Feline UPDATE
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The Feline Centre
Pfizer Animal Health
The Feline Centre Langford and Pfizer Animal Health working together for the benefit of cats

Feline Lower Urinary Tract Disease

A diagnostic approach

by Catherine Bovens *DVM CertSAM MRCVS.*

This issue of Feline Update is the first in a series focusing on the **Feline Urinary Tract.**
Articles Include:
- FLUTD: a diagnostic approach
- A guide to Urinalysis
- What's Your Diagnosis?

Fig. 1: FLUTD typically presents with pain and/or difficulty in passing urine.

Feline lower urinary tract disease (FLUTD) includes a number of conditions that affect the bladder and/or urethra in cats. It is a relatively common presentation in practice, with an annual incidence of around 1%. Clinical signs include dysuria (difficulties passing urine), stranguria (pain on urination), pollakiuria (increased frequency of urination), haematuria, periuria (urination in inappropriate locations), and excessive licking of the perineum (presumably in response to local pain). These clinical signs indicate the presence of a lower urinary tract condition. However the lower urinary tract can be affected by several conditions, all of which lead to similar clinical signs. Further investigation is thus required to determine a diagnosis.

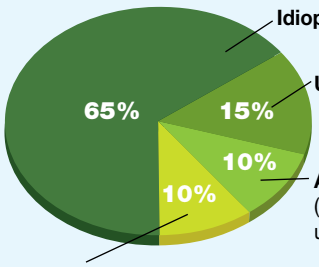
FLUTD in cats aged 10 years or older: The frequency of the conditions causing FLUTD changes with age. Cats which are 10 years old or older have an increased frequency of bacterial UTI (up to 55% of cases of FLUTD); this may be due to the existence of underlying systemic conditions such as renal disease or hyperthyroidism, which predispose to UTI. Neoplasia is also marginally more frequent in this age group, but remains a rare occurrence (less than 5% of cases). The frequency of uroliths also increases to >15% cases. The frequency of idiopathic cystitis decreases dramatically after 10 years old and accounts in this age group for only 5% of cases of FLUTD, in contrast with younger cats in which it accounts for the majority of cases.

DIAGNOSTIC APPROACH TO FLUTD

As the clinical signs of FLUTD are not specific for any of the possible conditions in the differential diagnosis, further investigation is required to determine the underlying cause and appropriate treatment. Idiopathic cystitis and behaviour disorders are diagnoses of exclusion. Further investigation should be recommended in cats with recurrent FLUTD, in all cats older than 10 years, in all cats presented with a urinary tract obstruction, and in cats suffering from concomitant systemic diseases, particularly if they predispose to urinary tract infections (such as diabetes mellitus, chronic renal disease, and hyperthyroidism). History and clinical examination are, as always, essential, although they are unlikely to

DIFFERENTIAL DIAGNOSIS The differential diagnosis for FLUTD includes the following diseases, depending if urethral obstruction is present or not:

NON-OBSTRUCTIVE FLUTD



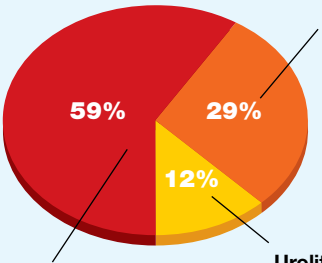
Idiopathic cystitis

Urolithiasis

Anatomical defects (such as a urethral stricture)

Other causes: <10% including neoplasia (of which the most common is transitional cell carcinoma of the bladder), primary behavioural disorders (such as spraying), primary bacterial urinary tract infection, incontinence and trauma.

OBSTRUCTIVE FLUTD



Obstructive idiopathic cystitis (in which urethral spasm plays an important role, creating a functional rather than mechanical obstruction).

Urethral plugs (usually a combination of protein-colloid matrix plus crystals, most frequently struvites).

Uroliths (struvites and oxalates being the most common).

lead to a definitive diagnosis. Urinalysis and imaging of the urinary tract are the most essential elements of further investigation. Blood tests may be recommended, particularly in older cats.

It is of course acceptable to symptomatically treat a young, otherwise healthy cat with a single occurrence of FLUTD signs and with non-obstructive disease; however antibiotics should not be administered as the condition is extremely rarely due to bacterial infection. Symptomatic treatment essentially involves analgesia with opioids (sublingual buprenorphine can be administered at home for a few days and is often effective) and/or a short course of non-steroidal anti-inflammatories if no contraindication is present. The owners of male cats should be warned about the signs of urethral obstruction and should be urged to seek veterinary attention immediately should these signs occur. Owners should also be warned that although an individual episode of FLUTD is frequently self-limiting (particularly when the underlying disease is idiopathic cystitis), FLUTD is frequently a recurrent condition, and that further investigation will be recommended in case of recurrence.

History

The signalment is relevant in FLUTD, in particular the age of the cat as it influences the frequency of possible underlying diseases. Persian cats are predisposed to idiopathic cystitis and to urolithiasis. Male cats are much more likely to suffer from urinary tract obstructions; such obstructions are very rare in female cats. The history is very important, as it may identify environmental factors predisposing to FLUTD such as a multi-cat household, the use of a litter tray, an indoor and/or sedentary lifestyle, the lack of access to core resources (such as litter trays, food, water and resting places), the feeding of a dry diet, and recent stress or environmental changes such as a house move, introduction of a new pet, change in diet, alteration to outdoor access, or a stay in a cattery. These factors may need to be addressed as part of the management at a later stage, particularly in feline idiopathic cystitis, which is usually linked with stress in cats. Episodes of idiopathic cystitis are more frequent in autumn and winter, or generally adverse weather conditions, probably because cats are less likely to have outdoor access or less inclined to go outdoors. The pattern of urination may be helpful; cats with behaviour problems are more likely to repeatedly urinate in the same places or to mark and spray, although an underlying medical condition should always be excluded prior to a diagnosis of behaviour disorder.

Clinical examination

Initial assessment will determine whether a urethral obstruction is present, and this will obviously determine the immediate course of action, with relief of the obstruction being a priority if present. Urethral obstruction should be suspected in cats with a large, distended bladder, particularly if unsuccessful attempts to urinate are witnessed. The body condition of the cat should be assessed, as obesity is a predisposing factor for idiopathic cystitis. Particular attention should be given to palpation of the kidneys and bladder, to determine if any masses are present, and to assess the degree of discomfort on bladder palpation. Any abnormalities on palpation of the kidneys (pain, renomegaly, asymmetry, or decreased renal size) should prompt evaluation for possible renal or upper urinary tract disease; renomegaly due to hydronephrosis following ureteral uroliths is recognised with increased frequency. The prepuce or vulva should be examined. Finally a general examination is required in case other medical conditions are present. Neurological conditions may cause incontinence; neurological and orthopaedic diseases may make urination difficult.

Blood tests

While it is good practice to assess haematology and serum biochemistry in all cats with FLUTD, these will most of the time be unremarkable in non-obstructive cases, especially in young cats. The results are useful as pre-anaesthetic screening in case anaesthesia is required at a later stage, and also to make sure the urea and creatinine are normal prior to use of non-steroidal anti-inflammatories, which are frequently used for analgesia in FLUTD cases but are contraindicated if renal disease is present. Occasionally cats with severe haematuria may be anaemic. Older cats should have at least their urea, creatinine and ideally total T4 checked, as renal disease and hyperthyroidism predispose to urinary tract infection. If persistent hyperglycaemia, glucosuria and/or ketones are present in the urine, further investigation should be performed to assess for possible diabetes mellitus. Urea, creatinine and electrolytes (sodium, potassium) should be assessed at admission in all cats with urethral obstruction. The electrolytes should be closely monitored following relief of the obstruction. ECG monitoring is also recommended.

