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Citation for published version:
Woods, G, Earley, N, Munro, E & Perez Accino Salgado, J 2023, 'A unique complication: Iatrogenic renal pelvis perforation following accidental urinary catheterisation of an intramural ectopic ureter', *Veterinary Record Case Reports*, vol. 11, no. 2, pp. 1-7. https://doi.org/10.1002/vrc2.639

Digital Object Identifier (DOI):
10.1002/vrc2.639

Link:
Link to publication record in Edinburgh Research Explorer

Document Version:
Publisher's PDF, also known as Version of record

Published In:
Veterinary Record Case Reports

Received: 21 February 2023 | Revised: 23 April 2023 | Accepted: 14 May 2023

DOI: 10.1002/vrc2.639

Vet Record CaseReports

CASE REPORT

Companion or pet animals

A unique complication: Iatrogenic renal pelvis perforation following accidental urinary catheterisation of an intramural ectopic ureter

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Abstract

A 5-month-old, female, entire golden retriever presented for investigation of urinary incontinence and recent urinary tract infection. While under general anaesthesia, a urinary catheter was placed to fill the bladder, aid accurate visualisation of the ureteral vesicular junction and facilitate a retrograde contrast study. The preliminary computed tomography was deemed unremarkable, and a computed tomography intravenous urethrogram was performed, followed by retrograde of contrast in an attempted vaginourethrogram. The post-contrast retrograde study highlighted an unusually straight distal right ureter and contrast escaping into the right retroperitoneal space. Contrast-enhanced ultrasonography supported haemorrhage into the perirenal space, and on retrospective analysis of preliminary pre-contrast computed tomography sequences, the urinary catheter was identified in the right renal pelvis. Accidental catheterisation of the right intramural ectopic ureter and iatrogenic renal perforation was ultimately concluded. The dog made a full recovery with conservative management and to date has no chronic repercussions of the injury.

BACKGROUND

The placement of a urinary catheter in canine patients is a commonly used diagnostic, therapeutic and management procedure in dogs both in general and referral practice. Urinary catheterisation is employed in the investigation of urinary incontinence and lower urinary tract disease. Urinary catheters are used to instil air, saline and contrast medium into the bladder and urogenital structures during contrast and double contrast retrograde studies. Other than difficulties experienced during their placement, procedural complications are rarely described. Reports of urinary catheter complications in veterinary literature are limited to ascending infections,[1] urethral trauma[2] and rare reports of urinary catheter kinking.[3]

Ectopic ureters (EU) are the leading cause of juvenile incontinence in dogs, and their immediate impact on owner welfare leads to prompt presentation to primary care vets.[4,5] Dogs born with EU can suffer from concurrent congenital urogenital abnormalities, which also contribute to urinary incontinence.[6] Therefore, incontinent dogs routinely undergo diagnostic imaging such as cystoscopy, intravenous urethrogram (IVU) and retrograde contrast studies during urinary incontinence investigations.

The dog in this study was diagnosed with a unilateral intramural EU. The caudal location of the EU resulted in its inadvertent catheterisation. Given that urinary catheter placement, acquisition of urine samples and administration of saline were largely uneventful, no complications were suspected by the authors. A retrograde vaginourethrogram was subsequently performed, culminating in an iatrogenic renal pelvis perforation secondary to accidental catheterisation of the EU.

To the authors' knowledge, this is the first reported case of inadvertent catheterisation of an EU in a dog. This case report describes an extremely rare and potentially hazardous complication of urinary catheter placement in an incontinent bitch.

CASE PRESENTATION

A 5-month-old, home-bred, female, entire golden retriever was referred with a life-long history of urinary incontinence. The dog had been in the owner's possession since birth. Three other bitches in the litter had already been euthanased as a result of severe urinary incontinence. The owner confidently characterised the urinary incontinence by continual urine leakage, however noted that incontinence intensified when the dog was exercising, climbing stairs and manoeuvring onto furniture. The owner confirmed that the dog was toilet-trained and had not experienced a season. Two

TABLE 1 Haematology and biochemical results were obtained at the referring veterinary surgeon.

