URINE MICROSCOPY (CRYSTALS AND CASTS MORPHOLOGY)

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OUTLINE

1. INTRODUCTION

Urine microscopy of crystals and casts

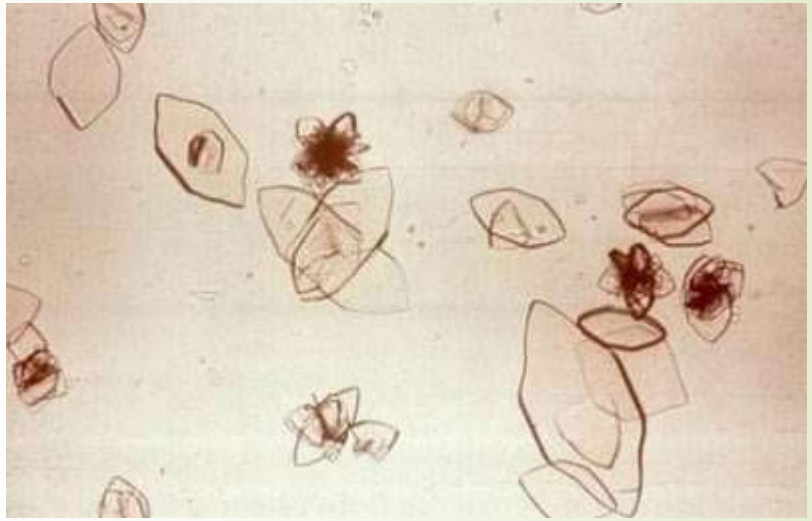
- Microscopic examination is a vital part of routine urinalysis
- As a diagnostic tool for detection and evaluation of renal and urinary tract disorders as well as other systemic diseases
- Specimen – first morning urine
- Casts and RBC tends to dissolve/lyse in specimens with low specific gravity or alkaline pH
- The first morning specimen usually provide the concentrated and acidic environment to maintain these structures
- Tools – bright field microscope

2. URINE CRYSTALS

- Crystal formation occurs when :
  - ✓ urine is supersaturated with a particular crystalline compound
  - ✓ the solubility properties of that compound are altered
- Many of crystals found in urine have little clinical significant except in case of metabolic disorders, calculus formation and the regulation of medication
- Crystal can be identified by :
  - ✓ Appearance
  - ✓ pH dependency
  - ✓ solubility characteristic

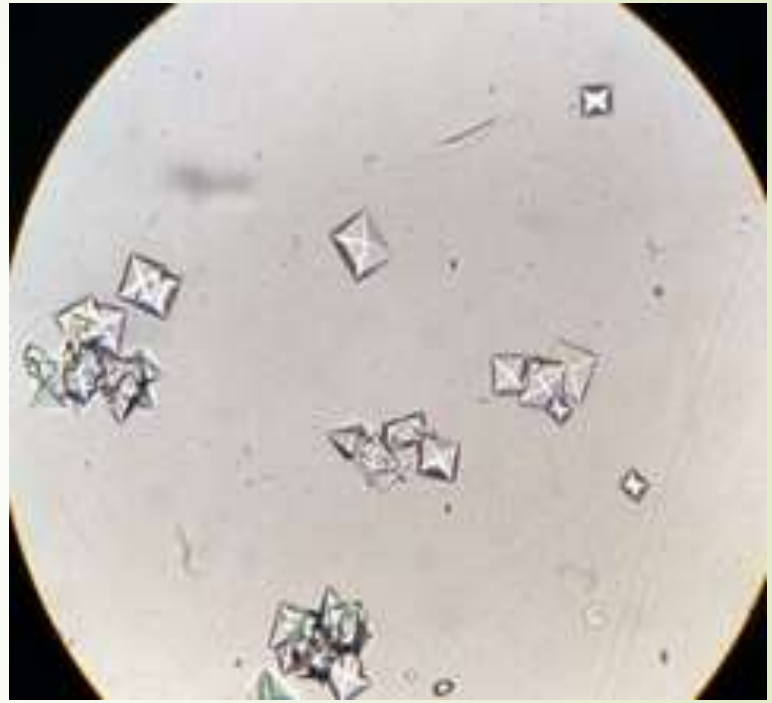
2.1 URIC ACID CRYSTALS

- **Shape** – diamond, rhombic prism, rosette
- Frequently found in acidic urine
- **Color** – yellow or red brown because its usually stained with urinary pigments
- **Soluble** – sodium hydroxide
- **Insoluble** – alcohol, hydrochloric acid, acetic acid
- Presence of uric acid crystals can be normal occurrence
- **Pathologic condition** – gout, high purine metabolism, acute febrile condition, chronic nephritis and Lesch-Nyhan syndrome