Urinalysis

Urinalysis is one of the essential elements of further investigation for FLUTD and should be performed in all cases. The sample can be collected via cystocentesis, catheterisation, free catch (difficult in cats) or litter tray collection (with use of a non-absorbent substrate). A free catch or litter tray sample are most reliable to assess for haematuria, as the sample will not be contaminated with blood at collection, but should not be used for bacterial culture. A cystocentesis should be performed for bacterial culture and can also be used for routine analysis, but the presence of blood should not be over-interpreted. Samples collected by catheterisation can be used for analysis and bacterial culture, but there is frequently some contamination from the

URINE EVALUATION

- **The macroscopic appearance of the urine should be recorded. The urine may be haemorrhagic or turbid.**
- **The specific gravity (via refractometer) will indicate the renal capacity to concentrate the urine.**
- **Dipstick analysis allows assessment for the following:**
  - Presence of blood in the urine. However haemoglobinuria and myoglobinuria cannot be distinguished from haematuria on dipstick.
  - Protein. However a protein:creatinine ratio is recommended for more accuracy to determine if significant proteinuria is present, as the protein value on dipstick is not always reliable and false negative results can occur (positive dipstick for protein with protein:creatinine ratio in the normal range). Protein would increase in the urine with inflammation.
  - Glucose. Glucosuria may be present with stress in cats, however in cases of persistent glucosuria and/or if ketones are present, further tests should be performed to assess for possible diabetes mellitus, as mentioned above.
  - Urine dipstick is frequently positive for leukocytes in cats; this is unreliable and does not indicate the presence of inflammation or infection.
  - Specific gravity on dipstick is unreliable in dogs and cats.
- **Sediment examination should always be performed and allows assessment for the following:**
  - Red blood cells confirm haematuria or blood contamination of the sample.
  - White blood cells can be present with inflammation or infection, but can also be present in low numbers with blood contamination of the sample.
  - Epithelial cells may be present if the urothelium has been damaged and may be dysplastic in the presence of inflammation. Occasionally neoplastic cells may be present in the urine, but most frequently biopsies are required to diagnose lower urinary tract neoplasia.
  - Crystals may be present. Low numbers of crystals, particularly struvites, can be a normal finding and should not be over-interpreted.
  - Lipid droplets are not unusual in urine from cats, and should not be mistaken for crystals, cells or bacteria.
  - Casts may be present with renal disease.
- **Bacterial culture and sensitivity of the urine should ideally be performed in all cases, even if bacterial infection is rare in young cats. It should always be performed if uroliths or glucosuria are present, if concurrent systemic diseases are identified which predispose to urinary tract infections (see above), and in all cats aged 10 or older.**

external genitalia, so a positive culture should be interpreted with caution. Accurate results for dipstick analysis and sediment examination are best obtained using very fresh samples. In particular crystals may start to precipitate in the urine within two hours, particularly if the sample is placed in a fridge. Biochemistry may begin to alter within 30 minutes in non-refrigerated samples, and any bacteria present will start to replicate. Ideally the specific gravity, dipstick and sediment examination should thus be performed in-house (particularly to look for crystals), and a refrigerated sample sent to an external laboratory as quickly as possible (and always within 12 hours of collection) for protein:creatinine ratio, bacterial culture and potentially repeat sediment examination if required, knowing that the presence of crystals should not be over-interpreted. Sediment examination in-house should be performed after centrifugation of the urine at 1500 rpm for 5-10 minutes, then re-suspension in a drop of the urine.

Imaging

Imaging is the other essential component for investigation of the lower urinary tract. It allows assessment for the presence of uroliths, and evaluation of the bladder wall and urethra.

Abdominal ultrasound can be performed in well-behaved conscious cats and is the best method to assess the bladder wall thickness. While a general increase in bladder wall thickness can be seen with bladder inflammation (such as in idiopathic cystitis, uroliths), any focal mass lesion may represent neoplasia. Ultrasound allows visualisation of bladder uroliths in most cases with an experienced ultrasonographer. It is also very useful to assess the kidneys, and these should always be examined too. Unfortunately ultrasound does not allow assessment of the urethra. Blood clots can occasionally be present in the bladder and should not be mistaken for uroliths. Fat droplets in the urine may appear as hyperechoic speckles; this should not be over-interpreted as sediment.

Plain survey radiographs can be performed to look for radio-opaque uroliths. They are however of limited value.

Contrast radiography is very useful, but requires general anaesthesia. An enema should always be administered prior to the study to avoid a full colon overlapping the bladder and urethra. A double contrast pneumocystogram allows evaluation for uroliths, including radiolucent ones, and for bladder wall lesions. Leakage of contrast media through the layers of the bladder wall can occasionally be seen with bladder inflammation (such as idiopathic cystitis cases).

A retrograde urethrogram is the only imaging modality to assess the urethra. It should always be performed in cases with urethral obstructions and is highly recommended in the presence of dysuria and straining, particularly in cats having undergone previous urethral catheterisation as this can lead to urethral stricture formation. Urethral uroliths and mural lesions (including neoplasia) can also be visualised.

Other investigations

Any uroliths removed by cystotomy should always been analysed and their composition determined to recommend the appropriate treatment and management to prevent recurrence. If cystotomy is performed, the bladder should be inspected for lesions. A bladder biopsy can be sent for bacterial culture as culture of biopsies is more sensitive than culture of the urine. Any lesions should be biopsied for histology. Any bladder mass lesions should be analysed; traumatic catheter samples (via catheterisation and suction at the level of the lesion) may be diagnostic. Otherwise samples should be obtained by biopsies, via cystotomy (or cystoscopy when available).

Intravenous urography can be considered to assess the kidneys and ureters, and allows diagnosis of ectopic ureters in cases of incontinence.

Cystoscopy can be performed in female cats and male cats having undergone perineal urethrostomy and can be useful to assess for uroliths and urethral or bladder wall lesions, but the equipment is only available at some specialised centres. Any biopsies obtained will be very small in size and may not be diagnostic.

Finally a specialist behaviour assessment is recommended in all cases diagnosed with behavioural disorders (after exclusion of potential medical conditions). It is also extremely useful in moderate or severe cases of idiopathic cystitis and has been shown to decrease the frequency and severity of cystitis episodes (unpublished study). It should be noted that both idiopathic cystitis and behaviour disorders are diagnoses of exclusion. They may be differentiated with the history (for example haematuria and stranguria should not be present in behaviour disorders) and investigation results (idiopathic cystitis often causes significant bladder inflammation which can be diagnosed on urinalysis and may create diffuse bladder wall thickening).

Clinical trial on the efficacy of a dietary supplement in **Feline Idiopathic Cystitis** at the Feline Centre, University of Bristol.

CALL FOR CASES

Free CPD for each cat with suspected idiopathic cystitis referred!

Feline idiopathic cystitis is a common cause of lower urinary tract disease in cats.

The pathogenesis of this condition is not fully understood. Current long-term treatment recommendations include measures to increase water intake and environmental modification, in particular decreasing stress within the household. The condition however may be chronic and long-term management is aimed at minimising trigger factors along with reducing the frequency and severity of symptomatic episodes, rather than providing a cure.

The Feline Centre at Langford Veterinary Services (University of Bristol) has now started a clinical trial to evaluate the clinical efficacy of a dietary supplement in conjunction to standard medical and behavioural management in cases of feline idiopathic cystitis. The study will be prospective, double-blinded and placebo-controlled, with a follow-up period of one year.

The Feline Centre is recruiting cats with a history of two or more episodes of lower urinary tract disease over a six-month period. An initial investigation to confirm the diagnosis of idiopathic cystitis (and thus confirm suitability for enrolment in the study) will be performed at a reduced cost. The package cost will include a full medical and behavioural assessment (by the feline medicine team and behavioural specialists), blood and urine analysis, and diagnostic imaging as appropriate. Owners will receive a detailed medical and behavioural treatment plan. The dietary supplement or placebo will be provided free of charge for a period of one year. We would be grateful to hear from any vets with suitable cases, and hope this study can further advance our understanding of this challenging condition.

For each case of suspected feline idiopathic cystitis that is referred for assessment for the trial, you will receive a free CPD evening at Langford, worth 2 hours of CPD. If you refer three cases for assessment over a one year period, you will receive a free CPD day at Langford, worth 7 hours of CPD.

For further information or queries about the suitability of a case, please see **http://www.langfordvets.co.uk** or do not hesitate to contact us:

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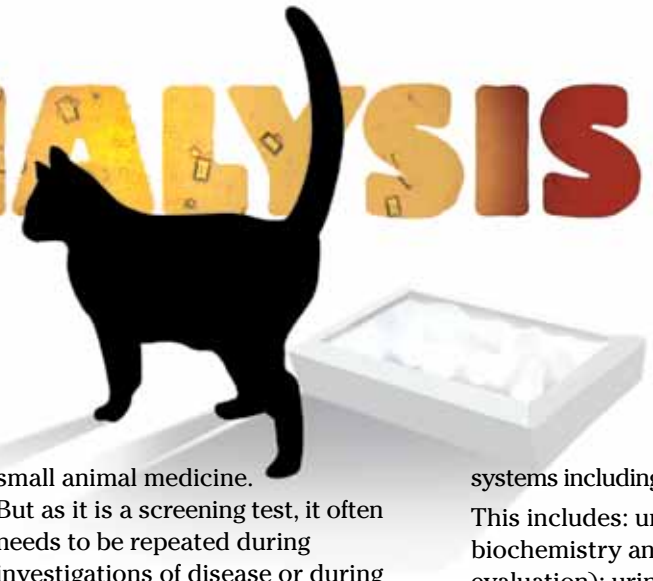
A GUIDE TO URINALYSIS

by Marta Costa *DVM, MSc, MRCVS.*



In this article, Marta Costa provides a quick reference of feline urinalysis for the general practitioner and includes a sediment identification chart with examples of some of the most common sediment findings.

