Original Article

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Association Between Serum Albumin Levels and Clinical Outcomes in Burn Patients: A Single-center Retrospective Analysis

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ABSTRACT

Objectives: Severe burns often result in significant intravascular albumin loss, leading to hypoalbuminemia. This study aimed to evaluate the association between serum albumin levels and clinical outcomes in burn patients.

Methods: A retrospective, single-center study was conducted at Velayat Hospital (Rasht, Iran), including burn patients aged ≥16 years, who were admitted between April 2019 and March 2020. Serum albumin levels were recorded on day 1, day 7, and at discharge. The main variables analyzed included albumin levels, length of hospital stay, skin graft rate, need for mechanical ventilation, and mortality.

Results: Among the 74 patients included in the study, 14 (18.9%) died, while 60 (81.1%) survived. The mean serum albumin levels on days 1, 7, and at discharge were significantly higher in survivors (3.09±0.22, 3.12±0.23, and 3.18±0.28 g/dL, respectively) than non-survivors (2.22±0.29, 2.74±0.29, and 2.07±0.69 g/dL, respectively) at all time points (p<0.001). The serum albumin level measured on day 1 was significantly lower in patients who required mechanical ventilation than in those who did not (2.86±0.47 vs.3.09±0.13, p=0.03). Additionally, a significant inverse relationship was observed between serum albumin levels and both total body surface area burned (TBSA) and graft extent (day 1: r_s=-0.76, day 7: r_s=-0.74, discharge: r_s=−0.62; p<0.001 for TBSA; and day 1: r_s=-0.59, day 7: r_s=-0.58, discharge: r_s=−0.50; p<0.001 for graft extent).

Conclusion: Hypoalbuminemia was associated with poor clinical outcomes in patients with severe burns. Serum albumin levels might serve as a specific marker of burn severity and a predictor of mortality.

Keywords: Serum albumin levels, Albumin, Burns, Mortality.

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Introduction

Burn injuries represent a significant public health challenge, particularly in developing countries [1-3]. According to data from the World Health Organization (WHO), burn injuries were responsible for 265,000 deaths, with 96% of these fatalities occurring in low- and middle-income nations [4]. In Iran, burns rank as the eighth-leading cause of death and the 13th-leading cause of disability [5]. Despite considerable advancements in treatment modalities, burn injuries continue to be associated with high rates of mortality and morbidity, often leading to cosmetic issues, economic hardship, mental health challenges, and disabilities [3, 6, 7]. The primary causes of burn-related deaths include septic shock, multi-organ failure, and respiratory failure [8].

Albumin, a significant protein synthesized by the liver, plays a critical role in maintaining blood osmotic pressure, with a normal reference range of 35-45 g/L [9]. This protein also facilitates the binding and transport of free fatty acids, hormones, and drugs [10]. In patients with extensive burns, significant amounts of intravascular albumin are lost at the burn site, leading to hypoalbuminemia [11]. The oxidative stress following burn shock damages the vascular endothelium, causing fluid leakage from blood vessels and the development of edema [12]. Additionally, albumin oxidation exacerbates this edema [13-15].

Severe burns trigger the release of various inflammatory mediators, such as histamine, prostaglandins, and cytokines, which contribute to both local and systemic inflammation. This inflammatory response leads to edema, increased metabolism, protein catabolism, immune suppression, sepsis, and multiple organ failure [16]. The heightened vascular permeability observed in both damaged and healthy tissues causes further albumin leakage into the interstitial space, which can result in hypovolemic shock, impaired wound healing, and an elevated risk of sepsis [16]. Serum albumin levels were associated with mortality and prognosis in patients with a range of acute and chronic conditions, including burn injuries and trauma [9, 16, 17]. As such, albumin levels might serve as a valuable marker of injury severity and could assist in the clinical staging of burn patients. Measuring serum albumin levels at admission might provide additional insight or serve as an alternative to traditional indicators such as the Abbreviated Burn Severity Index (ABSI). This information could be instrumental in improving the management and outcomes of patients with severe burns.