2.2 CALCIUM OXALATE CRYSTALS

- **Shape** – colorless octahedral or ‘envelope shape’ crystal. Sometimes appears oval spheres or biconcave disc
- Frequently found in acidic and neutral urine
- **Soluble** - hydrochloric acid
- **Insoluble** – acetic acid
- Normally present in urine after ingestion of various oxalate-rich food such as tomatoes, spinach, garlic, oranges, asparagus
- **Pathologic condition** – ethylene glycol poisoning, diabetes mellitus, liver diseases, and severe chronic renal failure



2.3 CYSTINE CRYSTALS

- **Shape** - colorless, refractile, hexagonal plates with equal or unequal sides
- **Insoluble** – acetic acid, acetone, ether, boiling water
- **Soluble** – hydrochloric acid , ammonia
- Solubility in ammonia helps differentiate cystine from colorless six sided uric acid crystals
- **Pathologic condition** – occur in patient with congenital cystinosis or congenital cystinuria
- Cystine Crystal also can form calculi

2.4 LEUCINE CRYSTALS

- **Shape** – oily, highly retractile, yellow or brown spheroids with radial and concentric striations
- **Soluble** – hot acetic acid, hot alvohol, alkali
- **Insoluble** – hydrochloric acid
- **Pathologic condition** – found in patient with maple syrup urine disease, oasthouse urine disease, terminal cirrhosis of liver, severe viral hepatitis, acute yellow atrophy of the liver

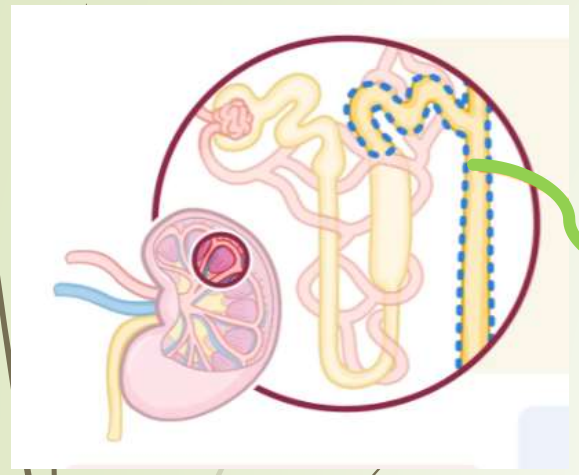
2.5 CHOLESTEROL CRYSTALS

- **Shape** – large, flat, transparent plates with notched corners
- **Soluble** – chloroform, ether, hot alcohol
- Sometimes found as a film on the surface of of urine
- Presence of cholesterol plates indicates excessive tissue breakdown
- **Pathologic condition** – presence in nephritis and nephritic conditions. May also present in chyluria (thoracic or abdominal obstruction of lymph drainage causing rupture of lymphatic vessels into urinary tract)

2.6 TYROSINE CRYSTALS

- **Shape** – very fine, highly retractile needles in clusters
- Needle clusters often appears black, but may take yellow color in the presence of bilirubin
- **Soluble** – ammonium hydroxide, hydrochloric acid
- **Insoluble** – acetic acid
- **Pathologic condition** – can be seen in tyrosinosis and oasthouse urine disease

3. URINE CASTS



- Microscopic clusters of particles wrapped in Tamm-Horsfall mucoprotein/protein matrix.
- Formed in the distal convoluted tubule and collecting duct system of kidney where the urine reaches its maximum concentration and acidification
- Factors that are involved in cast formation:

✓ Urinary stasis (marked decrease in urine flow)

✓ ↑ acidity and high solute concentration of urine

✓ Proteinuria or ↑ Tamm-Horsfall protein formation

✓ Strenuous exercise

✓ Diuretic medication use

✓ Intrinsic renal diseases (eg: glomerular damage, tubular damage, renal inflammation and renal infection)

