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Original Article

Status of Glucose-6 Phosphate Dehydrogenase Enzyme in Patients with Hemolytic Anemia

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Abstract:

Background: Glucose-6 Phosphate Dehydrogenase (G-6PD) enzyme deficiency is an important cause of hemolytic anemia. Acute hemolytic crisis may occur in G-6PD enzyme deficiency due to some oxidative stress. Hemolysis of RBC may occur even without prior administration of drugs in patients with G-6PD enzyme deficiency. Erythrocyte and serum level of G-6PD enzyme are lower in most of the patients with hemolytic anemia

Objectives: To assess the status of erythrocyte and serum level of G-6PD enzyme in patients with hemolytic anemia.

Method: The cross sectional study was carried out in the Department of physiology, BSMMU, Dhaka from July 2002 to 2003 to observe the status of Glucose-6 Phosphate Dehydrogenase (G-6PD) enzyme in patient with hemolytic anemia. For this, total number of 50 hemolytic anemic patients (Groups-B) with age ranged from 5 to 30 years of both sexes was studied. Among them, 25 were without G-6PD deficient hemolytic anemia (group-B1) and 25 were hemolytic anemia with G-6PD deficiency(group-B2).Age and sex matched 30 apparently healthy subjects with normal blood G-6PD were included to observe baseline data (Group-A) and also for comparison. The subject was selected from out Patient Department of Hematology, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka. Blood erythrocyte and serum levels of G-6PD enzyme level were measured by standard laboratory techniques. Analysis of data was done by unpaired student't' test.

Results: Both erythrocyte and serum level of G-6PD enzyme levels were significantly lower in patients with hemolytic anemia.

Conclusion: Erythrocyte and serum level of G-6PD enzyme may play important role in the diagnosis of hemolytic anemia with or without G-6PD enzyme deficiency and may help in prompt patient management.

Key words: Glucose-6 Phosphate Dehydrogenase Enzyme, Hemolytic Anemia.

Introduction:

Hemolytic anemia may be defined as anemia resulting from an increase in the rate of red cell destruction.[1] Erythrocyte of G-6PD enzyme deficiency is an important cause of hemolytic Anemia.[2] Acute hemolytic crisis may occur in G-6PD enzyme deficiency due to some oxidative stress, such as intake some anti–malarial drugs, Ingestion of Feva beans, and various types of bacterial & viral infection.[3-5] Hemolysis of RBC may occur even without prior administration of drugs in G-6PD enzyme deficiency.[6-8] It can also lead to life threatening hemolytic crisis in childhood and advanced age by interacting with specific drugs.[9] Hemolytic anemia induced by drugs is more common in patients with erythrocyte G-6PD enzyme deficiiency.[10] Erythrocyte enzyme concentration has been significantly lowered in hemolytic anemia suffering from any type of infection.[11] Again, when erythrocyte G-6PD enzyme efficiency its present usually more marked hemolysis occurs in this group of anemic patients.[12] On the other hand, oxidative stress, ingestion of certain drugs also causes marked hemolysis in similar group of enzyme deficient patients with hemolytic anemia.[13]

In hemolytic anemia erythrocyte G-6PD enzyme is significantly lowered during acute infection.[14] Erythrocyte and serum level of G-6PD enzyme were

lower in most of the patient with hemolytic anemia, while it remained normal in some cases.[15] on the other hand, the invesgators of different countries reported that erythrocyte and serum level of G-6PD enzyme has been decreased after prolong use of oxidative drugs.[16-17]

In Bangladesh, many people are suffering from hemolytic anemia due to erythrocyte G-6PD enzyme deficiency. Unfortunately, most of them are treated without knowing the underlying cause. In our country, there is lack of adequate information about deficiency of erythrocyte G-6PD enzyme in the hemolytic anemic patients and a few published data regarding the effects of erythrocyte G-6PD enzyme deficiency patients are available in our country.[18,19] and also from other countries.[14, 15]

Therefore, the present study was under taken to hemolytic anemic patients with and without erythrocyte G-6PD enzyme deficiency. The outcome of the study may be helpful to create awareness among the clinicians about the needful in avoiding various complications due to this deficiency in hemolytic anemia.

Methods

the present cross-sectional study was carried out in the department of Physiology, BSMMU, Dhaka from July 2002 to 2003. For this, a total number of 80 subjects with age range from 5 to 30 years of both sexes were included. Among them, 50 patients with hemolytic anemia were included in Group B.On the basis of G-6PD enzyme level subject B were further divided into Group B1, consisted of 25 patients without this enzyme deficiency and Group B2 consisted of 25 patients with this enzyme deficiency .Age and sex matched 30 apparently healthy subjects with normal blood G-6PD enzyme level were taken to observe the baseline data (control) and also for comparison. All the G-6PD enzyme deficient and non deficient patients were selected from personal contact. Patients with acute hemolytic episode or receive blood transfusion in the last 2 months and the thalassemia trait were excluded from the study. For all the subjects, 2 ml of blood was taken in an EDTA test tube for determination of erythrocyte and serum G-6PD enzyme level. Erythrocyte G-6PD enzyme level was determined by spectrophotometric method20. All of these tests were done in the Department of Hematology, BSMMU, Dhaka. Data were expressed as Mean±SE. Statistical analysis of the results were done by unpaired Student t test by using SPSS program version 12.