White blood cell	13.36	6.00–15.00	$\times 10^{10}$/L
Neutrophils (segmented)	7.482	3.60–12.00	$\times 10^{10}$/L
Neutrophils (non-segmented)	0.000	0.00–0.10	$\times 10^{10}$/L
Lymphocytes (absolute number)	4.542	0.70–4.80	$\times 10^{10}$/L
Monocytes (absolute number)	0.935	0.00–1.50	$\times 10^{10}$/L
Eosinophils (absolute number)	0.401	0.00–1.00	$\times 10^{10}$/L
Basophils (absolute number)	0.000	0.00–0.20	$\times 10^{10}$/L
Red blood cell (absolute number)	5.16	5.50–8.50	$\times 10^{13}$/L
Packed cell volume	0.38	0.39–0.55	L/L
Haemoglobin	12.4	12.00–18.00	g/dL
Mean corpuscle volume	73.3	60.00–77.00	fL
Mean corpuscle haemoglobin concentration	32.9	32.00–36.00	g/dL
Platelets (automated count)	289.00	200.00–500.00	$\times 10^{10}$/L
Reticulocytes (automated count)	13.7	0.00–60.00	$\times 10^{10}$/L
Protein (total)	52.9	58.00–73.00	g/L
Albumin	26.5	26.00–35.00	g/L
Globulin	26.4	18.00–37.00	g/L
Alanine transaminase	30	21.00–102.00	U/L
Alkaline phosphatase	113	20.00–60.00	U/L
Bile acids	4.7	0.00–10.50	μmol/L
Bilirubin (total)	2.3	0.00–6.80	μmol/L
Cholesterol	8.1	3.80–7.00	mmol/L
Triglycerides	0.77	0.57–1.14	mmol/L
Creatinine kinase	227	50.00–200.00	U/L
Urea	4.3	1.70–7.40	mmol/L
Creatinine	59	22.00–115.00	μmol/L
Calcium (total)	2.69	2.30–3.00	mmol/L
Phosphate inorganic	3.1	0.90–2.00	mmol/L
Magnesium	0.82	0.69–1.18	mmol/L
Sodium	145	139.00–154.00	mmol/L
Potassium	4.2	3.50–5.60	mmol/L
Chloride	109	102.00–118.00	mmol/L
Glucose	6.0	3.00–5.00	mmol/L

Note: Abnormalities are highlighted in red and attributed to an inappropriate starvation period and normal physiological variation of juvenile dogs.

weeks before referral, the dog had developed pollakiuria and the urinary incontinence acutely worsened. A urinary tract infection was suspected on free catch urine sediment (the urine was otherwise normal with adequate concentration) and treated empirically with amoxicillin clavulanic acid (Noroclav; Norbrook 15 mg/kg per os every 12 hours) for 7 days. The dog improved clinically during this time, with owner reporting resolution of pollakiuria and subjective improvement in the incontinence. A haematology and biochemistry were performed by the referring veterinary surgeon and were unremarkable other than physiological changes typical of a juvenile dog (Table 1). On presentation to our hospital, the dog had been off antibiotics for 7 days, and the owner noted recurrence of pollakiuria and persistent urinary incontinence.

The dog was fed a complete, commercially available, age-appropriate dog food, was up to date on vaccinations and worming and, other than the antibiotics prescribed, had not received any additional drugs or supplements before referral nor had it travelled out of the United Kingdom.

On physical exam, the dog was bright and alert. The dog weighed 29 kg and had a body condition score of 5/9. Vital parameters, cardiothoracic auscultation and abdominal palpation were within normal limits. The dog's vulva was immature, markedly hooded and the urogenital skin was lichenified due to chronic urine scalding. The dog leaked urine constantly throughout the examination. Rectal examination and vaginal digital palpation were unremarkable. Neurological examination was normal, and the dog was witnessed to micturate normally.

