EDUCATIONAL COMMENTARY - POLARIZING VS NONPOLARIZING CRYSTALS

Educational commentary is provided through our affiliation with the American Society for Clinical Pathology (ASCP). To obtain FREE CME/CMLE credits click on Earn CE Credits under Continuing Education on the left side of the screen.

LEARNING OUTCOMES

Upon completion of this exercise, participants will be able to

- explain the difference between positive and negative birefringence, and give examples of each.
- list the urine crystals that are birefringent using polarized light microscopy.

Polarizing microscopy helps identify and classify birefringent objects by making them shine brilliantly against a dark background. Polarized light vibrates in only one direction or plane. When polarized light passes through an optically active object, it splits into two beams. One beam remains in the original light path and the other rotates 90°. If the object is not optically active, the light passes through unchanged.

In the clinical laboratory, polarized light microscopy is used primarily to evaluate urine and synovial fluid. It assists in identifying crystals, which have the ability to rotate the path of the polarized light beam to produce characteristic colors. Objects seen using polarized microscopy are considered to be birefringent. Birefringent, or double refractive, is the ability to refract light in two directions, usually at 90° to each other. There are 2 types of birefringence: positive and negative. If an object rotates the plane of polarized light 90° in a clockwise direction, it has positive birefringence. An object that rotates the plane in a counterclockwise direction has negative birefringence.

Synovial Fluid Analysis

The optical rotation, or birefringence characteristic, provides a means of identifying crystals in synovial fluid. For example, monosodium urate (MSU) crystals, which are present in patients with gouty arthritis, exhibit negative birefringence. When viewed using a polarizing light microscope, crystals aligned parallel to the compensator’s axis appear yellow. When perpendicular to the axis of the compensator, MSU crystals appear blue.

Calcium pyrophosphate dihydrate (CPPD) crystals, which are present in conditions termed “pseudogout,” exhibit positive birefringence. These crystals appear blue when parallel to the compensator's axis, and yellow when perpendicular to the axis. Hence, their appearance is the opposite of MSU crystals.

Cholesterol crystals are often associated with chronic inflammatory conditions, such as rheumatoid arthritis. They appear as flat, rectangular plates with notched corners, and exhibit strong birefringence.
However, needlelike forms that resemble MSU or calcium pyrophosphate dihydrate crystals have been observed in synovial fluid. An experienced technologist is usually able to differentiate significant crystals from other crystals and artifacts in synovial fluid.

**Urinalysis**

Polarized microscopy also aids in the identifying urine crystals. The geometric shape of a crystal determines its birefringence and its ability to polarize light. Even though the size of a crystal may vary, the basic structure is the same; therefore, polarization characteristics are constant for a particular crystal. The majority of urine crystals do not polarize. The following are birefringent, and are often confirmed based on their ability to polarize light: uric acid, calcium oxalate (monohydrate and dihydrate forms), calcium carbonate, triple phosphate, cholesterol, and radiographic contrast media. When a technologist examines urine sediment, polarizing microscopy can help to differentiate crystals from urinary elements that do not polarize. Uric acid crystals are often mistaken for cystine crystals, calcium oxalate (monohydrate form) may be confused with red blood cells, and calcium carbonate may be confused with bacteria.

**Conclusion**

Polarizing microscopy is an important component of synovial fluid analysis and urine sediment examination. It helps identify significant crystals in the synovial fluid, which assist in making an accurate diagnosis. Although most urine crystals are not significant, a polarizing microscope can aid in differentiating crystals from other significant urine elements that do not polarize.

**SUGGESTED READING**


© ASCP 2011