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Case report

AN UNUSUAL CASE OF URETER RUPTURE FOLLOWING HYDROURETER IN A FEMALE FERRET

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Summary

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This article presents a rare case of unilateral hydronephrosis and hydroureter in a female ferret caused by urinary lithiasis, leading to spontaneous rupture of the ureter. The animal, a one-year-old non-castrated female ferret, was presented with anorexia, abdominal distention, and depression, showing signs of dehydration and mild cranial abdominal pain. The post-mortem examination revealed pale mucous membranes, abdominal distention, alopecia, and uroperitoneum, with a rupture of the right ureter and hydronephrosis. To our knowledge, ureteral rupture caused by calculi has not been previously described in ferrets. This case highlights the importance of considering ureteral obstruction and rupture in ferrets presenting with abdominal pain. This case contributes to veterinary knowledge, emphasising the need for advanced diagnostics in similar cases in the future.

Key words: calculus, ferret, hydronephrosis, hydroureter, ureter rupture

Ferrets (*Mustela putorius furo*) are small domestic mammals from the Mustelidae family, closely related to weasels and minks. These animals are known for their playful nature, soft fur, and inherent curiosity. They can learn tricks and develop solid and affectionate relationships with their human companions. Consequently, ferrets have become favoured as pets by many, leading to an increased demand for veterinary medical care not only for routine procedures like identification, vaccination, and deworming but also when the animal exhibits signs of disease (Williams, 2000; Talbot *et al*., 2021).

Urinary tract diseases in ferrets are less frequent than in other companion animals. The most common diseases: renal failure, urolithiasis, and ureteral disorders are seen with varying degrees of frequency (Antinoff, 1998).

Bilateral hydronephrosis and bilateral hydroureter in ferrets are documented in association with ureteral obstruction, renal pelvis neoplasia, cystitis, bladder herniation, and inadvertent ureteral ligation during ovariohysterectomy. Obstruction of the urethra is relatively common, often linked to adrenal-associated prostatic disease or, less frequently, to urolithiasis, neoplasia, and iatrogenic trauma (Bell & Moeller, 1990; Di Girolamo, 2020).

Unilateral hydronephrosis, which occurs due to compression or obstruction of the ureter, is uncommon. It can be caused by a retrocaval ureter (also known as circumcaval ureter) (Bernhard *et al*., 2022) or by obstruction (Kiš *et al*., 2020). The rupture of the ureter in ferrets is described only in one study as having a traumatic origin (Weisse *et al*., 2002). To our knowledge, this is the first description of a hydroureter rupture linked to urinary lithiasis.

Case presentation

A one-year-old non-neutered female ferret (*Mustela putorius furo*) pet, weighing 1.4 kg and not vaccinated, presented for consultation at the Exotic Service Veterinary Hospital of the University of Trás-os-Montes and Alto Douro (Vila Real, Portugal) with a history of prolonged hyporexia and abdominal distension. During the physical examination, the animal exhibited a body score of 2/9, signs of dehydration, lethargy, hypotension, hypothermia, abdominal distension impeding normal ambulatory movement, alopecia, and abrasion wounds on the ventral skin of the abdomen secondary to dragging on the floor. Pain was present cranially upon abdominal palpation.

An IV line was inserted into the cephalic vein, and a small blood sample was collected for haematology. Non-regenerative anaemia (normocytic, normochromic) was identified with no other abnormalities. X-rays (Fig. 1A) revealed a diffuse pattern on the abdomen consistent with ascites, and the abdominal fast ultrasound showed an enormous amount of fluid, with organ identification been challenging due to the abdominal distension.

Abdominocentesis was performed, and approximately 500 mL of translucent fluid was collected without sedation. Fluid analysis revealed a pure transudate. The animal was transferred to an incubator with a controlled temperature, and fluid replacement was continued. Unfortunately, the animal did not recover from the shock and succumbed a few hours later.

The *post-mortem* examination was performed according to the standard techniques in the Necropsy Service from Veterinary Hospital of the University of Trás-os-Montes and Alto Douro (Vila Real, Portugal). The animal at the external exam had pale mucous membranes, noticeable abdominal distention (Fig. 1B), and alopecia. Additionally, there were bruises and erosions of the skin of the ventral abdominal region, which resembled abrasion lesions (Fig. 1B). Upon opening, there was no subcutaneous or abdominal fat, and bruises were present underneath the cutaneous lesions. About 1 liter of colourless fluid was found in the abdominal cavity (uroabdomen) (Fig. 1C).

