Nephrolithiasis Stone Types (Part 2/2)

Struvite stones are typically caused by urinary tract infections. These stones are characterized by a "coffin-lid" appearance on microscopy, and are radiopaque in imaging studies. They precipitate when urine pH is increased. Calcium phosphate stones are commonly seen in hypercalcemia. These stones are characterized by a "wedge-shaped" appearance on microscopy, are radiopaque in imaging studies, and precipitate in the setting of increased urine pH.

PLAY PICMONIC

Struvite

Struvite (Ammonium Magnesium Phosphate)
Stove Crystals
Struvite stones consist of magnesium ammonium phosphate (struvite) and calcium carbonate-apatite. They are often large, and are found in the renal pelvis. They are sometimes known as "staghorn calculi" if they get big enough to look like the horns on a stag. Struvite stones can present as a white or gray stone, commonly smooth and easily broken.

Urinary Tract Infections
Kidney-and-bladder-on-Fire
Urease-positive microorganisms that often cause UTIs are common etiologic agents for struvite stones. Examples include Klebsiella, Staphylococcus, E. coli, and Proteus spp.

"Coffin Lid" Appearance
Coffin
Struvite stones have a characteristic "coffin-lid", or rectangular prism, appearance.

Radiopaque
Radiopaque Image
Struvite stones are most commonly seen as radiopaque on imaging, but can be variable. Opacity can occur due to the presence of calcium.

Increased Urine pH
Up-arrow Urinal and pH-scale
Struvite stones only occur in the presence of increased urine pH (alkaline). Urease-producing microorganisms will break down urea into ammonia and carbon dioxide (CO₂), resulting in alkaline urine. This increased pH will precipitate magnesium ammonium phosphate, contributing to stone formation.

Calcium Phosphate

Calcium Phosphate
Calcium-cow Phosphate-P
Calcium phosphate stones are seen in 10% of patients with kidney stones. These are also known as brushite stones, and can be recurrent. Brushite stones are resistant to ESWL treatment, especially large stones, and 75% of cases need percutaneous nephrolithotomy (PNL).

Hypercalcemia
Hiker-calcified-cow
Hypercalcemia is a risk factor for calcium phosphate stone formation due to precipitation in the urine. Hyperparathyroidism and sarcoidosis commonly lead to hypercalcemia/uria and stone formation. Other potential causes include granulomatous diseases, milk-alkali syndrome, hypervitaminosis D, prolonged immobilization, and malignancy.

Wedge-shaped Prisms

Wedge-shaped Prisms Stones

On microscopy, calcium phosphate stones can be visualized as wedge-shaped prisms in rosettes or amorphous patterns.

Radiopaque

Radiopaque Image

Calcium phosphate stones are commonly radiopaque on imaging given the presence of calcium (a metal).

Increased Urine pH

Up-arrow Urinal and pH-scale

Increased urine pH (alkaline) promotes the formation of calcium and phosphate-containing stones. On the other hand, decreased urine pH (acidic) promotes formation of uric acid and cystine stones.
