ORIGINAL RESEARCH PAPER

Plastic Surgery

EFFECT OF VITAMIN C THERAPY ON BURN PATIENTS ON FLUID RESUSCITATION

KEY WORDS:

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ABSTRACT

Aims And Objectives: To study the Efficacy of Vitamin C therapy on burn patients.

Material And Methods: We enrolled 20adult patients with severe burns (more than 30%) from January 2020 to October 2021 at Plastic Surgery and Burns Hospital, Dhule. Patients with co- morbidities and with pre existing diseases were excluded from the study.

Results: Fluid requirement in Group A was 3.74 ± 0.57 ml/kg/% of burns and in Group B was 2.46 ± 0.54 ml/kg/% of burns. Urine output was 1.05 ± 0.28 ml/kg/h in Group A, and in Group B, it was 1.42 ± 0.39 ml/kg/h. Fluid retention and body weight gain were lower in Group B. MDA levels were significantly lower at 36 h in Group B.

Discussion: The initial fluid resuscitation in major burn trauma is intravenous infusion of crystalloids solutions to correct hypovolemia and to improve peripheral tissue perfusion.[14] The accepted norms are to monitor the adequacy of resuscitation with urine output of 0.5–1.0 ml/kg/h of body weight and stable hemodynamic status. There have been reports of over resuscitation of burn patients leading to problems such as anasarca, abdominal compartment syndrome, prolonged mechanical ventilation, and pneumonias. This has been termed as "fluid creep" phenomenon.

Conclusions: In our study, we found that when high dose Vitamin C (12-15gram) is given as adjuvant therapy in resuscitating the burn patients in the first 48 h, it decreases fluid requirement, increases urine output, and decreases fluid retention in body.

INTRODUCTION

Burn injury still remains a major health problem in developing countries like India. Fluid resuscitation to maintain adequate tissue perfusion while reducing edema in a severely burnt patient is of utmost importance and still remains a challenge.[1] The post burn edema occurs not only in the burnt area but also in the unburnt area of the body. These occurs in severe burns due to initiation of a systemic inflammatory response that leads to endothelial dysfunction leading to fluid and protein leakage from the intravascular space to the interstitial space.[2] The resultant phenomenon of "fluid creep "leads to various complications of burn injury such as abdominal compartment syndrome and pulmonary edema.[3,4]Local mediators such as histamines, serotonin, prostaglandin, and free radicals produced during burn injury have been implicated in the development of capillary leakage.[5,7]Recent studies have suggested that free radicals generated as resultof burn injury play an important role in tissue injury.

Tanaka *et al*. investigated patients with >30% total body surface area (TBSA) burns. Two groups were compared. One was treated with only ringer lactate (RL) solution and the other group was treated with high dose of Vitamin C, 66 mg/kg/h as adjuvant therapy, along with RL solution as per the Parkland formula in 24 h, and it was concluded that adjuvant administration of high dose Vitamin C (as antioxidant) during the first 24 h after thermal injury significantly reduced resuscitation fluid volume requirement.[9]

Saffle[13] explained that the pathophysiology of burn edema is multi factorial and the greatest edema formation occurs almost immediately post burn within the wound, caused by near total permeability to even very large (350 Å) molecules permitting leakage of fluid which is essentially identical to plasma.

In our study, the effect of high dose Vitamin C as an antioxidant adjuvant therapy in burns patient and the outcome in terms of fluid requirement, fluid retention, urine output, and complications associated with burns, and other morbidities related to burn injury were evaluated.

MATERIALS AND METHODS

To evaluate the role of Vitamin C in reducing the resuscitation fluid volume, a randomized, prospective, comparative study on 20 adult burn injured patients (with TBSA more than 30%) admitted in the burns unit of Asha Plastic and Burn Surgery Hospital from Janauary 1, 2020 to October31, 2021 was carried out. Informed consent was taken from each patient and all aspects of the study were performed in accordance.

Only patients who reported within 24 hours of injury were part of study Randomized, and divided equally into Group A and Group B. The care givers were unblinded. Group A was resuscitated with only RL solution and Group B was given RL and Vitamin C.Resuscitation fluid was calculated as per Modified Parkland's formula, depending on the weight and percentage of burnt body surface area (fluid given before admission to hospital was included in this volume). Vitamin C was given in the form of infusion (12-15 gram for first 24 hours in 500ml DNS over 4-8 hours) along with remaining resuscitation fluid in 24 hours. The amount of fluid given in the form of infusion to administer Vitamin C was added to the resuscitation fluid volume. The infusion bottle of vitamin C was wrapped with black polythene bag to avoid oxidation of ascorbic acid.

Various hemodynamic parameters and urine outputwere recorded hourly. Resuscitation fluid administrationrate was adjusted to maintain the hemodynamic stability (systolic blood pressure [BP] above 100 mmHg) and urineoutput of 0.5–1.0 ml/kg/h. The two groups were compared.

Exclusion Criteria

Patients with following factors were excluded from the study

1) Preexisting hepatic, Respiratory, cardiac or renal disease (based on history of medication and organ specific function tests available at the time of admission)
2) History of diabetes
3) Patients reporting after24 h of incident and patients with inhalation injury were excluded.

Statistical Analysis

Continuous group variables were expressed as the mean ±

standard deviation, cat. variables as *n* (%). *t*-test was used to compare continuous data of the two groups and Chi-square test was used to find the association between categorical variables. $P < 0.05$ was taken as statistically significant.