Adhered to the peritoneum, a ruptured tubular organ was detected, later identified as the right ureter. The right ureteral wall appeared thin with heterogeneous coloration, featuring areas of necrosis and haemorrhage. It contained a round, yellow, firm calculus 2 mm in diameter. The right ureter was attached to the right kidney capsule and to the diaphragm. The kidney was enlarged, and upon cutting, it exhibited dilation of the pelvis and atro-

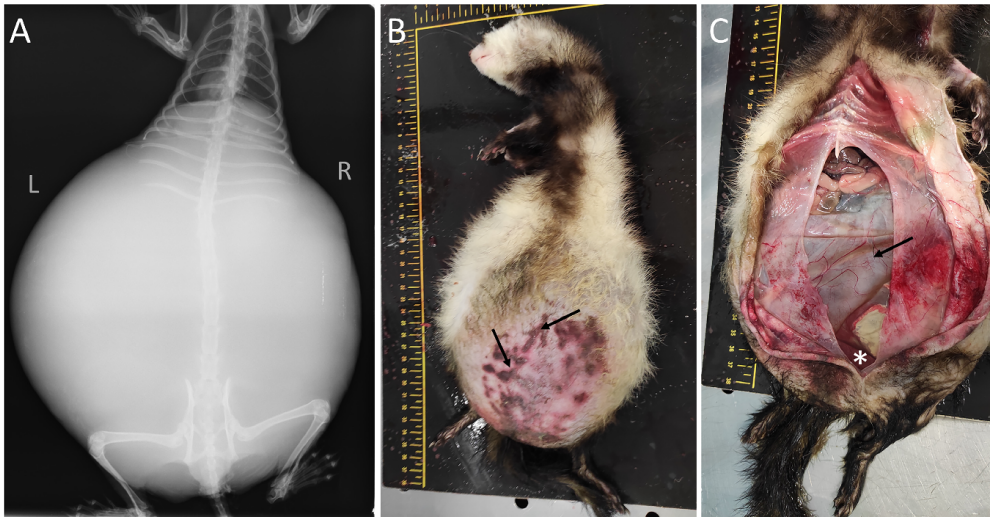

Fig. 1. Female *Mustela putorius furo*. **A.** X-ray image with diffusely increased density of the abdomen and poor definition of the soft tissue, compatible with ascites (L: left side; R: right side); **B.** Abdominal distension with cutaneous lesions (black arrow); **C.** Abdominal cavity post-incision, revealing uroabdomen (*) and an expanded saccular structure filled with transparent fluid (ureter) (black arrow).

phy of the medulla, with a yellow, oval calculus measuring 3 mm in diameter. The contralateral kidney showed multifocal red areas, difficult decapsulation, and slight dilation of the pelvis and ureter (Fig. 2). The urinary bladder exhibited no lesions in the wall, calculi, or dilations. Upon opening the thoracic cavity, the lungs did not collapse and appeared moist, heavy, and shiny. The liver had a dark appearance and decreased size. The adrenal gland was slightly enlarged. A small follicle (less than 3 mm) was observed in the right ovary. No other significant macroscopic changes were noted.

Tissue specimens from kidneys and ureters were collected, fixed in neutral buffered 10% formalin, and embedded in paraffin. Sections of 3 µm were then stained with haematoxylin-eosin (H&E) for diagnostic purposes. The microscopic examination revealed necrosis and calcification in the right ureter wall, mononuclear inflammatory cells and multinucleated giant cells, and desquamation of the urothelium (Fig. 3A, 3B). Additionally, medullary atrophy and interstitial fibrosis in the right kidney, accompanied by mild non-purulent interstitial nephritis and glomerulosclerosis in the cortex were seen (Fig. 3C).

The occurrence of ureteral rupture is a condition typically associated with various underlying factors, including physical trauma, the presence of urinary calculi, urinary tract blockages, neoplasia, unexplained retroperitoneal fibrosis, or complications following surgeries on the urinary tract. There are limited reported cases in humans (Liu *et al*., 2011) and animals, particularly in dogs and cats, with trauma often being the primary cause (Weisse *et al*., 2002).

