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Research Article

Effects of Enteral Albumin on Healing of Laser Doppler Determined Superficial Partial Thickness Fresh Flame Burns of Adults

Afzaal Bashir,[1] Sunaina Afzaal,[2] Salman Ali,[3] Hajra Ahmad,[4] Mohammed A. Alharbi,[5] Sunniya Afzaal[6]

[1] Department of Plastic Surgery, Allama Iqbal Medical College, Lahore, [2-3] Punjab Rangers Teaching Hospital, Lahore; [4]Department of Environmental Design, Health and Nutritional Sciences, Allama Iqbal Open University, Islamabad; [5]King Abdullah Medical City, Makkah, Saudia Arabia, [6]Shalama Medical and Dental College, Lahore,

Abstract

Background: Burn wounds have different injury levels which affects their healing potential. Along with wound care, burns healing requires additional macro and micronutrients to cope with high catabolic state. Albumin is one of the important macromolecule in this healing process.

Objective: The aim of this study is to define the role of albumin in healing of superficial partial thickness fresh flame burn wounds.

Methodology: This prospective double-blinded randomized control study was conducted from February 2019 to January 2020 in Mayo Hospital Burn Center, Lahore, Pakistan. One hundred adult patients of fresh flame burns having superficial partial thickness wounds which were assessed clinically and objectively determined by Laser Doppler Imaging were randomly allocated into supplemented albumin group (SAG) and non-supplemented albumin group (NSAG). Oral dietary supplementation by albumin 2g/kg body weight was given and outcomes were compared in terms of hospital stay, serum albumin at 7th day, number of dressings, mean pain score during first week of treatment and approximate cost.

Results: Mean age of the patients was 33±9.2. In SAG, mean hospital stay was 10(2.9) days, mean number of interactive dressings required were 2(1.3), mean pain score during first week was 4(1.7) and mean cost of treatment was 339(23) USD while in NSAG, mean hospital stay was 19(3.7), mean number of interactive dressings 4(1.7), mean pain score during first week 7(1.3) and mean cost was 522(70) USD.

Conclusion: Supplementation with oral albumin in acute burn management leads to quicker wound healing, less frequency of dressing change, lesser pain and decreased costs.

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Corresponding Author | Dr. Afzaal Bashir, Associate Professor, Department of Plastic Surgery, Allama Iqbal Medical College, Lahore. **Email:** dr.afzaal@yahoo.com

Keywords | Albumin, Superficial Partial Thickness Burn, Laser Doppler Imaging, Pain Score, Hospital Stay, Interactive dressing

Introduction

Burn injuries are a global public health problem with physical, psychological, social and economic implications resulting in insult to body tissues particularly the skin causing coagulative necrosis due to extreme temperature, electricity or chemicals.[1,2] No one is immune to burn injuries but adults of actively working age group (18 - 40 years) are more susceptible. Flame burns are the most common variety occurring at domestic as well as workplace incidences.[3] Depending on depth, we can classify burn wounds into superficial, superficial partial thickness, deep partial thickness and full thickness burns.[4] Knowledge of wound thickness in burns is mandatory as it helps in deciding the type of treatment needed ranging from ointments, interactive dressings, antibiotics and surgical techniques. Depth determination

is not only essential for making decisions regarding management but also its clinical estimation is a challenging task.[5] Laser Doppler Imaging is one of the latest gadgets which objectively determines burn tissue thickness as an adjunct to clinical diagnosis and gives pictures having red, yellow and blue color based on vascularity of the burned skin as shown in Fig 1.[4] Red color shows superficial partial thickness wound (normal vascularity), yellow indicates deep partial thickness (inadequate vascularity) and blue color shows full thickness wound (no vascularity). Patients having superficial partial thickness burn wounds are the group of particular interest in burn centers due to two reasons. Firstly, the majority of burn injuries fall in this group and secondly, these are the wounds which, if managed well, heal within three weeks satisfactorily without any surgical intervention.[6]

