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Intravenous ketamine-medetomidine anesthesia in combination with intrathecal lidocaine for prefemoral coeliotomy in red-eared sliders (*Trachemys scripta elegans*): A case series study

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Abstract

Background: Coeliotomy in chelonian species is performed to gain access to the abdominal cavity and requires general anesthesia. In reptile medicine, alfaxalone and propofol are often preferred, although the usage of these drugs is limited by cost and/or vascular access. Furthermore, according to a recent study, propofol produces significant oxidative stress in red-eared sliders (*Trachemys scripta elegans*), and in such cases, a ketamine and medetomidine combination may provide a better choice. **Case description:** Three owned red-eared sliders were separately presented with a history of recent lethargy, inappetence, dyspnea, and restlessness. **Findings/treatment and outcome:** In these three cases of chronic dystocia, a ketamine and medetomidine combination was used to achieve anesthesia induction for surgical treatment. Additionally, intrathecal administration of lidocaine was performed to achieve a potential analgesic effect in deeper intracoelomic reproductive organs. Preoperative changes in blood parameters were observed in one animal, suggesting abnormal kidney function. The same animal showed signs of resedation postoperatively, prolonged recovery, and had a fatal outcome 48 h after the surgery with signs of kidney damage in histopathological evaluation. In the recovery period, none of the surviving animals (n=2) showed neurological or respiratory complications that could be associated with subcarapacial sinus anesthesia administration or intrathecal local anesthesia. **Conclusion:** According to our observations, intrathecal lidocaine administration provided sufficient analgesia during prefemoral coeliotomy and reproductive organ manipulation. These modes of anesthesia in chelonians require further investigation.

Key words: Coeliotomy, Intravenous anesthesia, Ketamine, Medetomidine, Red-eared sliders

Introduction

Coeliotomies are frequently performed in chelonians for coelomic exploration, organ biopsies, foreign body removal, urinary bladder stone removal, and reproductive organ surgeries (Di Bello *et al.*, 2006; Stahl, 2019). Prefemoral and transplastron techniques have been described, but prefemoral coeliotomies are preferred because they are less invasive (i.e., no bone cutting) (Wüst and Divers, 2019).

Regardless of the technique, general anesthesia is necessary. Due to a lack of systematic research on drugs and anesthetic protocols, general anesthesia in reptiles is challenging (Scarabelli and Di Girolamo, 2022). Induction of anesthesia can be provided using inhalants or injectable drugs. Reptiles, especially aquatic species, can adjust to anaerobic metabolism for an extended period; thus, using inhalant anesthetics for anesthesia induction can show variable results (Mans, 2014).

Alfaxalone and propofol are preferred induction agents; however, the cost of alfaxalone and limited vascular access for propofol administration are factors that prevent their use in routine practice (Kischinovsky *et al.*, 2012; Meredith, 2015b). In reptile anesthesia, various combinations of ketamine have been tested but the results of studies are variable in red-eared sliders (Lutvikadić and Maksimović, 2023). In some studies, adequate anesthesia depth for endotracheal intubation was achieved, while in others only mild sedation was observed (Greer *et al.*, 2001; Meredith, 2015a; Cermakova *et al.*, 2017; Lutvikadić and Maksimović, 2023). Ketamine can be used in combination with other drugs to reduce the necessary dose of ketamine and to provide general anesthesia; a recent paper in giant tortoises further supports this for chelonians (Turner *et al.*, 2021).

As part of a balanced anesthesia protocol, a local anesthesia technique is also desirable in reptile surgery.

It will decrease the need for general anesthetics and provide good analgesia for the patient. Anesthetizing the sacral plexus and coccygeal nerves using intrathecal anesthesia can be used to provide adequate analgesia, especially for surgeries of the cloaca, reproductive organs, and hind limbs (Mans, 2014).

Case description

Three red-eared sliders (*Trachemys scripta elegans*) were separately presented to the Surgery Clinic of the University of Sarajevo, Veterinary Faculty, with a history of recent lethargy, inappetence, dyspnea, and restlessness. Two animals were 8 years old and weighed 350 (patient A1) and 300 (patient A2) g, respectively. One red-eared slider was 12 years old with signs of carapacial deformation, and weighed 1.5 kg (patient A3). According to the owners, the turtles had a history of dystocia, and one of them was serially treated with intramuscular oxytocin. Plain radiographs were prepared (Fig. 1) and blood was collected from the subcarapacial sinus with no signs of obvious lymph contamination.