This article presents a case of uroabdomen characterised by significant dilation, necrosis, and rupture of the ureter, likely attributed to obstructive factors, such as the presence of a calculus.

In ferrets, ureteral rupture is rare, with only one previously reported case associated with trauma (Weisse *et al*., 2002). Urolithiasis, however, is quite common in these animals, mostly in adult neutered male ferrets, and is often associated with ureteral obstruction and hydronephrosis. Several causes can lead to the formation of uroliths in ferrets. Inadequate hydration

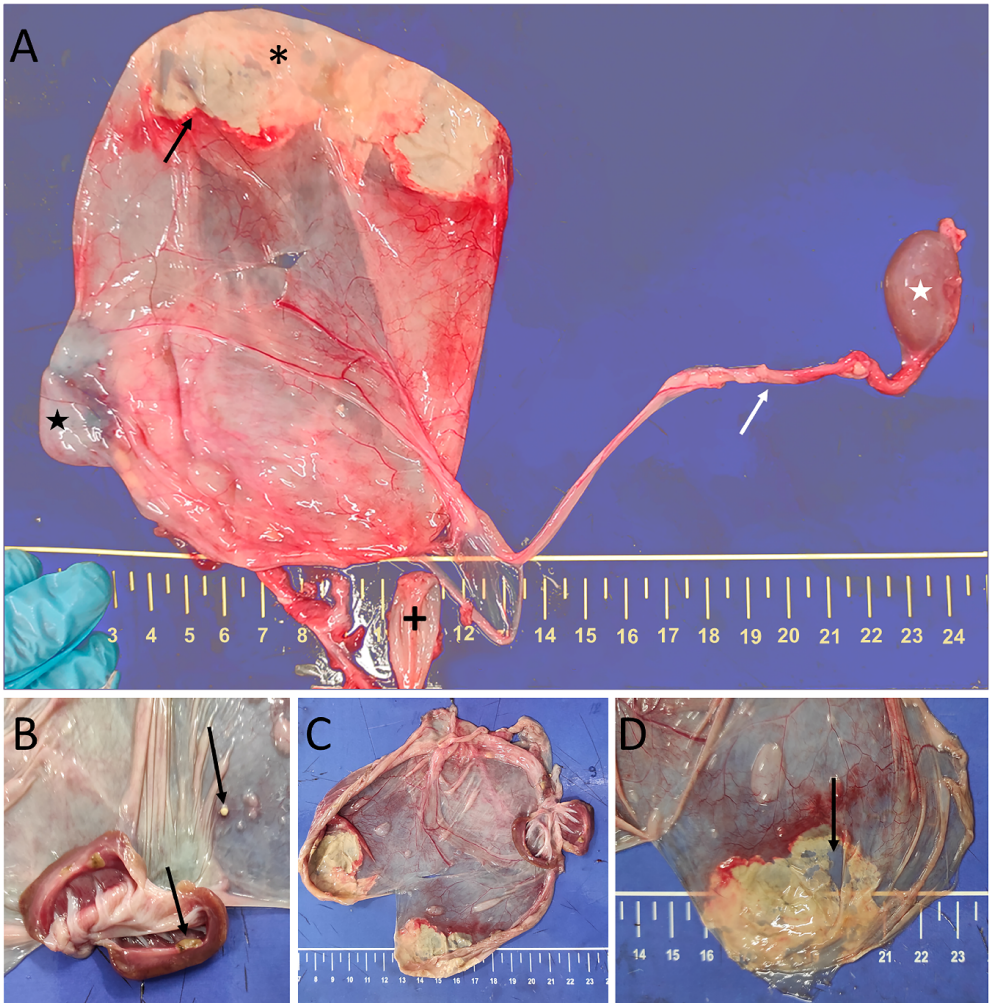

Fig. 2. Female *Mustela putorius furo*. **A.** Dilated ureter with thin wall showing area of necrosis (*) surrounded by a congestive haemorrhagic halo (black arrow), adjacent to the right kidney (black ★). Note the urinary bladder (+), the left kidney (white ★) and the slight dilatation of the left ureter (white arrow); **B.** Hydronephrosis in the right kidney, with a calculus observed in the renal pelvis and another in the ureter (black arrow); **C.** Ureter and right kidney; **D.** Necrosis in the right ureter and rupture (black arrow).

