

Original Article

Serum albumin levels in burn people are associated to the total body surface burned and the length of hospital stay but not to the initiation of the oral/enteral nutrition

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Abstract: Objective: Serum albumin levels have been used to evaluate the severity of the burns and the nutrition protein status in burn people, specifically in the response of the burn patient to the nutrition. Although it hasn't been proven if all these associations are fully funded. The aim of this retrospective study was to determine the relationship of serum albumin levels at 3-7 days after the burn injury, with the total body surface area burned (TBSA), the length of hospital stay (LHS) and the initiation of the oral/enteral nutrition (IOEN). Subject and methods: It was carried out with the health records of patients that accomplished the inclusion criteria and were admitted to the burn units at the University Hospital of Reina Sofia (Córdoba, Spain) and UAB Hospital at Birmingham (Alabama, USA) over a 10 years period, between January 2000 and December 2009. We studied the statistical association of serum albumin levels with the TBSA, LHS and IOEN by ANOVA one way test. The confidence interval chosen for statistical differences was 95%. Duncan's test was used to determine the number of statistically significantly groups. Results: Were expressed as mean±standard deviation. We found serum albumin levels association with TBSA and LHS, with greater to lesser serum albumin levels found associated to lesser to greater TBSA and LHS. We didn't find statistical association with IOEN. Conclusion: We conclude that serum albumin levels aren't a nutritional marker in burn people although they could be used as a simple clinical tool to identify the severity of the burn wounds represented by the total body surface area burned and the length of hospital stay.

Keywords: Albumin, early nutrition, plasma protein synthesis, protein nutrition state, starvation

Introduction

Albumin is the main protein synthesized by the liver and has several important functions; it is essential in the maintenance of normal plasma colloid oncotic pressure and is the primary serum binding protein responsible for the transport of various substances in the circulation including fatty acids, hormones, and drugs. The normal reference range for albumin is 35-45 g/L [1]. Due to the long half life of albumin (±20 days) and that its serum level is affected by many factors, the determination of albumin level is not a sensitivity and specificity indicator of protein nutrition state, although serum albumin is a reliable indicator of morbidity and mortality in hospitalized patients [2]. Unlike albumin, prealbumin has become the most frequently assayed protein in assessing the protein energy malnutrition (PEM) status since

it has a relatively short plasma half-life of 2.5 days and it is expected instant changes in response to correct protein intake. Nevertheless, has been proved that not even the serum prealbumin level in critically ill patients responds sensitively to nutritional support and that an increase in the prealbumin level does not indicate a better prognosis for critically ill patients [3].

In the acute period of burn disease accompanied by the increase of free-radical oxidation the level of serum OMP (oxidatively modified proteins) significantly increases. Oxidation of albumin causes the increase of platelet and erythrocyte aggregation and also the increase of erythrocytes aggregates strength [4].

Burn patients can also have important reduction in albumin level due to a higher vascular

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permeability in the burn wounds that produces exudation with an important protein loss through the burn wound [5] and an acute phase response of plasma protein synthesis in liver that occur with even a very small percentage of burn skin (0.8%) and that produces a decrease to about 80% of normal albumin and prealbumin levels [6].

Besides, initially depressed serum albumin level is associated with an increase in mortality in the major burn patients [7].

On the other hand, it has been proven that early enteral nutrition decreases duration of hospitalisation and mortality in children with burns [8], counteracts the euthyroid sick syndrome and improves the length of hospital stay in burn patients [9]. Thus, many physicians have used the serum albumin level to evaluate the severity of the burns and the nutrition protein status in burn people, specifically the response of the burn patient to the nutrition although it hasn't been proven if all these associations are fully funded.

The aim of this retrospective study was to determine the relationship of serum albumin level at 3-7 days after the burn injury, with the total body surface area burned (TBSA), the length of hospital stay (LHS) and the initiation of the oral/enteral nutrition (IOEN). It was carried out with medical patients with the inclusion criteria admitted to the burn units of Reina Sofia University Hospital (Spain) and UAB Hospital (USA) over a 10 years period, between January 2000 and December 2009.

Material and methods

Subjects selection

The information was compiled from clinical histories gathered from the databases of burn patients in Birmingham (Alabama, USA) and Córdoba (Córdoba, Spain) from January 2000 to December 2009. We were looking for patients who fit the inclusion criteria and we grouped the albumin data into three different classifications: groups according to.

