MEDIA KEDOKTERAN HEWAN VOL 36(1)
https://e-journal.unair.ac.id/MKH
ISSN Online: 2775-975X pISSN : 0215-8930

Elimination of Large Bladder Stone-Obstructing Pelvic Canal in African Spurred Tortoise (*Centrochelys sulcata*) with Per-Cloacal Bladder Stone Removal Method without Utilizing an Endoscope

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Received: May 16th, 2024
Accepted: September 3rd, 2024
Published: January 10th, 2025

Abstract

Bladder stone formation in reptiles arises from the accumulation and subsequent solidification of uric acid in the urinary bladder. The bladder stones vary in size and can migrate from the bladder to the pelvic canal. In cases where larger bladder stones enter the pelvic canal, they pose a risk of obstructing the digestive and urinary tracts of the tortoise. This study discusses managing bladder stone elimination in sulcata tortoises (*Centrochelys sulcata*) located in the pelvic canal without utilizing an endoscope. In 2023, four sulcata tortoises were presented at the Teaching Veterinary Hospital Universitas Brawijaya with diagnoses of large bladder stone-blocking pelvic canals that had been causing digestive and urinary tract obstruction. All of the tortoises have similar clinical signs, such as lethargy, anorexia, inability to defecate, and anuria. Physical examinations and radiography revealed the presence of bladder stones in the pelvic canal, exceeding the dimensions of the pelvic outlet and hindering passage through the cloaca. Treatment involved per-cloacal bladder stone removal. This procedure begins by anesthetizing the sulcata tortoise using ketamine and medetomidine combination, followed by fragmentation and extraction of the bladder stones from the pelvic canal through the cloaca. All procedures were performed without utilizing an endoscope. The success of the treatment was evidenced by radiographic examination, confirming the absence of bladder stones in the pelvic canal, and the recovery of normal defecation, urination, appetite, and activity levels.

Keywords

Bladder stone, obstruction, pelvic canal, per-cloacal removal, sulcata

DOI: 10.20473/mkh.v36i1.2025.68-76

Introduction

The Sulcata tortoise (*Centrochelys sulcata*) is one of the largest tortoises in the world originating from the sub-Saharan grasslands of the African continent (Petrozzi *et al*., 2017). A common health issue in sulcata tortoises is the formation of calculi or stones in the bladder, known as bladder stones (BS) or cystic stones (Amat *et al*., 2012). The composition of bladder stones consists of uric acid or a mixture of other minerals such as sodium, potassium or calcium (Takami *et al*., 2021). The etiology and pathophysiology of bladder stones in tortoises are still not clearly understood but are thought to be a complication of various causes (Keller *et al*., 2015; Sari, 2020; Takami *et al*., 2021). Some suspected causes include dehydration, nutritional deficiencies of vitamins A and D, or an excessive protein diet (Reavill and Schmidt, 2010; Takami *et al*., 2021).

Several factors are thought to trigger the formation of bladder stones in reptiles based on their anatomical and physiological conditions. Reptiles excrete nitrogenous waste primarily as uric acid, a byproduct of protein metabolism. This uric acid accumulates in the kidneys, interacting with cations such as potassium, leading to urate precipitation. The insolubility of uric acid in water reduces the water required for its excretion. Prolonged accumulation of uric salts eventually causes stone formation. The urinary bladder in reptiles also plays an important role in reabsorbing water from urine in conditions of fluid deficiency and has ciliated walls that can bind solid material contained in urine so that it remains in its lumen (Reavill and Schmidt, 2010; Sari, 2020). The combination of anatomy and physiology is the main factor that causes stone formation in reptiles. High protein feed intake contributes to increased uric acid formation, which can cause accumulation of crystal precipitates and increase the risk of bladder stone formation (Kartika Sari and Apritya, 2020; Takami *et al*., 2021). Furthermore, chronic dehydration can also trigger bladder stone formation. Turtles that lack fluid intake will automatically retain urine so that it remains in the urinary bladder and reabsorb water in the urine. Prolonged continuation of this process may lead to transformations in uric acid, shifting from its initial paste-like state to crystalline forms. Crystals will accumulate in large quantities to become bladder stones (Amat *et al*., 2012; Kartika Sari and Apritya, 2020; Takami *et al*., 2021).