Nutrition has very vital role in burn wound healing.[7] Early enteral nutritional support in the form of both micronutrients and macronutrients not only provides metabolic ingredients for wound healing but also protects against curling ulcers and trans-migration of bacteria from gut mucosa.[8] Albumin is an important component of dietary proteins. It is also one of the major proteins in our plasma playing vital role as a carrier of different substance in the blood and maintenance of plasma colloid osmotic pressure.[9] Decrease in plasma albumin level is commonly found in burns due to loss through wound surface and decreased synthesis in hypercatabolic state.[10] Hypoalbuminemia resulted in plasma water to migrate into interstitial tissues leading to tissue edema and ultimately delayed wound healing.[11] Intravenous albumin infusions are needed to correct plasma albumin levels, which are not only costly but also associated with severe anaphylactic reactions mandating cautious monitoring. Contrast to it, dietary albumin can be easily had from poultry eggs and does not cause any significant reaction.[12] After digestion, dietary albumin provides basic amino acids as building block for wound healing and also for de-novo synthesis of plasma albumin to maintain its certain level in blood which can help is healing of burn wounds.[11] The rationale of this study was to find out role of dietary albumin in healing of superficial partial thickness burns after determining wound thickness clinically and as well as by laser doppler imaging to enhance the accuracy so that effect of dietary albumin can be properly emphasized in the best interest of better wound care.

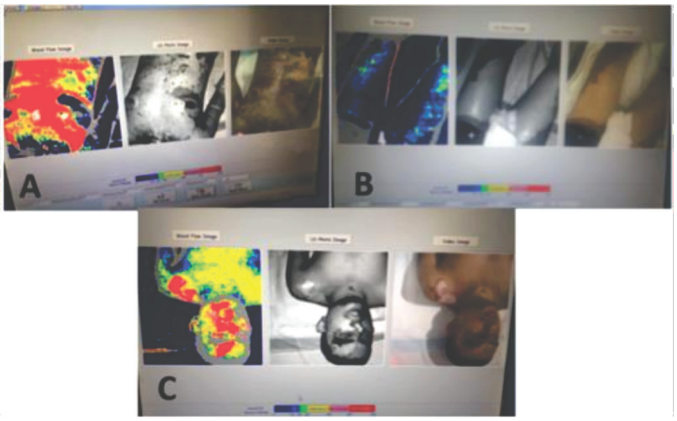

Figure 1: *LDI of Burn Wounds.* ***A.*** *Red color on LDI shows superficial partial thickness,* ***B.*** *Blue color on LDI shows full thickness,* ***C.*** *Yellow color on LDI shows Deep Partial thickness*

Methodology

In this double blinded randomized control trial, 100 adult patients were recruited from Burn Center, Mayo Hospital/King Edward Medical University, Lahore, Pakistan from February 2019 to January 2020 who were having 10% to 20% of total body surface area with superficial partial thickness burn presenting within 24 hours of the incident. Area of burn was calculated by Walace rule of nine and depth was determined subjectively by clinical examination as well as objectively by Laser Doppler Imaging as adjunct.[6] Patients with BMI below 18.9 or above 24.9 and those with abnormal serum albumin at admission were not considered for the study due to comorbidities associated with abnormal BMI. Similarly, patients with known allergy to albumin, having any metabolic disorder and/or uncontrolled co-morbidity (i.e. DM, HTN, CRF, CCF, CLD) were excluded.[13] Patients who were put on nil per oral (NPO) or refused to take diet from hospital kitchen were also excluded.[14]

The patients were randomly allocated into two groups, Supplemented Albumin (SA) group and Non-Supplemented Albumin(NSA) group, each containing 50 patients. Isonitrogenous and isocaloric diet prepared in hospital's kitchen with basic composition given in Table 1 was provided to all patients with calories according to Curreri Formula: (25kcal)(weight in Kg)+(40kcal) (%body surface area burned).[15] All patients were exclu-sively fed enterally and energy composition was used as 48% from carbohydrate, 41% from fat and 11% from proteins.[16] In addition, SA group also received supple-mental enteral Albumin 2g per kilogram body weight per day in two divided

doses in the form of boiled egg white from the time of admission to discharge from hospital.[17,18] So the diets of two groups differed only in albumin level. Patients and investigators were blinded to type of diet with respect to supplementation.

Table 1: *Dietary composition provided by hospital kitchen feed*

Components	Amount in 100gm
Calories (kcal)	488
Macronutrients	58.4
Carbohydrates (g)	
Proteins (g)	13.2
Lipids (g)	22.4
Micronutrients	
Vitamins	
A (µg retinol equivalent)	419.7
C (mg)	97.6
D (µg)	9.0
E (mg tocopherol equivalent)	12.0
Thiamin (mg)	1.0
Riboflavin (mg)	1.2
Niacin (mg)	10.0
B6 (mg)	1.1
K1 (µg)	52.5
Inositol (mg)	24.4
Pantothenic Acid (mg)	3.7
Folic Acid (µg)	104.4
Minerals/Elements Sodium (mg)	195.2
Potassium (mg)	595.4
Chlorine (mg)	439.2
Iron (mg)	6.3
Calcium (mg)	439.2
Phosphorus (mg)	341.6
Magnesium (mg)	73.2
Zinc (mg)	6.3
Copper (mg)	0.5
Iodine (µg)	49.1
Selenium (µg)	14.7
Molybdenum (µg)	14.6
Manganese (mg)	**0.8**
Chromium (µg)	15.0

