Original Article

Surgical Removal of Urethral and Bladder Stones in Female Asian Elephant (*Elephas maximus*) by Episiotomy and Urethrotomy

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Abstract

A 45-year-old female Asian elephant (*Elephas maximus*) was presented with urinary incontinence and solid masses at the perineal area. Vaginoscopy revealed stricture of the vaginal vestibule. Trans skin and rectal ultrasonography demonstrated presence of hyperechogenic uroliths. Episiotomy and urethrotomy were performed after standing sedation with xylazine and perineal infiltration with lidocaine. Total of 8 kg urethral calculi were retrieved manually. Calcium carbonate was identified as the main component of the stones. Due to acute urinary obstruction after the operation, an episiotomy was left open allowing urine to pass through the incision. Following urine scalding, necrotic tissues were detected along the tracts below the incision wound through umbilicus. Daily wound cleaning and antibiotics treatment for one month were performed. The episiotomy wound was left to heal by secondary intention and led to a 2 cm stricture. The healing process completed in 5 months post-operatively. The elephant can urinate via normal tract in 8 months after surgery.

Keywords: Asian elephant, episiotomy, surgery, urethral calculi, urethrotomy

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บทคัดย่อ

การผ่าตัดแก้ไขภาวะนิ่วในทางเดินปัสสาวะและกระเพาะปัสสาวะของช้างเอเชีย (*Elephas maximus*) เพศเมียด้วยวิธี episiotomy และ urethrotomy

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ช้างเอเชีย (*Elephas maximus*) เพศเมีย อายุ 45 ปี เข้ารับการรักษาด้วยอาการปัสสาวะกะปริบกะปรอย และพบก้อนบวมแข็งขนาดใหญ่ที่บริเวณฝีเย็บ จากการตรวจด้วยกล้องส่องตรวจช่องคลอดพบการตีบแคบของเวสติบูลส่วนที่ต่อกับช่องคลอด และจากการอัลตร้าซาวด์ผ่านทางผิวหนังและทวารหนักพบวัตถุที่สะท้อนคลื่นอัลตร้าซาวด์คล้ายก้อนนิ่ว ทำการวางยาซึมช้างในท่ายืนและให้ยาชาลิโดเคนบริเวณฝีเย็บใต้ทวารหนักแล้วทำการผ่าตัดผ่านฝีเย็บ (episiotomy) และผ่าเปิดท่อปัสสาวะ (urethrotomy) จากนั้นทำการล้วงดึงเอาก้อนนิ่วออก น้ำหนักก้อนนิ่วทั้งหมดเท่ากับ 8 กก. จากการวิเคราะห์ก้อนนิ่วพบว่าผลึกชนิดหลักที่พบเป็นแคลเซียมคาร์บอเนต ภายหลังการผ่าตัดและหลังการเย็บปิด พบการคั่งอุดตันของปัสสาวะบริเวณที่ผ่าตัด จึงทำการเปิดแผลผ่าตัดเพื่อให้ปัสสาวะไหลออกผ่านแผลผ่าตัด ต่อมาพบเนื้อตายจากการปนเปื้อนของปัสสาวะตลอดแนวด้านล่างของแผลผ่าตัดจนถึงสะดือ จึงให้ยาปฏิชีวนะควบคุมการติดเชื้อเป็นเวลาหนึ่งเดือนและทำแผลทุกวัน และปล่อยให้แผลผ่าตัดที่ฝีเย็บเกิดการหายแบบ secondary intention แผลฝีเย็บใช้เวลาในการหายและหดเล็กลงจนเหลือความกว้างของแผลประมาณ 2 ซม. ในเวลา 5 เดือน ช้างสามารถปัสสาวะได้ทางช่องเปิดปกติภายใน 8 เดือนหลังการผ่าตัด