Results

Mean erythrocyte G-6PD enzyme level was significantly ($P<0.001$) lower in G-6PD enzyme deficient group (G-6PD enzyme deficiency) than that of healthy control (Group A) and hemolytic anemia without G-6PD enzyme deficiency (Group B1).

Table-I: Erythrocyte Glucose-6 Phosphate Dehydrogenase Enzyme level in different groups of subjects (n=80)

Groups	n	RBC level (Mu/109erythrocyte) Mean(±SE)
A	30	119.79±1.69
		(101.60-140.20)
B_1	25	130.42 ±2.80
		(109.00-168.30)
B_2	25	41.28±3.99
		(16.40-91.10)

Statistical Analysis			
Groups	**df**	**t-value**	**P-value**
A vs B_1	53	-5.01	<0.001***
A vs B_2	53	18.76	<0.001***
B1 vs B_2	48	-18.30	<0.001***

Data were expressed as mean ± SE. Figures in parenthesis indicate ranges.

Group A: Apparently healthy subject

Group B_1: Hemolytic Anemia without G-6PD deficiency

Group B_2: Hemolytic Anemia with G-6PD deficiency

Table-II: Serum Glucose-6 Phosphate Dehydrogenase Enzyme level in different groups of subjects (n=80)

Groups	n	Serum Glucose-6 PD level(mU/ml) Mean(±SE)
A	30	14.01±0.24
		(11.77-16.82)
B_1	25	7.83-.50
		(3.36-11.77)
B_2	25	5.73±.53
		(2.50-12.60)

Statistical Analysis			
Groups	**df**	**t-value**	**P-value**
A vs B_1	53	11.84	<0.001***
A vs B_2	53	15.12	<0.001***
B_1 vs B_2	48	-2.90	<0.01***

Data were expressed as mean ± SE. Figures in parenthesis indicate ranges.

Group A: Apparently healthy subject

Group B_1: Hemolytic Anemia without G-6PD deficiency

Group B_2: Hemolytic Anemia with G-6PD deficiency

Discussion:

The patients with G-6PD enzyme deficiency had significantly lower both erythrocyte and serum level of G-6PD enzyme level in comparison to those of healthy control. These findings are consistent with those of some investigators of different countries.[23] On the other hand, erythrocyte and serum level of G-6PD enzyme level had significantly lower in patients without G-6PD enzyme deficiency than that of healthy control. These findings had also been reported by some other group investigators.[24] The erythrocyte and serum level of G-6PD enzyme level had significantly lower in patients with and without G-6PD enzyme deficiency due to excessive destruction of affected erythrocyte.[25]

Changes in red cell membrane integrity may be the possible cause of early destruction of RBC in G-6PD enzyme deficient in hemolytic anemia.[26] It has been suggested that abnormal degradation of hemoglobin may occur in G-6PD enzyme deficient hemolytic anemia.[27] Disturbance of intracellular metabolism may of also be the another possible underlying cause in this type of hemolytic anemia.[16]

Extensive studies on the occurrence of severe anemia in Erythrocyte G-6PD enzyme deficient patients indicate that such erythrocyte are prone to rapid and easy destruction by reticuloendothelial system. Abnormal degradation of hemoglobin, disturbances in intracellular metabolism or changes in membrane integrity is the possible underlying causes of early destruction of Erythrocyte G-6PD enzyme deficient erythrocyte in hemolytic anemia.

It is known that Erythrocyte depends upon the pentose monophosphate shunt for the production of energy to drive various associated cell processes and Erythrocyte G-6PD initiates this pathway. A deficiency of this enzyme leads to lower level of reduced hemoglobin, glutathione or NADPH.As a result, intracellular stability of the affected erythrocytes may be impaired due to disturbances metabolism and such cells undergo destruction more rapidly than normal cell.[26] In addition, it has also the lower level of reduced glutathione Erythrocyte G-6PD enzyme deficiency erythrocytes limit their ability to resist oxidative stress and leads to premature destruction.so,the deficiency of the enzyme leads to more hemolysis, though the exact mechanism involved for this markedly increased hemolysis is not clear, it appears to be due to changes in the erythrocyte membrane permeability that tenders it more susceptible to destruction.[27] Again Erythrocyte G-6PD enzyme is essential for maintain of the integrity of red cell membrane. Erythrocyte G-6PD enzyme deficiency might lead to more hemolysis. This is supported by markedly lower level in hemolytic anemic Erythrocyte G-6PD enzyme deficiency. Additionally changes in erythrocyte membrane characteristics as a result of oxidative damage may also act as a causative factor for erythrocyte life span.

All the above mentioned suggestions may also be the underlying cause of excess hemolysis of RBC in the G-6PD enzyme deficient hemolytic anemic patients of present series. But it is difficult to comment on all the above mentioned factors as they were not studied.

Conclusion

Therefore, this study concludes that in G-6PD enzyme deficiency, excess hemolysis of RBC occur possible due to membrane defect.

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