Burn wound management in both SA and NSA groups was done by the same surgical team under standard guidelines of burn wound care including resuscitation, pain relief, antibiotics and interactive silver dressing on all wounds except face where hydrogel dressing was applied to avoid silver induced pigmentation as shown in fig 2. Interactive silver impregnated dressing done for other wounds was assessed by inspection on daily basis for soakage due to oozing from wound and was immediately changed if more than 25% of the dressing area was soaked.[19] Outer covering of the dressing was removed on every other day and integrity of the wound dressing was assessed. Dressing easily fell off once the wound was complete epithelized.[20] Epithelization was further confirmed on clinical examination by consultant plastic surgeon. Further dressing of the wound was stopped and day of hospitalization was noted. Patients were discharged from hospital with advice to apply emollient on epithelized surface at home and visit for follow up. Pain was managed by intravenous acetaminophen and nalbuphine according to body weight and pain scoring was done by grading from one to ten by the patient every time before giving dose of analgesia.[21] Mean pain score was calculated at the end of 7th day. Serum albumin was assessed at the time of recruitment as well as at 7th day. Approximate treatment cost was calculate in Pakistani rupees and then converted into US dollar on latest market value. It included calculated cost of medications, dressings and nutrition while hospital charges and staff salaries were not included because Mayo Burn unit belongs to public sector hospital. The study protocol was reviewed and approved by the institutional review board and trial was registered at Clinical Trial Registry under registration number NCT03709069.

Figure 2: *A) Hydrogel Dressing on Face B) Silver dressing applied on superficial partial thickness burn wound of forearm*

Qualitative variables like gender, regions of body involved and primary cause of burn were expressed in proportion while quantitative variable like age, percentage body surface area burnt, body mass index at admission, serum albumin level, mean pain score during first week, total calories taken per day, number of dressings, hospital stay in days and approximate cost of treatment in US dollars were expressed as means (SD). Data analysis was done by using SPSS 21. Independent sample

t-test was applied to mean pain score during first week, hospital stay, number of dressings and approximate cost of treatment. The p- value < 0.05 was considered statistically significant.

3. Results

One hundred patients were managed for their superficial partial thickness fresh flame burn wounds with 50 patients in each SA group and NSA group. Regions of the body involved by burn were head and neck in 21% cases, chest 39%, abdomen 9%, upper limb 13% and lower limb in 18% cases as represented in figure 3.

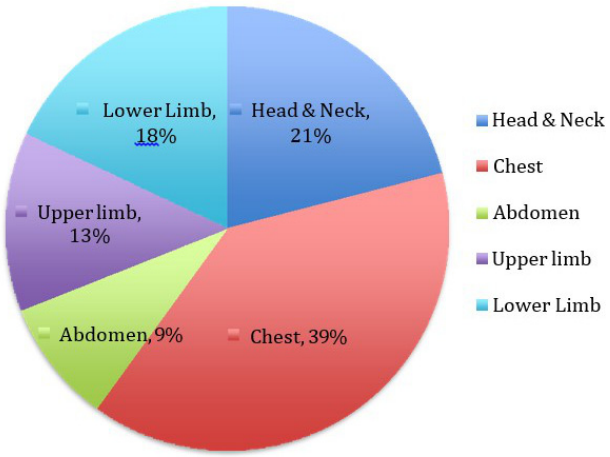

Figure 3: *Regions of body involved*

There was no significant difference between two groups regarding age, sex ratio, serum albumin at admission, BMI and burn surface area. All patients were exclusively fed on enteral diet. Real intake average was about 93% with no remarkable difference between SA (92%) and NSA (95%) group as given in Table 2.

Table 2: *Population characteristics of two groups at recruitment*

Character	SA Group	NSA Group
Age (Years)	33.5 (24 - 41)	32.7 (25 - 39)
BMI	21.3 (19 - 23)	21.7 (18.7 - 23.2)
Body Area Burn (%)	15.3 (11 - 19)	14.9 (11 - 18)
Serum Albumin at admission	4.7 (4.2 - 5.1)	4.7 (4.1 - 5.2)
Average kcal/day	2270.20 (170)	2310 (150)

