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Evaluation of Glucose-6-Phosphate Dehydrogenase Deficiency in Patients with Sickle Cell Anemia

Defne Ay Tuncel, Şule Çalışkan Kamış, Begül Yağcı-Küpeli

Health Sciences University, Adana Faculty of Medicine, Adana City Education and Research Hospital, Pediatric Hematology and Oncology Clinic, Adana, Türkiye

Abstract

Introduction: The aim of this study was to evaluate patients with a diagnosis of Sickle Cell Anemia (SCA) for Glucose-6-Phosphate Dehydrogenase (G6PD) enzyme deficiency.

Materials and Methods: In our study, patients diagnosed with SCA who presented to the Pediatric Hematology and Oncology Clinic at the Adana Faculty of Medicine, Health Sciences University, Adana City Training and Research Hospital, between August 1, 2022, and August 1, 2023, were evaluated. G6PD enzyme data from routine tests performed for the patients were recorded from the patient files or the hospital system.

Results: A total of 23 patients diagnosed with Sickle Cell Anemia (SCA) were included in the study. 65.2% (n=15) of the patients were female, and 34.8% (n=8) were male. The ages of the cases ranged from 4 to 30 years, with a median age of 12. Among the cases, 20 were within the age range of 0-18 years (87%), while 3 cases (13%) were over 18 years old. The median G6PD value was found to be 26.28 U/g Hb (2.22-36.98). G6PD deficiency was detected in 2 patients (8.7%), while it was not detected in 21 patients (91.3%). When individuals with G6PD enzyme deficiency were compared to those without, a borderline negative correlation was observed in terms of the frequency of blood transfusions (p: 0.052, r: -0.410).

Conclusion: Screening for G6PD deficiency is necessary in patients with Sickle Cell Anemia (SCA) to prevent deterioration of their condition during treatment. The co-inheritance of both diseases can worsen hemolysis in SCA patients. G6PD scanning enzyme is important in SCA patients.

Key words: Glucose-6-phosphate dehydrogenase; sickle cell anemia; hemolysis

Introduction

Sickle Cell Anemia (SCA) is a disease caused by the presence of hemoglobin S (Hb S). Hb S results from a point mutation where valine replaces glutamic acid at the sixth position of the beta-globin chain (1). Glucose-6-Phosphate Dehydrogenase (G6PD) enzyme deficiency is commonly observed in patients with SCA. This is because both conditions are hereditary disorders that can be passed down genetically. Some associations between SCA and G6PD enzyme deficiency have been reported in literature (1,2,3). G6PD enzyme deficiency leads to a decrease in the antioxidant glutathione in red blood cells (RBCs). Typically, affected individuals may not exhibit symptoms. However, they need to avoid foods or drugs that can trigger oxidative stress, such as fava beans, which can cause hemolysis (2). G6PD enzyme deficiency can contribute to severe clinical outcomes of SCA due to oxidative stress. It has been reported that G6PD enzyme deficiency may modulate strokes and vaso-occlusive crises in SCA. It is particularly important for SCA patients to be cautious of triggering factors due to G6PD enzyme deficiency. Certain medications (e.g., antimalarials, certain antibiotics), infections, certain foods (e.g., fava beans, soybeans, lentils), and certain chemicals can trigger oxidative stress in individuals with G6PD enzyme deficiency. Therefore, it is recommended that these patients avoid such triggering factors (3,4). In this study, our aim was to evaluate the presence of G6PD enzyme deficiency in patients monitored with a diagnosis of SCA at the Pediatric Hematology and Oncology Clinic of the Adana City Training and Research Hospital (ACTRH) over the past year.