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Introduction

Cystic and urethral calculi are found in domestic animals such as companion animals (Runge et al., 2011) more frequently than in elephant and wild animals. Calcium carbonate urolithiasis is the most common in horse (Mair and Osborn, 1986). Predisposing causes of stone in horse are not well understood. Tissue damage, cystitis, remaining suture material, supersaturation of urine with certain minerals and urine stasis have been proposed (Vengust, 2011). In human, the risk factors of urolithiasis are divided into intrinsic and extrinsic factors. Intrinsic factors include nationality, genetic, age and sex. Extrinsic factors include geography, climate, season, water, food and occupation (Tanthanuch, 2002). Urethral calculi infrequently occur in elephant. Two stones in the left ureter have been found during necropsy of an African elephant died from chronic renal failure (Morris et al., 1987). Calcium carbonate was noted as the type of both stones. Ruedi (1995) successfully identified bladder stone using endoscope. Surgical treatment of urethral calculi in elephant is infrequently done. There was a report cited by Hildebrandt et al. (2000) about urethrotomy for stone removing in male elephant by Lange et al. (1999). Their result revealed permanent urethral fistula similar to that in females after episiotomy for dystocia treatment. There are some manuscripts published about the episiotomy for removing dead body of the elephant calf during dystocia in Thailand (Yartbantoong et al., 2002; Thitaram et al., 2006). However, to our knowledge, there has been no report about urethral or bladder stones removal in female elephant. Surgical removal of urocystolith in large animal species has been described in horse. The surgical options included midline laparotomy and cystotomy (Weaver, 1968), pararectal cystotomy (Abuja et al., 2010), perineal urethrotomy (Hanson and Poland, 1995), urethral sphincterotomy (Firth, 1976) and parainguinal

laparocystotomy (Beard, 2004). In this present report, we describe the diagnosis, surgical procedure by using episiotomy and urethrotomy and post-operative care of urethral calculi in female Asian elephant (*Elephas maximus*).

Animal signalment and clinical signs: A 45-year-old female Asian elephant (*Elephas maximus*) exhibited signs of urinary incontinence and abnormal mass at perineal area. The estimated weight of the elephant was 3,000 kg. The elephant's body temperature was 99^0F with pulse rate and respiratory rate of 35 beats per minute and 5 times per minute, respectively. The elephant was admitted to Kasetsart University, Kamphaeng Saen Veterinary Teaching Hospital on 14 September 2012. The peroneal mass was around 30x 30 cm and continued to increase in size (Fig 1). The elephant became anorexic and strained to urinate and defecate. Further history taking revealed that the abnormal mass under anus has been identified one year earlier. However, the mass could be pushed back manually by mahout during that time. Rectal and topical palpation revealed the firm mass and the elephant showed mild pain when pressed.

Laboratory Tests: Pre-operative routine blood examination via auricular vein puncture was done. The samples were immediately sent to laboratory. Hematology and blood chemistry profiles are shown in Table 1 and 2. Hematological profiles, liver enzyme and kidney function were within normal limits.

Ultrasonography: Transrectal ultrasonography (ALOKA; SSD 500 with convex transducer probe; 3.5 MHz) was performed. Ultrasonography via transrectal and skin revealed circular masses in various sizes. The biggest size of the abnormal masses via ultrasonography image was 10 cm in diameter. These circular masses showed their hyperechogenic appearance similar to uroliths in horse (Hanson and Poland, 1995).

Vestibuloendoscopy and cystoureteroscopy: Vestibuloendoscopy and cystoureteroscopy were carried out using a fiber optic video endoscope with light source of PENTAX (EPM3300 and EC3830 fz). Vestibuloendoscopy was done on the first day before operation. Cystoureteroscopy was done one month

Figure 1 Abnormal mass under anus

Table 1 Hematology profiles of Kammoon before and after surgery

Parameter	Pre-operation	Post-operation			Reference value
	(Day 0)	(Day 4th)	(Day 17th)	(Day 33th)	(Silva & Kuruwita 1993[a,b])
Hb (mg%)	10.3	10.3	9.7	9.4	11-15
Hct (%)	27.6	26.9	25.4	25.0	30 - 40
RBC (x 10^6/µl)	2.38	2.3	2.18	2.14	2.5 – 5.0
PLT (x 10^5 g%)	220	254	240	223	200 - 600
PP (mg%)	7.4	7.8	7.8	7.8	6-12
WBC (x 10^3/µl)	12.6	10.4	14.3	8.8	10-18
Neutrophil (%)	28.1	55.9	66.0	31.0	20 - 40
Lymphocyte (%)	65.4	28.0	52.4	50.0	50 - 80
Monocyte (%)	31.5	17.4	19.9	16.0	20 - 40
Eosinophil (%)	4.0	2.5	1.9	3.0	1-10
Basophil (%)	0.7	0.6	0.33	0	0-0.3