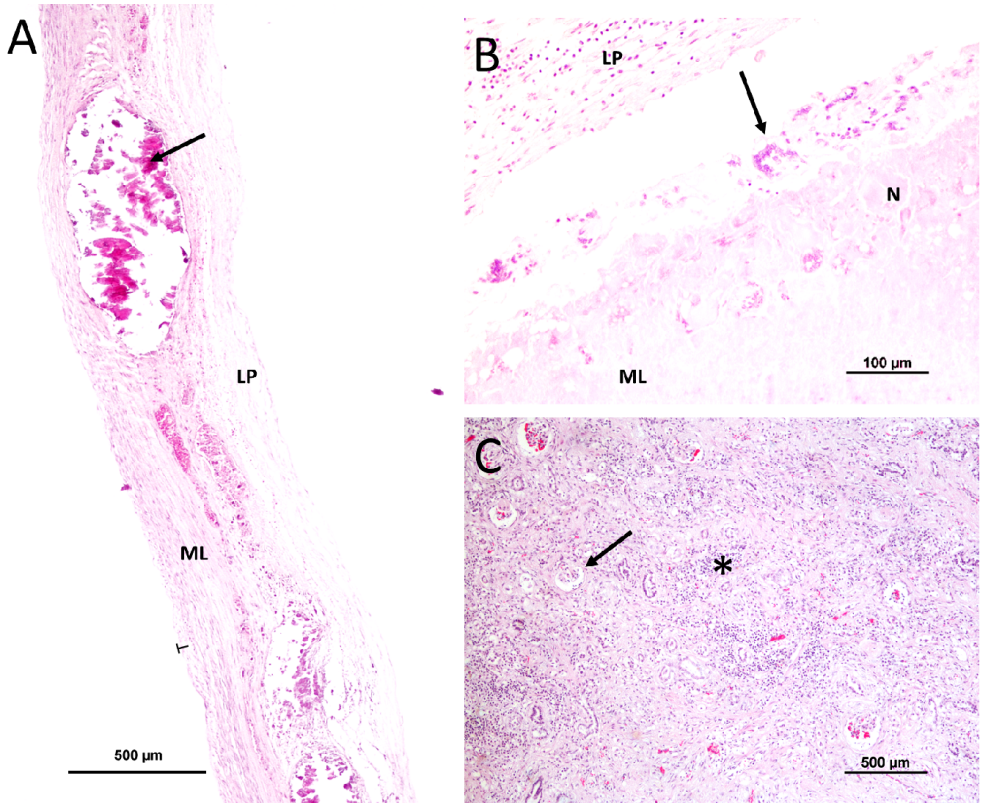

Fig. 3. Female *Mustela putorius furo*. **A.** Necrosis and calcification (black arrow) of *lamina propria* (LP) and muscular layer (ML) of the right ureter; adventitia layer; **B.** Multinucleated giant cells (black arrow) surrounding necrosis (N) in *lamina propria* (LP) and muscular layer (ML); **C.** Right kidney with interstitial fibrosis, non-purulent interstitial nephritis (*) and glomerulosclerosis (black arrow).

can cause urine concentration, increasing the risk of stone formation. Dietary choices, particularly those with high levels of minerals like calcium and phosphorus, are also a significant factor. Urinary tract infections can precipitate the formation of struvite calculi. Additionally, metabolic conditions and genetic factors can predispose ferrets to urolithiasis. High estrogen levels may interfere with calcium metabolism, thereby increasing the predisposition to calculi formation. Specific medications that impact the urine pH or mineral concentration can also play a role. Furthermore, the risk of developing uroliths tends to be higher in older ferrets and males (Nwaokorie *et al*., 2011; 2013; Di Girolamo, 2020). The aetiology of the present case is unknown. However, considering the animal's age and the fact that it was not on any medication and had no clinical signs of urinary tract infection, possible dehydration or an inadequate diet as contributing factors may be suggested. Weight loss, alopecia, non-regenerative anaemia, and lethargy can also be indicative of potential hyperestrogenism as a predisposing factor. Ferrets are seasonally

polyestrous animals with induced ovulation. In the absence of mating, females can enter prolonged estrus during the breeding season, increasing estrogen levels (Di Girolamo, 2020).

