Reptile anesthesia and analgesia

ABSTRACT

In reptiles, administration of safe and effective anesthesia and analgesia presents unique challenges to the veterinary practitioner. Reptiles are often, presented with chronic disease, signs of dehydration, malnutrition and secondary bacterial infections are common; throughout preanesthesia evaluation is essential including, history, physical exam and basic lab workup.

The patient should be placed in a temperature and humidity controlled environment. Most anesthetic protocols for reptiles are designed to include inhalational anesthetic agents for induction and maintenance of anesthesia. Facemask induction without prior administration of a sedative agent can be challenging in some reptiles. Most reptiles should receive sedative agents prior to induction of anesthesia.

Although challenging, cardiopulmonary performance of the patient should be closely monitored throughout the anesthetic event and fluid therapy should be provided. The anesthetic depth can be determined by the presence or absence of reflexes. In a surgical plane of anesthesia the righting reflex will be absent in all reptile species. Absence of the corneal and tongue withdrawal reflex indicates a too deep anesthetic plane.

Profound respiratory depression following induction and during the maintenance phase is present in all reptiles; thus it is essential to assist ventilation and provide intermittent positive pressure ventilation (IPPV).

During the recovery period the patient should be placed in a quiet, temperature controlled environment. Temperature in the incubator should be set within the preferred body temperature range of the particular species. Increasing the temperature above this range is not recommended since it will increase metabolic demands for oxygen. Reptiles should be closely monitored for evidence of respiratory depression and ventilation may have to be assisted well into the recovery period.

Recognition of pain in reptiles is challenging, therefore it is essential to be familiar with the species to be treated and its normal behavior. Prevention is the most effective method of pain management. Preemptive analgesic techniques may include pre-operative administration of analgesics such as opioid agents. Topical, regional and local infiltration techniques can be used in many reptile species.

Only fully recovered animals should be returned to their enclosure.

Key words: reptiles, anesthesia, analgesia, positive pressure ventilation, temperature controlled environment

RESUMEN

En los reptiles los procedimientos analgésicos y anestésicos presentan cientos retos únicos. Los reptiles frecuentemente se presentan con procesos mórbidos crónicos, la presencia de signos de deshidratación, malnutrición e infecciones bacterianas secundarias es frecuente. Por lo tanto la evaluación preanestésica es esencial y debe incluir la historia, examen físico, y análisis de laboratorio.

Los pacientes deben ser colocados en un ambiente controlado de humedad y temperatura. La mayoría de los protocolos anestésicos incluye el uso de agentes inhalantes para la inducción y mantenimiento de la anestesia. Sin embargo, la inducción con máscara sin la administración previa de un sedante puede ser desafiante en algunos reptiles. Los reptiles deberían recibir agentes sedantes previo a la inducción.

Aunque resulta difícil, debe monitorearse la performance cardiorrespiratoria durante la anestesia y proveer fluoroterapia. La profundidad anestésica puede ser determinada por la presencia o ausencia de reflejos. En plano quirúrgico el reflejo de incorporación estará ausente en todos los reptiles. La ausencia de reflejo corneal y de retirada de la lengua indica profundidad excesiva.

La depresión respiratoria profunda se presenta en todos los reptiles luego de la inducción y durante el mantenimiento por lo que es esencial asistir la ventilación y proveer ventilación a presión positiva intermitente (IPPV).

Durante el periodo de recuperación los pacientes deben ser colocados en un ambiente tranquilo y con la temperatura controlada. La temperatura de la incubadora debe colocarse a la temperatura ideal para la especie particular. Incrementar la temperatura por encima de este rango está contraindicado ya que incrementa las demandas metabólicas de oxígeno. Los reptiles deben ser monitoreados por la presencia de depresión respiratoria y pueden requerir ventilación asistida durante la recuperación.
In reptiles, administration of safe and effective anesthesia and analgesia presents unique challenges to the veterinary practitioner. Compared to mammalian and avian species, reptile anatomy and physiology differ considerably and knowledge of normal anatomy and physiology of the species to be anesthetized is essential. In particular, reptile respiratory anatomy and function is different from mammalian and avian species and affects response to anesthetic agents. In addition, the pathophysiology of many reptilian diseases is different from similar conditions described in mammals.