Fig. 1: Dorsoventral radiograph of a red-eared slider turtle with obvious shelled eggs

Findings/treatment and outcome

Blood parameters of turtles A1 and A2 were within the reference ranges (Gibbons *et al.*, 2019). The blood work of turtle A3 showed decreased hematocrit and mean corpuscular volume (MCV) but increased hemoglobin (Hb), mean corpuscular hemoglobin concentration (MCHC), and a slight increase in white

blood cell count (WBC). Increased urea, raised aspartate aminotransferase (AST) activity, and hyperphosphatemia were also observed. Calcium concentration was at the higher end of the range (Table 1).

Table 1: The most important changes (bolded) of CBC and blood biochemical profiles of three cases with reference ranges (Gibbons *et al.*, 2019). Other parameters were in the physiological range

Blood parameters	Animals			Reference range
	A1	A2	A3	
HCT (%)	9	11	6.8	8-44
Hb (g/dl)	11	12	14	10-12.2
MCV (fl)	300	487	140	179-697
MCHC (g/dl)	30	29	44	30
WBC ($10^3/\mu\text{l}$)	7	10	19.7	1-19.4
UREA (mg/dl)	30	41	94.9	2-64
AST (U/l)	248	301	430.6	44-358
P (mg/dl)	4	7	9	1.8-8.8
Ca (mg/dl)	13	11	22.5	6.5-22.6

After achieving optimal body temperature (20-25°C), a combination of ketamine (Ketaminol®10, 100 mg/ml, MSD, Netherlands) (20 mg/kg) and medetomidine (Sedastart®, 1 mg/ml, Dechra, UK) (0.2 mg/kg) (Lutvikadić and Maksimović, 2023) was administered into the subcarapacial sinus. Basal heart rate was determined preoperatively using an allometric scale suggested by Murray (2006). Lidocaine (Lidokain-hlorid 2%, 20 mg/ml, Galenika, Serbia) (Mans, 2014) at a dosage of 4 mg/kg, was administered intrathecally (Fig. 2), approximately 11±3 min after administering ketamine and medetomidine. Following lidocaine administration, the hind limbs and tail became completely relaxed, and all three turtles were connected to ECG and SpO₂ monitoring equipment. Preoperatively, meloxicam (Meloxidolor®, 5 mg/ml, Dechra, UK) (0.2 mg/kg) and enrofloxacin (Enroxil® 5%, 50 mg/ml, Krka, Slovenia) (5 mg/kg) were administered subcutaneously. The turtles were constantly monitored to assess muscle relaxation, which served as a primary indicator for endotracheal intubation (40 ± 2 min after induction of anesthesia). The two smaller turtles were intubated using an intravenous cannula (20 G) (Fig. 3) and the larger turtle was intubated with an uncuffed lubricated endotracheal tube (2 mm inner diameter). The turtles were connected to a non-rebreathing anesthesia circuit and intermittent positive pressure ventilated with two breaths per minute on 1 L/min of 100% oxygen during the surgery. Oxygenation, anesthesia maintenance, and patient monitoring were performed using the WATO EX-20Vet anesthesia unit with Mindray iMEC8V vital parameter monitor (Shenzhen, China). Animals were placed in right lateral recumbency, and the ECG electrodes were connected to the carapace or the phalanx level in the standard 3-lead formation. A side-stream capnogram was connected to the circuit, and the SpO₂ sensor was placed on the hind leg. Unfortunately, the readings could not be obtained. The body temperature probe was lubricated and placed into the cloaca. An electric heater was used to maintain the body temperature (Buster ICU Heat Mat

12V, Kruuse, Denmark). Before the surgery, one dose of 25 ml/kg of lactated ringer solution (LRS) was administered subcutaneously, and the left prefemoral fossa was aseptically prepared with chlorhexidine solution.



Fig. 2: Preoperative intrathecal lidocaine administration after aseptic skin preparation in a red-eared slider turtle

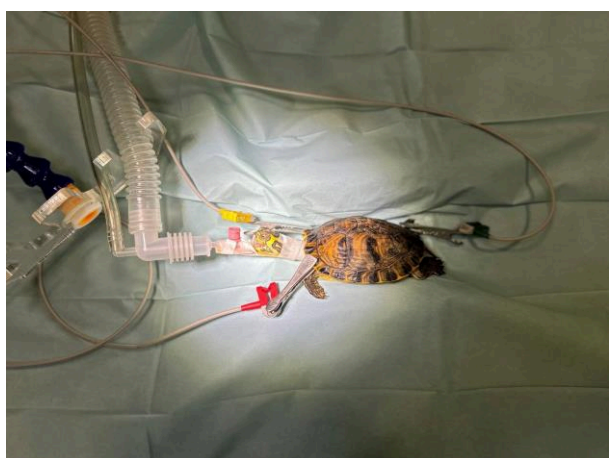


Fig. 3: Animal preoperative monitoring preparation and oxygenation by a non-rebreathing system