Average kilo calories consumed per day by patients of SA group were 2270.20Kcal/day (170) while in NSA group average kilo calories consumed were 2310 (150). In SA group, enteral supplementation of Albumin was done 2 gram per kilogram body weight per day and ranged from 110 to 170 grams with mean of 127.20 (10.50) given in two divided doses. Serum albumin level at 7th post admission day was significantly better in SA group with average of 5.1 (1.7) g/dl than in NSA group with average of 3.9 (0.7) g/dl, repeated measure ANOVA showed p < 0.05. In patients of SA group, 64% required only two dressings to get complete healing of their burn wounds, 14% required three, 18% required four, 2% required five and 2% required six dressings. Mean number of interactive dressings required were 2 (1.3). In patients of NSA group, 6% required two dressings to get complete healing of their burn wounds, 22% required three, 50% required four, 16% required five and 6% required six dressings. Mean number of interactive dressings required were 4 (1.7).

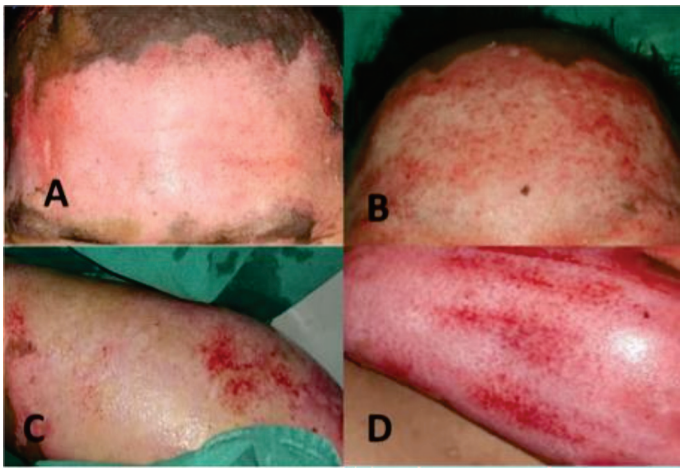

Figure 4: *Representative patient of NSA group*

Hospital stay in SA group was less than ten days in 86%, eleven to fifteen days in 8% and in 6% it was more than fifteen days while mean hospital stay was 10 (2.9) days. In NSA group, hospital stay was less than ten days in 22%, eleven to fifteen days in 62% and in 16% it was more than fifteen days. Mean hospital stay was 19 (3.7) days. In SA group, average pain score during first week of treatment was less than 4 in 44% patients, between 5 to 7 in 54% patients and more than 7 in 2% patients with mean pain score during first week of treatment was 4 (1.7). Average pain score in NSA group during first week of treatment was less than 4 in 4% patients, between 5 to 7 in 90% patients and more than 7 in 6% patients with mean pain score during first week was 7 (1.3). Approximate mean cost of treatment in SA group was 339 (23) USD per patient while in NSA group it was 522 (70) USD per patient. Student's t test was used to find out significance of differences between SA and NSA groups in number of dressings, hospital stay, mean pain score in first week and approximate cost which showed p < 0.05. Comparison of the two groups is shown in Table 3. Representative patients of NSAG and SAG groups are shown in fig 4&5 respectively.

Burn wound healing in two weeks in Non supplemented Albumin group. A. Forehead burn wound at admission B. Partially epithelized after two weeks C. Arm burn wound at admission D. Partially epithelized after two weeks.

Table 3: *comparison of outcomes between SA and NSA groups*

	SA Group	NSA Group
Mean Number of Dressings	2 (1.3)	4 (1.7)
Mean pain score during first week	4 (1.7)	7 (1.3)
Serum Albumin at 7th admission day	5.1 (1.7)	3.9 (0.7)
Mean Hospital Stay (Days)	10 (2.9)	19 (3.7)
Approximate Cost in USD	339 (23)	522 (70)

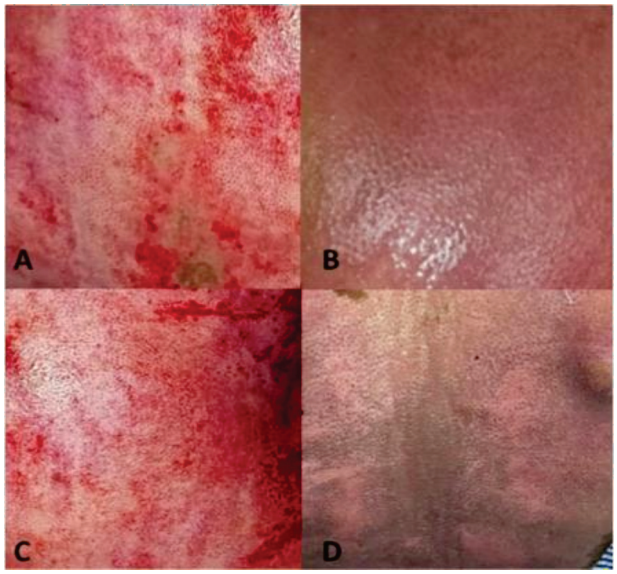

Figure 5: *Burn wound healing in two weeks in Supplemented Albumin (SA) group. A&B. Burn wound on anterior abdominal wall at admission & Completely epithelized after two weeks, C&D. Burn wound at back of Torso at admission & Completely epithelized after two weeks*

