Urine Under the Microscope

As part of a urinalysis, the urine sediment is centrifuged and examined microscopically for crystals, casts, red blood cells, white blood cells, and bacteria or yeast. Because examination of urinary sediment provides a direct sampling of urinary tract morphology, it provides important information useful for both diagnosis and prognosis. Microscopic examination of urine sediment is usually performed in addition to routine procedures. This examination requires a degree of skill acquired through practice under the immediate supervision of an experienced technician. The specimen used for microscopic examination should be as fresh as possible. Red cells and many formed solids tend to disintegrate upon standing, particularly if the specimen is warm or alkaline.

How to Prepare the Urine for Microscopic Examination

Correct interpretation of the microscopic urinalysis depends on proper specimen collection and preparation. The patient should be instructed on the proper technique for clean catch urine collection. Do not assume that the patient knows what to do from previous experience. Review how to cleanse the genitalia and instruct the patient to collect a midstream specimen. Pour five to ten milliliters of urine into a test tube. Conical bottom test tubes are preferred because they allow for better pellet formation. Please the tube in the centrifuge and balance with a second tube filled with water (or another urine specimen) of equal volume. Spin the urine for about five minutes. Remove the tube and decant the supernatant into the sink. Resuspend the sediment in the residual urine that clings to the bottom of the tube by tapping the tube against a hard surface several times. Place a drop of the resuspended sediment on a glass microscope slide using a pipette or by holding the tube upside down and carefully tapping it the slide until one drop falls onto the slide. Place a coverslip over the drop and place under the microscope. Although commercial stains are available to highlight cellular elements, examination of unstained urine is usually adequate.

How to Scan the Slide

Review the operating instructions for your microscope if you are unfamiliar with its operation. Place the slide under the scope and begin the examination under low power. Be sure to use a low light source (adjust he iris and condenser). Too much light makes the cellular and crystalline elements harder to see. Scan the slide under low power to locate areas of interest. Look for casts just inside the perimeter of the cover slip. Then switch to high dry magnification and examine ten random fields in the central part of the coverslip. Count the numbers of red cells and white cells in each and report the range of findings. If the field is covered with cells, report as "TNIC" (too numerous to count) or "packed." Add to the report an estimate of bacteria density, any casts seen and other structures noted. Sample microscopic urinalysis report 5-10 RBC/HPF, 15-25 WBC/HPF, few bacteria, occasional hyaline cast, no epithelial cells.

Clinical Significance of Microscopic Examination

In healthy people, the urine contains small numbers of cells and other formed elements from the entire urinary tract, and epithelial cells from the kidney, ureter, bladder, and urethra. In renal disease, the urine often contains increased numbers of substances discharged from an organ that is otherwise accessible only by biopsy or surgery. A microscopic examination of urine sediment detects the presence and amounts of:

- Red blood cells

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Urine sediment is assessed under a high power field (HPF) for the presence of red and white blood cells. Normally, there should be only an occasional red blood cell in the urine (2-3 per high power field). Hematuria, the presence of abnormal numbers of red blood cells in the urine may be due to:

- Glomerular disease
- Tumors that erode any part of the urinary tract
- Kidney trauma
- Renal infarcts
- Acute tubular necrosis
- Upper and lower urinary tract infections
- Nephrotoxins
- Traumatic catheterization
- Passage of renal stones
- Physical stress

In women, it is important to make sure that the urine specimen was not contaminated by the menstrual flow. Inserting a tampon and collecting urine midstream are ways to prevent contamination. Red blood cells may stick together and form red blood cell casts. The presence of oddly shaped red blood cells in the urine suggests a glomerular disease such as glomerulonephritis, as the odd shape is caused by the passage of the cells through a distorted and abnormal glomerular structure. White blood cells are normally not present in the urine. The presence of white blood cells indicates infection or inflammation within the urinary tract.