LEARNING POINTS/TAKE-HOME MESSAGES

- When placing a urinary catheter in incontinent dogs, clinicians should be aware of the possibility of catheterising an ectopic ureter.
- Acquisition of urine from a urinary catheter in a dog suspected to suffer from an ectopic ureter should not conclude adequate placement within the urinary bladder.
- To consider concurrent use of patient side abdominal ultrasonography when placing a urinary catheter in a bitch suspected to have ectopic ureter.
- When performing a computed tomography intravenous urethrogram, an asymmetric nephrogram and pyelogram phase should raise suspicion of ureteral blockage.
- Traumatic renal perforation, induced by ureter catheterisation, as witnessed in this case, can be managed conservatively.

INVESTIGATIONS

The dog was anaesthetised and a water enema was performed to facilitate assessment of ureters. A pre-CT topogram was then performed, with the dog positioned in sternal recumbency to assess adequacy of the enema. During this scan, it was noted that the urinary bladder was small (Figure 1). In order

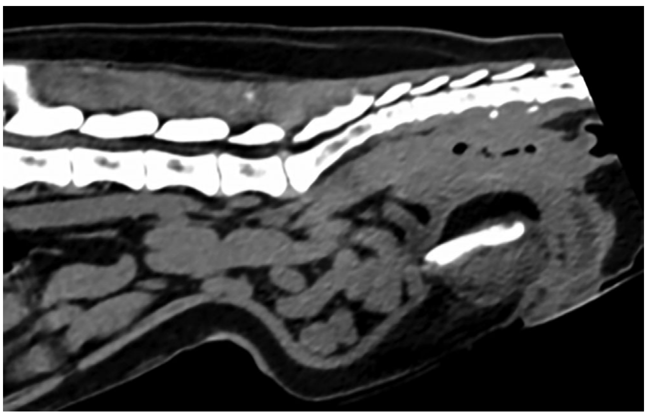

FIGURE 1 Sagittal plane soft tissue pre-contrast computed tomography (CT) reconstruction of the abdomen depicting no visible urinary bladder on the initial pre-contrast CT.

TABLE 2 Urine analysis performed on urine obtained from urinary catheter.

Urine specific gravity	1.026
Urine pH	8
Urine protein	++
Urine blood	+
Urine ketones	–
Urine glucose	–
Urine bilirubin	–

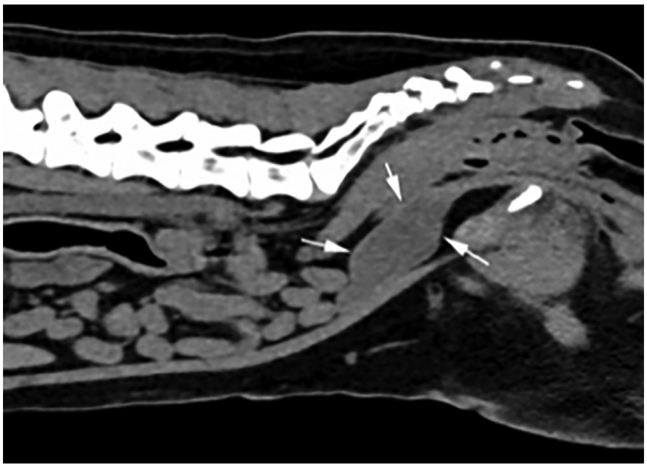

FIGURE 2 Sagittal plane soft tissue pre-contrast computed tomography (CT) reconstruction of the abdomen showing mild dilatation of the urinary bladder in the second pre-contrast CT after instilling saline (white arrows).

to facilitate adequate visualisation of ureter vesicular junctions and optimise diagnostic quality of the forthcoming CT intravenous urethrogram, we proceeded to place a urinary catheter to fill the urinary bladder with saline.

With the dog in sternal recumbency, its pelvis was raised above the level of the spine. To minimise contamination, the tail was secured to dogs' flank with Babcock forceps. The genital area was aseptically prepared with Povidone iodine. A sterile speculum was used to visualise the urethral orifice and an 8-French, 55-cm rigid polyester urinary catheter was advanced. Urine was visualised dripping from the urinary catheter, and 5 mL of urine was acquired for urine analysis (Table 2), urine culture and antimicrobial sensitivity before the urinary catheter was sealed by a sterile plastic cap.