Urinalysis is an important tool commonly used both in general health screening and disease investigation in small animal medicine. But as it is a screening test, it often needs to be repeated during investigations of disease or during monitoring of treatment.

A basic in-house urine analysis is inexpensive, and can provide a complete urinalysis information about the health of several organ systems including the urinary tract.

This includes: urine specific gravity; biochemistry analysis (dipstick evaluation); urine protein:creatinine ratio (UPC) and sediment analysis. The interpretation of the results of urinalysis will depend on the collection technique, the timing of the collection and the delay (if any) between

Test	Normal	Abnormal	Causes	Reported interferences
pH	6.0 - 7.5.	Increase.	Storage*; Transient following a meal*; Urease producing bacteria*; Renal tubular acidosis (early); Metabolic alkalosis; Diet rich in vegetables.	False colour (stained urine e.g. blood).
		Decrease.	Metabolic acidosis*; Renal tubular acidosis; Hypochloraemic metabolic alkalosis (uncommon); Hypokalaemia; Acidifying drugs.	Contamination with acids (e.g. detergents).
Glucose	Neg - trace.	Increase.	Diabetes mellitus*; Stress hyperglycaemia*; Hyperadrenocorticism; Renal tubular disease; Primary renal glycosuria; Fanconi's syndrome.	Chlorine bleach, cephalosporins, oxyglobin. False negatives: formalin; refrigeration (low temperature inhibits the reaction).
Ketones	Neg - trace.	Increase.	Diabetic ketoacidosis*; Starvation; Very young animals.	Oxyglobin, small increases with very concentrated urine False negatives: does not react with Beta-hydroxybutyrate.
Protein	Neg - trace.	Increase.	Inflammation or infection*; Protein losing nephropathy*; Haemorrhage.*	False positives in alkaline urine and concentrated urine. False negatives with Bence Jones proteins. Is best interpreted with the Protein to creatinine ratio *(see table two).*
Bilirubin	Neg.	Increase.	Hepatobiliary disease*; Haemolytic anaemia.	Exposure to uv light/sunlight (bilirubin degrades into urobilinogen).
Blood/ Haemoglobin/ Myoglobin	Neg.	Increase.	Haematuria* haemoglobinuria or myoglobinuria.	Bleach-based detergents.

Table 1 - Urine biochemistry tests by dipstick analysis: interpretation and reported interferences. * *Common conditions.*

collection and analysis. As urine deteriorates quite quickly and refrigeration can cause artefacts, the urinalysis is best performed in-house and ideally within 1 hour of collection. In many instances this is not possible, so refrigeration is recommended (ideally less than 4 hours, preferably no more than 6 -12 hours). It is important to allow the sample to return to room temperature and mix it well before proceeding with the analysis. Casts and cells degrade as urine sample "ages", bacteria tend to multiply leading to changes in the pH, and crystals may either sediment out of solution or dissolve. Refrigeration tends to increase the numbers of crystals present particularly for calcium oxalate.

Urine Specific Gravity (USG)

In veterinary practice, USG is measured with a refractometer, as the dipstick test for USG is unreliable. USG shows large inter- and intra-individual variability in healthy conditions, consequently USG should be evaluated in consecutive samples. Non renal factors that affect the ability to concentrate urine (giving a dilute urine) include endocrine diseases (e.g. diabetes), diet, steroids (endogenous or exogenous), infection, hypercalcaemia, use of drugs (e.g. diuretics) and fluid therapy.

Factors that cause an increased USG value include abnormal amounts of organic solutes such as proteins, glucose and amino acids and radiographic contrast media (which produce substantial direct increases in USG due to their large molecular weight).

Cats with normal renal function usually produce a highly concentrated urine (in excess of 1.035). As the number of viable nephrons reduces so does the ability to concentrate the urine. This occurs earlier in the course of renal failure than the increases in serum urea/BUN and creatinine, although cats may retain the urinary concentrating ability in the face of renal disease for longer than dogs. Animals that repeatedly produce dilute urine should be investigated for underlying renal disease. Cats with primary FLUTD tend to have highly concentrated urine:

The terms hypersthenuria (USG ≥ 1.035 in cats), hyposthenuria (USG < 1.008) and isosthenuria (USG between 1.008 and 1.012) imply that the urine USG is respectively higher, lower or similar to that of the glomerular filtrate.

In renal azotaemia, the kidney's concentrating ability is impaired. Early in intrinsic renal failure the USG is <1.035 in cats, but still hypersthenuric. With progressive loss of nephrons the USG falls and once > 75% of nephrons have been lost the USG falls into the isosthenuric range 1.007 - 1.012.

Urine Biochemistry

Biochemistry analysis of the urine is often performed with dipstick. The dipstick strip must be a fresh, in-date strip, and read at the time recommended by the manufacturer (colour tends to increase/develop with time). In *Table 1* the most common abnormalities and artefacts are listed for each of the biochemistry parameters reliable on routine urinalysis.

Sediment Evaluation

A consistent volume of urine should be centrifuged for the sediment examination. A minimum of 5 ml at 1500 rpm (rotations per minute) for 5 minutes is recommended. The supernatant should be discarded by decanting the sediment (or used to determine UPC, *Table 2.*).

UPC Ratio	Interpretation
<0.2	Normal.
0.2 – 0.4	Borderline proteinuria (may be up to 0.5 in single samples in healthy animals).
> 0.4 - 1.0	Mild increases.
1-2	Moderate increases. Significant proteinuria if from glomerular protein loss.
>2	Severe proteinuria usually due to glomerular protein loss.

Table 2 - Urine protein to creatinine ratio (UPC) interpretation: The proteinuria must be persistent (> 0.5 in three consecutive samples, 2 weeks apart) and interpreted in view of the collection method (ideally cystocentesis to prevent contamination with genital tract), the presence or absence of azotaemia and the presence or absence of an active sediment (evidence of inflammation or gross macroscopic haemorrhage) before pursuing further investigations if it is the only abnormality present.

The sediment is then resuspended/ mixed by gently tapping the tube or slowly pipetting up and down. If excessive force is used, casts and cells may be ruptured. The volume of urine used for sediment resuspension should be consistent. By keeping constant the initial amount of urine centrifuged and the amount used to resuspend the sediment, variability is reduced.

This means that quantification of any structures found is therefore more reliable.

The sediment can then be stained (e.g. using Sedistain usually adding equal volume to the sediment – thus altering quantification) or examined unstained. Consider doing both stained and unstained. Staining may assist in identifying and differentiating the cells and casts present in the urine sediment. To make a sediment slide, a drop of the sediment is placed in a microscope slide and a cover slip is gently placed on top, avoiding the formation of air bubbles.

To examine urine sediment microscopically, maximum contrast should be used. This is done by dimming the microscope light, closing the iris diaphragm and/or lowering the condenser. The sediment should then be evaluated at low-power field (lpf - x10 objective), to look for casts and clusters of cells, and at high power field (hpf - x40 objective) where smaller cells such as red blood cells, white blood cells, and crystals can be identified and subjectively quantified. In figures 1 to 13 examples of some of the most common findings present in the urine sediment (stained and unstained) are shown.

The method used to collect urine samples will influence the sediment findings.

Free catch samples are more likely to have squamous epithelial cells (*Fig 3*), be more cellular in general, have bacterial contamination (*Fig 10F*), or contain artefacts such as pollen (*Fig 10A*), plant material *(Fig 10D)*, etc.

Catheterised samples may have iatrogenic haemorrhage and are more likely to have clumps of transitional epithelial cells (*Fig 4C*).

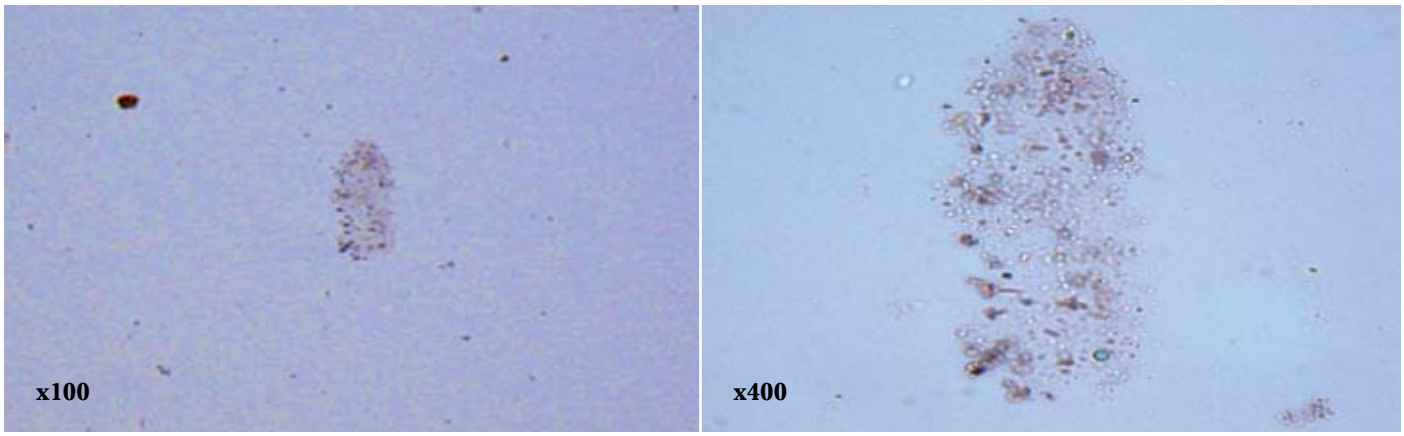


Fig. 1 - Fine granular cast (Sedistain). Fine granular casts can be normal if in low numbers on concentrated urine samples. When present in high numbers or in dilute urines they may indicate, along with hyaline casts, renal proteinuria.

