Anemia After Thermal Injury: Role of Oxidative Stress

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Abstract

Background: One of the most important changes that occur in burn patients is anemia, which represents a big clinical problem for both the burn patients and the healthcare along the course of management. There is evidence of both local and systemic oxidant changes manifested by increased oxygen, free radical activity and lipid peroxidation in animal burn models and also in human burn patients. The aim of this work is to study the incidence of anemia and the incidence of oxidative stress as a contributing factor in the development of anemia in burn patients.

Patients and Methods: This study was carried out on 118 burn patients with different ages of both sexes and varying burn percentage (group A) compared with group B which is 24 normal healthy subjects utilized for comparison. For each group, hemoglobin, hematocrite, serum level of malondialdehyde, and serum level of glutathione were measured according to standard methods.

Results: Results of this study showed that burn patients developed anemia at day 7 post burn as indicated by a significant decrease in hemoglobin level. They also showed the occurrence of oxidative stress that may be related in parallel way with the development of anemia in burn patients.

Conclusion: Monitoring of oxidative stress parameters, namely malondialdehyde and the natural antioxidant glutathione, are of great importance during the resuscitation and care of severely burned patients, since oxidative stress represents one of the contributing factors in the development of anemia in burn patients and this rationalizes the clinical importance of using antioxidants in the management of burn patients.

Keywords: Burn, anemia, oxidative stress.

(J Med J 2012; Vol. 46 (1): 28- 32)

Received	***Accepted***
June 8, 2011	*September 1, 2011*

Introduction

It is well known that patients with burns have suffered one of the most severe forms of trauma; the pathological changes produced in the circulatory and respiratory systems are complex, and failure to understand their progress and therapeutic management can cause the patient's further problems. [1]

One of the most important changes that occur in burn patients is anemia, which represents a big clinical problem for both the burn patients and the healthcare along the course of management. [2]

Burn patients rapidly become anemic due to the increased destruction and impaired production of circulating red blood cells in combination with external blood loss that is associated with diagnostic testing, daily burn wound debridement, and operative procedures. [3]

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Consequently, multiple blood transfusions to maintain the circulating red blood cell mass and oxygen delivery has become an established component of burn care.

Furthermore, burns are a common traumatic injury that results in both local tissue damage and a systemic mediator induced response; there is evidence of both local and systemic oxidant changes manifested by increased oxygen free radical activity and lipid peroxidation in animal burn models and in human burn patients. [4] It has been reported that both oxygen free radicals and lipid peroxidation play a major role in the injuries caused by skin burns. [5] In addition, it has been shown that burn injury causes a remarkable decrease in superoxide dismutase and total antioxidant status and a reduction in antioxidant scavenging capacity when compared with healthy subjects. [6]

The aim of this work is to study the incidence of anemia, and the incidence of oxidative stress as a contributing factor in the development of anemia in burn patients.

Patients and Methods

This study was carried out on 118 burn patients of both sexes, with age range 18-45 years, and varying burn percentage (15-50% total body surface area estimated according to the rule of nine). Consent was obtained from all burn patients when admitted to the burn unit in our department of surgery; the study was done according to the standard ethical guidelines. All burn patients (Group A) were treated according to hospital policy; Group B composed of 24 healthy subjects of the same age range as the burn patients and were selected to serve as a control for the purpose of comparison.

Blood samples were collected from all subjects by venipuncture; ten milliliters were taken on admission to the burn unit within the first 24 hrs post burn which was designed to be the first week reading. In addition to that, blood samples were taken at the second and third week which is the time of discharge from the burn unit. In all samples, changes were checked in hemoglobin percent, hematocrite, serum level of malondialdehyde (MDA), and serum level of glutathione (GSH), which are used as oxidative stress parameters. All measurements were done according to standard methods utilizing already available devices in the hospital lab, and readymade kits for such purposes. The statistical analysis used was student T-test, P with a value less than 0.05 was considered significant, and the results were expressed as mean±SD.

Results

Results of this study showed that the hemoglobin level decreased in burn patients compared to healthy subjects. Although the decrease in the hemoglobin level of burn patients in the first 24 hrs post burn was not significant, the change became significant at day 7 and day 14 post burn (Fig.1). In addition to that, (Fig.2) shows that the hematocrit of burn patients decreased after 7 days and 14 days.

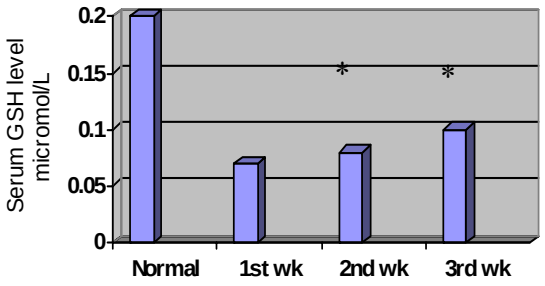

Figure (4): Serum Glutathione level in burn patients compared to normal subjects

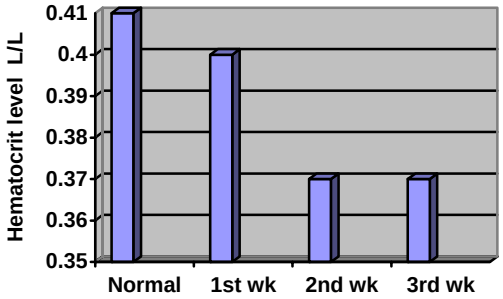

Figure (2): Hematocrit level in burn patients compared to normal subjects

Meanwhile, (Fig. 3) shows that the serum MDA level significantly (P≤0.05) increased in burn patients when measured 24 hrs post burn compared to healthy subjects; despite the significant decrease in serum MDA level at day 7 and day 14 post burn, it was still significantly higher than that of healthy subjects.