Hb: hemoglobin, Hct: hematocrit, PLT: platelet, PP: plasma protein

Table 2 Blood chemistry profiles of Kammoon before and after surgery

Blood chemistries	Pre-operation	Post-operation		Reference value [a]
	(Day 0th)	(Day 4th)	(Day 33th)	(Silva & Kuruwita 1993 [a, b])
BUN (mg%)	7.5	7.0	5.2	5-20
Creatinine (mg%)	1.9	1.0	1.3	1.0 – 2.0
AST (U/L)	16	NA	26	15 - 35

BUN: blood urea nitrogen, AST: Aspartate aminotranferase, NA: Not available

after surgery. The vestibuloendoscopy revealed the non-infected vestibule. The vestibuloendoscopy could not reach the vaginal canal due to the stricture of the vestibule. The cystoureteroscopy did not reveal any stones in both urinary bladder and ureters.

Fine needle aspiration: The sample for cytological examination was collected by fine needle aspiration at perineal area. The fine needle aspiration with 18 gauge needle collected few amounts of necrotic tissue, pus and bloody exudates. Cytology examination revealed the presence of pus cells with 3^+ cocci bacteria. However, the bacterial culture was not done.

Clinical diagnosis and differential diagnosis: Clinical diagnosis was based on rectal and topical palpation, fine needle aspiration, ultrasonography, vestibuloendoscopy, hematology and blood chemistry analysis. The list of differential diagnosis included neoplasia, abscess, dystocia and urethral calculi. From all of examinations, urethral stone was assumed as the clinical case.

Treatment plans: Due to the lack of information of surgical removal of urethral stone in female elephant, episiotomy for exploration was performed. Then, urethrotomy for removing stone was done. Closing of urethral muscle, vestibular wall and skin was also performed.

Sedation, pre-operative and surgical procedure: Before starting, the elephant was given fluid therapy by using NSS through ear vein. Flow rate of the fluid was around 2 liters per hour for 5 hours. The elephant was sedated by administering xylazine hydrochloride 0.08 mg/kg intramuscularly (Ilium Xylazil-100®, Troy Lab PTY Ltd, Smithfield NSW, Australia). Sixty ml of 2% lidocaine hydrochloride was infiltrated covering the incision area at perineum under anal opening with 1 ml per 1 cm^2. The elephant was calm and did not show signs of pain, then after 2 hours operation, she moved her back and front legs more frequently. Fifty mg of xylazine hydrocholide was given intravenously to sedate and provide additional analgesia. An episiotomy with a 15-cm incision line was performed at the perineum proximal to the anus. The vaginal vestibular muscle was deeply incised exposing the underlying mass. The urethrotomy toward the mass was then performed allowing the urine as well as urethral stones to come out. Various sizes of urethral stones ranging from 1-10 cm in diameter were removed. A total of 8 kg urethral calculi with various sizes were removed (Fig 2). During the calculi removal, the elephant urinated through the incisional wound all the time. The episiotomy was closed with chromic cat gut No. 2 (KRUUSE, Langeskov, Denmark) by apposing the vaginal vestibular muscle. The skin was closed routinely with Supramide No.2 (KRUUSE, Langeskov, Denmark). After the operation, the elephant was given yohimbine hydrochloride (Reverzine®, Parnell Lab Pty Ltd, NSW, Australia) 0.125 mg/kg intravenously.

Acute complication and treatment: Although the muscles and skin were completely closed, 3 hours post-operative period the elephant demonstrated a sign of stranguria without any urine coming out through normal tract. The urethral obstruction, as the consequence of soft tissue swelling and accumulation of urine under surgical area, was clinical detected. Consequently, all suture materials were cut letting the urine drained through the incision wound and the swelling disappeared subsequently. The elephant showed signs of bloating both sides of dorsal abdomen swelling with gas accumulation 5 hours post-operatively. The elephant was treated by enema with tap water to increase the gastrointestinal motility. The ear vein was cannulated for administering intravenous medication. Total of 300 mg of metoclopramide hydrochloride (MET-SIL®, T.P. Drug Lab, Bangkok, Thailand) were diluted in NSS intravenously. One hour later, the elephant defecated several times leading to the reduction in the size of abdomen. The elephant was persuaded to walk 20 min per hour. It took 5 hours for a full recovery with more than 20 attempts to defecate.

