Glucose −6− Phosphate Dehydrogenase Deficiency in Bahraini Blood Donors

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ABSTRACT

Glucose −6− phosphate dehydrogenase deficiency, a genetic defect, underlying the biochemical red cell abnormality is the most common red cell enzyme disorder and occurs world wide. Blood from donors with G6PD-deficiency survives normally unless the recipient is given certain oxidant drugs which may lead to a rapid destruction of the G6PD-deficient cells. 2680 male Bahraini blood donors attending the Central Blood Bank, Salmaniya Medical Centre were screened for G6PD-deficiency. The result of the study showed that 26.4% blood donors were G6PD-deficient. It is proposed to estimate quantitative enzyme levels to identify G6PD variants in the population to assess the extent of its severity, and a clinical trial to assess the effect of blood transfusion on patients receiving G6PD-deficient donor cells.

Glucose −6− phosphate dehydrogenase deficiency (G6PD-deficiency), a genetic defect, underlying the biochemical red cell abnormality occurs world wide. Its incidence and clinical presentation varies considerably among different ethnic groups and it may express itself as a drug induced haemolytic anaemia, neonatal jaundice, haemolytic anaemia following infection, chronic non-spherocytic haemolytic anaemia, favism or it may be asymptomatic[1]. G6PD-deficiency is a sex-linked disorder and shows a higher frequency in male than in female[2].

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The incidence of G6PD-deficiency is higher in the Arab World, and varies from 8% to 50% in different population[3,4,5,6,7,8]. A study recently conducted in Bahrain has shown a frequency of G6PD-deficiency as 20.9% in cord blood samples of both the sexes of Bahraini babies[9].

Blood from donors with G6PD-deficiency survives normally unless the recipient is given certain oxidant drugs which may lead to a rapid destruction of G6PD-deficient donor cells. Ideally, persons with the Mediterranean type of G6PD-deficiency should not be blood donors[10]. It is also shown that on storage, the viability of red cells is not maintained quite as well as that of normal red cells[11]. On the other hand no deleterious consequences were uncovered after a careful evaluation of the recipients of G6PD-deficient blood[12].

In view of the above facts we carried out a study to estimate the extent of G6PD-deficiency in blood donors. We briefly review and discuss the problems in donor selection and transfusion of G6PD-deficient blood. To the best of our knowledge this is the first published report on the prevalence of G6PD-deficiency in Bahraini Blood Donors.

METHODS

Between March 1986, and February 1987, 2680 male Bahraini blood donors visiting the Central Blood Bank, SMC, were screened for G6PD-deficiency. In our blood bank 96% of blood donors are male donors, therefore, females were not included in the study. The blood was collected in Na_2 EDTA anticoagulant and qualitative dye reduction test of Bernstein[13] as modified by Motulsky[14] was used to estimate G6PD-deficiency in red cells. This test depends upon the reduction and decolourisation of the dye 2,6 dichlorophenol indophenol (DCPIP) in the presence of buffered substrate (Glucose −6− phosphate), coenzyme (NADP) and intermediate

electron acceptor (phenazine methosulphate) which accelerates the decolourisation. In this system, haemolysates containing normal enzyme activity decolourise within 20 minutes.

Blood donors were routinely screened by history taking for their general health and fitness. Haemoglobin estimation was done by finger prick on OSM 2 Hemoximeter (by oxyhaemoglobin method) to exclude anaemia. All donors below the haemoglobin level of 13.5 g/dl were excluded.

RESULTS

Out of total number of 2680 male blood donors, 709 were found to be deficient, which gave the prevalence of the deficiency as 26.45% in males.

DISCUSSION

Results of our study show a high prevalence (26.4%) of G6PD-deficiency in Bahraini male blood donors. This figure is higher than 20.9% deficiency previously observed in Bahrain in cord blood samples of both the sexes. G6PD-deficiency is a sex-linked disorder and shows a higher incidence in male than in female. In similar study on male blood donors from Saudi Arabia 36% were found deficient[15].