Therefore, this study aimed to investigate the relationships between serum albumin levels and vital clinical outcomes in burn patients, including the length of hospital and ICU stay, the need for mechanical ventilation, the percentage of body surface area requiring grafting, and mortality.

Materials and Methods

A single-center, retrospective study was conducted at Velayat Hospital (Rasht, Iran), a burn center in the north of Iran. The study included all patients aged 16 years and older who were admitted to the burn center between April 2019 and March 2020. The study was approved by the Medical Research Ethics Committee of Guilan University of Medical Sciences (registration number: IR.GUMS.REC.1400.161).

The inclusion criteria were burns covering more than 20% of the total body surface area (TBSA) within 24 hours of thermal, liquid, or contact burns. Patients with pre-existing conditions such as diabetes, thyroid disorders, chronic liver problems, end-stage renal disease (ESRD), or those with electrical, chemical, or inhalation burn injuries were excluded from the study. Based on a correlation coefficient of 0.50 between the skin graft rate and serum albumin level, with a type II error of 0.05, a power of 90%, and accounting for a 10% dropout rate, the minimum required sample size was calculated to be 57 patients. Ultimately, 74 patients were included in the study and divided into two groups based on their clinical outcomes.

Patient data was collected using a researcher-designed registration form, which included demographic and clinical information. A trained interviewer extracted the data from the medical records. Serum albumin levels were recorded from patient charts on days 1, 7, and at discharge or time of death. These measurements were routinely taken from burn patients at Velayat Hospital. Clinical outcomes, such as length of hospitalization, length of ICU stay, the extent of skin grafting (expressed as a percentage of TBSA), and the need for mechanical ventilation, were also extracted from the patient records.

All data analysis was performed using SPSS software (version 24.0; IBM Corp., Armonk, NY, USA). Descriptive statistics (mean, standard deviation, and frequency) were used to summarize patient characteristics and outcomes. The Kolmogorov-Smirnov test was applied to assess the non-normal distribution of continuous variables. The relationship between serum albumin levels and other continuous variables was analyzed using Spearman's rho correlation coefficient. Serum albumin levels between survivors and deceased patients were compared using the Kruskal-Wallis test. When significant differences were identified in the Kruskal-Wallis test, post-hoc pairwise comparisons were conducted using the Mann-Whitney U test with Bonferroni correction. A p-value of less than 0.05 was considered statistically significant.

Results

In this retrospective study, 74 patients with a mean age of 44.96±13.44 years were included and divided into two groups: survivors and non-survivors.

Of the 74 patients, 57 were male (87.4%) and 16 were female (21.6%). The mean length of hospital stay was 12.62±5.15 days, with an average ICU stay of 8.11±6.31 days. The clinical and baseline characteristics of the patients are summarized in Table 1.

The relationships between the percentage of TBSA, graft extent, and albumin levels in the survivor and non-survivor groups are presented in Table 2. Serum albumin levels were measured at three time points: on day 1, day 7, and at discharge (or at the time of death). The mean albumin levels in the non-survivor group were significantly lower than those in the survivor group at all measured time points (p<0.001). Specifically, the albumin levels in the non-survivor group were 2.22±0.29 g/dL on day 1, 2.74±0.29 g/dL on day 7, and 2.07±0.69 g/dL at discharge. In contrast, the survivor group had albumin levels of 3.09±0.22 g/dL, 3.12±0.23 g/dL, and 3.18±0.28 g/dL, at the same time points, respectively. These differences were statistically significant between the two groups at all measured time points (p<0.001) (Table 2). The average serum albumin levels for all patients were 2.93±0.41 g/dL on day 1, 3.05±0.28 g/dL on day 7, and 2.97±0.50 g/dL at discharge. The mean serum albumin level on day 1 was significantly lower than the other two time points (p<0.001) (Table 3).

As shown in Table 4, the serum albumin level measured on day 1 was significantly lower in patients who required mechanical ventilation than those without mechanical ventilation (2.86±0.47 vs. 3.09±0.13 g/dL, p=0.03). A significant inverse relationship was observed between serum albumin levels and both TBSA and graft extent (day 1: rs=-0.59, day 7: rs=-0.58, discharge: rs=-0.50; p=0.003 for TBSA; and day 1: rs=-0.45, day 7: rs=-0.42r, discharge: rs=-0.38; p<0.001 for graft extent). However, no significant correlations were found between serum albumin levels and the length of hospital or ICU stays at any of the measured time points(p>0.05) (Table 5).