With the rigid catheter in place, the dog was positioned in lateral recumbency, and 180 mL of sterile saline was flushed into the bladder. At this point, the patient became tachypnoeic and tachycardic, with rates of 62 breaths per minute and 138 beats per minute, respectively. Atrial premature complexes became visible on electrocardiogram, but rhythm normalised within 30 seconds. There was no loss of anaesthetic depth, nor did the patient become haemodynamically unstable, with blood pressure remaining within normal limits.

The dog was repositioned in sternal recumbency and repeat pre-contrast CT documented an enlarged bladder (Figure 2) enabling CT IVU acquisition. The CT protocol was performed as per standard four-dimensional CT excretory urography (CTEU) protocol, as previously described.[7]

FIGURE 3 Dorsal plane soft tissue pre-contrast computed tomography reconstruction of the abdomen portraying a small gas bubble (white circle) within the proximal right ureter (white arrows).

On the provisional report, both ureters could be visualised along their length with the right being slightly larger than the left on the pre-contrast CT. In the post-contrast, the left ureter homogeneously filled with contrast agent, had a normal path and entered into the dorsolateral bladder wall before exiting into the bladder at the level of the trigone, where a jet of contrast was visible. In the initial excretory contrast studies, the left kidney demonstrated a normal pyelogram phase diminishing over time. The right kidney did not show a normal pyelogram phase (Figure 3), and instead there was progressive increase in contrast enhancement during the persistent nephrogram phase. The suboptimal pyelogram phase prompted the use of a 1 mg/kg furosemide intravenous injection (Dimazon), which failed to promote right-sided diuresis.

For further study, the urinary catheter was then withdrawn 20 cm and secured with Babcock forceps, with the intention of leaving the urinary catheter in the vestibule to subsequently facilitate retrograde vaginourethrogram. Ten millilitres of iodinated contrast (Omnipaque, GE Healthcare) was diluted 1:2 with sterile saline and then injected into the urinary catheter. The CT did not identify contrast within the urinary bladder but instead noted marked contrast attenuation of the entire right ureter. The contrast agent was visible within the right retroperitoneum, forming a rim around the right kidney and extending into the peritoneum between the liver lobes (Figure 4), alerting clinicians to a urinary tract rupture. The right ureter followed a straight and continuous path to the dorsolateral bladder wall (Figure 5), where it continued distally along the course of the urinary catheter (Figure 6).

In order to better describe the free fluid pattern and visualise urogenital tract, abdominal ultrasonography was performed. Hypoechoic right perirenal fluid was detected, consistent with CT findings. The right kidney parenchyma appeared unremarkable with minimal pyelectasia, and the right ureter was traceable along the flank to the level of the bladder. The right ureter was mildly dilated but exhibited normal peristalsis. The right ureter was witnessed to abut the wall of the urinary bladder but could not be traced further,

FIGURE 4 Dorsal plane soft tissue post-contrast computed tomography reconstruction of the abdomen representing the straight right ureter (black arrows).

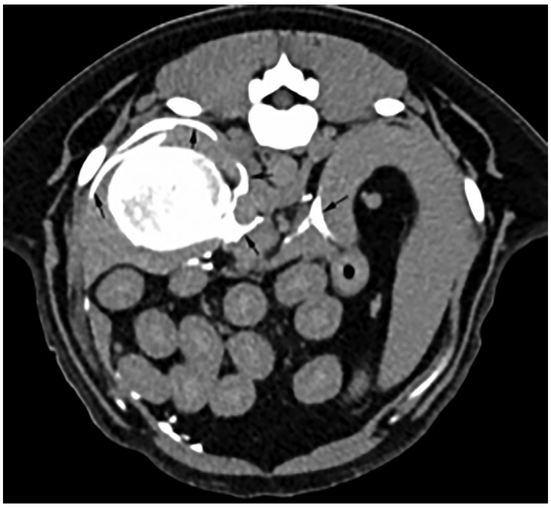

FIGURE 5 Sagittal plane soft tissue computed tomography reconstruction of the abdomen following positive contrast retrograde vaginourethrogram. The right ureter is visible caudally continuous with the urinary catheter (white arrows).

nor was a urine jet witnessed. The left kidney and ureter were unremarkable, with a jet from the left ureter visualised in the urinary bladder at the level of trigone. Contrast-enhanced ultrasonography (CEUS) was then performed using a micro-bubble contrast agent (SonoVue, Bracco International). Micro-bubbles were immediately witnessed within the perirenal fluid after intravenous administration of contrast. This confirmed a urinary tract rupture with marked contrast enhancement supporting haemorrhagic injury to the renal parenchyma.