At the same time, (Fig. 4) shows that the serum level of GSH- the natural antioxidant- significantly (P≤0.05) decreased in burn patients at 24 hrs, 7 days and 14 days post burn compared to healthy subjects; these data in combination with the significant increase in the MDA level clearly indicate the presence of oxidative stress in burn patients; taken together with the decrease in the hemoglobin level, the occurrence of oxidative stress may be related in a parallel way with the decrease in the level of hemoglobin in burn patients.

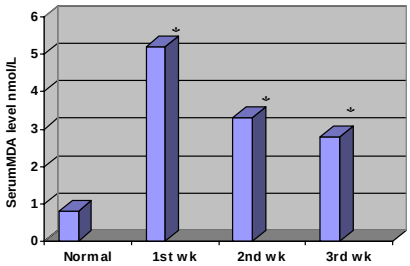

Figure (3): Serum Malondialdehyde level in burn patients compared to normal subjects

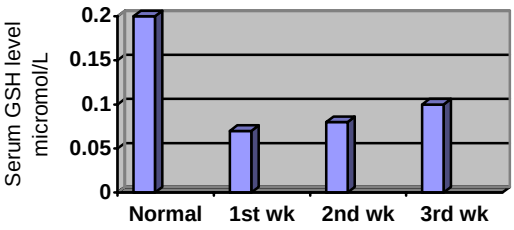

Figure (4): Serum Glutathione level in burn patients compared to normal subjects

Discussion

Estimation of the hemoglobin percentage and hematocrite value in the severely burned patients in our study showed that there was anemia after initial haemoconcentration phase; these data are consistent with those of El-Sonbaty and El-Oteify [7] who found that laboratory manifestation of anemia was evidenced six days post burn. It has been reported that anemia in burn patients may occur due to the accelerated decomposition of erythrocytes, and since massive blood transfusion in such patients cannot counter the defect, another cause may exist. An increase in the free radical activity that is produced in burn patients is a strong candidate as a contributing factor. [8] In our study, the measurement of the serum level of MDA which is the end product of lipid peroxidation is significantly increased in burn patients, and this is an indication about the increase of the free radical activity in those patients. [9] Free radicals are very reactive compounds that can destroy any molecule around it, with special priority to the poly unsaturated fatty acids of the plasma membrane of RBCs and other cells [10] especially when the antioxidant state of burn patients was inhibited as expressed by a significant reduction of GSH, the natural antioxidant molecule. This finding will open the door for employment of a new therapeutic strategy in the management of anemia in burn patients which is the use of antioxidants; therefore, antioxidants are proposed to decrease the activity of free radicals and this will lead to a decreased reaction of free radicals, ie, decrease the denaturation of biomolecules and decrease cell destruction like RBCs. [11] Based on these findings, the proposed use of antioxidants to burn patients may reduce blood loss and reduce blood transfusions which has a significant clinical importance in patients with major thermal injuries. [12]

In conclusion, monitoring of oxidative stress parameters, namely malondialdehyde and the natural antioxidant glutathione, are of great importance during the resuscitation and care of severely burned patients, since oxidative stress represents one of the contributing factors in the development of anemia in burn patients, and this will rationalize the clinical importance of using antioxidants in the management of burn patients.

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دور الاجهاد التأكسدي في حدوث فقر الدم بعد افات الحروق

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الملخص:

يعد فقر الدم من أهم التغيرات التي تحدث عند مرضى الحروق والتي هي مشكلة سريرية تواجه كلا من المرضى والفريق الطبي على حد سواء طوال فترة العلاج ،بالإضافة إلى حدوث التغيرات التاكسدية –الموضعية والجهازية– والتي يمكن ملاحظتها من خلال زيادة نشاط الجذور الحرة وزيادة تزنخ الشحوم اثناء الحرق المحدث في الحيوانات المختبرية وكذلك عند مرضى الحروق. لذلك فان الغرض من هذه الدراسة هو لتبيان حدوث فقر الدم وحدوث الاجهاد التاكسدي عند مرضى الحروق باعتبار ان زيادة نشاط الجذور الحرة يمكن ان يكون احد الاسباب المهمة في حدوث فقر الدم عند مرضى الحروق.

اجريت هذه الدراسة على 118 من مرضى الحروق من كلا الجنسين ومن فئات عمرية مختلفة ونسب حرق مختلفة تم تحديدها حسب قانون التسعات. وقد تم اختيار مجموعة من الأصحاء تتألف من 24 شخصاً من فئات عمرية مقاربة للمرضى استخدمت للمقارنة. للجميع تم قياس نسبة الهيموكلوبين والهيماتوكرايت وكذلك مستوى مصل الدم من المالونالديهايد والكلوتاثيون وحسب الطرق القياسية.

اظهرت نتائج هذه الدراسة حدوث فقر الدم في اليوم السابع بعد الحرق اعتمادا على انخفاض نسبة الهيموكلوبين عند المرضى، وكذلك حدوث الاجهاد التاكسدي منذ اليوم الاول بعد الحرق عند مرضى الحروق.

يمكن الاستنتاج من هذه الدراسة بان قياس متغيرات الاجهاد التاكسدي ذو اهمية كبيرة عند مرضى الحروق باعتباره احد اسباب حدوث فقر الدم عند هؤلاء المرضى الامر الذي يدعو الى استخدام مضادات الاكسدة في مثل هذه الحالات.

الكلمات الدالة: الحرق، فقر الدم، الاجهاد التأكسدي.