Materials and Methods

In our study, patients diagnosed with Sickle Cell Anemia (SCA) who presented to the Pediatric Hematology and Oncology Clinic at the Adana Faculty of Medicine, Health Sciences University, Adana City Training and Research Hospital (ACTRH) between August 1, 2022, and August 1,

*Corresponding Author: Defne Ay Tuncel Karslılar mahallesi YSE caddesi 82008 sok. Mavigöl villaları 9/2 Çukurova Adana Türkiye
E-mail: defneayinan@gmail.com **Orcid:** Defne Ay Tuncel 0000-0002-1262-8271, Şule Çalışkan Kamış 0000-0003-0008-303X, Begül Yağcı-Küpeli 0000-0002-1316-4501

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2023, were included for evaluation. The data of G6PD enzyme level, Hb level, Hb S level, the number of blood transfusions, and the number of painful crises experienced in the last year were recorded from patient files or stored in the hospital system as part of routine tests conducted on the patients. The reference range for the G6PD enzyme was accepted as 7.5-21 U/g Hb. Patients with missing data in the hospital records were excluded from the study.

Ethical approval: This study has been approved by the The Adana City Training and Research Hospital Ethics Committee in the meeting numbered 131 on 20.07.2023, with the decision numbered 2703.

Statistical analysis: The statistical analysis of the study was conducted using the "Statistical Package for Social Sciences" version 26 (IBM Corp., Armonk, NY, USA) program. Demographic data of the patients were presented using descriptive statistics, categorical measurements as numbers and percentages, and numerical measurements as mean and standard deviation (or median and range where appropriate). Correlation analysis was used to measure the relationship between variables. If the variables showed a normal distribution, Pearson correlation analysis was employed, while Spearman correlation analysis was used if the variables did not exhibit a normal distribution. A statistical significance level of $p \leq 0.05$ was considered for all tests. A p-value of 0.05 or less was considered statistically significant in all analyses.

Results

In our study, G6PD enzyme data were screened from the medical files or hospital system of 35 patients with a diagnosis of Sickle Cell Anemia (SCA) who were monitored at the Pediatric Hematology and Oncology Clinic of the Adana City Training and Research Hospital (ACTRH) between August 1, 2022, and August 1, 2023. A total of 23 patients with available G6PD enzyme levels were included in the study. Among the patients, 65.2% (n=15) were female, and 34.8% (n=8) were male. The ages of the cases ranged from 4 to 30 years, with a median age of 12. Out of the cases, 20 were within the age range of 0-18 years (87%), while 3 cases (13%) were over 18 years old. The median G6PD value was found to be 26.28 U/g Hb (2.22-36.98). G6PD enzyme deficiency was detected in 2 patients (8.7%), while it was not detected in 21 patients (91.3%). Among the patients, 18 (78.3%) did not have any painful crises at the age of 18. Three patients (13%) experienced one painful crisis, one patient (4.3%) had nine painful crises, and another patient (4.3%) had ten painful crises. The patient who had ten painful crises had G6PD enzyme deficiency. Among the patients, 9 (39.1%) did not receive any blood transfusions in the last year. Five patients (21.7%) received one blood transfusion, two patients (8.7%) received two blood transfusions, one patient (4.3%) received three blood transfusions, one patient (4.3%) received five blood transfusions, one patient (4.3%) received six blood transfusions, two patients (8.7%) received seven blood transfusions, one patient (4.3%) received eleven blood transfusions, and one patient (4.3%) received thirty-one blood transfusions. The patient who received thirty-one blood transfusions had G6PD enzyme deficiency. The median Hb level among the patients was 8.7 g/dL (ranging from 6.1 to 13.6). The median Hb S level was 69.7% (ranging from 34.8% to 88%). There was no significant correlation between G6PD enzyme level and Hb or Hb S levels (p: 0.196, r: -0.28; p: 0.443, r: 0.168). There was no significant correlation between G6PD enzyme level and the number of blood transfusions (p: 0.768, r: -0.065). Similarly, there was no significant correlation between G6PD enzyme level and the number of painful crises experienced in the last year (p: 0.985, r: 0.004). When individuals with G6PD enzyme deficiency were compared to those without, a borderline negative correlation was observed in terms of the frequency of blood transfusions (p: 0.052, r: -0.410) (Table1).