DIFFERENTIAL DIAGNOSIS

Given the age and breed of the dog, congenital abnormalities, such as ureter ectopia, were top differential diagnoses.

Although a reason for the poor right-sided contrast excretion in the CTEUs was initially unclear, the detection of perirenal contrast in the retrograde study immediately alerted

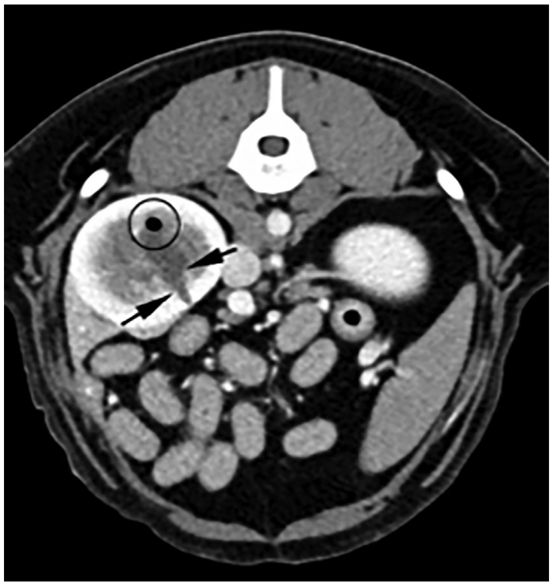

FIGURE 6 Transverse plane soft tissue post-contrast computed tomography reconstruction of the abdomen showing a gas bubble within the right kidney (black circle) and a dilated diverticulae extending into the cortex (black arrows).

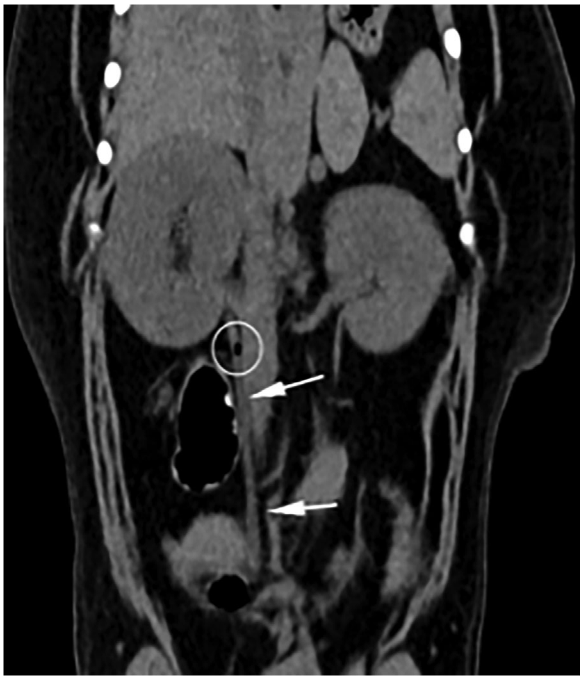

FIGURE 7 Transverse plane soft tissue post-contrast computed tomography reconstruction of the abdomen during the excretory phase demonstrating lack of contrast enhancement of the right renal pelvis (black arrows).

the authors to an iatrogenic urinary catheter injury. Images were systematically reviewed and retrospectively confirmed the presence of the urinary catheter within the right pelvis before CTEU (Figure 7). The urinary catheter in combination with saline flush, precluded contrast medium drainage from the renal parenchyma, resulting in a lack of pyelogram (Figure 3). The renal diverticulae were distended with hypoattenuating fluid following the saline flush. Interestingly, only after retrograde injection of contrast was perirenal free fluid identified (Figure 4). As such the urinary tract breach was attributed to diverticular rupture of the calyx resulting from back pressure of the retrograde contrast injection. Overall, a diagnosis of iatrogenic renal pelvis perforation caused by accidental catheterisation of the right intramural EU was made.