Bladder stones in tortoises cannot be dissolved with drugs, supplements or medical fluids (Divers and Innis, 2019). Consequently, their removal requires surgical or manual intervention. The treatment selection method can be considered based on the location of the bladder stone (Amat *et al*., 2012; Mans and Sladky, 2012). Bladder stones located within the urinary bladder can be treated with cystotomy techniques such as trans-plastron coeliotomy or pre-femoral coeliotomy (Kartika Sari and Apritya, 2020; Wüst and Divers, 2019). Per-cloacal method is the procedure to remove bladder stones in the pelvic canal or cloaca (Mans and Sladky, 2012). In cases where bladder stones are present in the pelvic canal or cloaca, endoscopic assistance may facilitate thorough cloacal removal (Holz, 2017; Mans and Sladky, 2012). The limited facilities for performing these pose a challenge for Indonesian veterinarians. Therefore, this study aims to discuss the management of bladder stone elimination in sulcata tortoises (*Centrochelys sulcata*) located in the pelvic canal without utilizing an endoscope.

Materials and Methods

Study Period and Location

The four sulcata tortoises were treated at the Teaching Veterinary Hospital Universitas Brawijaya from January to December 2023.

Symptoms, Anamnesis, and Clinical Symptoms

Four sulcata tortoises (*Centrochelys sulcata*) were assigned different patient codes to facilitate identification as seen in Table 1.

Table 1. Data and Clinical Signs of Patient

Code	Age (Year)	Body Weight (kg)	Clinical Sign
ST-1	1,5	2,25	lethargy, anorexia, anuria and inability to defecate
ST-2	1	0,548	lethargy, anorexia, anuria and inability to defecate
ST-3	1	0,331	lethargy, anorexia, anuria and inability to defecate
ST-4	3	2,7	lethargy, anorexia, anuria and inability to defecate

Physical and Radiographic Examinations

The physical examination of ST-1 and ST-4 by palpation using the little finger inserted into the cloaca can be felt as a solid mass. Conversely, a similar method could not be conducted for ST-2 and ST-3 due to their small size. Radiographic positioning for all sulcate tortoises was performed dorsoventrally, demonstrating bladder stone within the pelvic canal and exceeding the dimensions of the pelvic outlet (Figure 1).

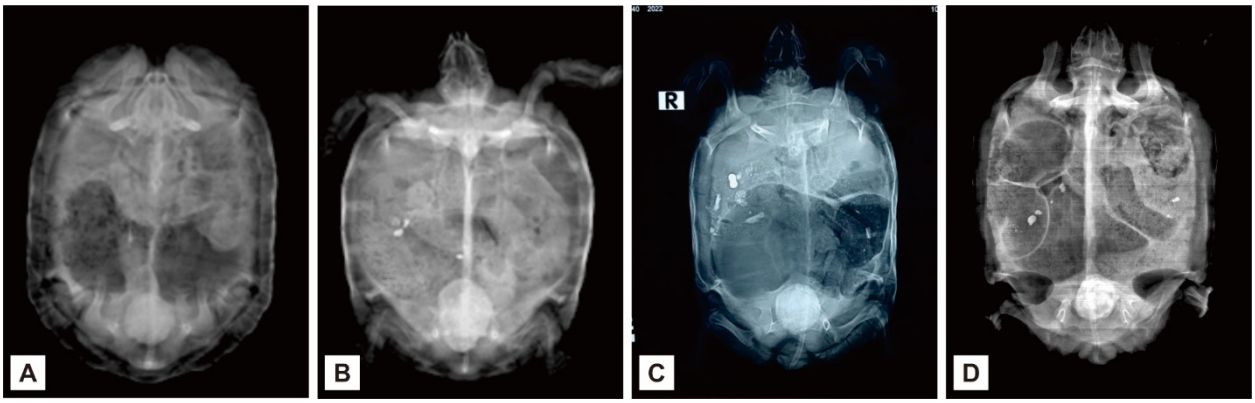

Figure 1. Radiograph examination result before treatment. (A) ST-1; (B) ST-2; (C) ST-3; (D) ST-4

Diagnosis

The diagnosis was a large bladder stone obstructing the pelvic canal.