Table 1. Subject baseline characteristics.

Parameters	Frequency, Number (%)
Sex	
Male	58 (78.4)
Female	16 (21.6)
Burn degree	
2nd day	14 (18.9)
3rd day	4 (5.4)
4th day	2 (2.7)
2nd and 3rd day	54 (73.0)
Cause of burn	
Scaled	18 (23.0)
Thermal	56 (77.0)
Mechanical ventilation	
Yes	53 (71.6)
No	21 (28.4)
Infection	
Yes	68 (91.9)
No	6 (8.1)
Outcome	
Discharged	60 (81.1)
Death	14 (18.9)

Discussion

This study investigated the association between serum albumin levels and clinical outcomes in burn patients.

Table 2. The comparison of serum albumin levels between survivors and dead burn patients.

Parameters	Died (N=14), mean±SD	Survived (N=60), mean±SD	*p* value
Total body surface area (%)	48.57±12.88	32.07±9.28	0.001
Extent of Graft (%)	26.93±13.14	18.63±9.14	0.001
Serum albumin level 1st day (g/dL)	2.22±0.29	3.09±0.22	0.001
Serum albumin level 7th day (g/dL)	2.74±0.29	3.12±0.23	0.001
Serum albumin level at discharge time (g/dL)	2.07±0.69	3.18±0.28	0.001

Table 3. The two-by-two comparisons of serum albumin levels by time periods.

Measurement time points	Test statistic	*p* value	Adjusted *p* value
1st day vs 7th day	74.82	<0.001	0.000
1st day vs. discharge time	109.17	<0.001	0.000
7th day vs. discharge time	34.34	0.018	1.000

Table 4. Comparison of serum albumin levels in patients with mechanical ventilation and without mechanical ventilation.

	With mechanical ventilation		Without mechanical ventilation		*p* value
	Min, Max	Mean±SD	Min, Max	Mean±SD	
Serum albumin level on 1st day (g/dL)	1.9, 3.7	2.86±0.47	2.9, 3.3	3.09±0.13	0.030
Serum albumin level on 7th day (g/dL)	2.1, 3.6	3.03±0.31	2.8, 3.5	3.11±0.16	0.263
Serum albumin level at discharge time (g/dL)	2.0, 3.6	2.91±0.56	2.3, 3.5	3.12±0.23	0.095

Table 5. The correlation coefficient between serum albumin levels and extent of graft, length of hospital stay (Day), and length of Intensive care unit (ICU) stay.

Parameters	Correlation Coefficient			*p* value		
	1st day	7th day	Discharge time	1st day	7th day	discharge time
Total body surface area (%)	-0.76	-0.74	-0.62	0.001	0.001	<0.001
Length of hospital stay (Day)	-0.17	-0.13	-0.05	0.142	0.241	0.656
Length of Intensive care unit (ICU) stay	-0.26	-0.23	-0.07	0.091	0.183	0.454
Extent of Graft (%)	-0.59	-0.58	-0.50	<0.001	<0.001	<0.001