TREATMENT

A renal perforation was concluded, the dog was moved to intensive care unit for observation. A new 8-Fr Foley catheter was placed, and its presence in the bladder was confirmed by ultrasound scan before balloon inflation. Intravenous fluid therapy was initiated at 3 mL/kg/h using isotonic crystalloid. To address visceral pain, methadone (0.2 mg/kg intravenously [IV] every 4 hours; Comfortan, Norbrook) was administered. This was weaned to buprenorphine (0.02 mg/kg IV every 8 hours; Buprecare, Animalcare) overnight. Over a 24-hour period, urine output remained static at 3 mL/kg/h, and sequential abdominal point-of-care ultrasound scans documented resolution of the free perirenal fluid. Furthermore, the patient's acid base status, electrolytes, blood pressure and creatinine remained unchanged. The dog remained clinically well with no alterations on physical examination.

OUTCOME AND FOLLOW-UP

The dog was discharged 36 hours after the renal perforation on 10 mg/kg every 12 hours of oral paracetamol (Paracetamol 250 mg/5 mL suspension, Rosemont). The owner stopped the paracetamol within 5 days, and the dog was reported normal at home, albeit persistently incontinent. The dog re-presented 14 days later, and a repeat 4D CTEU found no evidence of previous trauma and confirmed a right-sided intramural EU. The dog subsequently underwent an uncomplicated cystoscopic laser ablation (CLA) of the right intramural EU. The dog recovered uneventfully, but remained incontinent. The dog was discharged on oral phenylpropanolamine (1 mg/kg every 8 hours; Propalin, Vetoquinol). The client provided an update 14 days later and detailed the dog was completely urinary continent. The client was instructed to continue phenylpropanolamine until the patient experienced a season in the hope that sexual maturity would strengthen its urinary sphincter and limit incontinence. One month later, the client provided an update detailing that the dog had recently experienced its first oestrus and had remained continent. Repeat abdominal ultrasonography 6 weeks after CLA was unremarkable. Phenylpropanolamine was slowly weaned and the owner reported complete urinary continence. At the time of writing this report, 765 days after initial presentation, the dog was clinically well, with no incontinence or biochemical evidence of kidney disease following the injury.

DISCUSSION

The case presented highlights a rare complication of urethral catheterisation in an incontinent dog with congenital anomaly. It demonstrates that inadvertently catheterising an EU in a female dog is possible and that life-threatening complications such as renal perforation can occur. It provides evidence that much like other forms of urinary tract trauma, conservative management in the form of urinary catheterisation and pain relief can lead to full resolution.[8,9] With increasing awareness and availability of minimally invasive interventions for EU, both referral and primary care practitioners are performing retrograde studies, reinforcing the importance of this case report.

Complications associated with placement of urinary catheters in veterinary medicine are limited to bladder rupture,[9] ascending infection,[1] urethritis, urethra rupture[2] and rarely kinking.[3] Urinary tract iatrogenic damage and perforation are poorly described known potential complications of catheterisation. This is the first report of an inadvertently catheterised EU in a canine patient and demonstrates the potentially life-threatening complication of renal perforation. Although novel to veterinary literature, cases of accidental catheterisation have been reported in the human literature.[10–14] Much like the dog presented in this report, all human patients, even those who suffered hydroureteronephrosis, recovered uneventfully.[14]

This case report highlights that the attainment of free-flowing urine from the urinary catheter is not synonymous with successful placement of a vesical urinary catheter in dogs with EU. EUs, especially intramural, commonly are inserted as far caudal as the vaginal vestibule,[15] and in turn are often within close proximity to the urethra. In this case, authors quickly visualised free dripping urine from the urinary catheter and obtained diagnostic samples. This led authors to erroneously conclude adequate placement of the urinary catheter within the urinary bladder. An additional complicating factor in how this case progressed was that administration of saline into the erroneously placed urinary catheter still managed to result in bladder enlargement, as documented in the second pre-contrast CT (Figure 2). Given that no EU fenestrations were later identified on cystoscopy, we hypothesise that saline administered into the urinary catheter must have travelled in an anterograde manner down the right ureter and then drained in a retrograde fashion into the bladder from its orifice in the vestibule. Authors now promote the use of patient side point-of-care ultrasound to ensure adequate placement of the urinary catheter in the urinary bladder of any dog suspected of having an EU or any other congenital anomaly of the urinary tract.

