EDUCATIONAL COMMENTARY – A CASE OF INFECTION WITH A PLASMODIUM SPECIES

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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 Objectives

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

• describe morphologic features of selected peripheral blood leukocytes and normal erythrocytes;
• discuss significant morphologic characteristics of normal and large platelets; and
• identify distinguishing features of malarial parasites.

Case History

A CBC with differential was ordered on a 34-year-old male patient complaining of fever, fatigue, headache, and nausea after returning from an extended visit to the Dominican Republic. His CBC results are as follows: WBC=2.9x 10^9/L, RBC= 3.95 x 10^{12}/L, Hgb= 11.9 g/dL, Hct= 35.6 %, MCV= 90.1 fl, MCH=30.1 pg, MCHC=33.4 g/dL, Platelet= 74 x 10^9/L.

Introduction

The patient presented for this testing event contracted malaria caused by a Plasmodium species while traveling in the Dominican Republic. The images provided represent both normal and abnormal blood cells as well as the parasite, which can be seen in the peripheral blood during this infection.
Educational Commentary

Image BCI-11 is a lymphocyte. This particular cell is normal. Lymphocytes vary in size. This is an example of a medium-sized cell. Note that the nucleus of a small lymphocyte should be about the same size as a normal red blood cell (RBC). The mean corpuscular volume (MCV) for this patient is 90.1 fL, indicating that the average size of the erythrocytes is normal. However, the nucleus of this lymphocyte is slightly larger than the RBCs, suggesting that the overall size could be considered medium for this cell. The nuclear and cytoplasmic features are typical for a normal lymphocyte. The chromatin is condensed and clumped and stains a dark purple. The nuclear shape is round in this cell but a lymphocyte’s nuclear shape can also be oval. A moderate amount of blue cytoplasm is characteristic, as is a clear perinuclear area.

The arrow in Image BCI-12 points to a malarial parasite inside the RBC. There are four species of Plasmodium that cause disease in humans. The type of malaria infecting this patient is not specified. However, it is important to determine the species because the severity and clinical course varies among the four species. Species identification is usually performed by specialists in parasitology or microbiology departments. The erythrocyte in Image BCI-12 is infected with a ring trophozoite, a stage in the complex Plasmodium life cycle, often seen in the peripheral blood. Note the distinctive chromatin dot and the blue ring. The chromatin dot usually stains red, but with this particular stain, it appears to be a slightly more purple color. The blue ring is actually parasitic cytoplasm. It is important to systematically and carefully examine the stained peripheral blood smear when reviewing for intracellular malarial organisms. Artifacts can often be mistaken for ring trophozoites. Such artifacts can include precipitated stain and superimposed platelets. Intracellular organisms will focus with the erythrocyte whereas artifacts focus separately. Platelets are also granular and frequently are surrounded by a clear area or halo, whereas the parasitic ring is well defined.
The characteristics of a platelet can be appreciated in Image BCI-13. Platelets are variable in size and shape. Normal platelets are usually small, approximately 1 to 4 µm in diameter. This platelet actually appears larger than 4 µm (considering that a normal RBC is approximately 7 to 8 µm in diameter) and can be described as *large* or *enlarged*. Platelets that are as big as or bigger than a normal RBC are called *giant*. The platelet in Image BCI-13 can be considered large because it is smaller than the normal RBCs but still larger than 1 to 4 µm in diameter. Large platelets retain other features of normal platelets. Their shape is often round, but may be slightly oval. Sometimes the cytoplasmic margins are frayed and uneven. Platelets generally have a central, dense granular core with other granules dispersed around this core. The granules typically stain purple or blue-gray. Large platelets may represent younger cells that have recently been released from bone marrow megakaryocytes. They may be seen as nonspecific findings in thrombocytopenia or thrombocytosis and, occasionally, in patients without any bleeding diatheses, as in this case study situation.

Image BCI-14 shows a normal RBC. On peripheral blood smears, RBCs are morphologically evaluated for their size, shape, chromaticity (area of central pallor), distribution on the slide, and for the presence of any cytoplasmic inclusions (such as a malarial parasite). As noted above, the MCV in this case study patient is normal and this erythrocyte reflects a normal size. The cell is also evenly shaped with a normal area of central pallor, which is approximately one-third the diameter of the cell. The mean corpuscular hemoglobin (MCH) is a useful index to help assess the chromaticity of RBCs. In this case, the MCH is normal at 30.1 pg. Red blood cell distribution is evaluated considering all of the cells within a peripheral blood smear. The cells should be separated, with only occasional overlaps with other cells. This cell and others in the image show a normal distribution pattern. Finally, this particular cell has no inclusion.
The final cell for commentary in this testing event is a monocyte, shown in Image BCI-15. As seen in this example, monocytes are large cells. In fact, they are the largest cells that can normally be seen in the peripheral blood. These cells are typically round or oval. The nuclei in monocytes may also be round or oval but can be lobulated, kidney-shaped, or indented, as in this cell. Nuclear chromatin is usually minimally clumped and stains a lighter pink or purple. The cytoplasm in monocytes is characteristically abundant and blue-gray. The cytoplasmic color in this cell appears somewhat lighter than usual. Frequently, cytoplasmic extensions, as well as vacuoles, are visible. Cytoplasmic projections are not evident in this cell, but a few vacuoles can be seen, primarily on the outer edge of the cell’s right side. The cytoplasm typically appears rough or uneven, and sometimes fine pink or lilac (azurophilic) granules are visible, although no granules are present in this monocyte.

Malaria

Malaria is an acute condition seen worldwide, although transmission occurs most often in tropical climates. Humans become infected through the bite of a female *Anopheles* mosquito and then the microorganisms complete an asexual maturation cycle in the human host. The presence of ring trophozoites in the peripheral blood is a common manifestation of this disease. Although, it is possible to also see ameboid-shaped late trophozoites, schizonts and, less frequently, gametocytes. Because malarial parasites infect RBCs, and shorten their lifespan, a hemolytic anemia may develop. In this case study, the patient’s hemoglobin and hematocrit levels are decreased. In addition, thrombocytopenia may be seen as a nonspecific finding and it is present in this patient. Leukopenia is possible and is also seen in this patient, but some cases of malaria are associated with a mild leukocytosis.

Summary

The images presented in this testing event represent cells and a parasite seen in the peripheral blood of a patient diagnosed with malaria. A careful and systematic review of the stained blood slide must always be performed when abnormalities such as malaria are suspected. It is important to identify microorganisms but other changes in erythrocytes, leukocytes, and platelets may also be noted and reported.

Bibliography

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