

***Title of Lecture: Blood diseases (Anemia )***

***Date of Lecture:10-11-2014***

***Sheet no: 8***

***Refer to slide no. : 1***

***Written by: Dareen Mashaqbeh***

***This is the first lecture for doctor Tareq Al-adily.you have to refer to the slides along with this sheet .***

***Anemia***

*An: means negation , emia: means the blood,* and anemia means deficiency in the blood .

Slide #3:

anemia in it’s scientific definition means the reduction of total RBC **MASS** below average levels (**not** in the number ) and those levels are determined through tests which differ from age to another ,between males and females ,children and adults .

a person can have anemia even though the RBC’s count in his/her body is high and this is due to an abnormality within those cells ( RBCs are empty from the inside ) so it’s more accurate to define it as a reduction in the mass not in the count .

\*\***Anemia can be measured practically by :**

1) determining the Hemoglobin concentration (قوة الدم);

-in men from 14-16

-in women from 12-14

-in children it varies ;the highest in newborns then it starts to decrease until it reaches the normal adult range .

2)hematocrit

It’s a ratio not a number , determined by leaving the blood’s sample for a period of time and the RBCs will get down since they are heavier and the plasma gets up , so we take the ratio of the cells (RBCs) to the whole blood .

Slide #4:

Anemia is classified according either to the cause or to the morphology .

**\*according to the cause :**

-anemia of blood loss ;acute or chronic .

-anemia of decreased erythropoiesis; an issue that arises from the bone marrow therefore it doesn’t produce sufficient amount of cells .

🡪occurs mainly in nutritional anemia ; iron deficiency , vitamin B12 deficiency and in cases of malignant tumors in the bone marrow as in leukemia .

-anemia of increased destruction (Hemolytic anemia ) 🡪 it’s a premature destruction since the bone marrow produces the cells normally and in excessive amounts but there’s continuous destruction . This destruction occurs mainly: 1- Extra-vascular in the spleen since it works as a filter for old blood cells ;WBCs,RBCs and platelets . Spleen becomes over-functional and starts removing large amounts of cells.

2- destruction occurs intra-vascular ( in the blood vessels while the blood is circulating )

\* half life of RBCs 120 days .

**\*according to the morphology :** Slide #5

by looking to the size ,color and shape of the cells

-normal diameter of RBCs is 7-8 micron. If the size is less than that then it’s called microcytic anemia.

-if the size is normal then its called normocytic anemia and if its larger it’s called macrocytic anemia .

-there’s a test that is called blood film ;which means examination of blood cells by morphology by using the microscope .

-according to the color , it reflects the Hemoglobin inside . RBC has a central pallor because its biconcave in shape and being thin in the center so it appears empty there and the color appears lighter . ( in the center the diameter doesn’t count for more than one third of the whole diameter ).

🡪 if the cells don’t have enough hemoglobin then the pallor center becomes larger exceeding the one third and they are called **Hypochromic anemia (being light in color) .**

🡪 if the cells are large then by default they are known as **Hyperchromic anemia** however its not used in the terminology since the macrocytic anemia is usually hyperchromic .

**\*most types of anemia are microcytic and hypochromic as in iron deficiency anemia .**

**\* normochromic usually goes with normocytic; as in blood loss .**

**\*vitamin B12 results in the production of cells characterized of being large in their size however the number of those cells is less resulting in anemia ; called Macrocytic (hyperchromic ).**

All what is mentioned above is related to the morphology.

\*We have a test known as CBC ;complete blood test . we get a number by using a machine. In the case of volume its known as **mean cell volume (mcv)**; a measurement of a single RBC’s diameter is obtained through a machine .

🡪 it ranges from 80-100 femtoliter (fl) , if it’s below 80 then its microcytic anemia and if it’s above 100 it is considered macrocytic anemia .

\*We have another test known as **mean cell hemoglobin** ; the amount of hemoglobin inside the single RBC .

🡪if it is low then it is hypochromic anemia and if it is normal or high it’s normochromic , hyperchromic respectively .