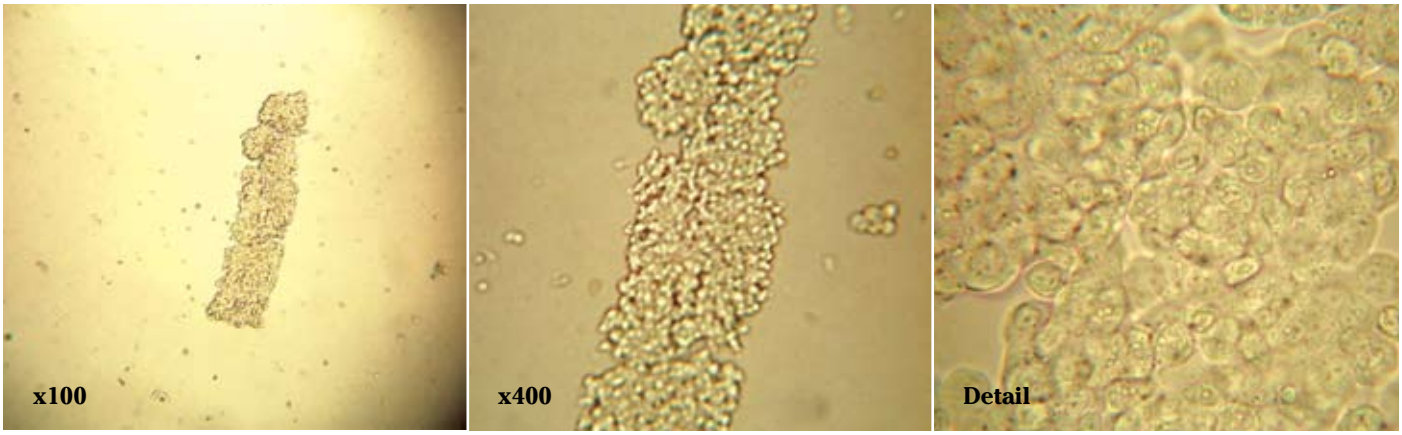


Fig. 2 - Cellular cast (unstained sediment): Renal epithelial cells Finding casts with epithelial cells suggest active renal tubular cell degeneration, inflammation or haemorrhage. Renal epithelial cells are round, slightly larger than leukocytes and with a distinct round nucleus and high nuclear to cytoplasmic ratio.

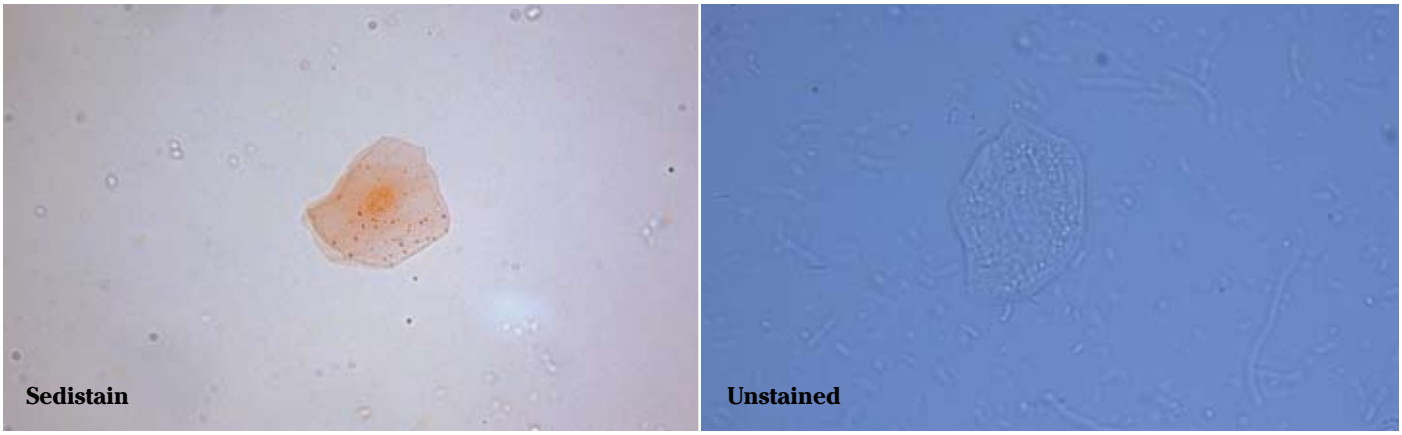


Fig. 3 - Squamous epithelial cell (x 400). Large epithelial cells with irregular, angular margins and small, condensed or absent nucleus. These cells are most commonly seen in free catch samples and originate in the distal urethra, genital tract or skin.

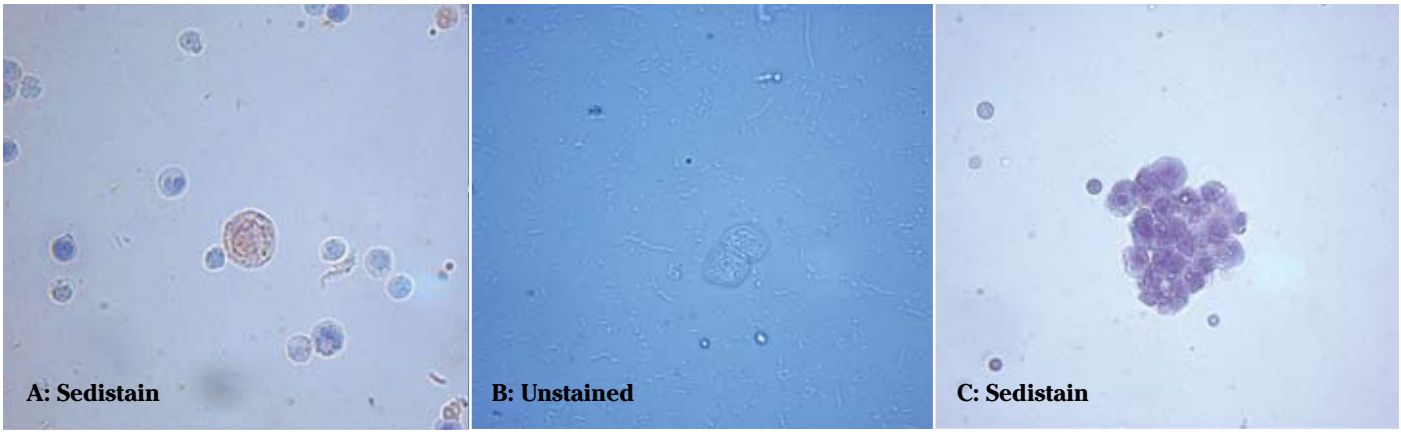


Fig. 4 - Transitional epithelial cell (x400). These cells originate from the proximal urethra, urinary bladder, ureter and renal pelvis. They are variable in size, round to oval or caudate (tailed) in shape and have a round central nucleus. A (Sedistain)- single transitional epithelial cell seen with leukocytes for size comparison. B (Unstained). Two transitional epithelial cells. C (Sedistain). Cluster of transitional epithelial cells and scattered leukocytes. These groups of epithelial cells are more commonly seen in catheterised samples.

