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***Title of Lecture: blood diseases***

***Date of Lecture: Tues. 11/11/2014***

***Sheet no: 16***

***Refer to slide no. : #20…#***

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**☺ Slide 20 :**

**Glucose-6-Phosphate Dehydrogenase Deficiency التفول(G6PD) ☺**

**-**Enzyme deficiency which causes Hemolytic anemia ( important enzyme in the free radicals cycle). This enzyme is present in all the cells in the body ,but the RBC’s have special condition.

G6PD Function : it can convert NADP🡪NADPH which is important for the cells , NADPH neutralizes/combats H2O2 (hydrogen superoxide, one of the strong free radicals and the most common one)

Oxygen free radicals (H2O2 ) الجذور الحرة: are high energy compounds , they get out after the cell metabolism of O2 , and if they strike anything they will cause physical & chemical damage.

So the cell combats this free radical(H2O2) by NADPH and convert it to H2O(normal).
 When there’s G6PD deficiency so there will be no NADPH and the H2O2 will increase in number and cause a lot of damage to the cell.

G6PD deficiency , deficiency not only 1% but relative “meaning that :
 1. It’s not totally absent, and if it’s so 🡪 early death “no chance for
 disease”
 2. In case of “disease” **Relative** means : - either low # of G6P
 - or abnormal function

- Multiple subtypes of the mutation; it could be deficient and small amount of the enzyme is present due to mutation, or the enzyme is present but not functioning so no NADPH is produced.

As we said This enzyme is present in all the cells in the body ,but the RBC’s have special condition. RBC’s are the most affected by G6PD deficiency because they are non-nucleated , long half life 120 day and can’t produce G6PD as the rest of other cells

G6PD deficiency is an inherited disease: X-linked disease; the responsible gene is on the X-chromosome it’s a sex chromosome diseases appear mainly in males; XY, rare in females; XX. (X-linked inheritance means that the gene causing the trait or the disorder is located on the X chromosome. Females have two X chromosomes, while males have one X and one Y chromosome).

We have two types of this disease , deficiency can be quantitative (quantity is less and common in African ) qualitative ( here quantity is ok but with abnormal function common in Mediterranean )

**☺ Slide 21 :** Pathogenesis

Some pathophysiology: any stress in the body that makes a lot of O2 metabolism and gives a huge number of H2O2which as we said a free radicalandhas a high energy, when it strikes against hemoglobin it causes changes in Hb characteristics; parts of Hb condense under the cell membrane ,these condensated Hb are called Heinz bodies.

-Heinz bodies: condensated (aggregated) Hb chains will cause changes in the structure of the RBC, break the cell membrane , and cause hemolysis inside the vessel as a result of H2O2 (occur secondary to G6PD deficiency),

When the Hb condense under the cell membrane the Splenic macrophages identify , sense the Heinz bodies and pluck them out resulting in indentation. The remaining RBC is known as “bite cells” 

G6PD deficiency appear under the microscope: bite cells &with crystal violet “special stain” Heinz bodies appear.

**☺ Slide 23:**

G6PD , the cases that lead to increase H2O2 . H2O2 increases in acute and immediate cases it’s not a chronic disease . one of these cases :

1. Infection; WBCs like (neutrophils) produce free radicals to kill bacteria in the lysosome which contain free radicals. So if these patients have infection, they’ll have high amounts of free radicals resulting in crisis (انتكاسي), severe drop in Hb and severe symptoms as pain .
2. Metabolism of drugs; some drugs produce free radicals when they’re metabolized ,most common drugs \*\*Some antibiotics: Antimalarials for malaria & can be given for rheumatic patients ;لعلاج مرضى الروماتيزم والملاريا

sulfonamide; commonly prescribed in dental, UTI & GI infections; their metabolism produce free radicals and causes crisis

**So before prescribing them , the patient should be asked if he had any type of anemia in order not to produce crisis.**

3. Certain types of food contain high amounts of oxygen & produce gases; these patients “with favasims” when they eat fava beans (فول) or legumesبقوليات ;oxygen accumulates & after 2-3 days hemolytic crisis appear, that’s why it’s called مرض التفول.

-Crisis appear 2-3 days after exposure to oxidant (drugs, fava beans, infection..)not sudden & not spontaneous . so when we take a history of a patient we asked about the factors 2 days ago .

**☺ Slide 24:**

Hemolytic Anemia secondary to physical damage

Remember in G6PD deficiency: as a result of Hb condensation RBC’s membrane is torn= Intravascular hemolysis, & when the spleen removes them =Extravascular hemolysis . So it is COMBAINED! Differs than heredity spherocytosis and thalassemia .

- Chronic symptoms of hemolysis are absent; it’s acute and in crisis.

