THE RELATIONSHIP BETWEEN SERUM ALBUMIN LEVEL WITH BURN SEVERITY AND TOTAL BODY SURFACE AREA BEFORE AND AFTER SKIN GRAFT SURGERY IN BURN PATIENTS

RELATION ENTRE ALUMINÉMIE, GRAVITÉ ET SURFACE D'UNE BRÛLURE, AVANT ET APRÈS GREFFE CUTANÉE

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SUMMARY. Burns and burn-related injuries are among the most common causes of morbidity and mortality worldwide. Research has shown that serum albumin levels can predict the burned patient's condition. Considering the limited studies and conflicting results regarding serum albumin levels around the time of skin grafting surgery in burn patients and its effect on the patient's recovery process, conducting a study in this field seems necessary. Thus, this study aimed to determine the relationship between serum albumin level and the severity and total body surface area (TBSA) of burns in patients before and after skin grafting surgery. This cross-sectional and correlational descriptive study evaluated 160 patients hospitalized in the burn department of Imam Khomeini Hospital in Urmia who were candidates for skin graft surgery. Serum albumin levels were measured before and after surgery, and basic information such as age and sex, severity and TBSA were collected and analyzed using SPSS version 22 software. The mean age of the patients was 39.16±12.68, and 57% were men. Fire was the most common cause of burns. The serum albumin level in patients with second-degree burns was significantly higher than in patients with third-degree burns before and after surgery. Also, serum albumin level had a negative and significant correlation with burn severity. Serum albumin level significantly correlates with the severity and TBSA of burns before and after surgery. Thus, serum albumin level can be considered a suitable indicator for predicting the patient's condition and the severity of trauma.

Keywords: burns, albumin, skin graft

RÉSUMÉ. *Les brûlures font partie des principales causes de morbidité et mortalité mondiales. La littérature montre que l'albuminémie peut prédire l'évolution des patients. Elle est toutefois parcellaire et discutée en ce qui concerne ses valeurs aux alentours de la pose de greffes cutanées et leur relation avec l'évolution du patient. De ce fait, nous avons étudié les relations entre albuminémie et surface brûlée avant et après greffes. Il s'agit d'une étude comparative descriptive réalisée auprès de 160 patients hospitalisés dans l'hôpital Imam Khomeini de Urmia, devant bénéficier d'une greffe cutanée. L'albuminémie a été mesurée avant et après greffe et les données épidémiologiques ont été répertoriées (âge, sexe, surface brûlée). L'analyse statistique a été réalisée avec SSPS 22. L'âge des patients était de 39,16 +/- 12, 68 ans, 57% étaient de sexe masculin, la brûlure était le plus souvent due à une flamme. Avant comme après chirurgie, l'albuminémie était plus élevée en cas de brûlure de 2ème degré qu'en cas d'atteinte au 3ème degré. Elle était aussi inversement corrélée à la surface atteinte. Ainsi, l'albuminémie peut être considérée comme un indicateur fiable de sévérité de la brûlure et un critère pronostic de valeur.*

Mots-clés *: brûlure, albuminémie, greffe cutanée*

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Introduction

Burns and related injuries are among the most common causes of morbidity and mortality worldwide.[1] According to the WHO report, 195,000 people died from burns caused by fire, and 95% of these deaths occurred in low and middle-income countries.[2] The healing of burn wounds in patients who need skin grafts needs favorable conditions in terms of metabolism. One of the main indexes for measuring this condition in burn patients could be serum albumin level.[3] An inflammatory and unpredictable response, especially in severe burns, is a decrease in serum albumin level.[4]

Albumin is one of the liver's most important serum proteins and is the main factor causing plasma osmotic pressure.[5] Patients who suffer from burns, especially on a large body surface, lose a large amount of intravascular albumin, leading to chronic hypoalbuminemia.[6] Hypoalbuminemia can occur due to various traumas, including burns.[7] A decreased albumin is usually associated with increased mortality in burn patients.[8] Thus, the serum albumin level is crucial and should be measured upon the patient's arrival.[1,9] Research has shown that relying only on physiological and demographic indicators, such as burn percentage and age, to predict the burned patient's situation is not enough, and biochemical markers, such as serum albumin level, can also be used.[9,10]