Within the authors' institution, CT is the modality of choice when investigating urinary incontinence, especially when EUs are suspected. Although the majority of EUs have an intramural course allowing both diagnosis and treatment to be performed via cystoscopy, CT enables the identification of patients with normotopic, bilateral ureters that are incontinent for other reasons (i.e., congenital rectovaginal fistulae or neurological causes) and the recognition of EUs with an entirely extramural course.

The dog presented in this case report did experience sinus tachycardia when saline was administered into the urinary catheter. This transient change was likely as a result of noxious stimuli from renal pelvis or right ureteral distension. In hindsight, the acute sinus tachycardia and atrial premature complexes in an otherwise cardiovascular stable patient could have prompted a more critical appraisal of the procedure.

This case highlights also, just how easily a plastic foreign item can be missed on CT. A standard, rigid, 55-cm, 8-French,

FIGURE 8 Transverse plane soft tissue post-contrast computed tomography reconstruction of the abdomen following positive contrast retrograde vaginourethrogram. Contrast agent is visible free within the right retroperitoneum and peritoneum (black arrows).

polyvinylchloride urinary catheter was used. Although retrospectively, the right ureter was unusually straight and a bubble was noted within it (Figure 8), the urinary catheter did not hyperattenuate, making it almost impossible to defer from the ureter wall. Foley catheters available for veterinary use are likely to be easier to identify on CT, given the increased density of their inflatable bulb and their radiopaque preinserted braided stainless-steel stylet. The presence of the bulb also increases tip diameter and may, in theory, have decreased the likelihood of inadvertent entry into the EU. On reflection, authors acknowledge that they did not pre-measure the urinary catheter. This simple step may have alerted the authors and precluded injury. The authors hope this case emphasises the importance of this simple procedural step of urinary catheter placement.

As this case unfolded, authors elected to use CEUS to better understand the iatrogenic injury. CEUS is an increasingly used modality, which employs the use of intravenous sulphur hexafluoride microbubbles (SonoVue, Bracco International) in real time to detect subtle perfusion abnormalities. Historically, veterinary CEUS has been used to differentiate tumours, pseudo lesions, complex cysts, tumour ablation and different malignant potentials.[16,17] The use of CEUS in detecting haemorrhage specifically, as was the intention in this case, is less common. CEUS has shown promise at being able to detect idiopathic renal haematuria[18] and previously been used to accurately diagnose spontaneous renal haemorrhage in a dog.[19] In the case described here, intravenously administered contrast microbubbles were immediately witnessed in the perirenal fluid of this patient, enabling authors to conclude renal haemorrhage and iatrogenic parenchymal damage.

AUTHOR CONTRIBUTION STATEMENT

Glynn Woods conceived, generated and reviewed the manuscript. Jorge Perez Accino reviewed the manuscript. Naomi Early and Elizabeth Munro both contributed imaging resources, contributed figure legends and reviewed the manuscript.

CONFLICT OF INTEREST STATEMENT

The authors declare they have no conflicts of interest.

ETHICS STATEMENT

This case report details a patient at our institution who suffered an accidental injury while undergoing routine urinary incontinence investigation. This dog was not involved in any prospective study, and diagnostic and treatment decisions were tailored to the dog's needs as decided by two clinicians involved in the case (Glynn Woods, Jorge Perez Accino). No ethical approval was pursued, but the owner provided informed written consent at the time of investigation and has since consented to publication of this case report.

FUNDING INFORMATION

The authors received no specific funding for the publication of this case report.

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How to cite this article: Woods G, Earley N, Munro E, Accino JP. A unique complication: Iatrogenic renal pelvis perforation following accidental urinary catheterisation of an intramural ectopic ureter. Vet Rec Case Rep. 2023;e639. https://doi.org/10.1002/vrc2.639