Reptile Anesthesia

Thomas H. Boyer, DVM, DABVP (Reptile & Amphibian Practice)
Pet Hospital of Penasquitos, San Diego, CA, USA

This talk will focus on reptile anesthesia by species presentation, excluding crocodilians, as well as general guidelines. The first consideration in reptile anesthesia should be is the patient stable enough for anesthesia, or should supportive care be provided until the patient is more stable. Often times the reptile patient has been sick for considerable time and supportive care can make the difference between success and failure. Through evaluation includes complete husbandry and presenting problem history, physical examination, and indicated additional diagnostics.

Warm reptiles to their preferred optimal temperature zone before treatment. Warming the patient in the hospital at least overnight is indicated and allows fluid support. A dedicated room kept between 80–85°F for reptiles with spot heating in cages helps and is easier than providing just spot heat to warm reptiles. Spot heat can be provided with under tank heaters, or overhead heat sources, be aware that both can burn reptiles. Overhead heat sources can be a fire hazard. Incubators are another means of heat support but are often too small for larger patients. Use indoor/outdoor thermometers to carefully monitor temperatures, overheating (> 105°F) kills reptiles quickly. During surgery a circulating water blanket or air warmer can be used to keep the patient warm. A pre-operative TPR will give you valuable normal guidelines for anesthesia.

Reptiles are capable of recovering from levels of dehydration that would kill mammals. Dehydration is difficult to estimate in reptiles, dehydration > 8–10% results in loss of moisture in the retro-orbital fat pads and sunken eyes. Reptiles have limited skin elasticity thus skin turgor is of limited value. Hypertonic dehydration is common in reptiles that are not drinking or have no access to water. Isotonic dehydration generally occurs as a result of hemorrhage, diarrhea, and short-term anorexia. Hypotonic dehydration is common with prolonged anorexia. Greater than normal packed cell volume (> 40–45%), total protein (> 8 gm/dL), sodium (> 160–180 Eq/dL) and chloride (> 120 Eq/dL) are good indicators of hypertonic dehydration, but must be referenced to species normal.

Fluid support for reptiles typically consists of 10 (large reptiles) to 30 ml (small reptiles)/kg/day (maintenance) plus 25 to 33% of the fluid deficit/day. Fluid deficits should be made up over 72 to 96 hrs. Rehydration should not exceed 40 mL/kg/day, although in cases of shock, rates of 3–5 mL/kg/hr can be used for 2 to 3 hrs. Fluid type has been heavily debated in reptiles due to their larger intracellular fluid volume with presumed lower osmolality relative to mammals, but recent studies have shown reptiles have osmolality similar or higher than mammals. Formulas estimating osmolality in reptiles have been shown to be inaccurate. Recommended fluids include any warmed, balanced, isotonic crystalloid. Lactated Ringer's Solution, Normosol-R and Plasmalyte-A are commonly used in reptiles. Isotonic fluids will not have a severe negative impact on electrolyte imbalances and will benefit the patient until more specific fluid therapy can be determined from bloodwork. LRS does not exacerbate lactic acidosis in mammals, even with liver disease and reptiles are more tolerant of lactic acidosis than mammals. 5% dextrose should not be administered subcutaneously, epicoelomically or intraosseously. Not all reptiles presented for anesthesia are dehydrated, preoperative volume loading of normovolemic patients is not indicated. However any fluid or electrolyte abnormalities in the sick patient should be corrected as much as possible before anesthesia, if surgery can be delayed.

Fluids can be given by soaking, enterally via stomach tube, subcutaneously, intravenously, intraosseously, or in chelonians, epicoelomically. Coelomic fluids are no longer recommended because SC fluids are rapidly absorbed and can be observed if not absorbed. Also coelomic fluids can inadvertently be given into internal organs such as the lung, gastrointestinal tract, reproductive tract, the bladder or other organ. If the patient will drink, soaking is typically used for mild dehydration. Use 75 to 80°F, shallow, chin deep, water for several hours to overnight. All reptiles can drown in deep water, especially snakes, if they start swimming, the water is too deep. Monitoring body weight will determine if they are taking in water. Enteral fluids can be given at 5 mls/kg via stomach tube with mild dehydration (< 5%). Too large a volume will cause regurgitation, especially in reptiles that haven't eaten