Skin graft surgery is one of the treatments that can save the burn patient's life, and it can be affected by several factors, such as the severity and TBSA of burns.[11] In 2020, a study in Indonesia showed that nearly 90% of patients had undergone debridement and skin graft surgery, influenced by the burn severity and serum albumin level.[12] In another study, the improvement of skin graft had no significant relationship with albumin level.[13] Other studies showed that low serum albumin is strongly related to the extent of affected TBSA and burn severity.[12,14] There are limited studies and conflicting results regarding serum albumin levels and the lack of reliable statistics on albumin levels (preoperative and postoperative) and its critical role in burn conditions, skin graft surgery outcome, and the patient's healing process. In addition, no study has investigated how much serum albumin predicts the severity and TBSA of burns in the literature review. Thus, this study aimed to determine serum albumin level and its correlation with the severity and TBSA of burns before and after skin graft surgery in burn patients.

Materials and methods

Sampling and study design

This cross-sectional descriptive-correlational study was conducted in Imam Khomeini Hospital in Urmia in 2022. After obtaining the ethics code and permission from the research committee, 160 hospitalized burned patients who needed primary skin graft surgery entered the study. The sample size was calculated based on a similar study with the mean and standard deviation of the albumin level (2.42±0.58) in burn patients.[15] It was calculated to be 160 patients, considering the confidence interval of 95% and the study power of 80. Sampling was completed over six months, from March to August 2022. With a burn specialist's guidance, the lead researcher identified the burned patients who were candidates for primary skin graft surgery at admission. Informed consent was obtained from patients after being given the necessary explanation regarding the study and its objectives.

The researcher assured the patients that there was non-interference in the treatment and diagnosis process and did not impose additional costs on patients. The inclusion criteria included patients with second or third-degree burns or burns that needed primary skin graft surgery, patients with no history of kidney failure, nephrotic syndrome or chronic liver problems, and patients who visited the hospital within 24 hours after the burn. Also, patients who needed albumin administration during the study due to specific clinical conditions (severe edema) were excluded.

Data collection

For all the patients who participated in the study, an albumin laboratory test was performed 6 hours before and 24 hours after primary skin graft surgery in the central laboratory of Imam Khomeini Hospital of Urmia. Serum albumin was measured by enzymatic calorimetric method and with autoanalyzer Biochemistry Hitachi 902 made in Japan and kits of

Bionic Autobio company. The researcher collected the rest of the required information by reviewing the patients' medical records in the pre-prepared checklist. The checklist included age, gender, cause and severity of burn, TBSA, inhalation burns, the time interval between burn and surgery, duration of surgery, and blood volume lost.

Data analysis

The data were analyzed using SPSS software version 22.0 (IBM Corp., Armonk, N.Y., USA) using descriptive (mean, standard deviation, frequency, and percentage) and inferential (Paired T-test, Independent-T test, Pearson's correlation test, and regression test) statistics. The normal distribution of the data was checked using the Kolmogorov-Smirnov test. The significance level was considered at 0.05.

Results

One hundred sixty patients were analyzed, and this study had no attrition. The mean score of patients' age was 39.16±12.68 years (65-13). Ninety-one patients were male (57%) and 69 were female (43%). The most common causes of burn were fire in 94 cases (59%) and hot liquids in 19 patients (12%). Also, in 60 percent of men (55 out of 91), the cause of burn was fire, and in 21 percent (19 out of 91) it was an explosion. While in women, 56 percent (39 out of 69) of burn cases were due to fire, and 26 percent (18 out of 39) were due to self-immolation. In general, inhalation burns were present in 52 patients (32.5%), and 108 (67.5%) had no inhalation burns. The results showed that 121 patients (75.6%) had 3rd-degree burns, and 39 (34.4%) had 2nd-degree burns. In men, 29 percent (27 out of 91) had 2nd-degree burns, and 71 percent (64 out of 91) had 3rd-degree burns, while in women, 17 percent (12 out of 69) had 2nd-degree burns and 83 percent (57 out of 69) had 3rd-degree burns, but this difference was not statistically significant (P=0.53).

The mean score of TBSA of burn in all patients was 45.02±13.58. It was higher in women (47.06±13.49) than in men (43.79±13.55) (P<0.001). On average, the time interval between burns and surgery in patients was 52.50±17.77 hours (24-72 hours). The mean duration of surgery was 175.03±35.25 min. (90-255 min.). Also, on average, patients lost 1091.25±368.64 mL of blood during skin graft surgery (400-1500 mL). The mean score of serum albumin level was 1.43±0.49 g/dL before graft surgery, and it was 2.18±0.38 g/dL after graft surgery, therefore significantly higher after surgery.

