Urine for a treat! Evaluation of the Urine Sediment

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The basics

Microscopic evaluation of the urine sediment is one component of complete urinalysis and is interpreted in conjunction with gross and chemical evaluation of urine. A urine sediment is prepared by centrifuging a urine sample for 5 minutes at a relatively low centrifugation rate. The supernatant is poured off or gently aliquoted, and the remaining sediment is resuspended. A drop of sediment is placed onto a glass slide and covered with a cover slip. Appropriate microscope settings for a wet-mount cytology include fully lowering the condenser and partially closing the iris diaphragm. The sediment is viewed using 10x (low power) and 40x (high power) objective lenses. Sediment evaluation may be performed without the use of stain, although applying stain may allow for evaluation of cell morphology and confirmation of infectious organisms in some cases.

Cellular components of urine

Red blood cells, white blood cells, and epithelial cells may be identified on a urine sediment and are typically quantified as a range of cells per hpf (high-power field). Red blood cells are the smallest cells of the sediment and may appear round or crenated depending on the urine concentration. >5 cells/hpf is considered abnormal and supportive of urinary tract hemorrhage. In some cases, cystocentesis may cause iatrogenic hemorrhage. Discordance between a positive blood reading on the urine dipstick and the absence of red blood cells on sediment evaluation may also occur in some cases. This may result from hemoglobinuria or myoglobinuria, or from *in vitro* lysis of red blood cells in very dilute urine.

White blood cells measure about 1.5-2x the size of a red blood cell, and often have a coarse appearance on an unstained sediment. >5 white blood cells per high power field is considered abnormal and supportive of urinary tract inflammation. This may occur with UTI (urinary tract infection), but sterile causes of inflammation including urolithiasis, feline idiopathic cystitis, neoplasia, etc. should also be considered. Thorough evaluation of the sediment for bacterial organisms should be performed if large numbers of white blood cells are identified.

Epithelial cells are the largest cells of the urine sediment and may vary in size and shape depending on their origin within the urinary tract. Squamous epithelial cells are angular in shape with a “cornflake”-like appearance on an unstained sediment; these cells originate from the distal urethra and may be observed in free-catch or catheter samples. These cells are considered an incidental finding unless their morphology is unusual. Urothelial (transitional cells) originate from the renal pelvis, ureters, urinary bladder, and proximal urethra. Large clusters of these cells may be identified in samples obtained via catheterization. In patients with suspected urinary tract neoplasia (transitional cell carcinoma), these cells may be evaluated for variability in cell and nuclear size, multinucleation, or other cytologic criteria of malignancy on a stained sample. Renal epithelial cells are smaller than other epithelial cell types, are rounded in shape, and are very rarely identified on a sediment. The presence of these cells is supportive of renal tubular disease, and casts are often noted concurrently.

Crystals and casts

Crystals may be seen in the urine of clinically healthy animals but may be pathologically relevant in some cases. Triple phosphate (struvite or magnesium ammonium phosphate) crystals have a “coffin lid” morphology and are typically seen in neutral to alkaline urine. Calcium oxalate dihydrate crystals have an “envelope” shape and are more commonly seen in acidic urine. Both crystal types may be found in

clinically healthy patients or may form *in vitro*. Calcium carbonate crystals are a normal and expected finding in urine from horses, rabbits, and goats. Bilirubin crystals are often needle-shaped and are associated with bilirubinuria. Amorphous phosphate crystals have a granular appearance and may mimic bacterial cocci. Crystals of specific pathologic significance include ammonium biurate and calcium oxalate monohydrate. Ammonium biurate crystals are typically associated with causes of hyperammonemia (i.e. portal vascular anomalies, hepatic insufficiency), but may also be normal in dalmatians and English bulldogs. Calcium oxalate monohydrate crystals are frequently associated with ethylene glycol toxicosis. Sometimes, crystal morphology is not readily identifiable, and thorough review of prescription drug history in these patients is recommended.

Casts represent an imprint of the renal tubule composed of Tamm-Horsfall protein matrix. Hyaline casts are purely composed of protein and may be an incidental finding or supportive of glomerular disease. Cellular casts contain intact or degenerating cells within the protein matrix and may indicate renal tubular hemorrhage (red blood cells), inflammation (white blood cells), or necrosis (epithelial cells). As cells degrade within urine, both cellular and granular casts may be visible; low numbers of granular casts alone have also been reported in patients without concurrent evidence of renal tubular disease. Waxy casts are the most clinically significant and indicate chronic renal tubular injury, often associated with decreased urine flow.

Infectious organisms

Bacteria are the most common microorganisms observed in the urine sediment. The presence of bacteria in a free-catch sample should be noted but interpreted with caution. A cystocentesis sample is ideal for quantification of bacteria and preparation of a sample for culture. Pathogenic bacteria will typically be accompanied by increased numbers of white blood cells indicating an inflammatory response, although the inflammatory response may be diminished in patients with diabetes mellitus, poorly concentrated urine, or other disease processes which alter the chemical properties of urine. Fungal yeast organisms are typically considered a contaminant, although *Blastomyces dermatitidis* yeast may be rarely diagnosed in urine. Parasitic ova in a free-catch sample may represent fecal contamination, although *Capillaria (Pearsonema) plica* is an uncommon bladder worm of dogs which may shed ova through the urine. If repeat-use stains (i.e. Diff-Quik) are employed during sediment evaluation, correlation between unstained and stained preparations is necessary to confirm the presence of infectious organisms. Bacterial or fungal overgrowth within these stains is relatively common and may result in inappropriate therapeutic decision making if not recognized.

Artifacts

Especially in free-catch samples, environmental fungi, pollen, plant material, fibers, or other artifacts may complicate urine sediment evaluation. These structures may be mistaken for cellular components, casts, or infectious organisms. Multi-use staining protocols are another potential source of artifact in stained samples. *Alternaria* spp. spores are a relatively common environmental contaminant with a "grenade-like" morphology.

Suggested reading

Rizzi TE et al. 2017. Atlas of canine and feline urinalysis. Hoboken, NJ: Wiley-Blackwell.

Sink CA, Weinstein NM. 2012. Practical veterinary urinalysis. Hoboken, NJ: Wiley-Blackwell.