in a long time. Start with a smaller volume the first few feedings. Soft tubes and oral speculums are better than metal or hard plastic, especially in lizards to avoid broken teeth or mandibles. Subcutaneous (SC) and epicoelomic fluids can be given for moderate dehydration (5–7%). The lateral body wall works well in squamates (snakes and lizards), but isn't typically used in chameleons or geckos. Avoid lung areas in small lizards. SC fluids can be given in the axillary or inguinal regions of chelonians, avoid thickly scaled areas. Epicoelomic fluids are useful in chelonians, in dorsal recumbency, a 1 to 1.5 inch needle is inserted ventral to the scapulohumeral joint and pectoral muscles, parallel and just under the plastron, and directed caudally towards the opposite hind leg. There should be little resistance to fluid administration if the fluid is epicoelomic and not intramuscular. For more severe dehydration (8–10%), intravenous or intraosseous fluids are needed. Intravenous fluid boluses of 5 ml/kg can be given in any accessible vein, usually the jugular or caudal tail vein, slowly over a few minutes with a butterfly catheter. Intraosseous fluids are feasible in lizards, the author prefers the proximal medial tibial crest, 2 view radiographs can confirm placement. In critical cases intravenous fluids can be given by constant rate infusion via catheter in the jugular vein or cephalic vein, which require cut down procedures, or in the tail vein. See Mitchell, 2006, and Heard, 2001, for descriptions of IO and IV catheters. Close monitoring of body weight helps keep track of fluid therapy long term.

Before invasive surgery a complete blood count and serum chemistry panel should be screened for anemia, hypoalbuminemia, hypocalcemia, potassium imbalance, dehydration or any other abnormalities. Many tortoises with hepatic lipidosis have anemia, hypoalbuminemia and hypocalcemia and will not survive invasive surgery such as transplastronal celiotomy. For elective surgery such as cystourolith removal, an esophagostomy tube and months of nutritional support may be needed before surgery (see hepatic lipidosis in What You Need to Know to Treat Tortoises).

Butorphanol is not thought to be an effective analgesic in reptiles, even at excessive dosages. Pain medications currently used by the author are 0.1 mg/kg buprenorphine, SC, IM, IV, pre-operatively, repeated q 24 hrs, for several days, 0.1 to 0.4 mg/kg meloxicam, SC, IM, IV, PO, repeated q 24 hrs for 1 to 2 weeks. Tramadol at 10–25 mg/kg PO q 48–72 hrs, or 10 mg/kg SC, morphine at 1–2 mg/kg SC, IM, and hydromorphine at 0.5–1 mg/kg, SC, IM, are also useful. Local analgesia works quite well in reptiles especially on extremities, such as lidocaine (1–2%) at 2–5 mg/kg, or bupivacaine (0.5 or 0.25%) at 1–2 mg/kg. Either can be diluted 50% to increase volume. Lower concentrations of local analgesics expand volume which can be useful in small patients.

Small endotracheal tubes can be made from 3.5 Fr tom cat catheters or red rubber catheters fit inside an endotracheal tube adapter. Small non-cuffed endotracheal tubes are also useful. Several minutes before intubation several drops of 1% lidocaine can be applied to the glottal opening. The endotracheal tube can be passed when the glottis opens or it can gently forced in. Small non-cuffed tubes must fit and stay snug within the trachea while attached to a ventilator. To do this, tape a tongue depressor ventrally behind the skull, and secure the endotracheal tube to the tongue depressor as it exits the mouth. In chelonians, to prevent neck retraction, which would dislodge the ET tube from the ventilator, extend the tongue depressor ventrally so that as the head and neck is retracted it abuts the muscles coming up off the plastron. Chelonians have complete tracheal rings and squamates have incomplete tracheal rings, so cuffed endotracheal tubes can be used in larger squamates but are rarely needed. A small animal ventilator (Vetronics, Bioanalytical Systems, West LaFayette, IN) is critical to provide intermittent positive pressure ventilation (IPPV) regularly at the resting respiratory rate (typically 1 to 4 breaths per minute) at 5 to 15 cm inspiratory pressure.

Reflexes are lost in reptiles cranial to caudal and regained while recovering caudal to cranial, except with alfaxalone which results in cranial to caudal return of reflexes. Palpebral (not in snakes), toe pinch, tail pinch, limb withdrawal, loss of righting reflexes, jaw tone and cloacal tone are all easy to monitor. Reflexes are lost as muscle tone decreases and anesthetic depth increases. At deeper levels of anesthesia chelonians limbs will hang limply from their shell. Snakes should retract their tongue at a surgical plane of anesthesia but loose this reflex at a deeper plane of anesthesia. A surgical plane of anesthesia is present when there is no response or increase in heart rate to a painful stimulus such as surgical incision. Most reptiles are apneic at this point. A fixed dilated pupil, not responsive to light, is an indicator of excessive anesthetic depth (or brainstem hypoperfusion).