Discussion

Burn management not only requires wound care but nutritional support is also mandatory to combat the hyper-metabolic state in burns.[22] To speed up healing process in burns, many studies have proposed different dietary supplementing agents.[16,23] The present study is peculiar in the way that it estimates benefits of albumin supplementation in burn wound management by prospective double blind randomized clinical trial using isocaloric diet.

BMI is considered to be a good predictor of fitness and healing.[24] It is also used as tool for assessing previous nutritional status of the patient.[25] Like most of other studies, its confounding effects were taken into account in our study as well. All the patients selected were having BMI in normal range. In most of the studies, burn depth has been determined by clinical examination which is highly observer dependent based on skill and practice.[4,26] Despite of managing burn injuries for years, clinical estimation of burn depth is not accurate and it has been noticed to be highly varied assessment from surgeon to surgeon. Laser Doppler is an adjunct to objectively help in determining the burn thickness so it has been employed in this study to segregate superficial partial thickness burn wounds from other classes of burns to emphasize the effect of albumin supplementation on uniform population of burn wounds.[27] This method has so far not been used in any of the currently published study to determine depth of burn for effect of nutrition elements particularly albumin.

Interactive dressings are considered as reliable and easy remedy for burn wounds.[19] These dressings have anti-microbial role and absorb ooze from the wound surface as a result of which no frequent change of dressing is needed until it is soaked.[28] Silver impregnated dressings as recommended by many studies are considered as icon of burn management.[29] Albumin has 585 amino acids and is easily available from poultry source.[14] Administration of albumin through enteral route is very easy without any special arrangement due to non-toxicity of over dosage.[30] Role of albumin on healing of burn wounds may be rendered to its specific amino acid variety and number. Supplementation by albumin improves healing potential of burn wounds by providing amino acids for maintaining level of serum albumin and compensating its loss through oozing from burn wound.[31] Maintained level of serum albumin also decreases tissue edema which is also an adjunct of healing.[32] As described in other studies, fall in serum albumin leads to poor wound healing as it results in tissue edema and in SA group serum albumin levels were well maintained particularly at seventh day as compared to NSA group.[33] Similarly, SA group patients were having low stretching of tissues by oedema and resulted in decreased pain as in NSA group. We found mean pain score during first week of treatment was interestingly lesser in population of SA group patients as compared to NSA patients.[34] Dressing soakage leading to dressing change was far less in SA group patients than in NSA group which was expected as proposed in other studies.[35]

As proposed by some studies that less tissue oedema due to intravenous albumin enhances healing process in burn patients but, unlike our study, none of them established the effect of oral albumin supplementation

on burn wound healing as we have seen in SA group patients.[36] In this study, dosage of albumin supplemented was 2 grams per kilograms body weight but the exact mechanism that how varied dose of albumin will affect healing process needs further studies.

This study had a limitation as most of the burn wounds are of mixed thickness. So we considered only those patients in which the most part of wound (> 90%) was superficial partial thickness clinically as well as shown in red color by LDI. Furthermore, due to limited oral intake of albumin, only burns with 10 to 20% body surface area involved were considered which may pave the way for more extensive burns in further studies.

Conclusion:

Supplementation of nutrition with albumin in acute burn management has no adverse effects and leads to faster wound healing, lesser analgesia demand, lesser wound care required to achieve burn wound healing short hospital stay and decreased economic burden.

Conflict of interest: None

Source of funding: None

Authors contribution

Dr. Afzaal Bashir: Conception and design of the study, Drafting the work, analysis and interpretation, data collection, Final approval of the version to be published and accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Dr. Sunaina Afzaal: Study design, drafting of work, Data Collection and analysis and interpretation

Dr. Salman Ali: Conception and design of the study, critical revision of the article and final approval of the article to be published

Hajra Ahmad: Data collection, Article Editing, Manuscript Revision, analysis and interpretation of data

Dr. Mohammed A. Alharbi: Article Editing, Manuscript Revision analysis and interpretation of data

Sunniya Afzaal: Data Collection, critical revision of the article and final approval of the article to be published

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