The design of anesthetic and analgesic protocols in reptile patients is further complicated by species and individual differences in response to commonly used anesthetic and analgesic agents. Knowledge and understanding of reptilian anesthesia and analgesia has increased in the past decade, however relatively few studies have investigated the cardiopulmonary responses of reptiles to various anesthetic agents. Assessment of cardiopulmonary performance in reptiles is complicated by the fact that anesthesia monitoring devices (e.g. pulse oximetry) commonly used in domestic animals are often of limited value in reptiles and have not been validated for use in reptilian species. Investigations into effective reptile analgesia have become more numerous and have shown species differences in response to analgesic agents and protocols. Effective management of peri-, intra- and post-operative pain in reptiles is important to eliminate the negative impact of pain on many body functions including the immune system and cardiopulmonary system. Comprehensive reviews of reptile anesthesia and analgesia have been published previously.

PREANESTHETIC EVALUATION
A detailed history of the patient should be obtained including environmental conditions as well as husbandry practices. Many disease problems diagnosed in reptiles are directly associated with inadequate husbandry such as improper nutrition and failure to provide the animal with appropriate temperature and humidity conditions. A complete visual and physical evaluation of the patient is essential. Abnormalities should be recorded while particular attention should be paid to the cardiopulmonary system. Rate and depth of respiration should be evaluated for signs of respiratory tract disease.

Baseline heart and respiratory rates should be recorded. Often, reptiles are presented with chronic disease processes and physical and laboratory findings indicating dehydration, malnutrition and presence of secondary bacterial infections are common. If possible, a venous blood sample should be collected for determination of hematological and plasma biochemical parameters. Minimally, a blood sample should be collected for determination of blood glucose, total protein and packed cell volume. Based on physical examination and laboratory findings, abnormalities and deficiencies should be treated prior to anesthesia.

The patient should be placed in a temperature and humidity controlled environment. Small animal incubators are ideal for this purpose and supportive measures including fluid therapy, nutritional support and antimicrobial therapy should be instituted. The patient should also be evaluated for any signs of pain and discomfort and if indicated, analgesic therapy should be initiated. For elective surgical procedures post-operative pain is anticipated, administration of pre-emptive analgesia is most effective for the management of intra- and post-operative pain.

INDUCTION OF ANESTHESIA
Most anesthetic protocols for reptiles are designed to include inhalational anesthetic agents for induction and maintenance of anesthesia. Induction of anesthesia via facemask without prior administration of a sedative agent can be challenging in some reptiles, especially in aquatic species capable of breath-holding for prolonged periods of time. Most reptiles should receive sedative agents prior to induction of anesthesia.

Ketamine HCl (5-10 mg/kg I.M.), either alone or in combination with synergistic agents such as opioid agents and benzodiazepines will facilitate handling of large and/or dangerous species and will also reduce the amount of induction agent needed for induction of anesthesia. If venous access has been established, administration of intravenous propofol (3-5 mg/kg I.V.) titrated to effect, will rapidly induce anesthesia. Alternatively, anesthesia can be induced with isoflurane or sevoflurane via face mask. Following induction, the trachea should be intubated and anesthesia should be maintained with an inhalational anesthetic agent such as isoflurane (1.5-3.0 %) or sevoflurane (2.5-4.5%).

MAINTENANCE AND MONITORING OF ANESTHESIA
Cardiopulmonary performance of the patient should be closely monitored throughout the anesthetic event since all anesthetic agents have cardiopulmonary depressant effects. Fluid therapy is necessary for maintenance requirements or correction of fluid deficits.

For maintenance, 5-10 ml/kg/hr of a balanced electrolyte solution is administered. For small species syringe pumps are ideal since they allow for correct administration of fluids and continuous rate infusions which are superior to bolus injections. Throughout anesthesia, the reptile should be kept within the preferred temperature range of the species. Hypothermia is commonly seen in anesthetized patients and supplemental heat should be provided with heat lamps or heating blankets. During surgery, the patient should be regularly evaluated for signs of pain (movement, increase in heart and respiratory rate) and if necessary additional analgesic agents should be administered.

In order to determine anesthetic depth, the presence or absence of reflexes is commonly determined. In a surgical plane of anesthesia the righting reflex will be absent in all reptile species. Absence of the corneal and tongue withdrawal reflex indicates a too deep anesthetic plane. Evaluation of cardiovascular performance can be challenging in reptiles. The most useful equipment is a Doppler flow device to monitor heart rate and rhythm. The probe can be placed at the level of the heart in snakes and lizards or over the carotid artery in chelonians and lizards. Electrocardiography can be performed in reptiles and leads are attached in a conventional manner. Direct arterial blood pressure measurements are impractical in most cases since a cut-down procedure is required in order to establish access to either the carotid or femoral artery.
All reptiles will exhibit profound respiratory depression following induction of anesthesia as well as during the maintenance phase. Consequently, it is essential to assist ventilation and provide intermittent positive pressure ventilation (IPPV). Small animal ventilators (pressure or volume driven) can effectively be used in reptiles. Although no studies have determined safe and effective ventilation in reptiles it is recommended to administer IPPV between 4 to 8 breaths/minute. Peak airway pressure should not exceed 10 to 15 cm H_{2}O.

