

ANESTHESIA, CHEMICAL RESTRAINT AND PAIN MANAGEMENT IN SNAKES (SERPENTES) – A REVIEW

Seven Mustafa, Nadya Zlateva

University of Forestry, Faculty of Veterinary Medicine, Sofia, Bulgaria

Email: nzlateva@ltu.bg

ABSTRACT

In the last few years the exotic animals are becoming more and more popular pets. The prophylactic and medical procedures in these animals require appropriate immobilization and anesthesia. The information for the anesthetic and analgesic agents for these animals is not enough.

The purpose of this study was to be made a review of the appropriate anesthetic agents, methods and schemes for sedation, analgesia and anesthesia in snakes, which could help veterinary doctors to perform safer clinical examination or painless invasive procedures with a minimal stress for the patient.

Key words: anesthesia, sedation, snake.

Introduction

Historically speaking clinical and surgical procedures in snakes have been performed by firm fixation with assistants or by controlled hypothermia. Cooling immobilizes them for a short time but does not reduce the level of perceived pain. Today, although not so well researched, there are drugs available to achieve safe and effective anesthesia in snakes. In order to be as useful as possible, the veterinarian should be familiar with the anatomical and physiological peculiarities of the specific type of patient.

Physiological characteristics in snakes

Snakes are poikilothermic vertebrates, whose body temperature is highly dependent on the ambient temperature. Their erythrocytes are nuclear and their metabolism equals about 15% of that of mammals. Via renal and hepatic portal system, they excrete mostly ammonia, urea and uric acid. They have cloaca, where the lower gastrointestinal tract, the reproductive system and the urinary tract are collected. Their lungs have simple structure and resemble vascular sacks rather than alveoli. Their tracheal rings are incomplete. Boas and pythons are more primitive snakes in evolutionary terms and have two lungs, while the other snakes have stunted left lung. There is no diaphragm and all internal organs are in a common cavity, called coelomic (Divers, 2014).

For short-term diagnostic procedures, it is sometimes enough to fix firmly the animals from their owners who have experience and evaluate the reactions of their pets. For longer-lasting and painful manipulations, snake sedation or anesthesia should be applied for the safety of physician staff and patient stress reduction.

Preanesthetic care

Prior to application of anesthetic agents, an accurate assessment of the clinical status of the reptile, the potential risk assessed and the exact weight measured should be performed. In dehydrated patients should be applied a fluid therapy (10–30 ml/kg per day – Mitchell et al., 2009). The degree

of dehydration can be determined by blood tests (Hct – 20–35%) as well as by the skin turgor (Divers, 2014).

Starvation diet prior to surgery is not prescribed, although a large prey located in the stomach during surgery may theoretically hamper and complicate the respiratory function of reptiles (Bertelsen, 2007). Colubridae are fed once a week, and the big Boidae once a month, so it's not that difficult to plan the surgery.

Monitoring

Maintaining body temperature

The body temperature of the snakes is monitored by cloacal thermometers or probes, with the possibility of reading lower values. The temperature of the snake should be maintained at about 28°C (Bertelsen, 2007).

One of the main conditions for the success of anesthesia and surgery in the cold-blooded animals is to maintain normal room temperature in the operating room, and the anesthetized snakes to be heated additionally by heating pads, pillows or other means that do not interfere with the procedure (Raiti, 2002). This contributes for proper distribution and metabolism of anesthetics, and the possibility of faster recovery (Katz, 2002; Mitchell et al., 2009).

Heart and respiratory rate

Physiological ranges of the heart rate are between 20-40 beats per minute (the smaller animals have a faster rhythm). Normal breathing frequency is 4 per minute (Raiti, 2002).

Control of the anesthesia

Snakes do not have legs or movable eyelids, so most of the reflexes that are observed in mammals for depth of anesthesia can't be used in snakes. However, it is possible to use the tongue retraction reflex, as well the cloacal and tail pinch reflexes. Reflexes and responses include: Toe and tail pinch, head withdrawal (Toe is pinched and head is slightly withdrawn), palpebral response, vent response, tongue response, corneal response, and jaw tone (Hernandez-Divers, 2008).