-we have types of anemia with different shapes of cells as in sickle cell anemia and in iron deficiency anemia . in these conditions we have a feature called Anizopoikilocytosis ( -an means negation ,izo means identical . anizo🡪 means they are not the same . –poikilo means different shapes . – cytosis means different sizes) .

**Microcytic –hypochromic anemia**

there’s a problem in hemoglobin itself as in:

1) iron deficiency , hemoglobin consists of heme ( heme consists of iron and globin chains ) ,therefore in iron deficiency we don’t have enough amounts of Heme .

2)In thalassemia , a hereditary disease , there’ll be insufficient production of alpha and beta chains the ones that make the globin’s

structure ending up with less amount of hemoglobin .

**Macrocytic anemia**

Due to an issue in the original stem cell in the bone marrow (the ones that are responsible of the production of all cells ) , if there’s a defect there we end up with large cells .

As a conclusion , small cells are present in the case of iron deficiency and Thalassemia . large cells arise due to stem cell disease in the bone marrow .

Slide #7:

The most common symptoms of anemia are dizziness and pallor .

-pallor can be mostly seen in the conjunctiva , lips and nails

-other symptoms as fatigue can be explained due to the decrease in oxygen levels so the body cannot perform normally.

-headache since the brain is not functioning normally.

-hypotension due to the ineffectiveness of the blood even though it is found in its normal ranges ,forcing the heart to pump more blood resulting in Tachycardia and leading the lungs to function more to produce more amounts of oxygen ending up with what is called Tachypnia .

\* in cases of hemolytic anemia , RBCs are being broken down ,hemoglobin gets out and undergoes metabolism producing Bilirubin than in turn causes jaundice .

🡪patients with hemolytic anemia usually have jaundice ,spleenomegaly (enlargement of the spleen since it becomes over-functional to break down more cells ).

🡪 children with severe thalassemia or sickle cell anemia have skeletal abnormalities resulting in growth retardation .

Slide #8 :

Anemia of blood loss can be either acute or chronic .

-acute occurs in sudden loss of blood so it’s level is decreased , the body compensates this by increasing the Erythropoietin release however the bone marrow requires time to respond(couple of days ). The sudden decrease in the blood is fatal and affects vital organs especially kidneys and the brain . what the body actually does is that it shifts fluid from the extravascular ( interstitium ) to the intravascular space ending up with dilutional anemia .

**Anemia of acute blood loss is not fatal by itself but the patient dies due to the bleeding that occurs in the case of hypotension , the problem arises from the blood’s volume and this is called hypovolemic shock .**

-the first cell produced by the bone marrow is called Reticulocyte; a premature RBC which is slightly larger in size and has remnants of DNA . once it undergoes maturation it becomes a RBC .

🡪in this type of anemia we have an increase in the reticulocyte’s count. Normally it’s range is less than 1.5% of total RBCs ,however in anemia of acute blood loss the count exceeds the normal range and it might reach 5 to 10% of total RBCs .

Slide #9:

Anemia of chronic blood loss occurs for prolonged periods of time due to the continuous loss of RBCs in small amounts outside the body in a way that exceeds the compensation of bone marrow .

-usually occurs in patients with hidden GI diseases , patients with colon cancer and women with gynecologic diseases “diseases that occur in females genital tract due to menorrhagia” .

-associated with iron loss “ keep in mind that once iron is lost from the body it is not regained easily and it requires a period of time to get back to its level unlike other nutrients “ ,leading to iron deficiency anemia .

**SUMMARY:**

|  |  |
| --- | --- |
| Anemia of acute blood loss | Anemia of chronic blood loss |
| Characterized by a decrease in the hemoglobin with maintaining normal morphology of the RBCs since there’s no problem in the bone it’s just due to the loss of blood outside the body . | Cells at first have normal morphology then they start developing iron deficiency anemia and becoming hypochromic-microcytic. |

Slide #10:

**Hemolytic Anemia**

In this case of anemia , bone marrow produces RBCs normally but the problem develops outside the bone marrow resulting in premature death of the cells either in the spleen (extravascular )since its function is to remove the abnormal RBCs but it becomes over-functional , or inside the blood vessels (intravascular) .