Hemolytic anemia resulting from trauma to RBC’s :

Something outside the RBC causes destruction, most common causes:

1. Cardiac valves ( synthetic, metal) in patients with valve diseases, its an abnormal environment for RBC& so it breaks down resulting in hemolytic anemia. The fragments of RBC’s resulted are called schistocytes (خلايا ممزقة ) that appear with different shapes .
2. Chronic physical stress : vigorous exercise in athletes & soldiers; destruction in peripheral sites caused by running and marching for along time .also this can cause hemolytic anemia .
3. Medical conditions like thrombosis everywhere in the body we called it Microangiopathic hemolytic anemia. “This is a medical emergencies wide spread of thrombosis in all circulation of the body , RBC’S will break down when hitting these solid thrombosis “
 🡪 Thrombus is **solid** causing damage

**☺ Slide 27:** Thalassemia مرض فقردم البحر المتوسط

Inherited disease; Autosomal ressive.

It’s a group of diseases not a single one . Caused by a Defect in the synthesis of Hb “one of the chains of hemoglobin either alpha (alpha thalassemia) or beta ( beta thalassemia ) “

•very common in Middle East, tropical Africa, India, Asia

**☺ Slide 28:** Beta thalassemia

2 genes are responsible for β -chain, if both are defected sever β-Thalassemias. But In α-thalassemia 4 genes are responsible for the α-chain, if two is defected the other 2 compensate. so the likelihood of the disease in β-thalassemia is higher. Beta thalassemia single mutations can be carrier “silent” or “intermediate” .

Types :

- In β-Thalassemia it’s a point mutation while in α-thalassemia it’s deletion.

- β0 *mutations,* sever defect, associated with absent β-globin synthesis

-β+ *mutations,* reduced β-globin synthesis(slow ) , relative deficiency. |

**☺ Slide 29 :pathogenesis**

In Beta thalassemia ,We have a genetic problem , so the stem cell of erythroid can’t give us enough normal hemoglobin , all are the same and defective .

We have Deficiency either in beta or alpha , first we will talk about beta the most common and serious one . beta is less but alpha is working normaly so hemoglobin A or adult hemoglobin which contain 2 alpha 2 beta the quantity of it become ‘less’ so the RBC will get out with less hemoglobin **hypochromic microcytic "صغار وفاتحين" anemia** (the patient will have persist anemia along the whole of his life) , RBCs with abnormal oxygen transport capacity so the tissues are always have hypoxia , high erythropoietin , erythroid cells are always proliferating but still defective and here the bone marrow will have a huge number of erythroid cells but still they are not coping well so the problem can’t be resolved Excessive erythroid precursors in bone marrow, steals oxygen and the nutrients either from the bone cells itself , causing bone growth abnormality , huge number of erythroid interfering with the growth of normal bone (patients come with short stature) , bone retardation skeleton abnormalities (mainly skull and face are enlarged and more prominent ; as a result of bone marrow activity)
 🡪 this is associated with sickle cell anemia also

Erythropoietin keeps in a huge number the whole life and erythroid , reticulocytes are also in a huge number , when the erythropoietin keeps In a high range for a long time it will activate erythropoiesis outside the bone marrow as in the fetal life , In fetal life; blood elements are produced from the liver &spleen so in these patients the liver and spleen are trying to compensate anemia resulting in extramedullary erythropoiesis “ “hepatosplenomegaly” enlargement of both liver and spleen.

In β-Thalassemia, β chain is less than normal & alpha is normal so the normal pairing is disturbed, unpaired excess alpha chain accumulates & cause death of erythroid precursors and lyses in early stages causing hemolysis in the bone marrow. So thalassemia is an inta and extra medullary vascular hemolysis .

- Remainder of Hb structure :

* Hemoglobin A (adult) : 2 alpha & 2 beta chains . 95% of normal Hb.
* Hemoglobin A2 (3%) : 2 alpha & 2 delta . this will help us in diagnosis because here there’s no beta so when we make hemoglobin electrophoresis which separate A from A2 , then we find a high level of A2 so here the patient is having beta thalassemia.
* Hemoglobin F (Fetal) : 2 alpha & 2 gamma. 1% in adults

2 genes for beta , when both of them are defected so this case called **beta major** and will have all the thalassemia’s features: anemia, growth retardation , skeleton abnormalities & hepatosplenomegaly.

- β- minor (carrier asymptomatic patient); normal β chain + β+ defect

 When the parents are both carrier (β minor) the child has a major thalassemia so it’s a genetic defect & need a blood transfusion for the rest of their life,

Carries asymptomatic patient , in blood films RBC appear as microcytic hypochromic& the **mean cell volume (MCV)** is low, and this is required for pre-marital tests . (Importance: 2 minor parents will have a major thalassemia child which is catastrophic).