A majority of G6PD-deficiency patients are symptomless, normal on physical examination and have normal haematological parameters. Their susceptibility to various adverse factors such as oxidative assult due to drugs and chemicals, fava bean ingestion, infections, diabetic acidosis etc, promote haemolysis. This varies from very mild to severe enough requiring admission to the hospital. In the blood transfusion practice at Salmaniya Medical Centre, we receive a large number of requests for blood transfusions in children presenting with severe haemolytic crises due to G6PD-deficiency, most often with history of ingestion of fava beans. Blood transfusion requests in new born babies presenting with neonatal hyperbilirubinimia due to G6PD-deficiency are also not uncommon where other predisposing factors such as prematurity, blood group incompatibility and drugs have been excluded. There are no studies conducted in Bahrain which show the distribution of G6PD variants in the population, but in favism and neonatal hyperbilirubinimia, the variant most commonly implicated is G6PD Mediterranean[16]. In the western region of Saudi Arabia the B+, A+, B slow and deficient Gd$^-$ variant of G6PD-deficiency was described[17]. Mediterranean variant has been reported in Bedouin in the eastern region of Saudi Arabia[18].

It has been reported[10] that the persons with the Mediterranean type of deficiency should not be blood donors. It was suggested that G6PD-deficient blood transfused to G6PD-deficient individuals may cause an increase in haemolysis[19], particularly during the exchange transfusion of G6PD-deficient infants. Similarly, injection of 51Cr-labelled cells from drug sensitive individuals into normal recipients who then received primaquine resulted in destruction of transfused cells only[20,21]. It was suggested that the use of a donor with this deficiency imposes a small but definite risk to the recipient[22]. The storage of G6PD-deficient blood results in accumulation of pyruvate[23]. Likewise, the activity of Glucose−6−phosphate dehydrogenase declines exponentially with cell age. Red cells with unstable variants undergo premature metabolic ageing. The older, enzyme-impoverished cells suffer the consequences[16].

In our experience a number of patients with haemolytic crises require multiple transfusions during their hospital stay. Is it because there is no expected rise in haemoglobin after transfusion of donor G6PD-deficient blood or because of reasons of continued haemolytic process ? In a majority of patients a desired rise in haemoglobin is achieved, but in certain patients who are on oxidant drugs (eg. chloramphenical, sulphonamides) and in whom other clinical explanations were excluded, blood transfusions fail to raise the haemoglobin to the expected level. However, this needs evaluation by further planned clinical studies. After a careful evaluation of the recipients of G6PD-deficient blood no deleterious consequences were uncovered[12], and no adverse haemolytic reactions were encountered in patients after transfusion[24].

In a study on blood donors in Saudi Arabia, it was observed that 3% of Saudis have severe enzyme deficiency with residual enzyme activity less than 10% of the normal[15], while 30% of males and 10% females have a mild enzyme deficiency between 10% and 60% of the normal enzyme activity. In our study, quantitative estimation of G6PD activity was

not carried out, but in view of the high prevalence of this deficiency in Bahrain and the conflicting reports on the use of G6PD-deficient blood in G6PD-deficient patients, further studies may be valuable in estimating the quantitative enzyme levels in the population to find out the extent of clinical severity. It may be possible to throw some light on the doubtful effects of transfusion of G6PD-deficient blood by conducting a prospective clinical study which includes this precise measurement. Blood is a precious commodity and if we have to curtail blood donation by G6PD-deficient volunteers it will be a substantial loss of a valuable resource.

REFERENCES

1. WHO. Standardisation of procedures for the study of glucose −6− phosphate dehydrogenase. WHO Tech Rep Ser 1967;366.

2. Dacie JV. The haemolytic anaemias. Part IV. 2nd ed. London : J and A Churchill Ltd, 1967:1003.

3. Gelpi AP. Glucose −6− phosphate dehydrogenase deficiency in Saudi Arabia. Blood 1965;25:486.

4. Walker DG, Bowman JE. Glutathione stability of erythrocytes in Iranians. Nature 1959;184:1325.

5. Laman Amin — Zaki, El-Din SJ, Kubba K. Glucose −6− phosphate dehydrogenase deficiency among ethnic groups in Iraq. Bull WHO 1972;47(1):1.

