Microcytic erythrocytes

Introduction

Microcytic erythrocytes can appear in the peripheral blood with and without shape changes. The morphological appearance is as varied as the different underlying causes. Whether microcytic cells lead to a low MCV (mean corpuscular volume) depends on whether the changes affect the major proportion of the cells or only part of the population.

In our proficiency testing survey specimen 2016-1 H3A, there was microcytosis and hypochromasia. The patient suffers from polycythemia vera (PCV). Regular phlebotomies (therapeutic bloodletting) lead to iron deficiency and thus to microcytosis of the erythrocytes. The erythrocyte count is increased due to polycythemia vera.

Mechanism of development of microcytic erythrocytes without changes in shape

If one looks at erythropoiesis, the hemoglobin synthesis begins in the proerythroblast. It continues up to the level of the polychromatic erythroblasts. Then the maximum hemoglobin concentration in the cell leads to condensation in the nucleus and thus makes the nucleus incapable of undergoing mitosis after the fourth mitosis. If the hemoglobin concentration in the erythrocytes, and thus during mitoses also in the cell nucleus, is abnormally low, a further fifth mitosis at the level of the polychromatic erythroblasts results. This leads to the formation of small, round microcytic erythrocytes.

In contrast, disturbances of mitosis (e.g. by vitamin B12 deficiency) lead to an early stop after the third mitosis, premature nucleus loss and thus to the formation of abnormally large erythrocytes.

Aspects of automated erythrocyte analysis

Hypochromasia

In microcytic erythrocytes without changes in shape, the mean corpuscular hemoglobin (MCH) of the cell is usually reduced. Whether the medium hb concentration of the cell is also reduced, can depend on the device technology used. In devices with hydrodynamic focusing or optical measurement of rolled up ERCs, the MCHC reference range is relatively narrow. This allows to very reliably detect a reduced average hb concentration in cells.

Microcytosis

Microcytic erythrocytes without changes in shape usually do not reach an MCV of < 65 fl in humans; therefore there is no risk of analytical measurement errors in hematology devices. However, microcytic erythrocytes with form changes often have a very low cell volume and in hematology machines with 3-part differentiation can lead to interferences in the platelet measurement.
### Microcytes without changes in shape

**Appearance**
- Regular round shape

**Microscopy**
- Small, spherical cells
- No central brightening

**Morphological Description**
- Reduced Hb synthesis leads to increased mitoses and to formation of microcytic cells
- ERC fragments with a relative lack of membrane form microspherocytes

**Mechanism of development**
- A structural defect of the erythrocyte membrane (often of the lipid distribution) leads to an increase of the cell surface without an increase of the cell volume. The formation of spiny protrusions results.

**Constrictions of fibrin strands in the vessel lumen with tearing-off of a cell portion and remaining residual fragment**

**Damage due to mechanical effects**
- Fusion of membranes touching another with formation of a pseudo-vacuole. Subsequent membrane rupture.

**Causes**
- Acquired: iron deficiency, anemia with chronic disease, MDS, etc.
- Inherited: Thalassemias and congenital hemoglobinopathies, congenital sideroblastic anemia, etc.
- see fragmentocytes/schistocytes hereditary spherocytosis autoimmune hemolytic anemia
- Abetalipoproteinemia (hereditary)
- Severe hepatic impairment
- Myelodysplastic syndromes
- Rare neurological disorders (neuroaxanthocytosis) after splenectomy
- DIG-disseminated intravascular coagulation
- MAHA-microangiopathic hemolytic anemia
- HELLP syndrome
- Extensive burns
- Mechanical damage
- Unstable hemoglobin
- Chemical damage
- Heinz bodies are usually detectable only after splenectomy or during hemolytic crisis. Supravital stains e.g. brilliant cresyl blue required.