Before surgery, the mean score of serum albumin level was 1.82±0.38 g/dL in patients with 2nd-degree burns, while it was 1.31±0.46 mg/dL in patients with 3rd-degree burns. The serum albumin level in the 2nd-degree burn was significantly higher than the 3rd-degree burns before graft surgery (P<0.001). After graft surgery, serum albumin level was 33.2±47.0 and 33.0±12.2 mg/dL in the 2nd- and 3rd-degree burn patients, respectively, therefore significantly higher in patients in the 2nd-degree burn group (P<0.001) (*Table I*).

There was a significant negative correlation between the TBSA of burn and serum albumin level before and after graft surgery (P<0.001) (*Table II*).

Table I - Mean serum albumin level based on severity of burn before graft surgery

Severity of burn	Serum albumin level before graft				Ind -T test	Serum albumin level after graft				Ind -T test
	Max	Min	Mean	SD		Max	Min	Mean	SD	
2nd-degree	2.92	1.78	1.82	0.38	P < 0.001	3.17	2.55	2.33	0.47	P < 0.001
3rd-degree	2.72	1.57	1.31	0.46		3.19	2.01	2.12	0.33	

Table II - Correlation of TBSA of burn with serum albumin before and after graft surgery

Pearson's correlation test	Serum albumin level before graft	Serum albumin level after graft
TBSA	r = - 0.045 p= 0.012	r = - 0.327 p= 0.000

Pearson's correlation test showed a significant negative correlation between severity of the burn and serum albumin level before and after graft surgery (P<0.001) (*Table III*).

Linear regression analysis showed that the regression model is valid and significant (P=0.001). According to the regression model, TBSA and burn severity significantly predict serum albumin level before skin grafting. TBSA and burn severity predict 36% of the variance of serum albumin level before skin graft surgery. Based on the Beta level before surgery, with an increase of one standard deviation in the TBSA of burn score, the standard deviation of serum albumin level will decrease by 22%. Also, with an increase of one standard deviation in burn severity score, the standard deviation of serum albumin level will decrease by 49% (*Table IV*).

According to the regression model, TBSA and burn severity significantly predict serum albumin level after skin grafting. TBSA and burn severity predict 25 percent of the variance of serum albumin level after skin graft surgery. Based on the Beta level, with an increase of one standard deviation in TBSA of burn score, the standard deviation of serum albumin level will decrease by 17 percent. Also, with an increase of one standard deviation in burn severity score, the standard deviation of serum albumin level will be reduced by 43 percent (*Table V*).

Discussion

Albumin is the main protein synthesized by the liver and has several vital functions, such as maintaining the normal colloidal oncotic pressure of plasma and binding to substances in the blood circulation, such as fatty acids, hormones and drugs. The normal reference range of serum albumin is 4.5-3.5 gm/dl.[16] Burn patients can experience a significant decrease in albumin levels due to higher vascular permeability in burn wounds and secretion, along with the loss of essential proteins through burn wounds, in such a way that a very small percentage of skin burns (0.8%) is associated with a decrease of up to 80% in serum albumin level. In addition, studies have shown that severity of hypoalbuminemia has a significant relationship with mortality rate in burn patients.[12,17] The greater the level of burn injury, the higher the mortality rate.[14] Therefore, according to the prominent role of albumin in predicting the outcome of burn patients and the importance of knowing the relationship between albumin level and severity and TBSA of the burn, this study was conducted to determine the serum albumin level before and after skin graft surgery and its relationship with the severity and TBSA of burns in the patient. In the present study, the mean age of the patients was 39.16±12.68 years, and 57% were male. In the study by Soedjana et al., the mean age of the patients was 33.9 years, and 71.43% were men.[12] Consis-

Table III - Correlation of severity of burn with serum albumin before and after graft surgery

Pearson's correlation test	Serum albumin level before graft	Serum albumin level after graft
Severity of burn	r = - 0.058 p= 0.000	r = - 0.493 p= 0.000

Table IV - Regression analysis to predict serum albumin level based on TBSA and severity of burns before graft surgery

Variable	B	SE	Beta	T	P
Constant	3.380	0.140	-	24.114	0.000
TBSA of burn	- 0.005	0.002	- 0.220	- 3.253	0.001
Severity of burn	- 0.391	0.053	- 0.497	- 7.340	0.000
ADJ.R^2=0.367	R^2=0.375	R=0.613			