6. El-Hazmi MAF, Warsy AS. Aspect of sickle cell gene in Saudi Arabia. Interaction with glucose −6− phosphate dehydrogenase deficiency. Hum Genet 1984;68:589.

7. Ranasinghe WAEP, Mali AS. Prevalence of glucose −6− phosphate dehydrogenase deficiency among the staff and children in a boys school of Eastern Province of Saudi Arabia. Saudi Med J 1987;8(2):163.

8. Warsy AS, El-Hazmi MAF. Glucose −6− phosphate dehydrogenase deficiency in Saudi Arabia — A review. Saudi Med J 1987;8(1):12.

9. Akbar Mohsin M, Nadkarni KV, Bhagwat GP, Al-Hilli F, Bapat JP. Hemoglobinopathies and glucose −6− phosphate dehydrogenase (G6PD) deficiency in hospital births in Bahrain. Paper presented at the XVII Congress of the Union of Middle-Eastern and Mediterranean Paediatric Societies. Palermo : 1987.

10. Worledge S. Practical Blood Transfusion : Post-graduate haemotology. 2nd ed. William Heinemann Medical Books Ltd, 1981.

11. Orlina AR, Josephson AM, MacDonald, Barabra J. The post storage viability of glucose −6− phosphate dehydrogenase deficient erythrocytes. Lab Clin Med 1970;75:930.

12. McCurdy PR, Morse EE. Glucose −6− phosphate dehydrogenase deficiency and blood transfusion. Vox Sang 1975;28:230.

13. Bernastain FE. A rapid screening dye test for the detection of glucose −6− phosphate dehydrogenase deficiency in red cells. Nature 1962;194:192.

14. Motulsky AG, Yoshido A. In : Yunis JJ, ed. Methods for study of red cells G6PD in biochemical methods in red cell genetics. New York and London : Academic Press, 1969;51.

15. El-Hazmi MAF, Warsy AS. Glucose −6− phosphate dehydrogenase deficiency in blood donors : A need for reassessment. Saudi Med J 1986;7(3):250.

16. Wintrobe. Clinical haematology. 8th ed. Philadelphia : Lea and Febiger, 1981.

17. Bayoumi RA, Omer A, Sameul APW, Saha N, Sebal ZA, Sabaa HMA. Haemoglobin and erythrocytic glucose −6− phosphate dehydrogenase variants among selected tribes in Western Saudi Arabia. Trop Geogr Med 1979;31:245.

18. Gelpi AP, King MC. New data on G6PD-deficiency in Saudi Arabia; G6PD variants and the association between enzyme deficiency and haemoglobin. Hum Hered 1977;27:285.

19. Beutler E. Haemolytic anaemia in disorders of red cell metabolism. New York : Plenum, 1978;23:168.

20. Weinstein IM, Dern RJ, Talmage DW. Study on the mechanism of haemolysis in primaquine — sensitive negroes. J Clin Invest 1953;32:609.

21. Bernini L, Latte B, Siniscalco M, et al. Survival of 51 Cr — labelled red cells in subjects with thalassaemia — trait or G6PD-deficiency or both abnormalities. Br J Haematol 1965;10:171.

22. Mollison PL. Blood Transfusion in clinical medicine. 7th ed. Oxord : Blackwell scientific publication, 1983.

23. Bensinger TA, Medina F. Excessive pyruvate accumulation in G6PD-deficient erythrocytes during liquid storage. Blood 1976;48:993.

24. Knox — Macaulay HHM. Glucose −6− phosphate dehydrogenase deficiency in blood donors : letters to the editor. Saudi Med J 1987;8:325.