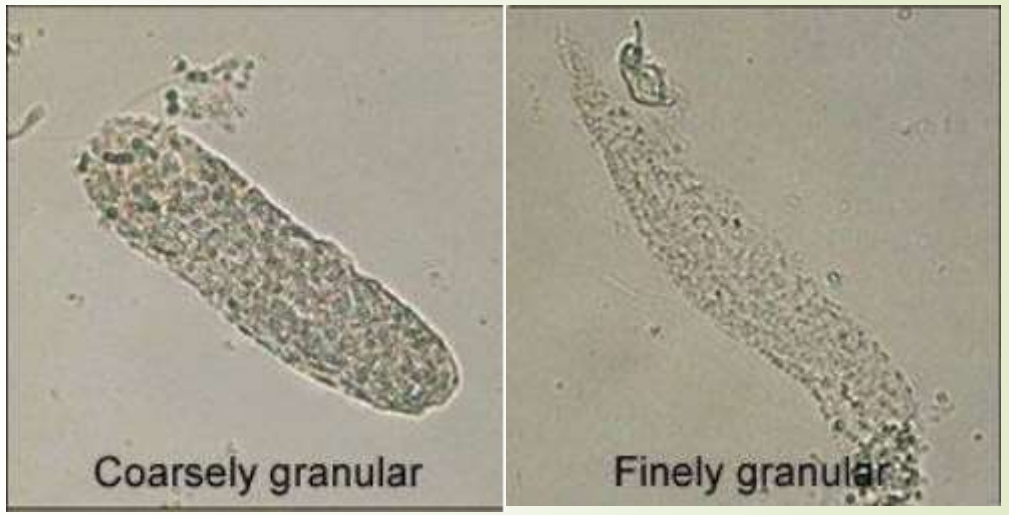
3.1 HYALINE CASTS

- Most frequently occurring casts in urine
- Glycoprotein matrix consisting mainly of Tamm-Horsfall protein secreted by tubules
- Very low refractive index (viewed under low light)
- Colourless, homogenous, transparent
- Rounded end
- **Significance**: nonspecific
- **Can be present in**:

1. normal urine/ in patients with low urine flow (eg: dehydration, diuretic therapy)
2. physiologic stress
3. Acute or chronic renal disorders (as broad casts formed in dilated tubules)

3.2 GRANULAR CASTS

- Gylcoprotein matrix with protein or cellular debris, often appears as “muddy brown”
- Granules are large and coarse at beginning, but when urine stasis is prolonged, these granules break down to fine granules
- Fine granular casts- contain fine granules, appear as gray or pale yellow in colour
- Coarse granular casts- contain large granules, darker in colour
- Indicate significant renal disease (eg: acute tubular necrosis)
- Occasionally occurs after exercise or dehydration in normal renal function person.



3.3 WAXY CASTS

- Glycoprotein matrix with degraded protein , formed in atrophic tubules
- High refractive index
- **Characteristics:**

1. yellow, gray, colourless
2. smooth homogeneous
3. short with blunt or broken ends
4. cracked or serrated edges

- **Pathologic condition:**

1. Severe chronic renal failure
2. Maglinant hypertension
3. Renal amyloidosis
4. Diabetic nephropathy
5. Acute renal disease
6. Tubular inflammationand degeneration
7. Renal allograft rejection

3.4 FATTY CASTS

- Fat droplets or oval fat bodies
- Cholesterol fat:
  - ✓ droplets will be anisotropic
  - ✓ demonstrate characteristic “Maltose-cross” formation underm polarized light
- Triglycerides fat:
  - ✓ isotropic droplets
  - ✓ not polarize
  - ✓ stain with Sudan III or Oil Red O

A. Bright field fatty cast

B. Polarized fatty cast

- **Pathologic condition:**

1. Degenerative tubular disease
2. Nephrotic syndrome
3. Diabetic glomerulosclerosis
4. Lipoid nephrosis
5. Chronic glomerulonephritis
6. Kimmelstiel-Wilson syndrome
7. Lupus nephritis
8. Toxic renal poisoning