It is important that urine is examined for bacteria, casts, crystals, and epithelial cells. Urine stored in the bladder is normally free of bacteria or yeast. However, bacteria are commonly found in urine specimens because of the abundant normal microbial flora of the vagina or external urinary meatus and due to the ability of bacteria to multiply rapidly in urine standing at room temperature. Bacteria noted on a microscopic examination should be interpreted in view of clinical signs and symptoms of urinary tract infection. Diagnosis of bacteriuria in a patient with a suspected urinary tract infection requires a urine culture and sensitivity. A colony count may also be done to
determine if significant numbers of bacteria are present. Generally, more than 100,000 bacteria of one organism per milliliter of urine indicates a urinary tract infection. A finding of multiple organisms usually reflects specimen contamination.

Casts are collections of protein, cells, and debris that are formed in the tubules of the kidneys. Cast width is described as narrow (one to two red blood cells in width), medium broad (three to four red cells in width), and broad (five red blood cells in width). Casts that form in the collecting tubules tend to be very broad. Broad casts usually indicate a significant reduction in the functional capacity of the nephron and indicate severe renal damage or "end stage" renal disease. A few hyaline casts are normal, but all other casts need to be evaluated. When cellular casts remain in the nephrons for some time before being flushed into the bladder urine, the cells may degenerate to a coarsely granular cast, later to a finely granular cast, and eventually, to a waxy cast. Granular and waxy casts are believed to be derived from renal tubular casts. The number of casts are reported as "number and type seen per low power field (LPF)". An example of a report might read: "5-10 hyaline casts/LPF."

Some epithelial cells from the skin surface or from the outer urethra can appear in the urine. Some forms of crystals appear in the urine of healthy individuals. Abnormal crystals can indicate liver disease or some forms of genetic abnormalities.

Summary of Clinical Significant Findings

Leukocytes, erythrocytes, and casts may all be of clinical significance when found in urine sediment.

Leukocytes—Generally, 0 to 3 leukocytes per high-power field will be seen on microscopic examination. More than 3 cells per high-power field probably indicates disease somewhere in the urinary tract. Estimate the number of leukocytes present per high-power field and report it as the "estimated number per high-power field."

Erythrocytes—Red cells are not usually present in normal urine. If erythrocytes are found, estimate their number per high-power field and report it. Erythrocytes may be differentiated from white cells in several ways:

- White cells are larger than red cells.
- When focusing with the high-power lens, the red cells show a distinct circle; the white cells tend to appear granular with a visible nucleus.
- One drop of 5% acetic acid added to the urine sediment disintegrates any red cells, but it does not affect the white cells (except that the nuclei become more distinct).

Casts—These urinary sediments are formed by coagulation of albuminous material in the kidney tubules. Casts are cylindrical and vary in diameter. The sides are parallel, and the ends are usually rounded. Casts in the urine always indicate some form of kidney disorder and should always be reported. If casts are present in large numbers, the urine is almost sure to be positive for albumin.

There are seven types of casts. They are as follows:

- Hyaline casts are the most frequently occurring casts in urine. Hyaline casts can be seen in even the mildest renal disease. They are colorless, homogeneous, transparent, and usually have rounded ends.
Red cell casts indicate renal hematuria. Red cell casts may appear brown to almost colorless and are usually diagnostic of glomerular disease. White cell casts are present in renal infection and in noninfectious inflammation. The majority of white cells that appear in casts are hypersegmented neutrophils.

Granular casts almost always indicate significant renal disease. However, granular casts may be present in the urine for a short time following strenuous exercise. Granular casts that contain fine granules may appear grey or pale yellow in color. Granular casts that contain larger coarse granules are darker. These casts often appear black because of the density of the granules.

Epithelial casts are rarely seen in urine because renal disease that primarily affects the tubules is infrequent. Epithelial casts may be arranged in parallel rows or haphazardly.

Waxy casts result from the degeneration of granular casts. Waxy casts have been found in patients with severe chronic renal failure, malignant hypertension, and diabetic disease of the kidney. Waxy casts appear yellow, grey, or colorless. They frequently occur as short, broad casts, with blunt or broken ends, and often have cracked or serrated edges.

Fatty casts are seen when there is fatty degeneration of the tubular epithelium, as in degenerative tubular disease. Fatty casts also result from lupus and toxic renal poisoning. A typical fatty cast contains both large and small fat droplets. The small fat droplets are yellowish-brown in color.