Reflexes

The reflexes are lost from the head to the tail and are restored in the reverse order - from the tail to the head.

The tongue retraction reflex when pulled out of the mouth (remains extended and flaccid) is the first to be noticed when anesthetized, and the last one to appear when awakening. Once the tail and cloacal reflexes are diminished or absent, the animal may be considered to be in an anesthetized state suitable for surgical intervention (Heaton-Jones et al., 2002).

For monitoring of anesthesia it could be used a Doppler blood flow monitor. A pulse oximeter and an electrocardiograph may also be useful. Advanced monitoring aids include blood gas saturation and capnography. Although readings for pulse oximetry may drop below 70%, aim for haemoglobin saturation above 90%.

Complications

Following the protocols rarely leads to complications, but as such the most commonly encountered are respiratory depression or apnea and prolonged recovery. It's reported that apnea periods of 5-10 minutes are unlikely to lead to undesirable consequences (Bertelsen, 2007). These problems can be reduced by providing adequate mechanical ventilation and by keeping the body temperature within physiological limits (28°C).

Methods for introduction of anesthetic drugs

Direct intracardiac application is described to be the fastest way for drug administration as well as for collection of blood samples because the topographic position of the heart could be easily determined on the ventral wall of the snake's body. According to the Bertelsen (2007) this method is stressful and it can damage the myocardium.



Figure 1: Cardiac puncture for i.c. application of drugs or for blood collection (original).

For more experienced specialists intravenous access via the tail vein is not difficult. The palatine veins could be accessed in large snakes.

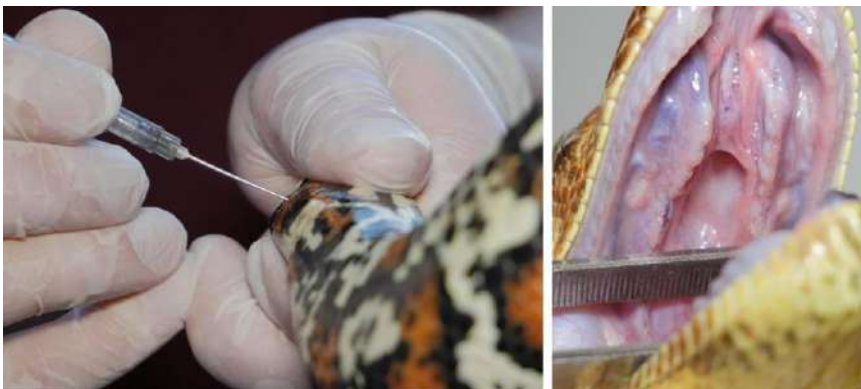


Figure 2: Intravenous catheterization of the caudal (ventral tail) vein and showing the palatine veins in *Boa constrictor* (original).

Intramuscular access is most easily applicable to snakes, with the most preferred location in the front third of the animal's body length.



Figure 3: Intramuscular application of drugs in snakes (original).

Anesthesia and sedation drugs

Anticholinergic agents

Parasympatholytic drugs reduce pulmonary secretion and prevent vagal bradycardia. Glycopyrrolate (0.01 mg/kg) is safer than Atropine sulfate, especially in small snakes, and does not pass through the haemo-encephalic barrier. It is injected intramuscularly, 30 minutes before anesthesia (Raiti, 2002).

Drugs used for sedation

Injectable anesthetics such as Propofol or dissociation agents (Ketamine, Tiletamine) are used to facilitate endotracheal intubation. It is safer for exhausted and risky patients to administer sedation using Isoflurane, supplied by a mask or by a bag in small snakes. It doesn't sensitize the myocardium to the circulating catecholamines and leads to good muscle relaxation (Raiti, 2002).

Dissociative agents are used for analgesia in clinical procedures. Although they are characterized as anesthetics, they do not provide sufficient visceral analgesia in mammals and should not be used alone in severe surgical interventions and in snakes. These drugs could be easily found, they are administered intramuscularly, but a major disadvantage is their long recovery period. Even with low doses of Tiletamine (5 mg/kg), the snakes are fully recovered within 24–48 hours (Mitchell et al., 2009).

