EDUCATIONAL COMMENTARY – MORPHOLOGIC CHARACTERISTICS OF MATURE AND IMMATURE PERIPHERAL BLOOD CELLS

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To view the blood cell images in more detail, participants enrolled in program #224 or 225 for Blood Cell Identification can click on the sample identification numbers underlined in the paragraphs below. After logging on with a Paperless Proficiency Testing user name and password, you will see 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. To avoid the need to log in for each image, use the online tool to choose the cell you want to view. Click on this link for the API ImageViewer Instructions.

Learning Outcomes

On completion of this exercise, the participant should be able to

- describe morphologic features of normal and mature peripheral blood leukocytes;
- identify morphologic characteristics of immature leukocytes and erythrocytes; and
- discuss significant peripheral blood findings in chronic myeloid (myelogenous) leukemia.

Case History

A CBC with differential was ordered on a 62 year old male patient with unexplained fevers, weakness, fatigue, and weight loss. His CBC results are as follows: WBC=88.3x 10^9/L, RBC=2.56 x 10^12/L, Hgb=8.2 g/dL, Hct=26%, MCV=102.5 fl, MCH=32.1 pg, MCHC=31.3 g/dL, Platelet=412 x 10^9/L, RDW-CV=25.3%.

Introduction

The images presented in this testing event are from the blood sample of a man diagnosed with chronic myeloid (myelogenous) leukemia (CML). The cells selected for identification and commentary include normal leukocytes as well as immature leukocytes and erythrocytes seen in the peripheral blood.
Educational Commentary – MORPHOLOGIC CHARACTERISTICS OF MATURE AND IMMATURE PERIPHERAL BLOOD CELLS (cont.)

Educational Commentary

**Image BCI-01** shows an eosinophil. Eosinophils are medium-sized cells. The cytoplasm contains numerous distinctive, red-orange granules. These granules are round and uniform in size and usually do not obscure the nucleus. Most eosinophils have only two nuclear lobes that are generally the same size. Note that it is difficult to visualize separate nuclear lobes in this particular cell. The nuclear chromatin is dense and clumped.

**Image BCI-02** is a segmented neutrophil. This cell is also medium-sized and similar in size to the eosinophil. Neutrophils have numerous small, pink, tan, or violet cytoplasmic granules. Sometimes, as in this example, individual granules may not be seen and the cytoplasm only appears grainy. Segmented neutrophils are characterized by their two to five nuclear lobes. These lobes are usually separated by thin chromatin strands. Two of the lobes in this cell are connected by a thread of chromatin. The chromatin is characteristically dense and clumped.

**Image BCI-03** shows a nucleated red blood cell (RBC). Nucleated erythrocytes are young RBCs and retain their nuclei. They represent specific stages in RBC maturation. The phrase “nucleated red blood cell” includes all erythrocyte precursors (normoblasts) in the peripheral blood, regardless of maturation stage. It is abnormal to see nucleated RBCs in the peripheral blood of an adult. However, it is not unexpected in a patient diagnosed with leukemia, owing to possible bone marrow stress. The size of nucleated erythrocytes varies depending on the particular stage of maturation for each cell. Generally, they are larger than mature RBCs. The cell in this image is typical of those usually seen in the peripheral blood. The cytoplasmic color varies as well and ranges from deep blue to pink and depends on the amount of hemoglobin synthesized by the cell. Likewise, the nuclear size and chromatin structure is variable and related to the maturation stage of the cell. Nuclei decrease in size, and the chromatin pattern becomes increasingly clumped and condensed, even pyknotic with no areas of parachromatin visible, as the cell matures. The morphologic characteristics of this nucleated RBC indicate it is at a later stage of development. It is not necessary to
EDUCATIONAL COMMENTARY – MORPHOLOGIC CHARACTERISTICS OF MATURE AND IMMATURE PERIPHERAL BLOOD CELLS (cont.)

identify the specific type of nucleated erythrocyte seen, but their numbers should be counted and reported.

The cell selected in Image BCI-04 is a basophil. Basophils are similar to eosinophils and neutrophils in overall cell size, shape, and nuclear characteristics. They are medium-sized cells. However, basophils are distinguished by blue-black or deep purple cytoplasmic granules. These granules are generally numerous, large, and round. They often obscure the nucleus. Basophilic granules are also water soluble and may be washed out and fade during the staining process, as may be seen in this cell. Although the nucleus is often not visible in basophils, the chromatin is clumped and dense.

The final image for discussion, Image BCI-05, is a blast cell. Blasts should not be seen in the peripheral blood, but it is not surprising to see this cell in a patient with CML. Blasts are large cells, with a high nuclear to cytoplasmic ratio. The scanty to moderate amount of cytoplasm is dark blue and usually agranular. These cells are typically round to oval with a generally round to oval nucleus. The nuclear chromatin is loose and open and stains a lighter purple. Prominent and multiple nucleoli may be visible. This cell has a distinctive centrally located nucleolus and at least two others, one near the top and the other near the bottom right side of the nucleus. Blasts are not easily classified according to type, because cells of different lineages share similar features related to size, cytoplasmic characteristics, and nuclear features. Once blasts have been visualized in the peripheral blood, additional laboratory procedures are usually needed to specifically classify the cell lineage. However, the large size, multiple nucleoli, and presence of other granulocytes in the peripheral blood suggest that this blast is myeloid in origin.

**Chronic Myeloid (Myelogenous) Leukemia**

Chronic myeloid (myelogenous) leukemia is classified by the World Health Organization (WHO) as a myeloproliferative neoplasm and results from a mutation to the pluripotent hematopoietic stem cell. It is characterized by a proliferation of myeloid cells in the bone marrow and subsequent increase of these cells in the peripheral blood. The white blood cell count may be markedly elevated. A normocytic, normochromic anemia may also be seen. This case study patient presented with a hemoglobin
concentration of 8.2 g/dL (reference range, 14-17.4) and hematocrit of 26.0% (reference range, 42.0%-52.0%) but essentially normal RBC indices. The maturation and development of normal red blood cells is affected by the increase in myeloid cells in the bone marrow. Eosinophils and basophils are frequently elevated. Blasts, however, are less than 20% of all leukocytes in initial stages of the disease. Chronic myeloid leukemia is confirmed through cytogenetic and molecular testing. The detection of the Philadelphia chromosome or the BCR/ABL fusion gene is necessary to diagnose this condition.

Summary

The images for this testing event are from a male patient diagnosed with CML. The cells selected for evaluation and discussion represent both normal and abnormal findings that may be seen in the peripheral blood in this condition. Although additional laboratory testing is needed to confirm a diagnosis, initial review of the blood smear by a laboratory professional is essential in providing information supportive of this diagnosis.

Bibliography