Β-intermedia : between major and minor , sever but doesn’t require blood transfusion.

**☺ Slide 31: α-Thalassemia**

* **α-Thalassemia:**

Defect in the α-chain which has 4 genes

- One gene is lost: silent carrier asyptomatic , no red sell abnormality .

- 2 genes are lost: silent Carrier with low MCV & asyptomatic (like β minor)

- 3 genes are lost: Hb-H (like β major) severe and also reassemble beta thalassemia intermedia

**Extra** : Hb-H: when β chains connect to each other & we can test it because it has physical characteristics.

- 4 genes are lost: incompatible with life, patient die in utero we called this case “ hydrops fetalis ; because alpha chain is present in all types (Hb A: Alpha &Beta, Hb A2: Alpha &delta ,Hb-F; Alpha& gamma).

**☺ Slide 32:**

Morphology : the cells are hypochromic microcytic .

Hypochromic microcytic appearance is seen in both thalassemia and iron deficiency the difference is the prominent ribosomes in thalassemia – related to something called **Basophillic stippling: (blue dots)** abnormal metabolism & accumulation of ribosomes (refer to slide 33) , high LDH .

Hemobyglobin electrophoresis - A2 is high-

Target cell: seen in thalassemia, sickle cell anemia and iron deficiency, Normally we have central pallor around the cell ,in thalassemia it appears as target cell with Hb abnormality inside. Target cell doesn’t have specific indication , ( refer to slide 35)

**☺ Slide 36 : sicke cell anemia**

Sickle cell anemia is an Autosomal recessive inheritance. (Every person has two copies of every gene on [autosomal](http://en.wikipedia.org/wiki/Autosome%22%20%5Co%20%22Autosome) chromosomes, one from mother and one from father. If a genetic trait is recessive, a person needs to inherit two copies of the gene for the trait to be expressed. Thus, both parents have to be carriers of a recessive trait in order for a child to express that trait)

**-Hb-S:** β globin chain is mutated in the sixth codon , one of the amino acid is replaced , glutamate (charged) is replaced with valine (uncharged) causing a change in the physical characteristics

**☺ Slide 37:**

\* sickle cell Carrier (Asymptomatic): one normal (Hb-A) & the other is Hb-S , completely normal . **but here 50% HbA2 50% Hb S**

Sickle cell Disease : both genes are defected ,

**Hb-A ( 2 alpha 2beta ) in this case no beta chains both are mutant Hb A = 0 % Hb S comes instead of it = 95% then HB A2 and Hb F the rest .**

Characteristics of globin chain will be changed into hydrophobic not normal as normal hemoglobin , Always remember hemoglobin S in normal conditions carry , deliver oxygen and work normally as Hb of the adult but in infection,acidosis, dehydration, hypoxia it changes its appearance & start to accumulate. Carriers have Hb A which prevents Hb S from a not good working .

Babies with Sickle cell anemia , they born with high hemobglobin F ( alpha , gamma ) which prevents sickle disease to happen until they became 1 year.

**☺ Slide : 39**

Hemoglobin S chains start to accumulate above each other to give a needle like structure , so at the end the RBC’s will give us the sickle appearance(منجلية الشكل) instead of a sphere .

When Hb-S accumulates which can torn RBC’s membrane (Intravascular hemolysis) & spleen removes them early in life (Extravascular hemolysis ) resulting in chronic anemia . but The main problem in sickle cell anemia –if it was irreversibly sickled- that it can obstruct capillaries & cause thrombosis(clot) after a while by hitting each other .

Thrombi is like a disaster in those patients with sickle anemia, they will suffer from iscimia at any organ and at anytime ( infraction may happen & risk of infraction in vital organs ) Vaso-occlusive crisis as we said a thrombi can happen at any part of the body ,skin(ulcers) lung(infracts) , bone marrow , spleen, brain & heart( myocardial infarction ) ; in vital organs the patient dies at age 15 or 20.

* Spleen in sickle cell anemia:

 -- Early in life spleen removes sickled cells [as in thalassemia; bone marrow is active to compensate lost RBCs & spleen is enlarged to remove them] but with chronic thrombi , autosplenectomy “Aspleen” happen as a result from thrombi in the spleen capillaries.

**Patients with Sickle cell anemia are resistant to malaria for an unknown reason. “no body know why”**

**☺ Slide 40,41:**

**Diagnosis**

Morphology of sickle cell anemia : we can see sickle cells , target cells , Howel Jolly bodies

Definite , we make hemoglobin electrophoresis to differentiate them with other diseases Hb S appears nearly 90%

**Best of Luck ☺**