We were looking for patients with the inclusion criteria and we grouped them in 3 different ways according to the parameter we wanted to determine the association with albumin level:

1. The initiation of oral/enteral nutrition after the burn injury (IOEN): Group 1 (<24 h), Group 2 (24-48 h) and Group 3 (>48 h).
2. The total body surface area burned (TBSA): 5-10%, 10-15% and 15-20%.
3. The length of hospital stay (LHS): ≤21 days, 21-30 days and >30 days.

The chart review was performed by a trained plastic surgeon with long standing experience in chart reviews.

624 patients suffering from burn injuries from January 2000 to December 2009 (457 from Birmingham and 167 from Córdoba) met the inclusion criteria and were selected for our study. All of them survived their injuries. The inclusion criteria were as follows: no pre-existing thyroid disease or use of thyroid medications, patients with partial and full thickness burns ranging from 5-20% TBSA (total body surface area), patients under intensive glucose control, age >18 and ≤50 years, no electrical, chemical, or burn associated with major trauma or serious illness, no presence of inhalation injury, Curreri formula applied for the nutrition of the patient, patients that ingested this formula calories prescribed per day, no administration of parenteral nutrition, no administration of corticosteroids, no antecedents of anorexia nervosa or malnutrition, not to be suffering any kind of inflammatory or hepatic disease and at least one serum albumin level determination at 3-7 days after the burn injury.

We considered a minimum of 5% TBSA and a maximum of 20% TBSA, as this was the size threshold capable of being treated at the burn unit of the University Hospital of Reina Sofia.

We didn't include people less than 18 years of age since the ethics committee from UAB did not permit it.

It was not necessary to obtain the authorization of an ethics committee from the University Hospital of Reina Sofia as this was a retrospective study that fulfilled all the terms this institution considered necessary to be excluded from such obligation. Those terms are as follows: the privacy and confidentiality of the patients will be guaranteed, no contact will be made with patients during or after completion of study, all

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data will be stored on password-protected institutional computers, and no money compensation granted to the research or ownership interest. For the American arm of the study we applied for and received authorization from the institutional review board (IRB) of the University of Alabama at Birmingham (protocol number: X100615005).

Patient anonymity was preserved in both arms of the study.

We considered at least one serum albumin level determination between 3-7 days after the burn injury because is the highest catabolic phase of the burn patient and when the serum albumin level drop in burn people. This phase covers the first two weeks after the burn injury [10]. This is due to 2 reasons: the levels of liver albumin and prealbumin synthesis decreased to about 80% of normal after 24 h of the burn injury [6] and the losses of albumin through the burn wound are greatest in the first 3 postburn days. After these 3 days protein loss in all burn types decreased to a relatively steady rate [5].

If there was for the same patient more than one albumin determination during that period, we calculated the mean of those measurements and we considered that mean for the collection and analysis of the data.

Initial management

On arrival at the burn center, a thorough evaluation was performed and a treatment plan was developed. A thorough history of the burn was obtained, which included the location of the injury, type of agent involved in the burn, duration of exposure to the agent, as well as details of the patient's other comorbidities. The TBSA was calculated and fluids, analgesia, tetanus vaccine, gastrointestinal protection and subcutaneous heparin were administered.

When calculating TBSA, we only included those areas of partial and full-thickness dermal injury (2° and 3° degree). Superficial burns involving only the epidermis were not included in the calculation. The rule of nines was the most frequent method used for calculating the extent of the burn as it is the most familiar. The fluid resuscitation formula during the first 24 hours following burn injury was the Parkland Formula [12]: $4 \text{ cc/kg/\% TBSA} = \text{total fluid to be adminis-}$

tered in the first 24 hours. 50% of fluid should be given in the first 8 hours and the remainder of fluid should be given in the next 16 hours. The fluid is lactated Ringer solution [11].

At the conclusion of the first 24 hours, we continued fluids to achieve a goal urine output of at least 30 cc/hr until the patient initiated oral tolerance and we considered it clinically indicated to discontinue fluids.

The administration of fixed amounts of energy to critically ill burn patients based on standardized equations or on the preestablished range of 167-188 kJ/kg day [12] is acceptable only when indirect calorimetry cannot be made. We had no means of obtaining indirect/direct calorimetry, and for that reason we applied the well known Curreri formula. This formula generally overestimates caloric requirements. The Curreri formula is as follows: $25 \text{ kcal} \times \text{weight (kg)} + 40 \text{ kcal} \times \% \text{ TBSA}$ [11].