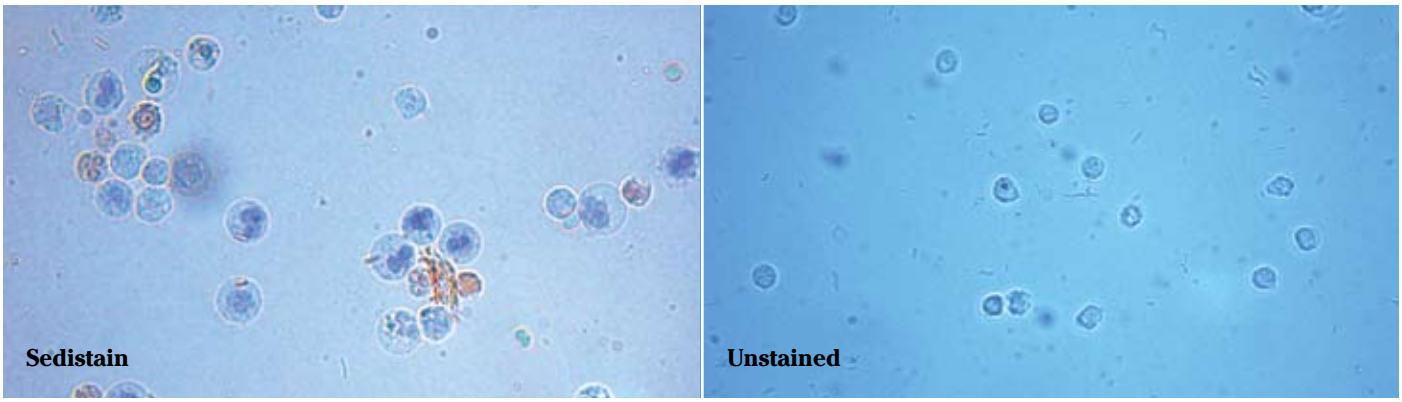


Fig. 5 - Leukocytes (x 400) and bacteria (bacillus). UTI case on a female cat, E. coli was cultured from the urine. Leukocytes can be present in normal urine sediment if in low quantities (<5 /hpf). If present in greater quantities are indicative of inflammation or infection. It needs to be noted that significant bacteriuria can occur without pyuria and pyuria should not be a criterion for determining the presence or absence of bacteriuria. UTIs are more common in geriatric female cats.

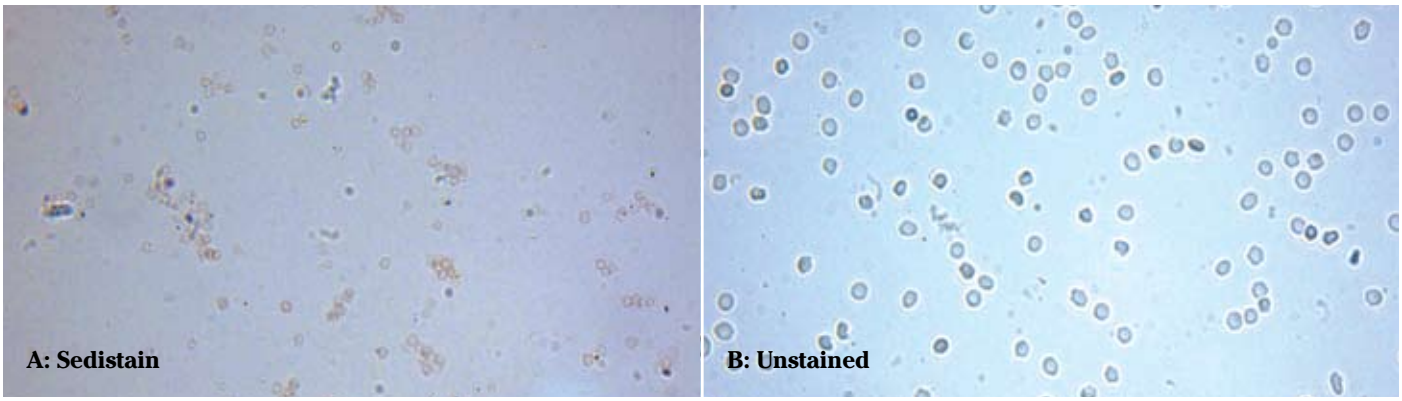


Fig. 6 - Red Blood cells (x400). A - Sedistain; B - unstained. Note that although the cells are stained so is the background. The RBC can be crenated or lysed (appearing as ghost cells with just the outline) Red blood cells can be present in normal urine sediment in low quantities (< 5 /hpf), especially with cystocentesis and catheterised samples. Haematuria and proteinuria in the absence of bacteriuria are typical findings of feline idiopathic cystitis. Gross haematuria and microscopic haematuria are observed in 81% and 95% of cats with idiopathic cystitis respectively.

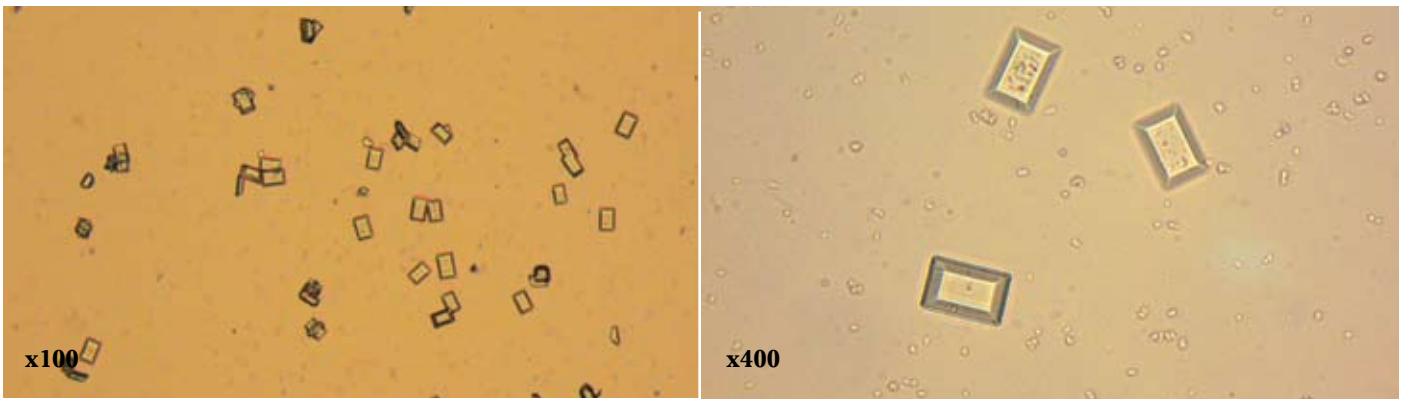


Fig. 7 - Magnesium ammonium phosphate - struvite - crystals (unstained sediment). Struvite crystals are pleomorphic crystals of variable sizes. Significance of these can vary: they may be present in normal animals, animals with different types of urolyths, or animals with UTIs (urease positive bacteria). Usually precipitate in alkaline pH and tend to dissolve in acidic urines.

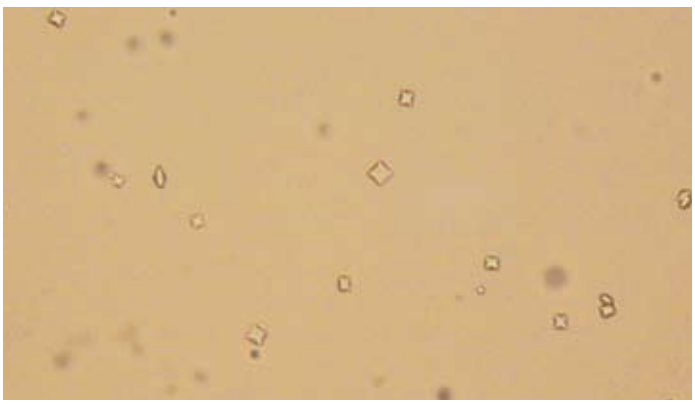


Fig. 8 - Calcium oxalate crystals dihydrate form (unstained sediment; x 400). These crystals are the most common form of calcium oxalate crystals, exhibiting a "maltese cross" structure. They tend to form in acidic urine, may be present in healthy animals or in the monohydrate form suggest hypercalciuria or hyperoxaluria (including ethylene glycol toxicosis or ingestion of oxalate rich plants).

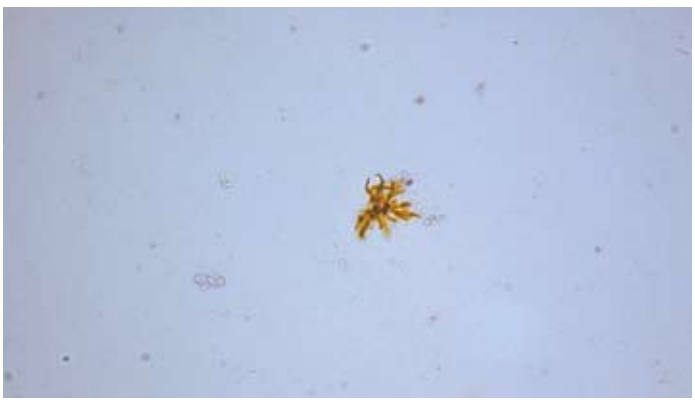


Fig. 9 - Bilirubin crystals (unstained sediment; x 400). Bilirubin crystals and bilirubinuria in cats are always significant and may precede hyperbilirubinaemia. It is present in the same conditions as hyperbilirubinaemia (pre-hepatic, hepatic and post hepatic). It must be noted that bilirubin is u.v. sensitive and will degrade if exposed to light.