The urinary calculi were not observed on the X-ray. While the severe ascites may have interfered with the visualisation of the calculi, the possibility that their absence on X-ray could be due to the composition of the calculus cannot be excluded. Indeed, some types of kidney stones, such as those made of cystine, are radiolucent and may not be visible on standard X-rays. Both struvite and cystine stones have been described in ferrets. Historically, struvite, composed of magnesium ammonium phosphate, was the most common type of calculus in ferrets in the United States and the United Kingdom. Struvite formation is frequently connected to dietary factors, especially those that affect urine pH, which is greatly influenced by dietary protein sources. Struvite crystals typically form in urine with a pH above 6.6. However, there has been a notable shift in the United States in recent years, with cystine becoming the predominant type of calculus in ferrets. This change may suggest a familial pattern potentially linked to inbreeding practices (Nwaokorie *et al*., 2011; 2013; Di Girolamo, 2020). Unfortunately, in this case, no conclusions about the composition of the calculus can be made because the analysis was not performed.

The rupture of the right ureter, observed in this case, could involve two mechanisms as described in similar human cases: direct erosion of the ureteral wall by the calculus or ureteral trauma and ulceration caused by a downward-moving calculus that obstructs the distal ureter (Liu *et al*., 2011). However, the calculus size (3 mm) may not have been sufficient to cause erosion or significant trauma directly to the ureteral wall. So, a third mechanism could be proposed. The persistent presence of even a tiny calculus, combined with other factors such as ureteral dilation, might have led to ischaemic necrosis due to vascular compromise from the pressure exerted by the ureter's contents against the abdominal wall. Over time, the resulting pressure and ischaemia could weaken the ureteral wall, making it more likely to rupture at its most vulnerable point.

In our case, the obstruction was unilateral, leading to hydronephrosis of the corresponding kidney. This type of presentation is uncommon, as most documented cases usually involve bilateral hydronephrosis (Di Girolamo, 2020).

Diagnosing urolithiasis in ferrets typically includes palpation, abdominal radiography, ultrasound scanning, blood tests, urinalysis, and bacterial culture with antibiotic sensitivity tests. In cases with no obstructions, supportive care usually involves administering parenteral fluids. Subsequently, a cystotomy is performed to remove cystic calculi and cleanse the bladder. Antibiotics are prescribed if an infection is suspected. Procedures like retrograde urohydropulsion or perineal urethrostomy are considered for urethral calculi cases. Dietary adjustments are recommended for long-term management, focusing on a diet primarily based on animal protein (Antinoff, 1998; Di Girolamo, 2020; Quesenberry & de Matos, 2020).

When there is a urinary obstruction, it should be considered as an emergency. Relieving the obstruction and initiating force diuresis are the primary management strategies. Additionally, medical treatment may be necessary for complications such as arrhythmias. Monitoring urine output

during supportive care is crucial during urinary catheterisation, a commonly used procedure in these cases. If catheterisation is unsuccessful, alternative methods like cystocentesis or temporary cystostomy tube implantation can alleviate the obstruction and effectively manage the patient's condition (Antinoff, 1998; Di Girolamo, 2020; Quesenberry & de Matos, 2020).

Ureter or urinary bladder calculi with aggressive treatment have a generally favourable prognosis, but the prognosis for bilateral renal calculi is uncertain (Di Girolamo, 2020). In addition, it is important to consider the possibility of ureteral obstruction and, as our case indicates, the risk of ureteral rupture, particularly in cases with significant dilation. The lack of specific clinical signs results in delayed diagnosis, making treatment sometimes impossible, as in our case.

In conclusion, this report details a case of unilateral hydronephrosis and hydroureter in a female ferret caused by urinary lithiasis, which led to a spontaneous rupture of the ureter. This case reminds veterinarians to consider ureteral obstruction and the possibility of rupture when diagnosing abdominal pain in ferrets. It underscores the importance of utilising advanced diagnostic techniques. Additionally, this report offers significant pathological insights, contributing valuable knowledge to the field of veterinary medicine, particularly in the diagnosis and treatment of similar cases in the future.

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