Table V - Regression analysis to predict serum albumin level based on TBSA and severity of burns after graft surgery

Variable	B	SE	Beta	T	P
Constant	3.765	0.148	-	25.439	0.000
TBSA of burn	- 0.004	0.002	- 0.170	- 2.314	0.001
Severity of burn	- 0.331	0.056	- 0.432	- 5.888	0.000
ADJ.R^2=0.259	R^2=0.268	R=0.518			

tent with the present study, in Aguayo-Becerra et al.'s study, most patients were under 40 (mean age 36.8 years), and 76% were men. This shows that the total population of burn cases is demographically similar in different regions.[8,13,18]

In Aguayo-Becerra et al.'s study, 50% of burns were caused by fire, and 26% were caused by electric shock.[8] In the current study, 59% were caused by fire, 19% were caused by hot liquids, and burns caused by electrocution accounted for a smaller share. Other studies have reported a relatively similar contribution to different causes of burns.[3,14]

In this study, the patients' mean score of TBSA of burns was reported to be higher than in similar studies, because in similar studies patients with mild burns without the need for skin grafting were considered. In the study of Aguayo-Becerra et al., the mean score of burn TBSA in patients who survived was reported as 13%, and in deceased patients was 47%.[8] Also, in the study of Roham et al., the mean score of burn TBSA was 61% in deceased patients and 21% in discharged patients.[19] In line with the present study, Munasinghe et al., who investigated cases of burns requiring skin surgery, reported the mean score of TBSA of burns to be high (56.75%).[20] In the present study, 75.6% of the patients had third-degree burns; the rest were second-degree burns. While in Becerra et al.'s study, 32% of patients had full-thickness burns (third and fourth-degree).[8] In Kuipers et al.'s study, full-thickness burns were reported in 4.3% of patients, and the difference with the current study was probably due to how the samples were selected. In their study, all patients referred to the burn center were selected.[21] The rate of inhalation burns in the present study was 32.5%. In the studies of Aguayo-Beccera et al., the rate of burns caused by inhalation was reported as 12.6%.[8] In the study of El-Helbawy et al., the incidence of inhalation burns was reported to be 46.3%, and the mortality rate among patients with inhalation burns was higher compared with patients without inhalation injury.[22]

The study results showed that average serum albumin after surgery had improved significantly compared to before surgery, and there was hypoalbuminemia in victims of extensive burns before surgery. Improving serum albumin levels after surgery shows that surgery can reduce the consequences of burns and prevent patient death. Ishida et al. concluded that hypoalbuminemia in burn patients occurs mostly in the context of high fluid resuscitation and increased vascular permeability in burn injury.

In this study, serum albumin level had a significant negative correlation with TBSA and burn severity before and after receiving the graft. In the study of Soedjanaa et al., a significant negative correlation was reported between serum albumin level and TBSA of burns before surgery.[13] Also, in the study of Cucereanu-Bădică et al., a negative linear correlation was reported between TBSA of burn and serum albumin level in the first 48 hours after injury.[23] To the best of our knowledge, this is the first research that predicts serum albumin levels with burn severity and TBSA before and after skin graft surgery. This prediction rate was higher before skin graft surgery (36%) than after surgery (25%). Therefore, serum albumin level is a simple clinical tool and a sensitive and specific marker to identify the extent and severity of burn wounds[8,14,18] and hypoalbuminemia is a good indicator of burn severity or its related complications.[14] Burn patients with serum albumin concentrations less than or equal to 2.2 g/dL experience significantly higher morbidity and mortality.[24] Burn patients lose a significant amount of intravascular albumin and suffer from hypoalbuminemia. This hypoalbuminemia may persist for weeks after injury. Hypoalbuminemia is commonly seen in critically ill patients and is associated with poor clinical outcomes.[25]

One of the limitations of this study was the low sample size and limited time for data collection, which could affect the study results. Similar studies with a larger sample size and a longer period are recommended.

Conclusion

The results showed that serum albumin level had a significant relationship with severity and TBSA of burns and can be used to predict patients' conditions. Therefore, to help burn patients, especially patients with extensive and deep burns, the serum albumin level should be regularly monitored, and necessary measures should be taken to replace it before and after skin graft surgery. It could be used as an indicator to follow up on the patients' surgery outcome and healing process.

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