Patients received a high protein diet with at least 2 grams of protein per kilogram per day and were supplemented with polyvitamins, minerals, vitamins A, C, and zinc.

The caloric and protein intake was increased by the daily intake of high calorie protein shakes. The minimum number of shakes ingested by each patient was calculated by the hospital nutritionist. From that minimum shakes the patient could consume as many shakes as he wanted to ingest.

Blood sampling

At least 1 blood sample was collected from each patient at 3-7 days periods after the burn injury. If there were more than 1 blood sample during that period of time, we calculated the mean of those measurements.

Whole blood (3.5 mL) was collected in serum separator gel tubes and centrifuged at 3500 rpm for 10 minutes, and serum was separated and processed for albumin, using standard methods (colorimetric methods with automatic analyzers).

Statistical analysis

We calculated the mean for quantitative factors and the percentage for qualitative factors as it is shown in **Table 1**. We studied the asso-

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Table 1. Mean or percentage for the different factors

Quantitative Factors	Mean±SD
Age	36.46±10.89
Albumin	2.07±0.14
% TBSA	12.63±4.34
LHS (days)	23.94±6.98
Qualitative Factors	Percentage
Sex: male/female	77%/23%
IOEN: <24 h/24-48 h/>48 h	34.1%/39%/26.8%

ciation of serum albumin level with the following parameters: TBSA, LHS and IOEN (**Table 2**). Statistical differences between the parameters of each group were analyzed by ANOVA one way test with SPSS 12.0 (SPSS Inc., Chicago, IL, USA) and are expressed as mean±standard deviation. If significant differences were observed, Duncan's test was used to determine the number of statistically significantly groups. The confidence interval chosen for statistical differences was 95%. Before the Anova one way test, Kolmogorov-Smirnov and Shapiro-Wilk tests were used for testing normality. The assumption of homoscedasticity was determined with the F-Snedecor test.

Results

The study included 624 patients. **Table 1** shows the mean for the 3 different parameters studied: TBSA, LHS and IOEN. As there were no significant differences in both arms of the study for all the parameters examined ($p>0.05$), the data of both arms were pooled and presented together in order to simplify the analysis.

As we show in **Table 2**, serum albumin levels were associated with TBSA and LHS but not with IOEN.

Association of serum albumin levels with total body surface area burned (TBSA)

As we can see in **Table 2**, serum albumin levels were statistically different in the 3 groups of TBSA, with greater to lesser serum albumin level found in: 5-10% of TBSA, 10-15% of TBSA and 15-20% of TBSA, in that order.

Association of serum albumin levels with the length of hospital stay (LHS)

As we show in **Table 2**, serum albumin levels were statistically different in the 3 groups of

LHS, with greater to lesser serum albumin level found in: <21 days of LHS, 21-30 of LHS and >30 days of LHS, in that order.

Association of serum albumin level with the initiation of the oral/enteral nutrition (IOEN)

As we can see in **Table 2**, serum albumin levels were statistically equal in the 3 groups of IOEN, so serum albumin level is not associated to the IOEN.

Discussion

The burn wounds produce an important protein loss [5] and an acute inflammatory phase that affects the plasma protein synthesis in liver [6], this can explain our findings of association between the higher TBSA and the lower serum albumin level since higher percentage of burn wounds will have associated higher percentage of protein loss and higher inflammatory response with lower liver plasma protein synthesis.

According to Vanek [2], serum albumin is a poor nutritional marker, but it is a good prognostic marker correlating with morbidity and mortality in hospitalized patients. For that reason, it's hardly surprising that hypoalbuminaemia is associated with increased mortality and prolonged length of stay in ICU [13]. We agree with these statements since our results show an association between higher morbidity, represented in our study by a higher LHS, and lower serum albumin level. Moreover, it is supposed that an early initiation of the oral/enteral nutrition (IOEN) will produce a better nutritional status than a later IOEN, nevertheless our results showed no association between the initiation of the oral/enteral nutrition (IOEN) and the serum albumin level and therefore confirm the previous statement that says that serum albumin level is a poor nutritional marker in hospitalized patients.

Moreover, there weren't any deaths in any groups. We think this could be due to the inclusion criteria applied; specifically the fact that the severity of injury in the patients assessed was not very high (TBSA <20%). This is supported by a study conducted by Gangemy et al. [14]. They found that a TBSA value >20% is the threshold that largely discriminates (78% of accuracy) between survivors and nonsurvivors.