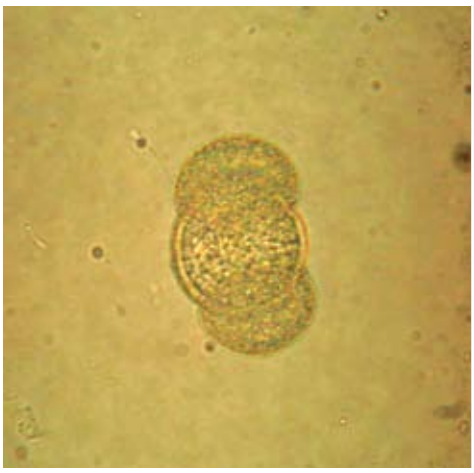


Fig. 10 A: Unstained x400

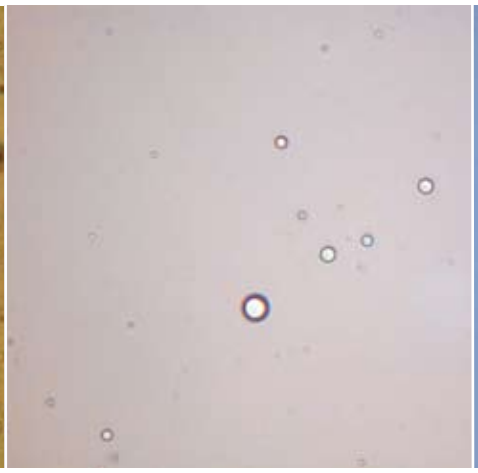


Fig. 10 B Unstained x400

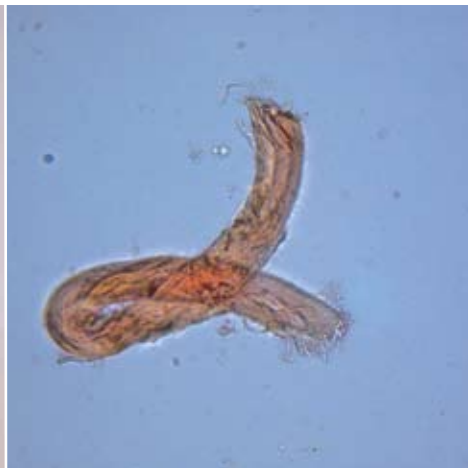


Fig. 10 C Unstained x400

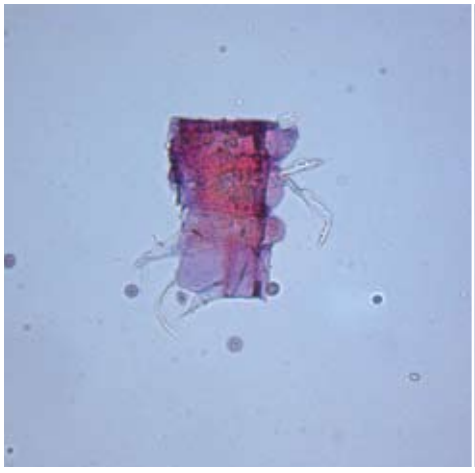


Fig. 10 D Sedistain x400

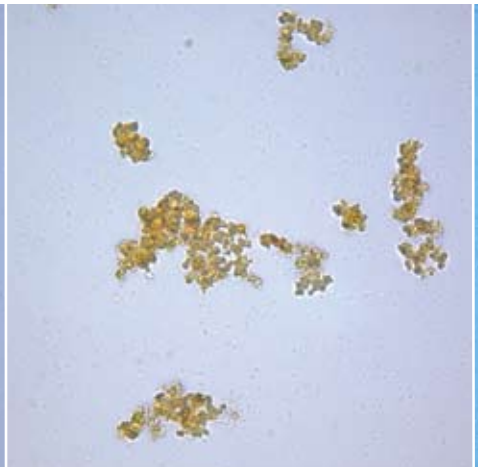


Fig. 10 E Unstained x400

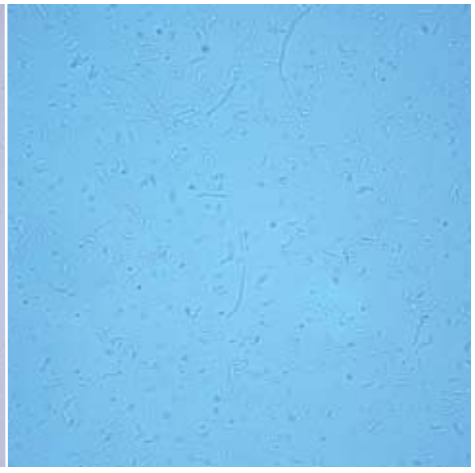


Fig. 10 F Unstained x400

Fig. 10 series - Common artifacts seen in urine sediments (most examples present here taken from free catch urine samples).

A - Pollen granule from Pinus spp.
B - Lipid droplets. Common in cats urine samples, may come from renal tubular cells (cats store triglycerides in renal epithelial cells) or may represent contaminating lubricants used during sample collection.
C - Cloth fibres.
D - Plant material. Cloth fibres or plant material are also common in free catch urine samples.
E - Amorphous material - amorphous material may appear for example in samples collected from the litter tray or contaminated.
F - Bacteria. These may be contaminants from the skin, genital tract; are frequent in free catch samples and can increase in number with delayed processing.

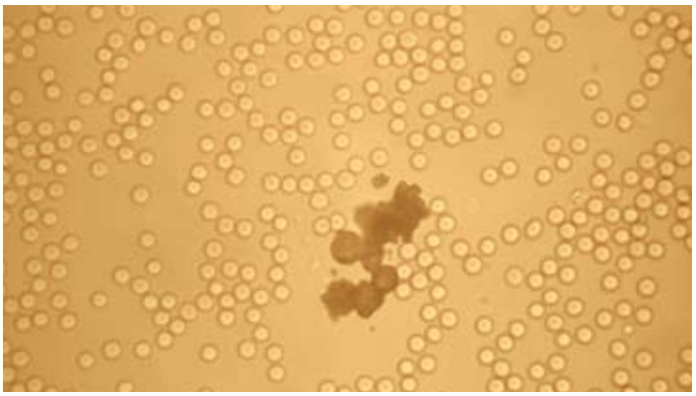


Fig.11 - Ammonium biurate crystals and RBCs (unstained sediment; x400). May be seen in Egyptian Maos or may be suggestive of hepatic dysfunction and portosytemic shunts.

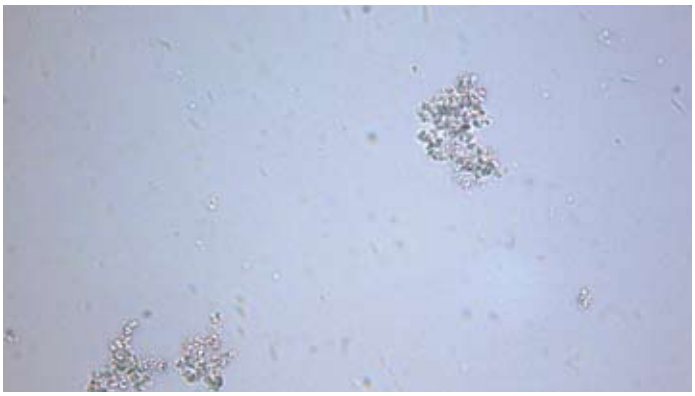


Fig. 12 Amorphous crystals (unstained sediment; x400) - these may be urate or phosphate crystals. Amorphous urates and amorphous phosphates are not easily distinguished by microscopy.
However amorophous phosphates typically form in alkaline urine and amorphous urates in acidic urine. These may be present in healthy animals or may be a result of in vitro precipitation.

Fig. 13 Calcium phosphate crystals: "brushite".

Fig. 13 A Enlarged sample of Fig. 13.

Type	Appearance	pH where commonly found			Notes
		Acidic	Neutral	Alkaline	
Magnesium ammonium phosphate (struvite).	Three to six sided colourless prisms. Often described as roof tops or coffin lids.	±	+	+	Fig. 7.
Calcium oxalate dihydrate.	Small colourless envelope (octahedral form).	+	+	±	Fig. 8.
Calcium oxalate monohydrate.	Small spindles or dumbbells.	+	+	±	No example given, highly suggestive of ethylene glycol toxicity (but may be absent in these cases).
Bilirubin.	Orange to brown needles or granules.	+	–	–	Fig. 9.
Ammonium biurate.	Yellow-brown spherulites, thorn apple appearance.	+	+	±	Fig. 11.
Amorphous crystals.	Amorphous or small spheroid refringent structures.	+	+	+	Fig. 12. Urates in acidic urine; Phosphates in alkaline urine.
Calcium phosphate (brushite).	Long thin prisms, may form clusters.	±	+	+	Figs. 13 and 14.
Drugs.	Sheaves of needles with central or eccentric binding (fan shaped cluster).	±	±	±	Form dependant on drugs. Drugs commonly causing crystals e.g. sulphonamides, thyroxine.