Although not validated for the use in reptiles, pulse oximetry is a useful tool to monitor trends in relative arterial oxygen saturation. Both, transmission and reflectance probes can be used. In most species an esophageal reflectance probe can be placed at the level of the carotid artery. Arterial blood gas analysis is challenging in reptiles since a peripheral artery is not readily available. Interpretation of arterial blood gas parameters should be done with caution since arterial blood gas analyzers are calibrated based on the human oxygen hemoglobin dissociation curve. Values should be interpreted at 37°C since correction of arterial blood gas parameters to the patients’ temperature will further compromise the accuracy of obtained values. Both, pulse oximetry and arterial blood gas analysis may provide valuable data to assess trends in cardiopulmonary performance.

Capnography is of limited value in reptiles because they can develop cardiac shunts. However, changes in end-tidal CO_{2} concentrations may indicate complications such as airway leaks and airway obstruction. As mentioned above the reptile should regularly be evaluated for any evidence of pain during surgery. Additional administration of systemic analgesic agents as well as local anesthetic agents (e.g. bupivacaine) may be indicated.

**RECOVERY**

During the recovery period the patient should be placed in a quiet, temperature controlled environment. Small animal incubators are ideal for this purpose since they allow visualization of the patient without disturbing or handling it.

Temperature in the incubator should be set within the preferred body temperature range of the particular species. Increasing the temperature above this range is not recommended since it will increase metabolism and demand of the tissues for oxygen which may not be met by a patient with some degree of respiratory compromise following anesthesia. Reptiles should be closely monitored for evidence of respiratory depression and ventilation may have to be assisted well into the recovery period. Only fully recovered animals should be returned to their enclosure.

Following a surgical procedure the reptile should also be regularly evaluated for any evidence of post-operative pain such as increased aggressiveness or abnormal posture. If needed, additional analgesics should be administered and the analgesic protocol should be re-evaluated. It may be necessary to combine different analgesic agents to provide the most effective pain relief for the patient.

**ANALGESIA**

While all vertebrates experience pain, there may be different pathways and receptors between mammals and reptiles.\(^1\)

Prevention and treatment of pain is essential in order to provide state of the art care for the reptilian patient. An effective analgesic protocol should be in place for any surgical or painful procedure. Although information on effective analgesic drugs and dosages is increasing, it is well established that there are pronounced species and individual differences in response to analgesic agents. Also, effective dosages and treatment intervals vary considerably between species.

Recognition of pain in reptiles may be challenging and it is essential to be familiar with the species to be treated and its normal behavior. Clinical signs of pain include abnormal body position, reluctance to move or to lie down, restlessness, anorexia, increased aggression, increased respiratory rate and trembling. The most effective method of pain management is prevention of pain. Local anesthetic techniques are commonly used in reptiles for minor procedures (e.g. abscess debridement, mass removal). Techniques for local anesthesia described for mammalian species can also be applied to reptiles, although consideration must given to anatomic differences.

Topical, regional and local infiltration techniques can be used in many reptile species. Similar to mammalian species, preemptive analgesic techniques are recommended in reptiles and will include pre-operative administration of analgesics such as opioid agents. Opioid agents (e.g. butorphanol, buprenorphine) are most effective in the treatment of acute pain. Administration of these agents prior to a noxious stimulus will often provide effective preemptive analgesia and will also provide various degrees of sedation prior to induction of anesthesia. Balanced analgesic regimens have been described in domestic animals and should also be administered to reptiles.\(^2\)

A combination of an opioid agent (e.g. butorphanol (0.4-2 mg/kg) or buprenorphine (0.02-0.2 mg/kg)) with a long-acting local anesthetic (e.g. bupivacaine (1-2 mg/kg)) agent is often more effective in relieving pain then the use of either one of these drugs alone. While chronic pain is often neglected in reptiles, many patients are presented with chronic disease processes associated with pain and discomfort including renal disease and metabolic bone disease. Nonsteroidal anti inflammatory agents (NSAIDs) can be used in reptiles, however information on effective drugs and dosages is scant. Meloxicam (0.1-0.2 mg/kg P.O.) has been used successfully for the management of chronic pain as well as post-operative pain in reptiles.

**REFERENCES**