Diethelm (2004) gives average doses for Ketamine 10–20 mg/kg, and for Telazol (Tiletamine & Zolazepam) 3–6 mg/kg for short-term procedures (Mitchell et al., 2009).

Local anesthetics

Local anesthetics (Lidocain) are almost not used in reptile medicine. They can be combined with other anesthetics or applied around the surgical incision, but there are no studies yet on their toxicity. Mitchell et al. (2009) indicate that doses up to 5 mg/kg are safe.

Volatile anesthetics

Volatile anesthetics provide better control over anesthesia. The most appropriate anesthetic delivery is obtained by an endotracheal intubation.

Technique: the glottis is located on the bottom of the oral cavity, just behind the tongue. Non-cuffed tube should be used (Mitchell et al., 2009). For very small snakes, venous catheters 16-19 G can also be used (Bertelsen, 2007). It should be ensured that the endotracheal tube does not become clogged with mucus.

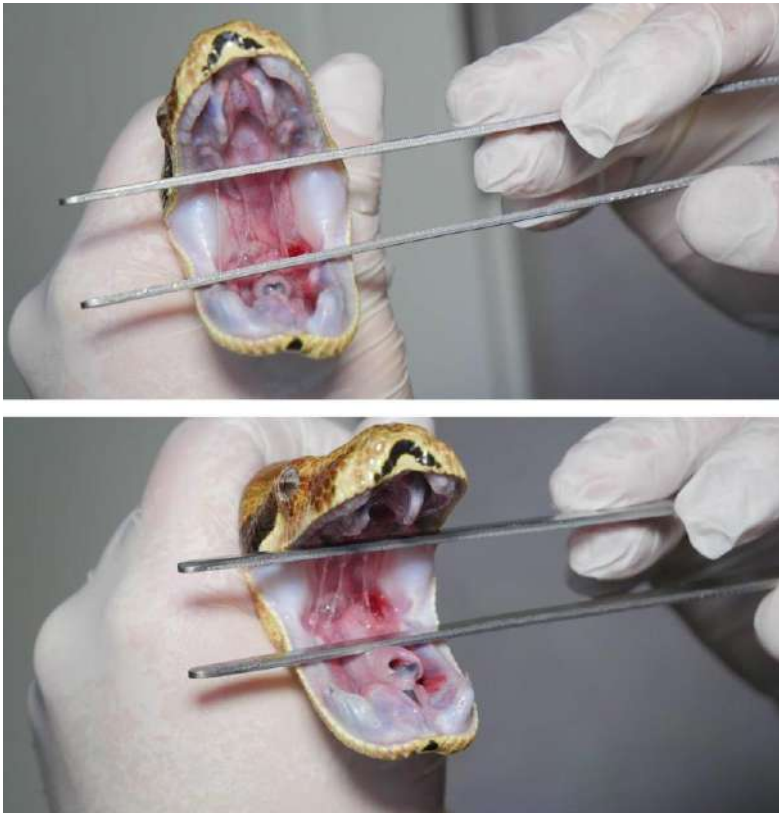


Figure 4: Oral cavity of Boa constrictor showing the rostral location of the closed glottis and the same patient with the opened glottis ready for intubation (original).

Small patients could be closed in a zip-lock bags (with 5% Isoflurane or 8% Sevoflurane. It usually takes about 10-20 minutes to reach an operational stage of narcosis (Divers, 2014).



Figure 5: A small corn snake (*Pantherophis guttatus*) in a zip-lock bag (original).

Because snakes lack a diaphragm and can become apneic for extended periods of time, a positive-pressure ventilation of the snake 4 to 6 times per minute is recommended (Mitchell et al., 2009).

Drug for general anesthesia

Volatile anesthetics

Isoflurane - at low levels the snakes preserve their respiratory activity, but mechanical ventilation is usually required at levels suitable for surgical intervention. Isoflurane lowers heart rate moderately (by 25%) and reduces respiratory rate. In most patients, vaporizer settings of between 2 and 2.5% are suitable for maintaining surgical anesthesia at an ambient temperature of 30–32°C. (Bertelsen, 2007). MAC decreases with decreasing of the body temperature.