Pulse rate and sound quality can be measured by a Doppler ultrasound probe on the jugular vein (chelonians) or over the heart (snakes) or in the axillary area lateral to the heart (lizards). An ECG doesn't offer much advantage if Doppler ultrasound is used because baseline ECG and heart rate can continue in reptiles even after central nervous system death. But if Doppler ultrasound is not available ECG is recommended. Small gauge needles or stainless steel suture can be placed through skin and muscle and attached to ECG leads. In snakes ECG leads should be two heart lengths anterior and posterior to the heart, in most lizards, ECG leads should be cranial and caudal to the forelimbs, in monitors and tegus, ECG leads should be placed posterior to the front limb and anterior to the hind limbs, and in chelonians leads should be placed at the bases of the neck and in the prefemoral fossa. Be forewarned, the reptile heart normally does not produce sound readily auscultable by human ears. Indirect blood pressure monitoring is not recommended because of poor correlation with direct blood pressure measurements, perhaps because of the low blood pressure of reptiles compared to mammals, especially with anesthesia. Direct arterial blood pressure measurement is possible in research but not practical in daily veterinary practice. Body temperature can be monitored rectally and pulse oximetry can be monitored through the cloacal dorsally or the esophagus laterally or ventrally. Pulse oximetry underestimates oxygen saturation of blood when measured by arterial blood gases but is none the less still valuable. For example, in conscious green iguanas, arterial oxygen saturation was measured to be 92 +/- 5%, whereas pulse oximetry showed oxygen saturation to be 86 +/- 6%.

ANESTHETIC REGIMES

There is a wide variation of size in reptiles, keep in mind with dosage ranges larger reptiles will require lower mg/kg dosages than smaller reptiles. Anesthetic preferences are variable between practitioners. For an excellent review of multiple anesthetic options, see Table 3, in Heard 2001.

Snakes: Anesthesia of snakes can be divided into venomous and non-venomous. Most snakes can be easily masked down with isoflurane, or sevoflurane. Fitting slit Parafilm "M" laboratory film (Bemis Flexible Packaging, Neenah, WI) under the rubber face mask seal enhances the airtight seal. Once anesthetized the patient can then be intubated and connected to a ventilator for longer procedures or masked for shorter procedures. Observing the respiratory rate of the patient prior to anesthesia is a good guide for IPPV. In anesthetized South American rattlesnakes, *Crotalus durissus*, 5 breaths per minute lead to respiratory alkalosis, and 1 breath every 2 minutes lead to mild hypercapnia and mild respiratory acidosis, thus 1 to 2 breaths per minute was recommended. For large snakes induction is easier with propofol, alfaxalone or Telazol (see table).

Venomous viperids can coerced into a tube with one end closed, big enough to fit their head, but not so big that they can turn around. Placing the tube along a wall, under a V-trough entrance, works well to coerce the snake into the tube. Once halfway up the tube the snake can be restrained by grabbing the snake and the tube entrance simultaneously so that the snake can't back up. Once in the tube, gas anesthesia can be introduced by a face mask over the tube. Venomous elapids and colubrids are better induced in an anesthetic chamber or squeeze box with intramuscular injectables.

Lizards: Leopard geckos shed their tails which makes IV injection in the caudal tail hazardous. Chamber induction with 5% isoflurane induces anesthesia in 15 minutes at which point they can be transferred to a face mask and maintained for short procedures. For longer procedures intubate and use a ventilator.

Bearded Dragons: Anesthesia can be induced with intravenous propofol, or alfaxalone, which allows intubation and gas anesthesia. Again tape a ventral tongue depressor behind the skull and tape the anterior endotracheal tube to the tongue depressor before attaching to a ventilator.

Iguanas: 5 mg/kg Telazol, IM in the front leg works well for induction but is painful. Intravenous propofol or alfaxalone also work well. Once induced, an endotracheal tube can be placed as described for bearded dragons.

Chameleons: Chameleons induce fairly rapidly with chamber isoflurane but are hard to intubate because the trachea is in a small sheath. Once chamber induced push the glottis up and into view for intubation when open. Intraosseous propofol also works well.

Monitors: Small monitors go down as quickly as birds with isoflurane by mask induction.