The surgery was performed using the technique

described by Stahl (2019). Spontaneous locomotion, muscle relaxation, and sensitivity scores of animals were recorded as described by Alves-Júnior *et al.* (2012). During the surgery, only turtle A3 experienced hemorrhage as an intraoperative complication due to the increased tissue fragility. Still, no significant adhesions were noted between the reproductive tissues and eggs (Fig. 4). Bradycardia was noted in turtle A3, with the heart rate decreased by 60% from the baseline; however, it spontaneously stabilized. The heartbeats of the other two turtles remained normal. The surgery duration averaged 70 min, with a slight increase in case A3 due to hemorrhage management. At the end of the surgery, atipamezole (Sedastop®, 5 mg/ml, Dechra, UK) (Lutvikadić and Maksimović, 2023) was administered intramuscularly at a dose 5 times the medetomidine dose. Spontaneous movement was present 15 ± 2 min post-reversal in the smaller turtles, but turtle A3 showed signs of resedation 30 min after atipamezole administration. Overall, turtle A3 had a prolonged recovery and lethal outcome 48 h post-operation. No gross changes or internal bleeding were observed at the necropsy. However, histopathology revealed diffuse degeneration, necrosis, and loss of tubular cells in both kidneys. Moderate to severe multifocal or coalescing infiltration of heterophils were also present (Fig. 5). The smaller turtles showed immediate interest in food 24 h after surgery and produced urates and feces within 72 h of surgery. The surviving turtles were on meloxicam and enrofloxacin at the same preoperative dose for the next 7 days, and neither showed any post-surgical complications. Suture removal was possible on day 21, and owners reported an improved appetite and weight gain of about 10%.

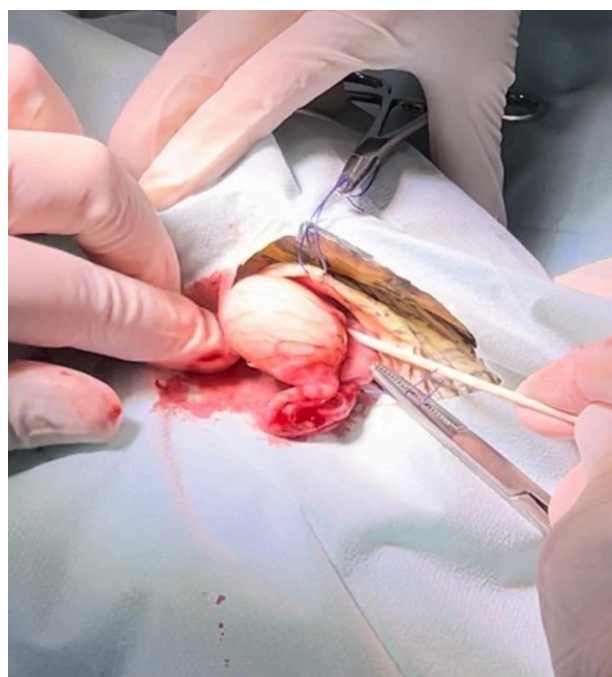


Fig. 4: Reproductive tissue tearing during organ manipulation as a result of increased tissue fragility. No adhesion between tissue and eggs was noted

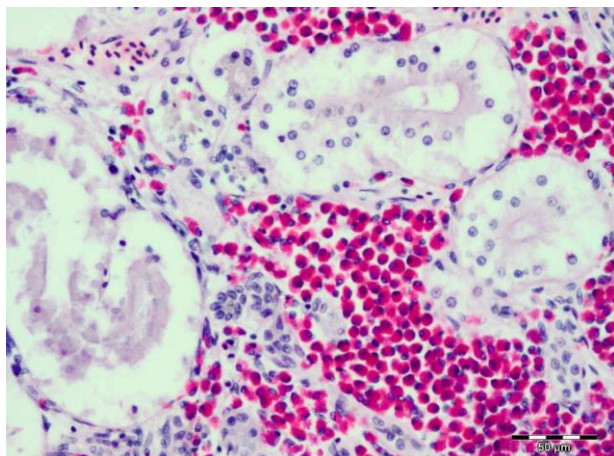


Fig. 5: Photomicrograph of the kidney of a red-eared slider (A3 case) turtle. Diffuse degeneration, necrosis, and loss of tubular epithelium, and severe infiltration of heterophils are present