Table 3: Common characteristics of some urine crystals.
+ : commonly occur at this pH; ± may occur at this pH but are more common at other pH; – : uncommon at this pH.

WHAT'S YOUR *imaging* DIAGNOSIS?

by ***Nathaniel Harran*** *DVM, MRCVS*

HISTORY: *An 8 year old spayed female British Shorthair cat was presented for inappetence, lethargy and dysuria. On physical examination, no abnormalities were detected apart from a grade II cardiac murmur. Blood work at this time showed a urea of 16.8 mmol/L (ref. 6.5 -10.5), a creatinine of 211 µmol/L (ref. 13 -175) and a total calcium of 3.4 mmol/L (ref. 2.3 - 2.5). Abdominal radiographs (Figs. 1A and 1B) were taken following the blood tests.*

BASED ON THE HISTORY ABOVE, YOUR ANSWERS TO THE FOLLOWING ARE INVITED:

1. **Describe the radiological abnormalities present in Figs.1A and 1B.**
2. **What would be your differential diagnoses for the abnormalities you have detected?**
3. **Which other imaging modality would be beneficial in the management of this case?**
4. **What would be the most appropriate way to manage this case in the long term?**

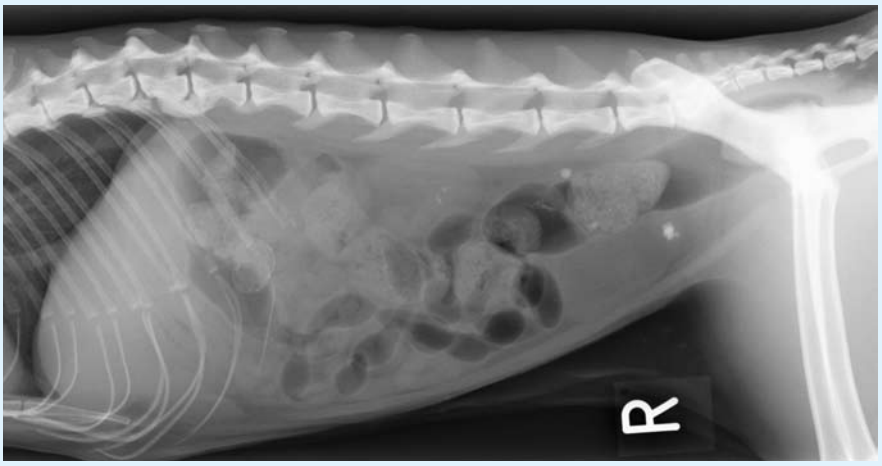


Fig. 1A: Lateral abdominal radiograph.

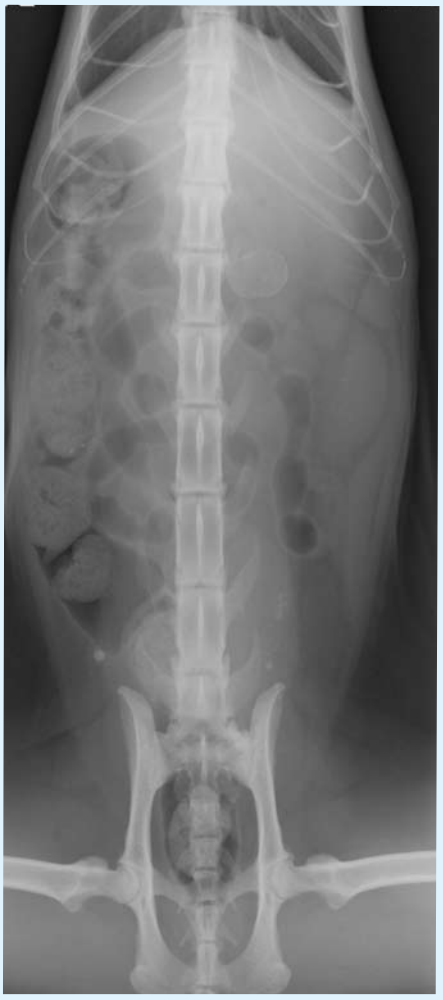
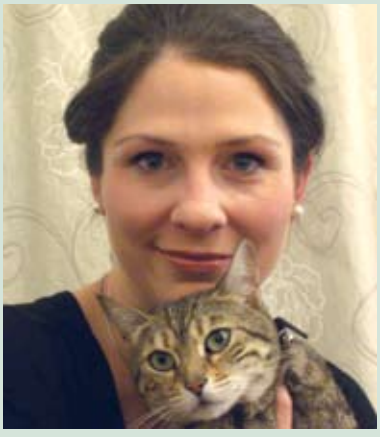


Fig. 1B: Ventro-dorsal abdominal radiograph.

Welcome to Natalie Finch BVSc PhD MRCVS FAB Senior Clinical Training Scholar in Feline Medicine



Natalie joined the Bristol Feline Centre as a Feline Advisory Bureau (FAB) sponsored senior clinical training scholar in feline medicine in May 2011. Following graduation from the University of Liverpool in 2005, she initially worked in small animal practice in Cheshire. Natalie then obtained her PhD at the Royal Veterinary College in early 2011 for her research in chronic kidney disease in cats.

Her passion is everything feline and her clinical research focus is feline geriatric medicine, in particular chronic kidney disease.

She has two Bengal cats, Phoenix and Toulouse, who regularly cause mischief.

DISCUSSION:

1. The lesions are annotated in Figs. 2 A and B.

An ovoid structure with a thin mineralised shell is visible in the left cranial abdomen cranio-medial to the left kidney *(arrowheads)*. Some small mineral radiopacities are observed within the left kidney on both projections *(black arrow)* and subtle similar changes are superimposed on the right kidney on the lateral view. There is a large mineralised structure (3 mm diameter) ventral to and on the right side of the 6th lumbar vertebra, located within the retroperitoneum. Also, multiple small mineral opacities of variable size (largest one measuring 2 mm) are located on the left side in a similar location *(white arrows)*.

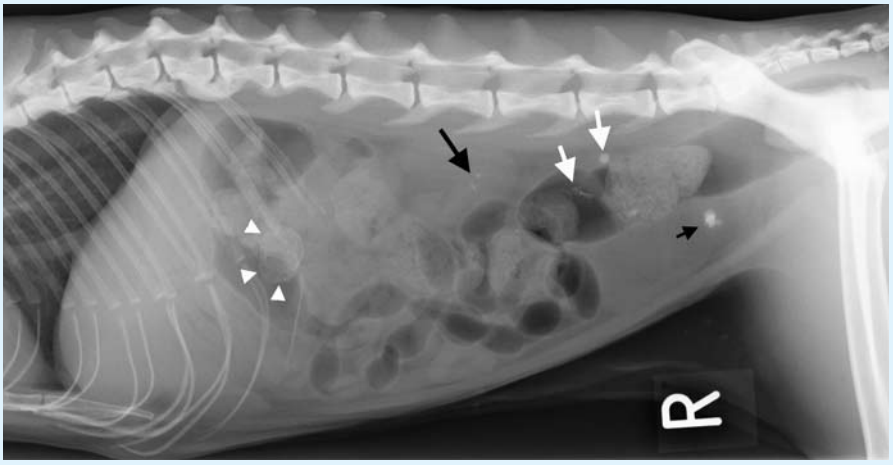


Fig. 2A: as Fig. 1A.

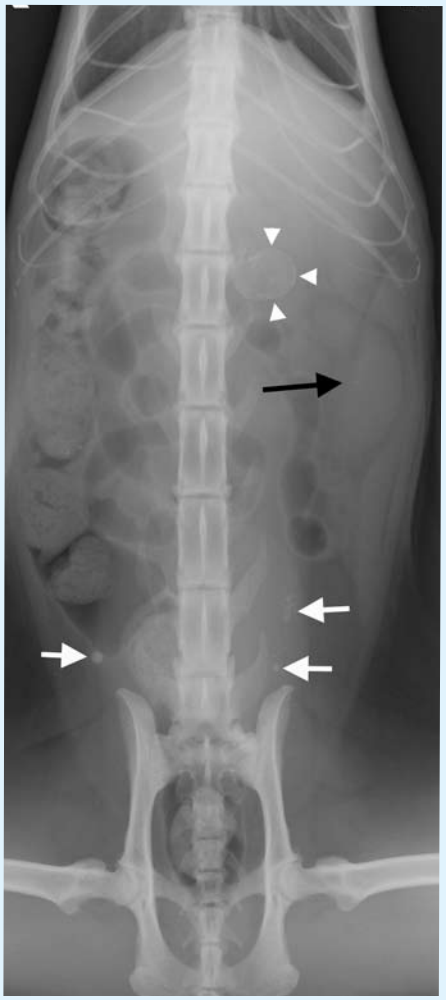


Fig. 2B: as Fig. 1B

There are two larger mineralised opacities (4-5 mm) visible at the level of the bladder neck on the lateral projection (small black arrow).
A moderate amount of gas is present in the small intestines.
Finally a moderate to severe amount of new bone formation is located on the ventral aspect of the 10th, 11th, 12th, and 13th thoracic vertebrae as well as the 1st lumbar vertebra.

