Casts in Urine (Differential Diagnosis)

Microscopic urinalysis is a laboratory test used to evaluate intrinsic renal diseases. Depending on the findings, different conditions can be diagnosed and classified. One such finding is known as casts; these are collections of protein, specifically Tamm-Horsfall protein that form within the tubular lumen and contain different cell types and proteins depending on the disease process. A variety of casts may be found in the urine, and these include: RBC casts in glomerular disease, WBC casts in acute interstitial nephritis and acute pyelonephritis, fatty casts in nephrotic syndrome, granular casts in acute tubular necrosis, waxy casts in end stage renal disease, and nonspecific hyaline casts.

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Characteristics

RBC Casts

RBC Casts

RBC casts form when red blood cells leak through the glomerulus and clump together within the tubular lumen. RBC casts in urine indicate glomerular damage due to nephritic syndromes or hypertensive emergency. Note that this finding is distinct from hematuria, which occurs with post-renal obstructive diseases. Red-stained cells (RBCs) can be seen stuck within RBC casts.

Glomerular Disease

Glow-mare with Kidney-on-fire

The presence of RBC casts in urine indicates glomerular damage due to diseases like Berger disease (IgA nephropathy) and post-streptococcal glomerulonephritis (PSGN) that produce nephritic syndrome. In some cases of hypertensive emergency (BP >180 systolic OR >120 diastolic), RBC casts may be identified due to pressure damage of the glomerulus.

WBC Casts

White-mac-man Casts

WBC casts form when WBCs, like neutrophils and eosinophils, clump together in the tubular lumen. Presence of WBC casts in urine indicates an intrarenal inflammatory process that may be precipitated by infection, medications, or systemic diseases, like sarcoidosis and amyloidosis. Multilobed cells, like neutrophils, can be seen stuck within WBC casts.

Acute Interstitial Nephritis

Acute-angle Interstate-sign Kidney-on-fire

Acute Interstitial Nephritis (AIN) is inflammation of the interstitium within the nephron. It can be caused by a variety of drugs (beta-lactam antibiotics, sulfa drugs, NSAIDs, etc.), systemic diseases such as sarcoidosis and amyloidosis, transplant rejection, or even heavy metal exposure. Patients may present with fever, rash, and signs of renal failure like oliguria.

Acute Pyelonephritis

Acute-sign Pillar with Kidneys-on-fire

Often occurring as a complication of an ascending urinary tract infection, acute pyelonephritis may also cause the production of WBC casts. This often occurs in women, and patients may present with fever, chills, flank pain, dysuria, and nausea. Urinalysis will likely show WBC casts and at least 100,000 CFU/mL of urine.

Fatty Casts

Fat-guy in a Cast

Sometimes called oval fat bodies, fatty casts form when lipid levels rise and lipids accumulate within the tubular lumen. They can be identified on microscopy under polarized light by their unique “Maltese Cross” sign, and are most commonly affiliated with nephrotic syndrome.

Maltese Cross Sign

Maltese cross

Under polarized light on urine microscopy, fatty casts appear like a “Maltese Cross.”

Nephrotic Syndrome

Nerd-frog

Nephrotic syndrome refers to a constellation of symptoms that may be caused by distinct but related diseases. Signs and symptoms include: proteinuria > 3.5 g/day, hypoalbuminemia, hypogammaglobulinemia, hyperlipidemia, pitting edema, and a hypercoagulable state. Examples of nephrotic syndrome include minimal change disease and membranous glomerulonephritis.

Granular Muddy Brown Casts

Grains and Muddy Brown Casts

More commonly referred to as “muddy brown casts,” granular casts form after degeneration of epithelial cells due to tissue ischemia. Clumps of dead epithelial cells slough off into the urine, and are identified as the granular casts unique for their muddy brown color.

Acute Tubular Necrosis (ATN)

Acute-sign Tuba Necrosis-crow

Acute tubular necrosis (ATN) is commonly caused by tissue ischemia or nephrotoxic injury from drugs like aminoglycosides. When tubular epithelial cells become damaged and die, they slough off and produce granular, muddy brown casts. Any cause of prerenal acute kidney injury that decreases renal perfusion may progress to ATN if left untreated, and may become an intrinsic renal disease.

Waxy Casts

Candle-wax Cast

Waxy casts are believed to originate from cellular casts that have had all their intact cell components obliterated and merged with the underlying Tamm-Horsfall protein excreted by the tubular epithelial cells. They are called waxy because they have a high refractive index compared to other cast types.

End Stage Renal Disease (ESRD) (Chronic Renal Failure)

End of Stage Kidney Diseased

Waxy casts are believed to be obliterated cellular casts combined with Tamm-Horsfall protein. For this degradation to occur, a chronic process must be present, and thus these cast types are affiliated with ESRD.

Hyaline Casts

Highlighter Casts

When no other components mix with Tamm-Horsfall protein excreted by tubular epithelial cells, the cast will build up and eventually break off into the urine. Hyaline casts appear clear on microscopy.

Non-Specific

Nun-specific-stick

Hyaline casts are often seen in concentrated urine samples and are formed under normal physiologic processes, though their presence in urine does not aid towards diagnosis.