According to the findings of the study, a significant relationship was found between the need for mechanical ventilation and serum albumin levels on day 1. While lower serum albumin levels on the first day were significantly associated with the need for mechanical ventilation, they should not be regarded as an exclusive predictor. Low albumin levels might reflect fluid retention and an increased risk of pulmonary complications, such as pulmonary edema, which could contribute to respiratory failure. However, other clinical factors, including inhalation injuries, pneumonia, and acute respiratory distress syndrome (ARDS), likely play a role in this relationship. Therefore, while low initial serum albumin levels might indicate a higher likelihood of requiring mechanical ventilation, they should be interpreted in the broader context of the patient's overall clinical condition. Complications of burn injuries, such as inhalation injury, pulmonary edema, pneumonia, and ARDS, could impair gas exchange and lead to respiratory failure [18]. Hypoalbuminemia can exacerbate fluid retention and increase the risk of thromboembolic events, further complicating respiratory conditions. Addressing hypoalbuminemia effectively might help reduce the need for mechanical ventilation by mitigating some of the associated complications. [19, 20]. In the present study, the lowest serum albumin levels were recorded at admission and compared across subsequent time points. Due to the treatment protocols for burn patients, including albumin administration, the mean serum albumin level on day 7 approached the normal range. However, the findings revealed that albumin levels in deceased patients declined again at the time of death. Moreover, the analysis of recorded data showed that, at all three measured time points, the average serum albumin levels in deceased patients were consistently lower than in survivors. This was consistent with previous studies [21, 22], which also reported lower albumin levels in non-survivors than survivors. These findings reinforced the idea that declining albumin levels might contribute to increased mortality in burn patients. Albumin plays a crucial role in maintaining plasma oncotic pressure, supporting growth and tissue repair, and facilitating the transport of hormones, nutrients, and certain drugs. Reductions in serum albumin levels could impair wound healing and increase susceptibility to sepsis, thereby contributing to higher mortality and morbidity rates [23, 24]. A previous study reported that baseline albumin levels at the time of admission in burn patients could predict both outcomes and mortality [25]. Moreover, they reported that low albumin levels (<2 g/dL) had high sensitivity and specificity in determining burn mortality rates. In the present study, non-survivors required more extensive skin grafting than survivors, highlighting the association between higher grafting needs and worse outcomes. This finding suggested that the extent of grafting could serve as a marker of injury severity and might predict a poorer prognosis. Additionally, the findings indicated a significant inverse relationship between serum albumin levels and both TBSA and the extent of grafting required. Thus, lower serum albumin levels could predict the need for more extensive grafting during patient management. Our results also revealed a trend of longer hospital stays with decreasing serum albumin levels, although no statistically significant associations were found between serum albumin levels and the duration of hospital or ICU stays. A recent study presented evidence of a significant relationship between serum albumin levels in deceased patients and survivors one week after discharge, with albumin levels associated with burn injury prognosis. Consistent with the present study, they found no significant relationship between serum albumin levels and the length of hospital stay [22]. Serum albumin levels in burn patients tend to decline due to two primary mechanisms. First, albumin is directly lost from the wound site. Second, the systemic inflammatory response induced by burn injuries increases vascular permeability in both damaged and healthy tissues, leading to additional albumin leakage from the bloodstream. This phenomenon is especially pronounced in patients with extensive burns, where widespread inflammation and heightened vascular permeability contribute to more significant albumin loss [16].

The retrospective design of this study might limit data availability and accuracy, potentially introducing biases and confounding factors. Additionally, the single-center setting and relatively small sample size constrain the generalizability of the findings, reduce statistical power, and hinder the ability to draw definitive conclusions. However, a notable strength

of this study was the comprehensive evaluation of serum albumin levels at multiple key time points (days 1, 7, and discharge), which provided valuable insights into the dynamic changes in albumin levels throughout burn treatment. Furthermore, the study offered clinically relevant data by exploring associations between albumin levels and critical outcomes, such as mortality, mechanical ventilation, and grafting requirements, which could guide future research and clinical decision-making.

Most patients in the present study had the lowest serum albumin levels at admission, which improved to near-normal levels by day 7. However, serum albumin levels decreased again in deceased patients. Significant associations were observed between serum albumin levels and mortality, TBSA, and the extent of grafting. While hypoalbuminemia appeared to be a potential predictor of mortality and mechanical ventilation in burn patients, the single-center design without a comparison group limited the generalizability of these findings. Future multi-center studies with comparison groups are necessary to confirm these findings and better understand the role of serum albumin in predicting outcomes in burn patients.

Declaration

Ethics Approval: The study received ethical approval from the Ethics Committee of Guilan University of Medical Sciences (Reference number: IR.GUMS.REC.1400.161). As a retrospective study, patient-informed consent was not required because the analysis relied on previously collected data from the hospital information system. To ensure patient confidentiality, no personally identifiable information, such as names, was retrieved from the database.

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