2. The radiographic findings were consistent with the following abnormalities:

- Either nodular fat necrosis or mineralisation of the left adrenal gland is visible within the cranial abdomen. Nodular fat necrosis is an incidental common finding in cats which can be identified on abdominal radiographs because of its tendency to mineralise.

Mineralisation of the adrenal glands is also an incidental common finding in feline patients. In this case nodular fat necrosis was suspected on radiographs because of the size and location of the lesion.

- In this case, the multiple mineral structures located within the kidneys, retroperitoneum and superimposed onto the bladder are consistent with uroliths. However when smaller, less defined or mineralised, these opacities could represent other abdominal structures. The most common causes of renal mineralisation are nephrocalcinosis and nephrolithiasis (i.e. phosphates and oxalates). Nephrocalcinosis is characterised by dystrophic parenchymal mineralisation and is often difficult to differentiate from nephrolithiasis on radiographs. Faint linear mineralisations are seen in the renal parenchyma, adjacent to the diverticula and renal crest. These are common in old patients and of uncertain significance. Some dystrophic mineralisations could also be found within haematomas, cysts, abscesses, granulomas and neoplasms.
- Ureteral calculi can often be visualised on plain radiographs if the composition provides enough contrast. Calcium oxalate is the most common type of ureteral calculus in cats. When identified, focal mineralisations within the area of the ureters should be further investigated to decide whether they are true calculi. Mineralised material within the colon as well as the end-on deep circumflex iliac arteries could be mistaken for calculi. It could sometimes be valuable to perform an enema in cases where faecal material is superimposed onto the kidneys or the ureters.
- The amount of gas identified within the small intestinal loops in this cat is abnormal. However, it was suspected here to be secondary to previous aerophagia.
- Spondylosis deformans was identified ventral to the thoracolumbar vertebral column. It is a common condition Characterised by formation of osteophytes on the vertebral endplates. Radiographically, it appears as smooth, bony proliferation centered on the disc space that may bridge the ventral aspect of the vertebral bodies. No clinical significance is usually attributed to this finding.

3. Abdominal ultrasonography would be valuable in this case as kidneys, ureters and bladder could be readily assessed on a conscious patient. An intravenous urography study either radiographic or assisted by computed tomography could also help in further assessing the urinary tract however a general anaesthesia would be required.
In this case, an abdominal ultrasound was performed.
The right and left kidneys showed some mineralised

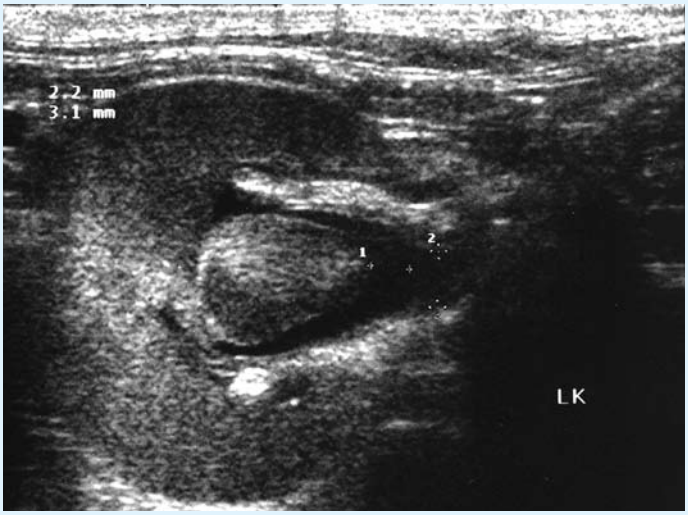


Fig. 3 – Transverse plane image of the left kidney. The renal pelvis is mildly dilated, measuring slightly more than 2 mm in depth (callipers). It appears as a hypoechoic semilunar-shaped structure at the renal hilus. The echogenicity of the cortex and medulla is comparable with little corticomedullary distinction. This is a non-specific indicator of chronic renal disease.

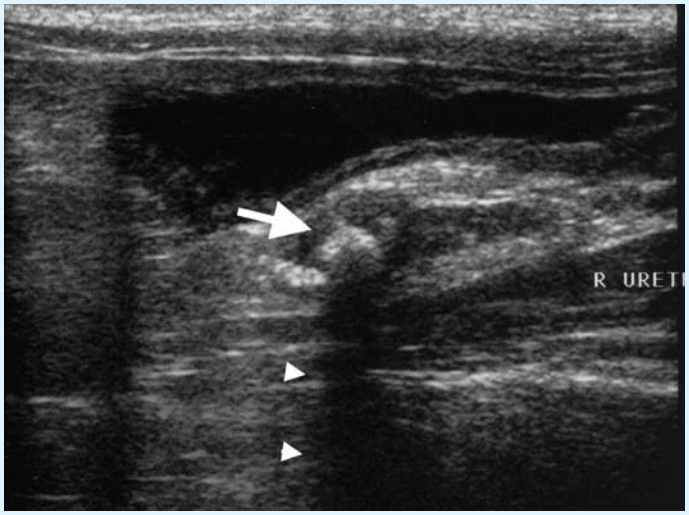


Fig. 4 – Oblique plane image of the bladder and right ureter. A large calculus (arrowed) is present within the distal ureter just dorsal to the bladder appearing as a hyperechoic structure with a well defined distal acoustic shadow (arrowheads).

continued from page 11

diverticuli and a mild pelvic dilation (2 to 4mm) was also identified *(Fig. 3)*.

The kidneys also showed thick hyperechocortices and a reduced cortico-medullary definition. The right kidney appeared smaller than the left but normally shaped. The bladder contained multiple hyperechoic foci consistent with sediment as well as two small stones (5 mm), which were located in the neck. The left and right ureters contained a large number of mineral structures all along the way down to the trigone *(Fig. 4)*. A very mild diffuse dilation of the ureters could be observed.

In conclusion, a severe urolithiasis was confirmed. A partial obstruction of the right and left ureters with secondary chronic renal disease was suspected. The decreased size of the right kidney suggested a more chronic history on this side.

4. In severe ureteral obstructions, surgical management is recommended however experienced clinicians may start to manage the cases medically. Indeed, increasing diuresis would help in flushing the ureteral calculi into the bladder. However, this alternative is challenging and requires a close monitoring of the renal pelvic dilation as well as the location of the calculi by ultrasound.

Surgical management consists in either removing the calculi by ureterotomy or placement of ureteral stents. In this case, ureteral stenting was performed *(Fig. 5)*.

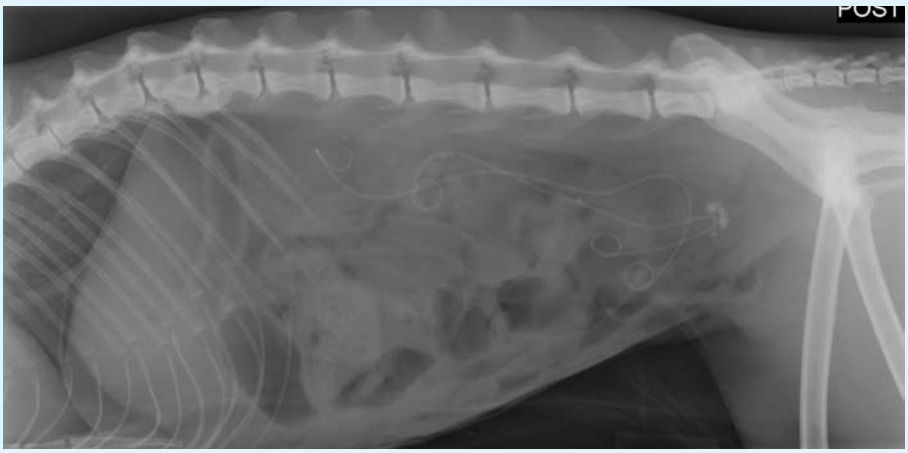


Fig. 5 – Lateral abdominal radiograph. Ureteral stents were positioned in both ureters and appear as linear radiopacities running from the renal pelvises to the bladder lumen. The calculi present in the left ureter and at the level of the bladder neck and bladder trigone are still visible.

Langford VETERINARY SERVICES

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