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Assessing SOD 1 Activity in Thalassemia: New insights

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ABSTRACT

Thalassemia is an inherited blood illness where there is a decrease or lack of one or more globin chains in haemoglobin, resulting in anaemia and associated problems. The disease's pathogenesis includes inadequate erythropoiesis, hemolysis, and significant oxidative stress caused by iron excess, particularly in patients receiving frequent blood transfusions. The ELISA technique was utilised to quantify the amounts of superoxide dismutase1(SOD1) in the samples under investigation. Each group comprised 10 participants. The average SOD level in the patient group was 17,856 units, with a median of 16,492 units and a standard deviation of 6,391 units. The control group had a mean SOD level of 19,915 units and a median of 13,548 units, showing a higher variability with a standard deviation of 16,874 units.

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1-INTRODUCTION

Thalassemia is a group of inherited blood disorders characterized by the reduction or absence of one or more of the globin chains in hemoglobin, leading to anemia and various other complications [1]. The disease's pathophysiology involves not only ineffective erythropoiesis and hemolysis but also a marked state of oxidative stress due to iron overload, especially in patients who undergo regular blood transfusions [2]

Superoxide dismutase 1 (SOD1), a critical antioxidant enzyme, catalyzes the dismutation of the superoxide anion into hydrogen peroxide and molecular oxygen, mitigating the harmful effects of superoxide radicals produced during normal cellular metabolism [3]. In thalassemia, the persistent oxidative stress can overwhelm the antioxidant defense mechanisms, including SOD1 activity, which can lead to cellular damage and contribute to the pathology of the disease [4]. Research has suggested that the assessment of SOD1 activity in thalassemia patients could provide new insights into the disease's oxidative stress profile and the potential therapeutic role of antioxidants [5]. Furthermore, studies have indicated that the modulation of SOD1 activity might have implications for the management of iron overload and related oxidative damage [6].

This study aims to assess SOD1 activity in patients with thalassemia and compare it with healthy controls to better understand the oxidative stress mechanisms in thalassemia. By exploring the SOD1 activity profile, we seek to uncover potential biomarkers for oxidative stress and explore new therapeutic strategies to ameliorate the complications associated with thalassemia.

2-METHODS

The blood samples were collected from Al-Kadhimiya Teaching Hospital and Ibn Al-Balady Hospital in Baghdad(December 2023-April 2024). Serum blood was collected for serological analysis. The groups were divided into main groups: control and patients. The control involved 10 healthy patients. The patient group involved 10 samples also. By using the ELISA method (Biotech, USA), blood samples were examined for SOD1 enzyme.

Ethical consent

The consent for blood collection was obtained from the leukemic participants and by anethics committee in Iraqi Ministry of Health .

3-RESULTS

After the completion of measuring SOD activity the results of each sample are showing in table (1). The samples have been grouped to patient and control groups.

Table (2) presents the comparative analysis of the mean superoxide dismutase (SOD) levels between the patient group and the control group. Both groups consisted of 10 individuals each. The mean SOD level in the patient group was 17,856 units, with a median of 16,492 units and a standard deviation (SD) of 6,391 units. In contrast, the control group exhibited a higher mean SOD level of 19,915 units and a lower median of 13,548 units, with a significantly larger variability as indicated by the SD of 16,874 units. Despite the observed differences in mean and median SOD levels between patients and controls, the statistical analysis indicated a p-value of 0.722. This p-value is greater than the conventional alpha level of 0.05, suggesting that there is no statistically significant difference in the mean SOD levels between the two groups. The large standard deviation in the control group points to a high degree of variability in SOD levels among the control subjects, which may have influenced the statistical outcome.It is important to note that the higher mean value in the control group coupled with the lower median suggests a skewed distribution, potentially indicating the presence of outliers or a non-normal distribution of SOD levels in this group. However, the lack of statistical significance implies that the difference in central tendency measures (mean and median) between patients and controls does not reflect a systematic difference in SOD levels attributable to the condition being studied.