Post-operative care: Daily wound cleaning was done by using chlorhexidine scrub (O.R. Scrub, Sinopharm Co. Ltd., Bangkok, Thailand) on the skin and subcutaneous tissue. The bladder was larvaged with clean tap water and 10 liters of NSS using equine stomach tube. Topical of nitrofurazone ointment (Bactacin®, Osoth Inter Lab, Bangkok, Thailand) and insect repellent (Negazun®, Bayer CropScience Ltd.) were applied. A systemic control of bacterial infections was also performed by using long acting amoxycillin at (Longamox®, Vetoquinol, Lure, France) a total dose of 7,500 mg/day for 30 days intramuscularly. After 14 days of amoxycillin injection, administration of enrofloxacin at (Syvaquinol 100®, SYVA Lab, LeÓn, Spain) a total of dose of 4,800 mg per day for 14 days intramuscularly was administered to the elephant. The total course of antibiotic injections was one month. Phenylbutazone (Butasyl®, Novartis Animal Health, Australia) at a total dose of 9000 mg daily was injected intramuscularly for 5 days. The injectable supplement containing butaphosphan and cyanocobalamin (Catosal®, Bayer Health Care, Kansas, USA) at a total of 50 ml was intramuscularly administered every 2 days for a 30-day period. Thirty tablets of Serratiopeptidase were also daily given per

Figure 2 Urethral stones removed from Kammoon

oral for 30 days. Urethral canula modified from the re-used elephant endotracheal tube was inserted to the urethra canal. The elephant could urinate via the canula. However, the fitting of the canula on the elephant perineum was not entirely secured and was later removed unintentionally on the first day when the elephant wagged its tail on the canula. These resulted in a urine-contaminated surgical wound and an undermining of the urine through the subcutaneous tissue extending from perineal area to ventral part of abdomen including umbilicus (Fig 3). The accumulation of urine under the subcutaneous tissue and the urine scalding led to pustular exudates and necrotic tissues around the surgical wound. The wound was then cleaned and the necrotic tissues were removed daily. After the operation, the elephant had good appetite and was able to defecate normally.

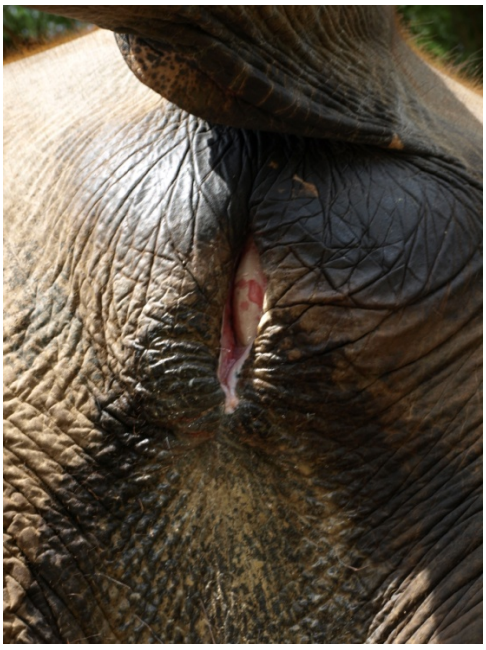

Figure 3 Secondary intention healing after episiotomy

Figure 4 Wound cleaning for removing necrotic tissue originated from urine scalding

However, the elephant was unable to lie down in lateral recumbency position for sleeping. The elephant slept only in standing position. She used her head and trunk to support her weight. The wound was healed by secondary intention and the healing significantly narrowed the surgical wound after one month (Fig 4). Cystoureteroscopy was also performed one month after surgery through the incisional wound and no stone was found inside the bladder (Fig 5) and both ureters (Fig 6). Then, the elephant was sent back to her facility. Five months after surgery, the examination showed that the incision was covered with some necrotic tissue and once the necrotic tissue was removed the examiner found a stricture with 2 cm in diameter (Fig 5). The elephant could still urinate through the stricture and through its normal tract via vestibule and vulva. The patency of vaginal vestibule lower than the incision was confirmed by putting 20 liters of sterile water via the modified equine stomach tube. However, the elephant could urinate via normal tract in 8 months after surgery.

