Is red cell from an otherwise healthy G6PD-deficient donor efficient for transfusion to favism patients?

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Abstract

Aim Glucose-6-Phosphate dehydrogenase (G₆PD) deficiency is the most common X-linked defect of enzyme pathways in human. The aim of this study was to inspect the efficacy of G₆PD deficient red cell transfusion to G₆PD patients, who were admitted for hemolysis after Broad bean ingestion, and to find out whether prolong management program and retransfusion are needed as severe hemolysis would take place.

Methods This was a cross-sectional study, which was performed on patients admitted to hospital due to hemolytic anemia after broad bean ingestion in Jahrom and Shiraz medical school hospitals on February and March 2007. 2^{ml} samples of transfusion blood bags, were sent to the laboratory in order to investigate the G₆PD enzyme sufficiency. Hemoglobin level was checked six hours after blood transfusion. We compared the amount of hemoglobin level elevation after transfusion in patients received G₆PD sufficient and G₆PD deficient red cell using independent sample t-test.

Result In 114 transfused bags, 14 bags (12.3%) were G₆PD deficient. We divided patients into two groups. Group A received G₆PD sufficient red cell and group B were transfused with G₆PD deficient red cell. Hemoglobin level was significantly raised after transfusion of red cell in each group. The amount of hemoglobin elevation was more in group A in comparison to group B.

Conclusion Based on our study results, proper hemoglobin level would be achieved using non G₆PD deficient red cell for transfusion to G₆PD deficient patients.

Keywords Glucose-6-Phosphate dehydrogenase enzyme · G₆PD deficiency · Hemolysis · Blood transfusion.

Introduction

Glucose-6-Phosphate dehydrogenase (G₆PD) deficiency is the most common X-linked enzyme pathway defect in human. According to the world health organization (WHO) announcements, four hundred million people are affected by G₆PD deficiency in the world. [1]

G₆PD is the first enzyme in the pentose phosphate pathway, involved in diverse physiological processes such as antioxidant defense mechanisms (for instance in erythrocytes), endothelial growth modulation, erythropoiesis, vascularization and phagocytosis. In patients with G₆PD deficiency, formation of reduced glutathione (GSH) from oxidized glutathione (GSSG) is diminished. GSH is one of the antioxidant agents that prevents lipids from peroxidation. This problem leads to the integration of oxidant materials in cells finally leads to cell destruction [2].

The G₆PD deficient red cell life is about 90–110 days. The older cells lyses before the younger ones [3].

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G₆PD deficient patients pose hemolysis in exposure to oxidative materials in some drugs or food [4–6]. Broad bean is one of the food which contain two oxidative agents, vicine and convicin. These two substances produce free oxygen radicals during oxidation and may cause hemolysis [7].

In a recent study, all neonates with hyperbilirubinemia who received G₆PD deficient red cell for blood exchange transfusion need reexchange, and consequently, it may cause sever hemolysis and increase bilirubin level inversely [8]. Transfusion of G₆PD deficient red cell to premature neonates may cause hemolysis and increase bilirubin level. Increasing level of bilirubin and lactic dehydrogenase (LDH) is presented in adults transfused with G₆PD deficient red cell, which may mostly occur in presence of hemolytic anemia and may be mistaken with transfusion reaction [9].

Beutler fluorescent spot test is the most specific and reliable test among the different methods of G₆PD deficiency analyses. This is a quick test that specifically diagnoses producing NADPH by G₆PD enzyme under ultraviolet (UV) light [10, 11]. The intensity of the fluorescent is low or even negative in the patients with G₆PD deficiency.

As its high prevalence in Iran (about 12% in male & 1% in female) [12], this study aim to inspect the efficacy of G₆PD deficient red cell transfusion to G₆PD patients, who were admitted for hemolysis after broad bean ingestion, if this may result prolongation of management program.

Methods

This was a cross-sectional study, which was done on patients who were admitted to Jahrom and Shiraz medical school hospitals due to hemolytic anemia after broad bean ingestion during February and March 2007.

One hundred fourteen patients who were gradually admitted due to severe G₆PD deficiency hemolytic anemia in Jahrom and Shiraz medical school hospitals during February and March 2007. They were divided into two groups of receiving G₆PD sufficient red cell (group A 100 patients) and G₆PD deficient red cell (group B 14 patients). All the 114 transfused blood bags to patients were investigated. Each patient was transfused with one unit blood.

After inform consent, a 2 ml sample of each transfusion blood bag was sent to the laboratory in order to investigate the G₆PD enzyme sufficiency. Hemoglobin level was checked before and 6 hours after blood transfusion. All blood bags had near equal volume (350–400ml) and hematocrit.

100 μ L of indicator was added to 20 μ L of blood and after 10 minute in room temperature, one drop (qtt) of solution was put on the test kit paper (Kimia Pazhouhan, Iran). The paper was checked for G₆PD enzyme sufficiency when the blood was dried completely.