-DISCUSSION

The objective of this study was to assess the activity levels of superoxide dismutase (SOD) in patients diagnosed with thalassemia compared to a healthy control group. The data presented in Table (2) showed mean SOD activities of 17,856 units for thalassemia patients and 19,915 units for controls, with a p-value of 0.722, indicating no statistically significant difference between the two groups. Thalassemia is associated with increased oxidative stress due to the chronic hemolysis and iron overload that typify the disease [7]. The enzyme SOD plays a critical

role in mitigating oxidative damage by converting superoxide radicals into less reactive species. Given the oxidative stress in thalassemia, one might expect to observe altered SOD activity in this patient population.

Table (1); SOD activity results of each samples included in this study

Group	Sample number	SOD concentration (µmol/l)
patients	1	14831.76
	2	29229.06
	3	10131.7
	4	9767.029
	5	26370.55
	6	14437.9
	7	20404.17
	8	17736.36
	9	15247.75
	10	20404.17
Control	11	1753.451
	12	8814.22
	13	21202.37
	14	15687.81
	15	23003.74
	16	47280.92
	17	8673.05
	18	51896.77
	19	9427.528
	20	11408.43

Table (4-2); Comparative Analysis of SOD Mean between Patients and Controls

Group	N	Mean	Median	SD	P-Value
patient	10	17856	16492	6391	0.722
control	10	19915	13548	16874	

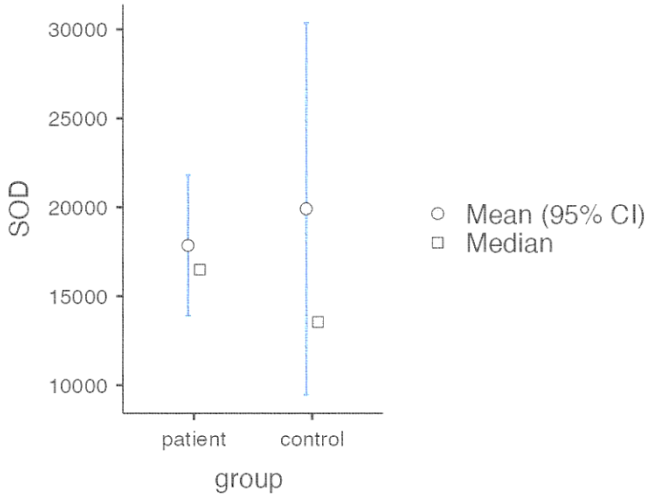

Figure (1); Comparative Analysis of SOD1 Mean between Patients and Controls

The absence of a significant difference in SOD activity between thalassemia patients and controls in our study could suggest several possibilities. Firstly, the adaptive response of SOD to increased oxidative stress might be adequate to maintain its activity at levels comparable to healthy individuals. This compensatory mechanism might reflect an effective upregulation of SOD in response to the oxidative environment in thalassemia patients [8]. Alternatively, the lack of a significant difference could indicate that other factors contribute to the oxidative stress in thalassemia beyond the SOD-dependent pathways. The increased iron load from frequent blood transfusions, a common treatment for thalassemia, may catalyze the generation of highly reactive hydroxyl radicals through the Fenton reaction, which would not be neutralized by SOD activity [9]. Another consideration is the high variability of SOD activity levels within

the control group, suggested by the large standard deviation. This variability could reflect the heterogeneity of the control population or a wide normal range of SOD activity. Furthermore, the high standard deviation in the control group points to the necessity for a larger sample size to achieve the statistical power required to detect potential differences [10].

It is also noteworthy that the median values between patients and controls diverge from the means, indicating potential skewness in the data distributions. This skewness could be a result of outliers or non-normal distribution within the samples [11].

Given the essential role of SOD in counteracting oxidative stress and the complexities of thalassemia pathophysiology, further research is needed. Larger, more comprehensive studies could clarify the relationship between SOD activity and thalassemia. Moreover, longitudinal studies examining SOD activity across different stages of thalassemia and under various treatment modalities may provide deeper insights into the dynamic nature of oxidative stress in this patient population [12].

CONCLUSION

In conclusion, while our study did not find a significant difference in SOD activity between thalassemia patients and healthy controls, this does not negate the potential impact of oxidative stress in thalassemia pathogenesis. The findings highlight the need for further investigation into the oxidative mechanisms and their clinical implications in thalassemia.

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