Sevoflurane – it is recommended to set the vaporizer at about 3% (Bertelsen, 2007). It is preferred for large reptiles and has a faster recovery period than Isoflurane (Divers, 2014). This applies to short-term procedures – for deep anesthesia that difference is insignificant. With the new volatile anesthetics, the time of the recovery period appears to be influenced more by the duration and depth of anesthesia rather than the applied agent (Bertelsen, 2007).

CO₂ – Carbon dioxide is used to immobilize poisonous snakes during venom extraction. It is not recommended in clinical practice because it is believed to cause respiratory acidosis (Bertelsen, 2007). A mixture of 3% CO₂ in oxygen can be used during mechanical ventilation to stimulate the respiratory center, and a mixture of 10% CO₂ is recommended for stimulation during the recovery period.

At the end of surgery, patients are allowed to breathe in atmospheric air rather than pure oxygen. Spontaneous breathing in reptiles is not so much caused by the increase of carbon dioxide in the blood as by the decrease of oxygen (Katz, 2001). Therefore, supplying pure oxygen would delay spontaneous breathing.

Injectable anesthetics for anesthesia

Many injectable anesthetics have been used in reptiles such as etorphine hydrochloride, pentobarbital sodium, thiopental sodium, methohexital, MS-222, urethane, nicotine, decamethonium iodide, tubocurarine chloride, procaine hydrochloride and alphaxalone/alphadolone. Except the alphaxalone, these agents are considered outdated in the clinical practice (Bertelsen, 2007). Propofol is preferred if intravenous access is possible.

Propofol – intravenously induces anesthesia within 1–5 minutes. Perivascular is not effective, but doesn't cause damage to tissues such as barbiturates. Ventral tail vein administration is possible in patients weighing over 250 g. (Bertelsen, 2007). In snakes, it lowers cardiac and respiratory activity. The duration of anesthesia depends on the dose. At low doses (5 mg/kg) it is about 20–30 minutes (Diethelm, 2004). It can be combined with inhalation anesthesia.

Alfaxalone – administered intravenously in a dose <9 mg/kg (Meredith, 2015), but its advantage is that it's also effective in intramuscular administration in a dose of 10–20 mg/kg (Divers, 2014).

Ketamine – The dose depends on the body temperature. At lower temperatures, lower doses are required, but a slower recovery is observed (Bertelsen, 2007). Doses of 12–44 mg/kg are recommended for sedation and 55–88 mg/kg for surgical anesthesia. The time to peak is about 30 minutes after intramuscular application (Diethelm, 2004).

It increases the heart rhythm, leads to hypertension and respiratory depression, and in higher doses can lead to apnea, bradycardia and death. Its main disadvantage in reptiles is the long time for postoperative recovery – at high doses it may reach up to 7 days. Bertelsen (2007) reported recovery up to 24 hours at doses of 15 mg/kg, 2–3 days at doses between 40–80 mg/kg and up to 7 days at 100–130 mg/kg. Ketamine can be combined with sedatives such as benzodiazepines and alpha-2-agonists for better muscle relaxation and dose reduction: Ketamine 5 mg/kg + Medetomidine 0.01 mg/kg IM (Meredith, 2015).

Tiletamine & Zolazepam – anesthesia is achieved faster than ketamine, but its effects are similar. However, the duration of anesthesia and its effects are very differently described, so large variations in doses have been reported (from 5 to 80 mg/kg for snakes). It has been studied poorly but it is reported that at low doses (2–5 mg/kg) it can be used for sedation when intubating large snakes (Bertelsen, 2007).

Analgesics

Analgesics should be used each time when the animals are subjected to painful sensations. Unfortunately, the knowledge of pain perception in snakes is quite limited. Mitchell et al. (2009) recommended using of pain relieving agents such as Butorphanol (0.5–1 mg/kg IM), Carprofen (2–4 mg/kg IM, PO) and Meloxicam (0.5 mg/kg PO) every 24 hours. Studies on Buprenorphine show no efficacy when applied to reptiles (Meredith, 2015). In case of neurological damage or intolerance, in order to control the condition of the animal, it may be necessary to inject Diazepam at a dose 5 mg/kg (Raiti, 2002).