* In the Extravascular there’s a defect in cells’ shapes ,therefore if a cell has an abnormal shape the macrophages of the spleen will catch it to get rid of it .

After the premature destruction of RBCs there’ll be accumulation of their hemoglobin’s degradation products (Bilirubin ) resulting in jaundice in the patients .

\*The body responds in hemolytic anemia by increasing Erythropoietin levels which in turn stimulates the bone marrow leading to the same sequence that is mentioned previously .”increasing reticulocytes ..” .

**SUMMARY**

**Features of Hemolytic anemia:**

1. **Jaundice**
2. **Spleenomegaly**
3. **Increased erythropoietin**
4. **Increased reticulocyte count**

\*in addition to other features as the enzyme **lactate dehydrogenase** that is found inside the RBC ,once the cell is destructed this enzyme gets outside and it can be measured .

\*we have another feature which is the enzyme **Haptoglobin** which is found in the serum ; it has to do with binding to hemoglobin that gets out of the destructed cell .

🡪 Hemoglobin by itself is toxic if it is out the RBC ,once it is out it starts degrading the surrounding cells’ proteins . the body prevents this from occurring through Haptoglobin enzyme which in turn catches the hemoglobin and neutralizes it to get it outside the body .

\*\* in hemolytic anemia we have low haptoglobin levels in serum since it binds to Hemoglobin and get along with it outside the body .

Slide #11:

**Extravascular hemolysis**

Characterized by an abnormality in the RBC’s shape ,so while entering the spleen the RBC gets stuck in spleen’s sinusoids and this is followed by phagocytosis by spleen’s macrophages .

Slide #12:

**Intravascular hemolysis**

RBCs get destructed while circulating in the blood . this type is usually associated with defects in enzymes that are inside the cells resulting in destructions of the cells due to defects that arise from the cells themselves.

**This type has nothing to do with the shape of the cells .**

**-**malaria and other infections lead to intravascular hemolysis

-there’s no spleenomegaly in this type . the amount of hemoglobin that gets out is very high thus having severe toxicity and resulting in more harm to the body .

-lactate dehydrogenase here is higher than in the extravascular type. And haptoglobin’s level is almost zero .

🡪since hemoglobin’s level is very high , it could be excreted in the urine (makes the urine darker in color ) causing damage to the kidney .

**Features of intravascular hemolysis :**

1. **Dark urine**
2. **Renal hemosiderosis ( while the hemoglobin is getting out through of the kidney ,some of it can accumulate in the kidney and if iron accumulates then it’s known as Hemosiderosis ) .**

* Iron by itself is toxic and once it accumulates in large amounts ,it causes physical damage to the cells in the kidney .

Slide #13:

**Hereditary spherocytosis**

The cells are spherocytes (globular ) . it’s an inherited disorder ; autosomal dominant .

-occurs due to defects in cell membrane’s proteins as in **spectrin** , **ankyrin** and **band 3** .

🡪 normally those proteins give the integrity for the membrane ,however due to genetic mutation in the genes that produce these proteins as in this disease they become inefficient or even absent resulting in weakness of the cell membrane’s skeleton .

-as the RBCs are circulating in the blood , they keep on losing fragments of their cell membranes since they are fragile now. This results in the transformation of the biconcave shape of the RBC to the globe/sphere shape .

- once these small spherical cells reach the spleen they’ll be recognized and eliminated by the macrophages . the patient will have Extravascular hemolysis and will develop it’s specific features .

-RBCs with the spherical shape can function normally but the problem arises from their destruction in the spleen .

\*this disease is only treated by removing the spleen .

- these cells appear in the blood film appear as small red cells with no central pallor .

Some of RBCs have remnants of DNA known as **Howell-Jolly bodies** . those normally are not seen since the spleen removes them but after splenectomy they start to appear.

🡪reticulocytes before maturation have pieces of DNA in which those are lost upon maturation . some RBCs will still have remnants of DNA and normally are eliminated by the spleen but if the spleen is removed for any reason or another some cells will still have remnants of DNA resulting in Howell-Jolly bodies .