Discussion

Even though alfaxalone and propofol are preferred for inducing anesthesia, their use is limited in some countries, and a recent study concludes that propofol has a significant oxidative stress effect in red-eared sliders' anesthesia (Kischinovsky *et al.*, 2012; Meredith, 2015b; Došenović *et al.*, 2020). Ketamine has been tested in various doses and combinations in chelonians, but the results are variable (Greer *et al.*, 2001; Meredith, 2015a; Cermakova *et al.*, 2017; Lutvikadić and Maksimović, 2023). According to a previously published retrospective study, it has been used by the intramuscular route as an adjunct for anesthesia in giant tortoises (Turner *et al.*, 2021). Intravenous ketamine administration in chelonians is insufficiently described, especially in combination with medetomidine (McArthur, 2004). Based on a previous report, intramuscular administration of these drugs results in light anesthesia in red-eared sliders (Meredith, 2015a). In our cases, we used a combination of ketamine (20 mg/kg) and medetomidine (0.2 mg/kg) administered intravenously to achieve induction of anesthesia, as was previously investigated by Lutvikadić and Maksimović (2023). Muscle relaxation was present and endotracheal intubation was performed in all three cases. As a part of the multimodal analgesia approach, intrathecal lidocaine administration is highly recommended for surgical procedures on the cloaca, hind legs, and genitalia. Since red-eared sliders possess a prominent intravertebral venous plexus, aspiration is necessary before the intrathecal administration (Turner *et al.*, 2021). Even though lidocaine was contaminated with a small amount of blood in the turtle A3, we proceeded with its administration. Using lidocaine at a dose of 4 mg/kg intrathecally provided additional perioperative analgesia in our cases. None of the animals showed signs of discomfort during or after surgery. According to the results of intraoperative vital parameters, animals were in the surgical plane of anesthesia, and we assume that intrathecal lidocaine administration was also an adequate

technique for this procedure, with no signs of systemic drug absorption after intrathecal administration.

Some studies have warned of the possible neurological complications after subcarapacial drug administration, such as permanent paralysis or death (Quesada *et al.*, 2010; Perry and Mitchell, 2019), or lung injuries (Rockwell *et al.*, 2022). Performing caudal intrathecal drug administration in reptiles carries a minimal risk of spinal cord damage, as it only comprises up to 50% of the canal (Rivera *et al.*, 2011). The authors were aware of these possible complications, and none of our surviving animals experienced any signs of spinal cord or lung injury, suggesting that subcarapacial and caudal intrathecal drug administration is a safe, effortless, and helpful technique, especially in semi-aquatic species due to their anatomical differences.

Oxytocin usage in chelonians is well tolerated, except in obstructive or chronic dystocia (Stahl and DeNardo, 2019). It is also well known that a high dose of oxytocin in reptile medicine has an antidiuretic effect, causing a reduction in renal glomerular filtration (Divers and Innis, 2019). In mammals, oxytocin affects angiotensin-II, resulting in serious renal damage leading to tubular epithelial cell necrosis and desquamation, degeneration of basement membranes, and interstitial fibrosis (Phie *et al.*, 2015). To our knowledge, this effect is not reported in reptiles; therefore, the relationship between prolonged oxytocin usage in turtle A3 and histopathologically confirmed renal damage cannot be confirmed. However, based on the histopathological findings indicative of renal damage, we can assume that renal clearance of used drugs was not adequate, resulting in prolonged animal recovery. This can be additionally supported by the presence of narcosis in the animal after reversal. The complete antemortem biochemical renal assessment (Heatley and Russell, 2019) was not performed as we did not get permission for this procedure from the owner.

Based on this case series, a ketamine and medetomidine combination administered intravenously may be considered an adequate technique for anesthesia induction in clinically healthy red-eared sliders. According to intraoperative results, intrathecally administered lidocaine can induce sufficient analgesia even for deeper intracoelomic structures. In the described anesthesia protocol, surgical procedures can be applied to clinically healthy red-eared sliders in less-developed countries where preferred drugs are inaccessible. Further studies and reports are warranted to probe these findings.

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Conflict of interest

The authors declared that there is no conflict of interest.

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