signs should be monitored in the recovering animal every 15-20 minutes or as appropriate until the patient is sternal (Fereidoon, 2005). Then as needed until the animal is ambulatory and able to return to a kennel or released to the client (Riebold, 2007).

Consideration during using anesthetics in small ruminants

Reducing the potential for adverse effects depends on several factors: Assessment of the patient and any potential risk factors; familiarity with side effects and contraindications of different agents and appropriate protocol choice, often including multi-drug use to achieve balanced anesthesia (Stafford *et al*., 2003). General anesthesia in farm animals, like cattle, sheep, and goats requires special attention due to the uniqueness of the anatomical and physiological characteristics as compared to dogs, cats, and horses (Davis *et al*., 2009). All inhalation agents require a scavenging system (ventilated hood or anesthetic machine), to prevent personnel from inhaling waste anesthetic gases.

Small ruminants produce copious amounts of saliva and should have their noses lower than the rest of the head to allow the saliva to flow out (Muir, 2000). Ruminants are also prone to bloat when anesthetized if they have not been held off feed prior to anesthesia. When gas builds up in the rumen it puts pressure on the diaphragm and hampers ventilation (Stoelting and Mikhail, 2007). A stomach tube can be inserted to relieve the ruminal distention and may need to be left in place for the remainder of the procedure. Small ruminants should be starved of food for 12 hours and of water for 8 hours (Lyon, 2006).

Monitoring vital signs continuously during anesthesia will provide early warning of potential problems and emergencies that may be averted by appropriate and quick corrective actions. Do not rely on a single parameter to assess the animal's condition. All parameters should be evaluated prior to initiating any corrective actions (Riebold, 2007).The basic parameters that can be monitored include heart rate, color of the mucous membranes, capillary refill time, respiratory rate and body temperature (Galatos, 2011; Garcia, 2012).

Risk of using anesthetic drugs in small ruminants

Anaesthetic drugs may compromise patient homeostasis at unpredictable times and unpredictable ways. Because of their unusual anatomy and physiology, general anesthesia and even heavy sedation can be complicated and life threatening. Not only are the anesthetic drugs sometimes an issue, but complications associated with the stomach and digestive systems of small ruminants need to be considered as well (Sharon, 2011).

Local anaesthetics affect all excitable tissues in the body, so toxicity can occur when sufficient amounts of the drug are absorbed into the circulation. Inadvertent intravenous injection is the most usual cause of toxicity but care must be taken with injections of large volumes in very vascular tissues. The rate of absorption may exceed the rate at which the drug is metabolised (Adams, 2001).

Localized toxicity occurs following injection of local anaesthetic directly into a structure or when a structure is exposed to a high con-centration for a prolonged period. Direct injection into a muscle provokes an intense inflammatory reaction resulting in areas of muscle necrosis, which is worsened by added vasoconstrictor (Mclure and Rubin, 2005). Reverses any analgesic benefit of α2 agonist; can cause muscle tremors, increased respiratory rate, and hyperaemic mucous membranes; has no use as a stand-alone drug (Arras *et al*., 2001). Anesthetics also produce a depressant effect on the cardiovascular, respiratory, and thermo-regulatory systems.

Conclusions and Recommendations

Generally in small ruminants local and regional anesthesia are commonly used, as they are considered both safe and effective. Lidocaine is commonly used in small ruminants as local anaesthetic whereas ketamine as general anaesthetic. Inhalant anesthetics are widely used for longer procedures. However, general anesthesia is not common in small ruminants. Local anesthetics provide inexpensive analgesia with minimal side effects. Local infiltration, regional blocks, epidural and systemic administration can be performed and will decrease the dose requirement of other drugs, such as inhalants anesthetics. Anesthetic drugs affect all excitable tissues in the body, so toxicity can occur when sufficient amounts of the drug are absorbed into the circulation.

- Based on above conclusion, the following recommendations are forwarded:
- The dose, route of administration, duration of action and side effect of anesthetics have to be well monitored.
- In case of GA Preanesthetic medications have to be encountered in order to reduce the risk of induction drugs.
- Before anesthesia, the status of animal must be assessed and proved as wether it can recover or not and during maintenance vital parameter have to be cheked.

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Novelty Statement

The novelty of our work entitled “Review on Commonly Used Veterinary Anesthetic Drugs in Small Ruminants” can be summarized as Now a day a variety of drugs are on use for providing anesthesia in animals. Small ruminants, due to their anatomy and physiology, are not suitable for many of the anesthetic drugs. With strict consideration, some drugs commonly used in these animals. Anesthetic drugs classified based on their action and efficacy. The commonly used local anesthetic agents include procaine, lidocaine and bupivacaine. Understanding the pharmacology of local anesthetics enables the anesthetists to predict the potency, speed of onset, duration of action and safety of a specific drug in a given clinical situa.

Author’s Contribution

All authors took part in drafting, revising, or critically reviewing the article, gave fial approval to the version to be published, have agreed on the journal to which the article has been submitted, and agree to be accountable for all aspects of the work.

Abbreviations

ACTH, Adrenocorticotropic hormone; COX, Cyclooxygenase; GA, General anesthesia; GABA, Gamma-amino butyric acid; IM, Intramuscular; IV, Intravenous; IVA, Intravenous anesthesia; Kg, Kilogram; LA, Local anesthesia; Mg, Milligram; NSAIDs, Non-steroidal anti-inflammatory drugs; SC, Subcutaneous; TIVA, Total intravenous anesthesia.

Conflict of interest

The authors have declared no conflict of interest.

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