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
Red blood cell casts consist of erythrocytes trapped within a protein matrix formed in renal tubules, indicating glomerular or renal parenchymal bleeding rather than bleeding from the lower urinary tract. Their presence confirms that hematuria originates from the kidney.

Glomerular Disease
Glow-mare with Kidney-on-fire
The presence of RBC casts in urine indicates glomerular damage due to diseases such as Berger disease (IgA nephropathy) or post-streptococcal glomerulonephritis (PSGN), both of which produce nephritic syndrome. RBC casts may also appear in hypertensive emergencies (BP >180 systolic or >120 diastolic) due to pressure-induced glomerular injury.

WBC Casts
White-mac-man Casts
White blood cell casts form when neutrophils or eosinophils aggregate within the renal tubules, signifying inflammation or infection of the kidney rather than the lower urinary tract. They are a key finding in conditions involving intrarenal inflammation.

Acute Interstitial Nephritis
Acute-angle Interstate-sign Kidney-on-fire
Acute interstitial nephritis is inflammation of the renal interstitium, often caused by drug-induced hypersensitivity reactions (e.g., beta-lactam antibiotics, sulfa drugs, NSAIDs, diuretics), or by systemic diseases such as sarcoidosis and amyloidosis. Patients may present with fever, rash, eosinophilia, and signs of acute kidney injury such as oliguria. WBC casts may be present on urinalysis.

Acute Pyelonephritis
Acute-sign Pillar with Kidneys-on-fire
Acute pyelonephritis is a bacterial infection of the renal parenchyma, usually resulting from an ascending urinary tract infection. It occurs more commonly in women and presents with fever, chills, flank pain, dysuria, and nausea. Urinalysis typically shows WBC casts and bacteriuria, confirming an upper (not lower) urinary tract infection.

Fatty Casts
Fat-guy in a Cast
Also known as oval fat bodies, fatty casts form when lipid-laden renal tubular cells accumulate in the lumen. Under polarized light, they demonstrate the characteristic “Maltese cross” appearance. Fatty casts are strongly associated with nephrotic syndrome and reflect heavy proteinuria and lipiduria.

Maltese Cross Sign
Maltese cross
On polarized light microscopy, fatty casts display a Maltese cross pattern, caused by birefringent cholesterol esters within the cast, a classic finding in nephrotic syndrome.

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Nephrotic Syndrome

Nerd-frog

Nephrotic syndrome is characterized by proteinuria >3.5 g/day, hypoalbuminemia, hyperlipidemia, and pitting edema, along with a hypercoagulable state. Fatty casts and oval fat bodies are typical urinary findings. Common causes include minimal change disease, membranous nephropathy, and focal segmental glomerulosclerosis.

Granular Muddy Brown Casts

Grains and Muddy Brown Casts

Granular or “muddy brown” casts form from degenerating epithelial cells and granular debris, usually after ischemic or toxic injury to renal tubules. Their brown color and coarse texture are diagnostic clues.

Acute Tubular Necrosis (ATN)

Acute-sign Tuba Necrosis-crow

Acute tubular necrosis results from ischemic or nephrotoxic injury (e.g., due to aminoglycosides, radiocontrast agents, or prolonged hypotension). Damaged tubular epithelial cells slough off into the lumen, forming muddy brown granular casts. ATN is a leading cause of intrinsic acute kidney injury (AKI) and may follow untreated prerenal azotemia.

Waxy Casts

Candle-wax Cast

Waxy casts are broad, refractile casts formed from degenerating cellular casts and Tamm–Horsfall protein. Their appearance reflects prolonged tubular stasis in dilated or atrophic nephrons and is associated with chronic kidney disease (CKD) and low urine flow states.

End Stage Renal Disease (ESRD) or Chronic Kidney Disease (CKD)

End of Stage Kidney Diseased

Waxy casts are most commonly seen in end-stage kidney disease (ESKD) or advanced chronic kidney disease (CKD). Their presence indicates long-standing renal parenchymal damage and markedly reduced renal function.

Hyaline Casts

Highlighter Casts

Hyaline casts are composed purely of Tamm–Horsfall protein (uromodulin) secreted by tubular epithelial cells and appear clear and homogeneous on microscopy. They are the most common cast type.

Non-Specific

Nun-specific-stick

Hyaline casts are non-specific and can appear in healthy individuals, especially with dehydration, vigorous exercise, or mild prerenal azotemia. Their presence alone does not indicate intrinsic kidney disease.

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