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Table 2. Association of serum albumin level with TBSA, LHS and IN

TBSA	5≤x<10%	10≤x<15%	15≤x≤20%	Statistical differences
Albumin level (g/dl)	2.28±0.08	2.04±0.06	1.95±0.02	P<0.05; A, B, C*
n	169	232	223	624
LHS	<21 d	21-30 d	>30 d	Statistical differences
Albumin level (g/dl)	2.15±0.15	2.08±0.13	1.95±0.02	P<0.05; A, B, C*
n	208	282	134	624
IOEN	<24 h	24-48 h	>48 h	Statistical differences
Albumin level (g/dl)	2.09±0.14	2.06±0.14	2.07±0.14	P>0.05
n	213	242	169	624

*The A, B and C Duncan's groups indicate that they are statistically different.

We consider that the hypoalbuminemia of burn patients will be resolved when they recover from the general inflammation process, hypert-metabolism and the burn wounds. no matter how early the nutritional administration is done.

In conclusion, serum albumin levels are not a nutritional marker in burn people and shouldn't be used to asses the nutritional protein status. Nevertheless, we believe that the measurement of serum albumin levels at 3-7 days period after the burn injury in patients with a TBSA 5-20% could be used as a simple clinical tool to identify the severity of the burn wounds represented by the total body surface area burned and the lenght of hospital stay.

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References

- [1] Lyons O, Whelan B, Bennett K, O'Riordan D and Silke B. Serum albumin as an outcome predictor in hospital emergency medical admissions. *Eur J Intern Med* 2010; 21: 17-20.
- [2] Vanek V. The use of serum albumin as a prognostic or nutritional marker and the pros and cons of IV albumin therapy. *Nutr Clin Pract* 1998; 13: 110-21.
- [3] Lim SH, Lee JS, Chae SH, Ahn BS, Chang DJ and Shin CS. Prealbumin is not sensitive indicator of nutrition and prognosis in critical ill patients. *Yonsei Med J* 2005; 46: 21-6.
- [4] Levin GY, Egorihina MN. The role of oxidized albumin in blood cell aggregation disturbance

in burn disease. *Int J Burns Trauma* 2013; 18: 3: 115-21.

- [5] Waxman K, Rebello T, Pinderski L, O'Neal K, Khan N, Tourangeau S, Himes E, Cordill K. Protein loss across burn wounds. *J Trauma* 1987; 27: 136-40.
- [6] Dickson P, Bannister D and Schreiber G. Minor bums lead to major changes in synthesis rates of plasma proteins in the liver. *J Trauma* 1987; 27: 283-87.
- [7] Kim GH, Oh KH, Yoon JW, Koo JW, Kim HJ, Chae DW, Noh JW, Kim JH and Park YK. Impact of burn size and initial serum albumin level on acute renal failure occurring in major burn. *Am J Nephrol* 2003; 23: 55-60.
- [8] Khorasani EN and Mansouri F. Effect of early enteral nutrition on morbidity and mortality in children with burns. *Burns* 2010; 36: 1067-71.
- [9] Pérez-Guisado J, de Haro-Padilla JM, Rioja LF, Derosier LC and de la Torre JI. The potential association of later initiation of oral/enteral nutrition on euthyroid sick syndrome in burn patients. *Int J Endocrinol* 2013; 2013: 707360.
- [10] Ramos G, Guastavino MP, Bolgiani A, Prezzavento G, Patiño O and Benaim F. Hypoalbuminemia in burned patients: an outcome marker that could define evolution periods. *Rev Argent Quemad* 2000; 15: 23-29.
- [11] Klein MB. Thermal, chemical and electrical injuries. *Grabb and Smith's Plastic Surgery*, 6th edition 2007; 17: 132-50.
- [12] De Biasse MA and Wilmore DW. What is optimal nutritional support? *New Horizons* 1994; 2: 122-30.
- [13] Blunt MC, Nicholson JP and Park JR. Serum albumin and colloid osmotic pressure in survivors and non survivors of prolonged critical illness. *Anaesthesia* 1998; 53: 755-61.
- [14] Gangemi EN, Garino F, Berchiolla P, Martinese M, Arecco F, Orlandi F and Stella M. Low triiodothyronine serum levels as a predictor of poor prognosis in burn patients. *Burns* 2008; 34: 817-24.