Treatment

The bladder stone removal procedure was performed using the per-cloacal removal method without utilizing an endoscope (Figure 2). All sulcata tortoises were anesthetized with a combination of ketamine 10 mg/kg and medetomidine 0.3 mg/kg intramuscularly. The tortoises were positioned in dorsal recumbency to facilitate operator visualization during the procedure. A nasal speculum was utilized to open and hold the cloacal position. A bone drill was used to fragment the bladder stone for

easier extraction. Modified 1 ml and 3 ml syringes without needles, with their tips cut off, were inserted into the cloaca until they adhered to the bladder stone. After the bladder stone broke, the bladder stone fragments were slowly and carefully removed using hemostatic forceps from the pelvic canal. Irrigation of normal saline into the pelvic canal was performed to facilitate the removal of small bladder stone fragments and clean the pelvic canal. After the pelvic canal was clean, the radiographic examination was performed to ensure no bladder stone fragments remained in the pelvic canal. Examination showed no bladder stones in the pelvic canal (Figure 3).

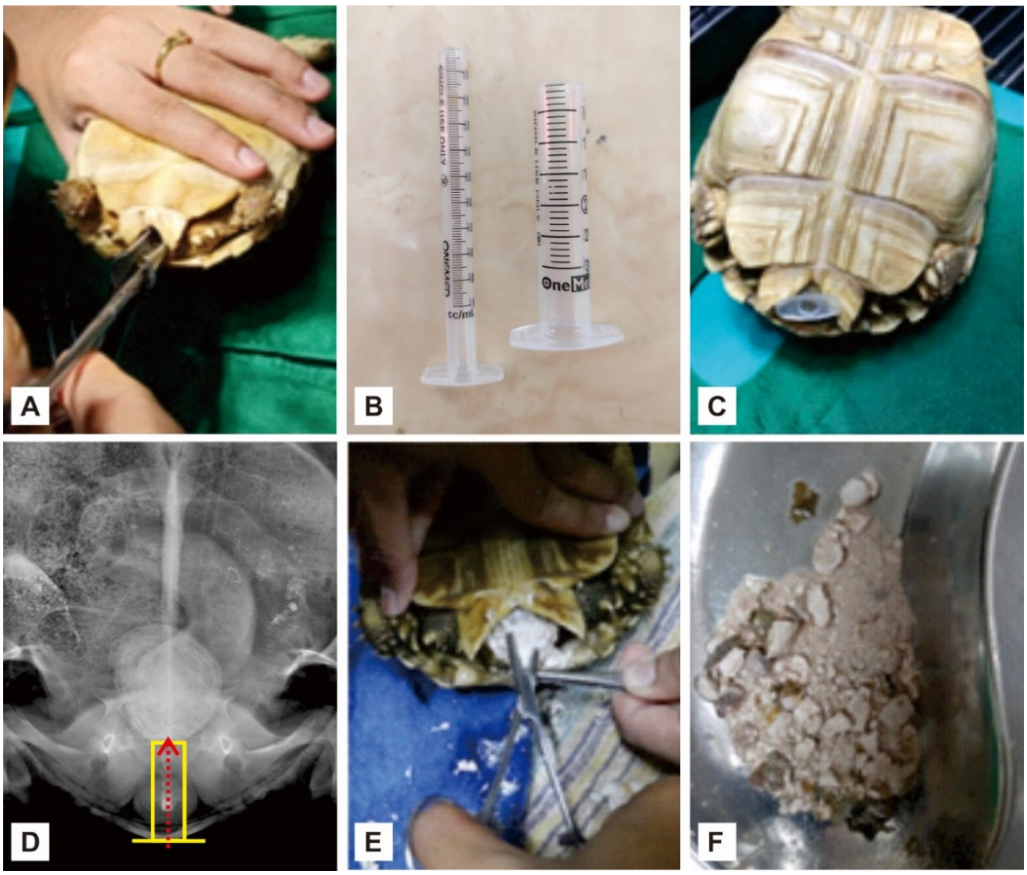

Figure 2. Per-cloacal removal method without utilizing an endoscope procedure. (A) After being sedated, the tortoise positioned in dorsal recumbency and a nasal speculum was utilized to open and hold the cloacal position; (B) A modified 1 ml and 3 ml syringe without needles, with their tips cut off; (C) The syringe inserted into cloacal until adhered to the bladder stone; (D) Illustration of the syringe position (yellow line) and the insertion of the drill bit into the cloaca during the fragmentation process (red line); (E) The bladder stone fragments were gradually and carefully removed using hemostatic forceps from the pelvic canal and cloaca; (F) Successfully extracted bladder stone fragments from the pelvic canal.