A. Bright field fatty cast B. Polarized fatty cast

3.5 RED BLOOD CELL CASTS

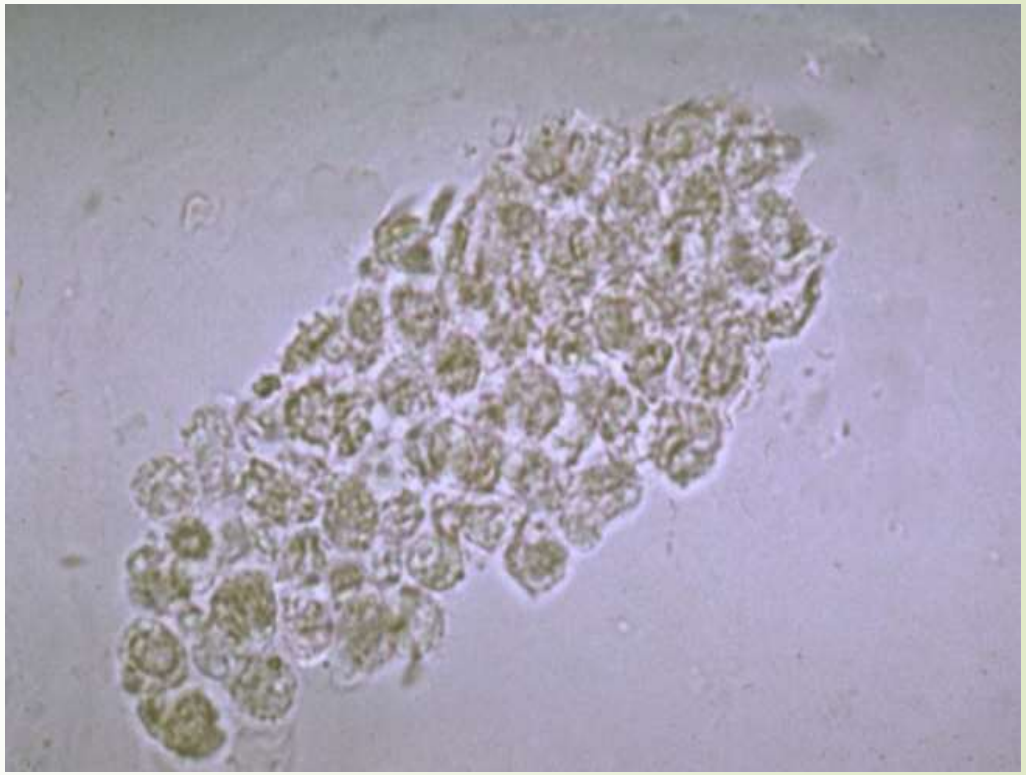
- Glycoprotein matrix with red blood cells
- Often appears red-orange
- Reagent-strip findings : positive for protein and blood
- **Pathologic condition:**

1. Renal hematuria
2. Acute glomerulonephritis
3. Lupus nephritis
4. Goodposture syndrome
5. Subacute bacterial endocarditis
6. Renal trauma
7. Severe pyelonephritis
8. Renal vein thrombosis
9. Renal infarction

3.6 WHITE BLOOD CELL CASTS

- Protein matrix variably filled with white blood cells
- Majority of white cells present in casts are polymorphonuclear neutrophils
- Present in renal infection and in noninfectious inflammation
- Reagent-strip findings: positive for protein, leucocyte esterase, nitrite (if bacteria are present)
- **Pathologic condition:**

1. Acute pyelonephritis
2. Interstitial nephritis
3. Lupus nephritis
4. Proliferative glomerulonephritis



3.7 EPITHELIAL CELL CASTS

- Protein matrix variably filled with tubular cells
- Formed due to the stasis and desquamation of renal tubular epithelial cells
- Rarely seen because of the infrequent occurence of renal diseases affecting the tubules (necrosis)
- Arrange in parallel rows/ haphazardly in casts and vay in size, shape and stage of degeneration
- Reagent strip findings: positive for protein
- **Pathologic condition:**

1. Urine exposure to nephrotoxic agents (eg: mercury, ethylene glycol) or viruses (eg: cytomegalovirus, hepatitis virus)
2. Acute tubular injury
3. Glomerulonephritis
4. Nephrotic syndrome

4. CONCLUSION

- Urine crsytals and casts morphology identification helps in detection and evaluation of renal disorders.

- It can be used to confirm urinalysis chemical findings and to identify the false negative urinalysis results.

5. REFERENCES

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Book

- Graff's Textbook of Routine Urinalysis and Body Fluids