ADVANCED BLOOD CELL ID: IDENTIFYING PERIPHERAL BLOOD LEUKOCYTES AND ERYTHROCYTES IN A PATIENT WITH IRON DEFICIENCY ANEMIA

Educational commentary is provided for participants enrolled in program #259- Advanced Blood Cell Identification. This virtual blood cell identification program includes case studies with more difficult challenges. To view the blood cell images in more detail, click on the sample identification numbers underlined in the paragraphs below. This will open a virtual image of the selected cell and the surrounding fields. If the image opens in the same window as the commentary, saving the commentary PDF and opening it outside your browser will allow you to switch between the commentary and the images more easily. Click on this link for the API ImageViewer™ Instructions.

Learning Outcomes

After completion of this exercise, participants will be able to:

- describe morphologic features of monocytes and lymphocytes, and
- identify distinguishing morphologic features in red blood cells associated with iron deficiency anemia.

Case Study

A 78 year old female patient was seen by her primary care physician due to extreme fatigue and headaches. The CBC results are as follows: WBC=9.3 x 10^9/L, RBC=4.43 x 10^12/L, Hgb=8.7 g/dL, Hct=26.1%, MCV=58.9 fL, MCH=19.6 pg, MCHC=33.3 g/dL, RDW=24.8%, Platelet=425 x 10^9/L.

Educational Commentary

The cells annotated for commentary in this advanced testing event were selected from the peripheral blood smear of an elderly woman diagnosed with iron deficiency anemia (IDA). IDA is a common worldwide disorder. It can be caused by lack of adequate dietary iron, the malabsorption of iron, increased need for iron as in pregnancy or infancy and, most often, by bleeding.

The cell chosen for ABI-15 is a microcytic red blood cell. Microcytes are small erythrocytes with a mean corpuscular volume (MCV) less than 80 femtoliters (fl) or less than 7 microns (µm) in diameter. Note that the MCV for this patient is 58.9 fl. The approximate size of this cell can also be measured with the ImageViewer and verified as a microcyte. Normal RBCs are about 7-8 µm in diameter. Another guide to determine RBC size is to compare the nucleus of a small, normal lymphocyte to the erythrocytes. Normal red blood cells are about the same size as the lymphocyte’s nucleus. Microcytosis is a classic finding in IDA, resulting from an imbalance of hemoglobin production associated with the lack of iron. Hemoglobin synthesis occurs in the RBC’s cytoplasm as the cell matures in the bone marrow. When iron is deficient, cellular divisions in developing erythrocytes are increased, producing smaller cells.
The cell annotated in **ABI-16** is an ovalocyte or elliptocyte. Ovalocytes are variable in shape, but all forms have almost parallel sides with round ends. Some elliptocytes have been described as appearing cigar or egg-shaped. In cases of IDA, they have been referred to as pencil cells. Ovalocytes have an area of central pallor. Elliptocytes may sometimes be seen on a normal peripheral blood smear, but will be present in numbers less than one percent. A review of other areas of this digital slide with ImageViewer will show additional ovalocytes.

The arrow in **ABI-17** identifies a monocyte. The cell is a classic example of this type of leukocyte. It is a large cell. The cytoplasm is characteristically blue-gray and vacuolated. It is also unevenly stained and rough appearing. A few normal purple or purple-red azurophilic granules are sometimes visible in a monocyte, but are not well defined in this particular cell. Monocyte nuclei are variable in shape. This nucleus is lobated, but they may also be round, oval or kidney-shaped.

Another leukocyte has been selected for **ABI-18**. This cell is a lymphocyte. Note the smaller size of this cell when compared to the monocyte in ABI-17. Lymphocytes vary in size and this is a nice choice for a normal, resting lymphocyte. The scanty amount of blue cytoplasm is typical for a small lymphocyte. Nuclei in these cells are generally round, but sometimes slightly indented or oval. The nuclear chromatin in small lymphocytes is condensed, clumped, and stains a deep purple. As mentioned, the nucleus of a small, resting lymphocyte can be used as an internal guide to assess the size of red blood cells. There is also a small lymphocyte in annotation ABI-15. Comparing surrounding RBCs with the lymphocyte nuclei in both ABI-15 and ABI-18 indicates there are many microcytic cells on this virtual peripheral blood slide. Likewise, the ImageViewer measure tool can verify the presence of numerous microcytic erythrocytes.

**ABI-19** shows a polychromatophilic RBC. These cells represent an immature erythrocyte, one stage before the mature red blood cell, also called a reticulocyte. The condition associated with the appearance of polychromatophilic erythrocytes in the peripheral blood is described as polychromasia. Normally, reticulocytes mature approximately 48 hours in the bone marrow and another 24 hours after their exit into the peripheral blood. Their presence in the peripheral blood indicates accelerated bone marrow activity and early release of RBCs in response to decreased oxygen reaching tissues and organs of the body. Polychromatophilic cells have no nucleus, but still have small amounts of ribonucleic acid (RNA). The cells, therefore, appear blue-gray when Wright stained. They are often larger than normal red blood cells, reflecting their slight immaturity. Polychromatophilic erythrocytes generally have no or only a slight area of central pallor.

The cell annotated in **ABI-20** represents another important erythrocyte morphologic finding in IDA and is a hypochromic RBC. In normal red blood cells, the area of central pallor occupies about 1/3 of the diameter of the cell. Cells with a larger area are defined as hypochromic. Hypochromia is one of the...
consistent RBC abnormalities associated with defects in hemoglobin synthesis, and especially IDA, as seen in this case study patient. The mean corpuscular hemoglobin (MCH) is a helpful parameter to assess hypochromia. A normal MCH is approximately 27-31 picograms (pg), depending on individual laboratory reference ranges. The MCH in this patient is 19.6 pg, clearly indicative of the presence of hypochromic RBCs. Note there are several other hypochromic erythrocytes in this screen shot of the peripheral blood smear.

The final cell selected for discussion in this testing event, ABI-21, is a normal RBC. Erythrocytes are evaluated on a peripheral blood smear to assess their size, shape, size of the area of central pallor (chromicity), as well as their color, whether or not they have inclusions (they should not), and their distribution on the slide. This cell appears slightly larger than the microcytic RBC in ABI-15 and is considered normal in size. Again, use of the ImageViewer measure tool verifies this cell is normal in size at greater than 7 microns in diameter. This cell is also evenly shaped. The area of central pallor is about 1/3 the diameter of the cell, which is also normal. Compare the chromicity in this RBC with that seen in the cell identified as ABI-20. Likewise, the cell in ABI-21 has no inclusions. Finally, the overall distribution of erythrocytes is uniform, with no abnormalities such as rouleaux or agglutination.

Iron Deficiency Anemia

Iron deficiency anemia develops in stages. The first phase is depletion of iron stores followed by iron-deficient erythropoiesis and, finally, a complete iron deficient state. These stages in the progression of IDA are important to remember because the degree of morphological variation in erythrocytes, including microcytosis and hypochromia, will vary with the level of iron impairment. Although the peripheral blood smear reveals characteristic changes in red blood cells when iron deficiency is present, confirmation of this anemia is made through additional testing to include serum iron values, transferrin saturation, total iron binding capacity, and other iron-related studies.

Summary

IDA is a common, worldwide disorder with classic morphologic features in RBCS that are evident on the peripheral blood smear. The laboratory professional contributes to the diagnosis by accurately assessing and reporting these erythrocyte abnormalities.

References