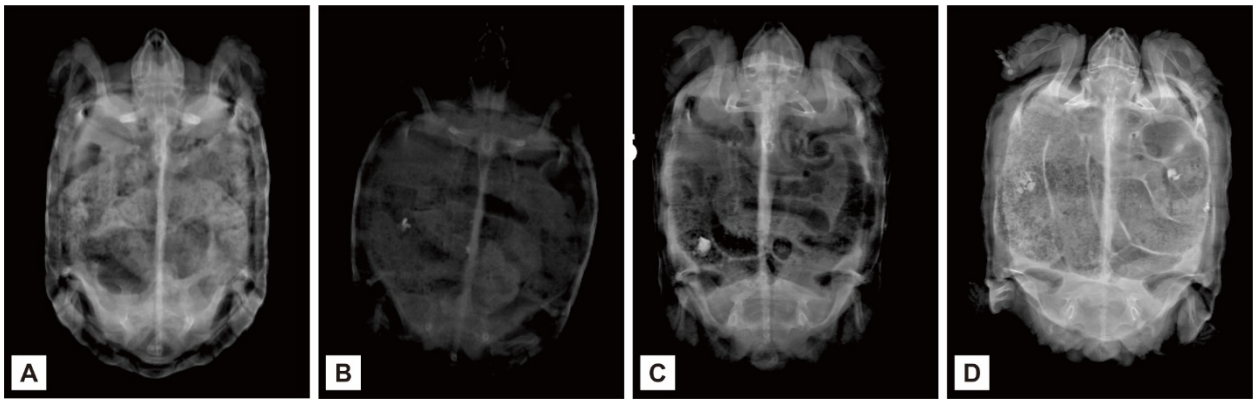

Figure 3. Radiograph examination result after treatment. (A) ST-1; (B) ST-2; (C) ST-3; (D) ST-4

The anesthetic reversal was done using atipamezole 0.5 mg/kg IM. Post-treatment therapy was given enrofloxacin 5 mg/kg IM and meloxicam 0.2 mg/kg SC for 3 days. The tortoise must be placed on a heating pad during the surgical process until the recovery period. The use of a heater aims to prevent hypothermia during the anesthesia process, surgery and recovery. All sulcata tortoises could defecate and urinate normally within less than one day after treatment. Appetite and activity gradually recovered a few days after treatment.

Results and Discussion

Sulcata tortoises excrete nitrogenous waste in the form of uric acid called uricotelic (Divers and Innis, 2019). The formation of uric acid begins with the degradation of proteins into nucleic acids, and nuclease enzymes degrade nucleic acids into nucleotides (Kartika Sari and Apritya, 2020). The enzymatic hydrolysis process can convert nucleotides into purines and pyrimidines. Pyrimidines are converted to carbon dioxide and ammonia, while purines are converted into adenine and guanine. Xanthine oxidase converts adenine and guanine into uric acid (Divers and Innis, 2019; Kartika Sari and Apritya, 2020).

Suspected causes of bladder stones are a high-protein diet and dehydration (Chu *et al*., 2014; Flanagan, 2015; Takami *et al*., 2021). Protein that is metabolized in large quantities will become uric acid which accumulates in the urinary bladder. In dehydration conditions, the reptile's urinary bladder can reabsorb water from urine (Chitty and Raftery, 2013; Girling, 2013a). Increased water absorption in the urinary bladder causes uric acid and other minerals to concentrate and solidify. The process, which occurs continuously, triggers the formation of bladder stones in the urinary bladder which appear radiopaque on x-ray examination (Flanagan, 2015; Holz, 2017).

The size of the bladder stone varies in that those smaller than the pelvic inlet can exit the cloaca through the pelvic canal (Takami *et al*., 2021). Meanwhile, large bladder stones can enter the pelvic canal to clog the urinary tract and digestive tract. Therefore, it can cause difficulty urinating and defecating so clinical symptoms appear in constipation and dysuria. In addition, there will be signs of discomfort and decreased appetite due to enduring pain (Mans and Sladky, 2012). Bladder stones can be

detected by palpating the cloaca (Divers and Innis, 2019; Mans and Sladky, 2012). Radiographic examination with the dorsoventral position showed the presence of bladder stones in the pelvic canal. Based on the results of a radiographic examination, bladder stones were of an irregularly lamellated and irregularly rounded shape While a bladder stone located within the bladder rarely leads to obstruction, its presence in the pelvic canal and cloaca may result in obstruction (Divers and Innis, 2019).