Chelonians: Aquatic turtles and box turtles require much lower Telazol doses than tortoises. Intravenous propofol or IM dexmedetomidine combinations are useful in aquatic turtles and box turtles. African tortoises (sulcatas and leopards) are difficult to inject. Telazol is the authors preferred approach at 20 mg/kg IM (or SC) in the brachial muscles. A shortened syringe case, large enough to inject through, jammed behind the front leg, allows one to inject a large Sulcata. These tortoises are so powerful that it often isn't clear if the injection is IM in the brachial muscle or SC, with Telazol, either method works. At 20 mg/kg almost all tortoises are recovered enough to be discharged within 3 to 4 hours, no ventilatory support is needed. With medetomidine or dexmedetomidine, either must be given IM, not SC, or the onset of anesthesia is delayed for several hours, or not at all, which can wreak havoc on a busy clinicians' schedule. With smaller aquatic turtles, box turtles and *Gopherus* species often one can palpate the muscle and be sure the injection is IM. Intravenous propofol, or alfaxalone in the tail or jugular veins, or subcarapacial venous plexus, are other options but not easy in large Sulcatas. Once induced the author intubates and goes to gas anesthesia by ventilator.

In gopher tortoises, *Gopherus polyphemus*, combination IM anesthesia with 75 mc/kg dexmedetomidine, 8 mg/kg ketamine, and 1 mg/kg morphine, followed by reversal with 0.02 mg/kg atipamezole, produced sedation sufficient for nasal flushing and blood collection. Average time to first effects was 9.7 minutes, to induction was 21.6 minutes, to total recovery after administration of reversal was 92.7 minutes, and the mean time from administration of anesthesia through complete recovery for adult tortoises was 129 minutes but ranged from 40 minutes to 300 minutes.

In red eared sliders 20 mg/kg alfaxalone IM at 68°F allowed intubation at 15–25 minutes with a plateau phase lasting 15 to 41 minutes and complete recovery within 109–143 minutes. With lower doses (10 mg/kg) or higher temperatures (90°F) authors were unable to intubate all sliders. However, in Horsfeild's tortoises, 20 mg/kg alfaxalone IM resulted in moderate to deep sedation but not enough to intubate a third of the tortoises with significant bradycardia. Addition of medetomidine resulted in even worse bradycardia, respiratory depression and, in two patients, no cardiac activity for 10 minutes. The authors concluded these complications may limit the use of this combination for routine anesthesia in tortoises.

Intranasal administration of 0.2 mg/kg dexmedetomidine, combined with 10 mg/kg ketamine, resulted in moderate to heavy sedation, sufficient to do physical examinations, blood collection and other minor procedures in yellow bellied sliders, *Trachemys scripta scripta*. Sliders were reversed with 0.5 mg/kg atipamizole and became active in 19 +/- 7 minutes. In contrast, intranasal administration of dexmedetomidine (0.05 and 0.15 mg/kg), or midazolam (0.5 and 1.5 mg/kg), did not provide effective sedation in red-footed tortoises, *Chelonoidis carbonaria*, and Indian star tortoises, *Geochelone platynota*.

Recovery

Gas anesthesia is typically discontinued half way through the surgical procedure, or at least 15 to 20 minutes before the end, to increase blood pressure, but IPPV is continued until the patient is breathing regularly on its own, which can take hours. If the patient starts to recover before surgery is finished, returning to 5% isoflurane will regain a surgical plane of anesthesia within minutes. Recent studies found no difference between room air and oxygen in reptile recovery. A 5 ml/kg intravenous fluid bolus of LRS, or colloid, slowly, post operatively may improve circulation.

Table. Analgesic, sedative and anesthetic dosages in reptiles, excluding crocodilians.

In general larger reptiles require lower mg/kg dosages than smaller reptiles.

Buprenorphine	0.1 mg/kg SC q 24 hrs	No evidence of analgesic efficacy.
Morphine	1–2 mg/kg IM, SC > 5 mg/kg IM, SC not rec'd	Good analgesic efficacy in RES, bearded dragons, unknown efficacy in snakes. Significant respiratory depression, reverse with naloxone (0.04–0.2 mg/kg SC) after procedure.