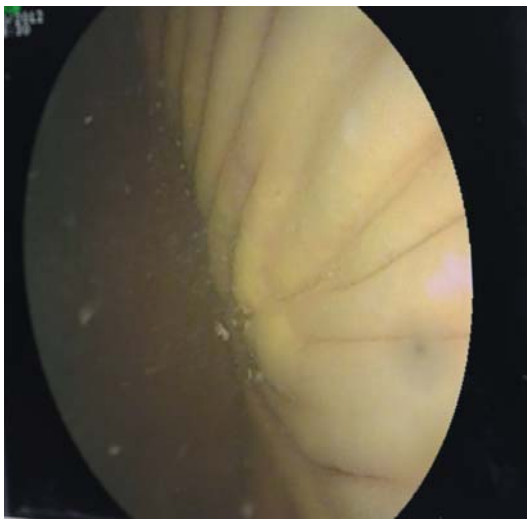

Figure 5 Cystoureteroscopy of the affected elephant at one month after surgery: the urinary bladder wall

Figure 6 Cystoureteroscopy of the affected elephant at one month after surgery: the ureter

Laboratory test during post-operative care and urolith analysis: Blood samples were also collected on 4th, 17th and 33th days post-operatively. Mid-stream urine samples were collected on the 4th and 92th days after the operation. Hematological findings revealed neutrophilia on the 4th-17th days after operation and normal level on the pre-operative period day 0 and day 33 after the surgery. The liver enzyme and kidney function were within normal limits. Urinalyses were done on the 4th and 92th days after surgery. On day 4, the results revealed alkalinuria (pH 9), hemoglobinuria and pyuria. Calcium oxalate monohydrate and calcium oxalate dihydrate crystals were found in urine sediment. On the 92th day, the results revealed lower urine pH 8 compared to the previous analysis and hemoglobinuria was no longer found. Upon urine sediment, only calcium carbonate was found. Urine specific gravity (USG) of both days revealed isostenuria (Table 3). The stone were sent for composition analysis by using IR Spectrum technique (Uldall, 1981) at the Department of Surgery, Faculty of Medicine, Prince of Songkla University. The stone composition analysis with IR Spectrum revealed only calcium carbonate in both surface and nuclear regions.

Discussion

In this present report, the causes of urethral calculi in elephant remained unclear. Low water intake or high mineral water drinking and low amount of water in the food were considered. Due to the elephant's translocation from mainland to the island, the water and food supply might not be ideal

Figure 7 Stricture of episiotomy wound at 5 month after surgery

resulting in an opportune condition for calculus formation. It remains unknown whether renal pelvis of an elephant can produce mucus that can prevent crystal formation similar to a horse (Mair and Holt, 1994). Equine urine also contains other components such as pyrophosphate, citrate, magnesium, and glycosaminoglycans that also help inhibit urolith formation (Schott, 1998). However, such factors have not been elucidated in elephant yet. The predisposing factor studies of the stones formation in elephant need to be done in the near future.

In elephant, there are several reports about ureteral calculi (Morris et al. 1987; Ruedi, 1995). However, there was no report about the urethral and bladder stone removal in female elephant. The reason might be due to the low predisposing factors, the

Table 3 Urinalysis results of Kammoon on the 4th and 92th days after surgery.

Parameters	Post-operation (Day 4th)	Post-operation (Day 92th)	Reference value (Weidner *et al*. 2009)
Color	Yellow	Yellow	pale yellow (54%), medium to dark yellow (45%)
Transparency	Cloudy	Cloudy	clear (36%), cloudy (64%)
Sp. Gr.	1.022	1.024	1.010 - 1.036
Nitrite	+	+	-
pH	9	8	6.8 – 8.6
Protein (mg/dl)	Negative	Negative	0.12 – 0.248
Glucose (mg/dl)	Negative	Negative	Negative
Ketone	Negative	Negative	95% negative
Urobilinogen	Negative	Negative	Negative
Bilirubin	Negative	Negative	95% negative
Hemoglobin	+4	Negative	-
Blood	Negative	Negative	5% positive
RBC	Negative	Negative	4.5%
Casts	Negative	Negative	Negative
Crystals	Calcium oxalate monohydrate 100/hpf Calcium oxalate dihydrate 10/hpf	Calcium carbonate 100/hpf	Samples with crystals (100%) Samples with multiple types of crystals (32%) Calcium carbonate (86%) Magnesium ammonium phosphate (18%) Calcium oxalate dihydrate (9.1%) Amorphous phosphates (14%)
Cells	WBC 20/hpf	WBC 1/hpf	9.1%
	Transition cell 1/hpf	-	4.5%
	Bacteria +1	-	18%