The commonly used anesthetic drugs in reptiles are presented in the table 1.

Table 1: Commonly used sedation, analgesic and anesthetic drugs in reptiles.

Drug	mg/kg, applic.	Comment
Glycopyrrolate	0,01 i.m.	parasympatholytic, 30 minutes before anesthesia
Propofol	3 – 5 i.v.	deep sedation
Ketamine	5 – 10 s.c., i.m.	moderate sedation, intubation ^a
Telazole	2 – 5 s.c., i.m.	moderate sedation, intubation (for large snakes) ^a
Isoflurane	5%	by envelope, chamber-induction or mask
Sevoflurane	8%	by envelope, chamber-induction or mask
Lidocain 2%	5 s.c. infiltration	local anesthetic
Propofol	5 – 10 i.v., i.c.	mild anesthesia (followed by inhalation agent)
Alfaxalone	<9 i.v., 10 – 20 i.m.	mild anesthesia
Telazol	2 – 6 i.m.	induction, followed by inhalation agent
Medetomidine + Ketamine	0,1 + 5 i.m. ^b	combination for anesthesia ^b
Isoflurane	2 – 2,5%	by endotracheal tube
Sevoflurane	2,5 – 3,5%	by endotracheal tube
Butorphanol	0,5 – 1 i.m.	q24
Carprofen	2 – 4 i.m., p.o.	q24
Meloxicam	0,5 p.o.	q24
Diazepam	5 i.m.	for seizures

^a*Spray of local analgesic for desensitization of the glottis (Bertelsen, 2007).*

^b*Reversal agent for Medetomidine is Atipamezole in dose x5 of injected Medetomidine (Raiti, 2002).*

Other techniques

Hypothermia – although sometimes used for taming or „training” reptiles, as well as electro-anesthesia are considered unacceptable in clinical practice (Bertelsen, 2007).

Conclusion:

The principles of anesthesia and analgesia for snake are the same as mammals, but the anesthesiologist must have knowledge about the anatomy and physiology of the snakes.

For every patient and procedure, risk, needs and potential for pain should be assessed individually.

References

- Bertelsen, M. (2007). *Squamates (Snakes and Lizards), Zoo Animal and Wildlife Immobilization and Anaesthesia*. Blackwell Publishing, 233–241.
- Diethelm, G. (2004). *Chemical restraint/anesthetic/analgesic agents used in reptiles, Exotic Animal Formulary*. Elsevier Saunders, Third edition, 73–83.
- Divers, St. (2014). *Anesthesia of zoological species (exotic pets, zoo, aquatic, and wild animals), Veterinary Anaesthesia*. Saunders Elsevier, Eleventh edition, 549–558.
- Heaton-Jones, T., Jeff C (2002). *Reptile Anesthesia and Analgesia, Veterinary Anesthesia and Pain Management Secrets*. Hanley & Belfus, 288.
- Hernandez-Divers, S. (2008). *Snake anesthesia and surgery*. Proceedings of the North American Veterinary Conference, 22, pp 1767.
- Katz, Ch. (2001). *Anesthesia and Immobilization of Wildlife and Exotic Pets*. Two Rivers Veterinary Hospital, Wisconsin, <http://www.vetandwild.com/reptiles.html>.
- Meredith, A. (2015). *Small Animal Formulary*. 9th edition – Prt B: Exotic Pets, British Small Animal Veterinary Association, 320–321.
- Mitchell, M. A., Thomas N. T. Jr. (2009). *Manual of Exotic Pet Practice*. Saunders Elsevier, 160–162.
- Raiti, P. (2002). *Manual of Exotic Pets*. British Small Animal Veterinary Association, Fourth edition, 254.
- Rossi, J. Roxanne Rossi. (2006). *What's Wrong with My Snake?* Advanced Vivarium Systems, Irvine, 222–229.