Strong fluorescence is achieved when the sample is G₆PD sufficient, otherwise, weak and no fluorescence is seen in partial G₆PD deficiency and severe enzyme deficiency, respectively.

Based on the enzyme activity, samples with activity of 9 or more units per gram of hemoglobin are defined as strong fluorescent and the samples with less than 3 units had no fluorescent [13, 14].

We used paired sample T-test to evaluate the impact of transfusion on hemoglobin level rising in each group and independent sample T-test for comparison of hemoglobin level elevation after blood transfusion between patients who received G₆PD sufficient and G₆PD deficient red cell (our two groups). The P-value of less than 0.05 % is considered significant.

Results

We observed 59.6% of patients were male and 40.4% were female and they were between 4 to 15 years old. From 114 transfused bags, 14 bags (12.3%) were G₆PD deficient. Blood transfusion has increased hemoglobin level irrelevant to G₆PD enzyme level. (P value < 0.001)

Group A (which received G₆PD sufficient red cell) (100 patients) had an average hemoglobin level of 6.26 (6.3 ± 0.84) before transfusion, and the average hemoglobin level of 9.27 (9.3 ± 1.56) after transfusion. Mean hemoglobin level elevation was 3.00 (Table 1).

Group B (which received G₆PD deficient red cell) (14 patients) had an average hemoglobin level of 5.54 (5.9 ± 0.77) before transfusion, and the average hemoglobin level of 7.86 (7.9 ± 1.55) after transfusion. Mean hemoglobin level elevation was 2.32 (Table 1).

Hemoglobin level was significantly raised after transfusion of red cell in each group using paired sample T-test (P value < 0.001).

In comparison, post-transfusion hemoglobin level elevation was higher in Group A, but it was not of significant value (P value = 0.098).

Discussion

As blood transfusion complications are the most important concern in blood banks, blood bags are checked for Hepatitis viruses (B and C), Human immune deficiency

Table 1 Mean hemoglobin level in two groups

Group	Mean Hemoglobin level elevation	Number of cases
Group A	3.00	100
Group B	2.3214	14
Total	2.9211	114

Fig. 1 Comparison between hemoglobin level before and after transfusion. Group A: Patients transfused with G6PD sufficient hemoglobin. Group B: Patients transfused with G6PD deficient hemoglobin. Hb1: Hemoglobin before transfusion. Hb2: Hemoglobin after.

virus, and also in some specific circumstances for Cytomegalovirus.

Transfusion of G₆PD deficient red cell may cause some complications in special circumstances such as neonates' transfusion, neonatal jaundice and patients who need recurrent transfusion. Transfusion of G₆PD deficient red cell to/in premature neonates may cause hemolysis, and G₆PD deficient red cell exchange transfusion to neonate who were admitted due to jaundice, may not have enough efficiency in reducing the bilirubin level [8]. Transfusing G₆PD deficient blood to adults may also increase lactic dehydrogenase and lactate level which may be mistaken with/by transfusion reaction [9].

G₆PD can be detected by several methods. Fluorescent spot test has been introduced as a more reliable and specific method with 99% specificity [15]. The advantage of this method is the capability to use low volumes of blood, about only 10 μ L or a single drop of dried blood on a specific filter paper [16]. False negative results are rare in this method. There are only 0.1 percent of false negative results using this method. Therefore this method is selected for our study. False positive results are seen only in heterozygote women and hemi-zygote men after severe hemolysis that caused increase in the young RBCs [10].

G₆PD deficient blood transfusion to G₆PD deficient hemolytic patients not only have little effect on hemoglobin correction, but also may augment hemolysis due to transfused red cell lyses, consequently it may result in treatment prolongation, repeated blood transfusion, and increasing risk of blood transfusion reactions and complications.

G₆PD deficiency is prevalent in Iran [17], and we reached (12.3%) plenitude of G₆PD deficiency in transfusion blood bags in this study. We have not reached significant elevation in hemoglobin level in comparison between our two groups, even though we achieved higher mean hemoglobin elevation in group A which received G₆PD sufficient red cell. Not having enough sample size might be the cause of non-significant difference in our results. It is hard to achieve adequate number of G₆PD deficient blood bags due to scarce number of G₆PD deficient blood donors.

Conclusion

We recommend a routine G₆PD enzyme sufficiency examination of each blood bag that will be used for transfusion to/in G₆PD deficient patients, premature

neonates, exchange transfusion of neonates and patients who need repeated transfusion. In conclusion based on our study results, proper hemoglobin level would be achieved using non G₆PD deficient red cell for transfusion to G₆PD deficient patients in contrast to an unsatisfactory hemoglobin elevation using G6PD deficient red cell.

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