Discussion

Inherited anemias share similar features, including Sickle Cell Anemia (SCA), Fanconi anemia, G6PD enzyme deficiency, and thalassemia (5). Enzyme deficiencies, membrane defects, and hemoglobin disorders in red blood cells (RBCs) lead to hereditary hemolytic anemias. G6PD enzyme deficiency causes hemolysis in the presence of oxidative stress. SCA and thalassemia are hemoglobinopathies characterized by chronic hemolysis (6). In a study by Kambale-Kombi P. et al., they reported more hospitalizations, major vaso-occlusive crises, and anemia cases requiring blood transfusion in SCA patients with G6PD enzyme deficiency compared to those without deficiency (7). G6PD converts glucose-6-phosphate (G6P) to 6-phosphogluconate within the pentose phosphate pathway and protects RBCs against oxidative damage. This deficiency renders RBCs susceptible to hemolysis. SCA patients are prone to hemolysis due to the shape of their RBCs, and if G6PD enzyme deficiency is present, hemolysis can be further increased (8).

Table 1: Patient clinical data distribution

Clinical data	Number of Patients (Percentage)
Total number of Patients	23 (100%)
Female	15 (65.2%)
Male	8 (34.8%)
Median Age (year)	12
Age 0-18	20 (87%)
Age >18	3 (13%)
Median G6PD / G6PD range	26.28 U/g Hb 2.22-36.98 U/g Hb
G6PD enzyme deficiency	2 (8.7%)
No painful crisis	18 (78.3%)
3 painful crises	3 (13%)
9 painful crises	1 (4.3%)
10 painful crises	1 (4.3%) - had G6PD enzyme deficiency
No blood transfusions last year	9 (39.1%)
1 blood transfusions last year	5 (21.7%)
2 blood transfusions last year	2 (8.7%)
3 blood transfusions last year	1 (4.3%)
5 blood transfusions last year	1 (4.3%)
6 blood transfusions last year	1 (4.3%)
7 blood transfusions last year	2 (8.7%)
11 blood transfusions last year	1 (4.3%)
31 blood transfusions last year	1 (4.3%) - had G6PD enzyme deficiency
median Hb level / range	8.7 g/dL / 6.1 to 13.6 g/dL
median Hb S level / range	69.7% / 34.8% to 88%

Antwi-Baffaur S. et al. reported that G6PD enzyme deficiency could exacerbate anemia severity in SCA patients (9). In a study by Fasola F. A. et al., they reported a higher prevalence of G6PD deficiency in SCA patients compared to the healthy group (10). Even though G6PD deficiency is rather common, patients with SCA do not seem to be clinically affected by it. Nevertheless, assessing G6PD status is crucial (11). Patients with SCA who have both disorders may experience worsening hemolysis; therefore, caution should be used when selecting medications for those with SCA (12). Overall, the findings of our study align with previous literature highlighting the relationship between SCA and G6PD deficiency. This underscores the importance of screening for G6PD deficiency in SCA patients and exercising caution in the selection of medications and management of triggering factors to prevent oxidative stress-related complications. Further research and larger studies are needed to better understand the impact of G6PD deficiency on the clinical outcomes of SCA patients and to explore potential strategies for their optimal management.

Study limitations: The small number of cases is a limitation of the study. The reason for this is that G6PD enzyme levels will not be accurate in sickle cell patients who received transfusion, so these patients were excluded from the study. Conducting the study for one year was thought to be effective in limiting the number of patients.

Conclusion

The transfusion rate of patients with G6PD enzyme deficiency was higher than that of patients without enzyme deficiency. Therefore, it has been determined that patients with G6PD enzyme deficiency require blood transfusions more frequently than those without the deficiency. Screening for G6PD deficiency is necessary in patients with SCA to prevent deterioration of their condition during treatment. The co-inheritance of both diseases can worsen hemolysis in SCA patients. Drug selection in SCA patients with G6PD enzyme deficiency should be cautiously made to prevent further hemolysis.

Ethical approval: This study has been approved by the Adana City Training and Research Hospital Ethics Committee in the meeting numbered 131 on 20.07.2023, with the decision numbered 2703.

Written informed consent: It was obtained from each patients.

Conflict of interest: The authors declare no competing interests.

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