Bladder stones in the cloaca can be removed manually using a non-invasive procedure like a per-cloacal removal method. The recovery period for this procedure is faster than plastrotomy-coelieotomy (Amat *et al*., 2012; Mans and Sladky, 2012; Knotek and Wilkinson, 2017). Anesthesia for tortoises can be done using a combination of ketamine-medetomidine (Perpiñán, 2018). The combination of these two anesthetics provides good sedation and recovery effects for various examination and surgical procedures, including manual bladder stone removal (Girling, 2013b; Rickyawan *et al*., 2020). The procedure using the per-cloacal removal method consists of fragmentation, elimination of fragments, flushing and rinsing until no bladder stones are found (Mans and Sladky, 2012). In all of these cases, the method was performed without utilizing an endoscope. This procedure ensured that, during the intervention, the bladder stone drilling process was precisely and the cloacal wall was not injured. The use of modified syringes aims to provide a pathway for the burr to directly target the bladder stone and protect the cloacal mucosal wall. Normal saline irrigation is recommended for this procedure because it facilitates cloacal dilatation and enables the continuous evacuation of small fragments (Mans and Sladky, 2012; Divers, 2019). The successful removal of all bladder stone fragments was indicated by the absence of any debris or small white fragments found in the cloaca during irrigation, along with normal defecation and urination (Mans and Sladky, 2012). Radiographic examination is also recommended after bladder stone removal surgery to ensure the absence of any residual fragments.

Atipamezole is usually used to reverse medetomidine and speed up the recovery process (Mans and Sladky, 2012' Hedley, 2023). Providing antidotes after treatment can prevent the side effects of anesthetic drugs, such as respiratory depression and death (Girling, 2013b; Hedley, 2023). Administration of meloxicam can reduce inflammation and pain due to acute and chronic musculoskeletal disorders and reduce postoperative pain and inflammation after orthopedic or soft tissue surgery (Bekker *et al*., 2018; Hedley, 2023). The use of a heater pad aims to prevent hypothermia during the anesthesia process, surgery and recovery. Reptiles are included in poikilothermic animals, which means that their body temperature depends on the environmental temperature, and each species has an average optimal temperature that supports all organ systems to work effectively (Perpiñán, 2018; Rickyawan *et al*., 2020). The metabolism of anesthetic drugs in the body and organ function depends highly on environmental temperature. Therefore, it is important to keep reptiles at their ideal temperature (Perpiñán, 2018). Non-ideal environmental temperatures can slow down the healing process and reduce the immune system (Rickyawan *et al*., 2020).

The prognosis following this procedure is good, though the chance of recurrence remains

(Divers and Innis, 2019). Prevention of bladder stones can be done by providing adequate drinking (Kartika Sari and Apritya, 2020). The owner can provide water in a container or pond that the tortoise can easily reach. The water intake required by land tortoises is 20-30 ml/kg per day (Girling, 2013c). In addition, it is not recommended that the sulcata diet contains high protein because it can increase the formation of uric acid (Amat *et al*., 2012; Kartika Sari and Apritya, 2020).

Conclusion

Per-cloacal method without utilizing an endoscope can be safely performed to remove bladder stones obstructing the pelvic canal. The method is carried out under anesthesia and evaluated through radiographic examination to ensure the absence of any residual fragments. All tortoises' condition gradually improved after the procedure, characterized by the ability to defecate and urinate normally. Additionally, appetite and activity recovered within a few days post-treatment.

Approval of Ethical Comission

The ethical clearance certificate number is 117-KEP-UB-2023 from Ethical Commission Universitas Brawijaya.

Acknowledgment

The authors would like to express our sincere gratitude to Teaching Veterinary Hospital Universitas Brawijaya management and all staff for supporting, sharing their knowledge, and providing the necessary facilities for conducting this case.

Author's Contribution

Nofan Rickyawan as a corresponding author has a main role in performing a physical examination, giving recommendations for radiograph examination and surgery for all patients in this case. Vivi Oktavia and Dodik Pasetyo as a second and third author are a team that helps the corresponding author to perform surgery and collect the data of patients.

Conflict of Interest

The authors did not have a conflict of interest in financial, personal, or professional conflicts of interest that could influence the research or its outcomes. This article is based on a real case at the Veterinary Teaching Hospital Universitas Brawijaya.

Data Availability Statement

The detailed patient data is secret information because it is written in the patient's medical record in the Veterinary Teaching Hospital Universitas Brawijaya.

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