Fentanyl 12.5 mcg/hr transdermal patch	12.5 mcg/hr transcutaneously 24–72 hrs 10% of total surface area of 12.5 mcg/hr transcutaneously in prehensile tailed skinks	Antinociception in corn snakes, ball pythons.
Tramadol	5–10 mg/kg PO q 48–72 hrs	Chelonians, less respiratory depression than morphine.
Meloxicam	0.1–0.4 mg/kg, IV, IM, SC, PO	No evidence of analgesic efficacy, presumed anti-inflammatory efficacy.
Lidocaine 1–2%	1–2 (< 5) mg/kg SC, IM 4 mg/kg intrathecal RES, Galaps	No evidence of analgesic efficacy but clinically works well.
Bupivacaine 0.25–0.5%	1 (< 2) mg/kg SC, IM 1 mg/kg intrathecal RES	No evidence of analgesic efficacy but clinically works well.
Propofol	3–5 mg/kg, IV, intraosseous, can repeat	Useful for short procedures or intubation, no analgesia, lower dose in large reptiles.
Tiletamine/zolezepam	5 mg/kg IM, SC squamates, aquatic turtles 10–20 mg/kg IM, SC tortoises	Useful for intubation, long recoveries, preferred sedative for large or African tortoises.
Ketamine + 2 mg/kg midazolam IM	30–50 mg/kg IM Lizards 20–60 mg/kg IM Snakes, light sedation 60–80 mg/kg IM Snakes, light anesthesia 50 mg/kg IM aquatic turtles 70–100 mg/kg IM tortoises	Useful for small reptiles where inhalant anesthesia not practical.
Dexmedetomidine/ketamine/ buprenorphine or morphine or hydromorphone Reverse dexmedetomidine/medetomidine with equal volume atipamizole	D 0.05–0.15 mg/kg, K 10 mg/kg, B 0.1 mg/kg, or M 1–2 mg/kg, or H 0.5–1 mg/kg, IM only, not effective SC. Can substitute medetomidine at 0.1 to 0.2 mg/kg.	Seems to work better in aquatic turtles, box turtles than tortoises.
Dexmedetomidine/midazolam/ketamine Reverse dexmedetomidine /medetomidine with equal volume atipamizole	D 0.05–0.15 mg/kg, M 1 mg/kg, K 10 mg/kg, combined, IM only, not effective SC. Can substitute medetomidine at 0.1 to 0.2 mg/kg.	Seems to work better in aquatic turtles, box turtles than tortoises.
Alfaxalone	5–10 mg/kg IV 10 mg/kg IM RES 20 mg/kg IM green iguanas	Lizards, snakes Expensive in large reptiles
Isoflurane	Induction 5% Maintenance 2–3%	Mask induction in snakes, lizards, but not chelonians.
Sevoflurane	Induction 7–8% Maintenance 2.5–5%	Mask induction in snakes, lizards, but not chelonians.

References

1. Davis H, Jensen T, Johnson A, Knowles P, Meyer R, Rucinsky R, Shafford H. 2013 AAHA/AAFP fluid guidelines for dogs and cats. *JAAHA*. 2013;49(3):149–159.

Divers S. Management of reptiles. *Merck Veterinary Manual*. 10th ed. 2011.

Emery L, *et al*. Sedative effects of intranasal midazolam and dexmedetomidine in 2 species of tortoises (*Chelonoidis carbonaria* and *Geochelone platynota*). *J Exot Pet Med*. 2014;23(4):380–383.

Hansen L, Bertelsen M. Assessment of the effects of intramuscular administration of alfaxalone with and without medetomidine in Horsfield's tortoises (*Agrionemys horsfieldii*). *Veterinary Anaesthesia and Analgesia.* 2013;40(6):e68–e75.

Heard D. Reptile anesthesia. *Vet Clin of NA: Exot Anim Pract*. 2001;4(1):83–117.

Mitchell M. Therapeutics. In: Mader D, ed. *Reptile Medicine and Surgery*. St. Louis, MO: Saunders Elsevier; 2006:631–639.

McGuire J, Hernandez S, Smith L, Yabsley M. Safety and utility of an anesthetic protocol for the collection of biological samples from gopher tortoises. *Wildlife Society Bulletin*. 2014;38(1):43–50.

Schnellbacher R, Hernandez S, Tuberville T, Mayer J, Alhamhoom Y, Arnold R. The efficacy of intranasal administration of dexmedetomidine and ketamine to yellow-bellied sliders (*Trachemys scripta scripta*). *JHMS*. 2012;22(3–4):91–98.

Schumacher J, Mans C. Anesthesia. In: Mader D, Divers S, eds. *Current Therapy in Reptile Medicine & Surgery*. St. Louis, MO: Elsevier Saunders; 2014:134–153.

Sladsky K. Analgesia. In: Mader D, Divers S, eds. *Current Therapy in Reptile Medicine & Surgery*. St. Louis, MO: Elsevier Saunders; 2104:217–228.