limitations of diagnostic tools and surgical procedure. Episiotomy has only been performed to correct dystocia (Yartbantoong et al., 2002; Thitaram et al., 2006;) and vaginal prolapse (personal data) in this species but perineal urethrotomy has not been done. The present study shows the surgical technique that could remove urethral stone in a female elephant. The complications after surgery to remove urethral calculi with the episiotomy technique were also found in the present study. In a normal episiotomy patient, when the incision reaches the hollow of the vaginal vestibule, there should be a space. Nevertheless, in the present case, the stones pressed firmly against the urethral muscles and were attached to the vestibule wall. As a consequence, no space was left inside the vestibule and excising through the deeper layer of the urethral muscles was the only option to remove the stones. A perineal urethrotomy in a male horse has been suggested as a surgical procedure of choice for removal of urethral calculi in the presence of urethral stricture (Hanson and Poland, 1995). In this study, similar to the perineal urethrotomy in a male horse, the episiotomy was allowed to heal by secondary intention. Urethral stricture or fistula formation may occur in the post-operative period. In this report, the stricture was formed and urine was allowed to pass through this opening. The prolonged term undermining of urine in the subcutaneous and skin occurred and led to bedsore, bacterial infection and drainage of exudates from the infected area for a period of 1 week post-operation. Even though immediately after the detection of the complication attempts to prevent the infection by draining the urine with 18 gauge needles were made, the infection occurred. The authors suggest that the drainage of urine from subcutaneous tissue by a more aggressive but systematic method such as making strategic incisions and placing at least passive drains allowing the fluid drainage through gravity flow must be considered to prevent serious infection. Wound cleaning and trimming of the necrotic tissues were performed on a daily basis. Despite the surgical wound being contaminated with urine every day, the granulation tissue at the opening occurred and caused a stricture with a diameter of 2 cm. The authors observed that when the wound was closed by necrotic tissue unexpectedly, the elephant could pass its urine through the vaginal vestibule. After the removal of necrotic tissue, the elephant could urinate through the stricture (Fig 7).

Another life threatening complication in this report was the 5-hours bloating after surgery. The bloating was corrected by enema with tap water, intravenous administering of diluted 300 mg metoclopramide hydrochloride in NSS and continuous walk for 20 min per hour. The previous dose of metoclopramide (250-400 mg per elephant, IV) as an antiemetic has been recommended (Cheeran et al., 1995). Metoclopramide has been shown to be effective in treating post-operative ileus in animals, thus it was helpful in preventing the gastro-intestinal stasis associated with bloating. In only one hour, she defecated several times. The decreasing abdominal size was detected. During 5 hours later, the elephant defecated more than 20 times and sometimes there was only flatulus expelled though the anus.

There are 2 other reports on the high percentage of calcium based crystals in healthy elephant urine (Kingsukon et al., 2006; Weidner et al., 2009). Moreover, 2 stones in the ureter, which were also calcium carbonate, were found to be the cause of the African elephant death from chronic renal failure (Morris et al., 1987). The finding of the present study confirms that calcium based crystals are common in elephant urine. The high level of calcium salts in the diet as well as limited water intake are the contributing factors of urolith in this elephant. In spite of the alkalinity of urine and the high concentration of calcium in urine, urolithiasis is an uncommon disease in elephant compared to other species.

Conclusion

In conclusion, this report exhibits the authors experience in the removal of urethral and bladder stones in a female elephant. This is the first case that the calculi have ever been removed ante-mortem surgically in female elephant. The authors are confident that the combination of episiotomy and urethrotomy can be used in future cases to manually retrieve urethral and bladder calculi in the female elephants.

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