RESULTS

In our study, the mean age in Group A was 35.0 years, and in Group B, it was 40.2 years. It is not statistically significant. The gender difference is also not statistically significant. The mean burnt body surface in Group A was 45.7%, and in Group B, it was43.8%; the difference is not statistically significant [Table 1].

In Group A (treated with RL only) patients, the average fluid requirement to achieve hemodynamic stability and adequate urine output in first 24 h was 3.7 ml ± 0.6/kg/%of burn whereas, in Group B (treated with RL and VitaminC) patients, the fluid requirement was 2.5 ml ± 0.5/kg/% of burn. The difference was statistically significant (P < 0.001) [Table 2].

In Group A, urine output in first 24 h of resuscitation was 1.1 ml ± 0.3/Kg/h, whereas, in Group B, it was1.4 ml ± 0.4/Kg/h.The difference was again statistically significant (P = 0.006) [Table 2].

Fluid retention in the body was also calculated, i.e., total fluidintake – total fluid output in first 24 h. In Group A, it was122.6±40.7, and in Group B, it was81.2±63.8. This was statistically significant (P = 0.051) [Table 2].

Table 1: Age, Sex, And Percentage Of Burnt Surface Area Of Patients In Two Groups

	Group A (RL)	Group B (RL + Vitamin C)	*P value*
Age (years), mean±SD	35.0±18.6	40.2±14.3	0.399
Sex, *n* (%)			
Female	3 (30.0)	4 (40.0)	0.605
Male	7 (70.0)	6 (60.00)	
Percentage of total body surface area			
Percentage of burn	45.7 (12.6)	43.8 (17.7)	0.565

RL: Ringer lactate, SD: Standard deviation

Table 2: Various Parameters Noted In The Two Groups In The First 24 H Of Resuscitation

Parameter noted	Group A (RL)	Group B (RL + Vitamin C)	*P value*
Fluid requirement (ml/kg/%burn)	3.7±0.6	2.5±0.5	<0.001
Urine output (ml/kg/h)	1.1±0.3	1.4±0.4	0.006
Fluid retention (ml/kg)	122.6±40.7	81.2±63.8	0.051

Outcome

In our study, 53.33% of patients of Vitamin C recovered as compared to 40.00% of RL group, none of the patients in the two groups suffered from renal failure. Pneumonia was seen in 26.67% in Vitamin C group and in 40% of RL group [Table 3], but all these differences were not statistically significant.

Table 3: Complications In The Two Group

Complications	Group	Group	Total, n (%)	P value
	Group A (RL), *n (%)*	Group B (RL + Vitamin C),*n (%)*		
Pneumonia/pulmonary edema	6 (40.00)	4 (26.67)	10 (33.33)	0.439

RL: Ringer lactate

DISCUSSION

The initial fluid resuscitation in major burn trauma is intravenous infusion of crystalloids solutions to correct hypovolemia and to improve peripheral tissue perfusion.[14] The accepted norms are to monitor the adequacy of resuscitationwith urine output of 0.5–1.0 ml/kg/h of body weight and stable hemodynamic status. There have been reports of over resuscitation of burn patients leading to problems such as anasarca, abdominal compartment syndrome, prolonged mechanical ventilation, and pneumonias. This has been termed as "fluid creep" phenomenon.

Fang et al. in their study explained that thermal injury generates free radicals from various cellular populations, and modulations of free radical activity with scavengers may improve outcome.[15]

Horton explained that the free radical mediated cell injury has been supported by postburn increase in systemic and tissue levels of lipid per oxidation products such as MDA levels. Antioxidant therapy in burn patients has been shown to reduce burn and sepsis-mediated mortality. He concluded in his study that antioxidant strategies designed to scavenge the burst of free radicals have been shown to reduce tissue injury to improve organ function and to improve outcome.[14]

Our study consisting of 20 patients of burns studied the effects of antioxidant, i.e., Vitamin C in reducing the fluid requirement in burns patients. Patients treated with only RL solution (Group A) required3.74 ± 0.57 ml of fluid/kg/% of burn area, where as patients who were resuscitated with Vitamin C as adjuvant therapy (Group B) required 2.46 ± 0.54 ml of fluid/kg/% of burn in the first 24 h of resuscitation. This was significantly different (P < 0.001). Fluid required in Vitamin C group was34.3% lesser as compared to fluid required in RL group.

Tanaka et al. in their study required 5.5 ± 3.1 ml/kg/%of burns in RL group and 3.0 ± 1.7 ml/kg/% of burns in Vitamin C group and demonstrated 45.5% reduction in the initial resuscitation fluid volume in Vitamin C group patients.[16]Whereas Kahn et al. in their study reported fluid requirements in the first 24 h was 7.1 ± 1 ml/kg/% TBSA for RL group and5.3 ± 1 ml/kg/% TBSA for Vitamin C group (P < 0.05).[17]

Matsuda et al. demonstrated in their experimental model that treatment with high dose ascorbic acid reduces edema formation and fluid requirements during resuscitation. In their subsequent study, they reported that with a high dose of ascorbic acid therapy, the 24h fluid resuscitation volume was reduced to 32.5% of the Parkland formula, while maintaining adequate cardiac output values.[18]

Urine output in Group A was also significantly lower(1.05 ± 0.28 ml/kg/h) than in Group B (1.42 ± 0.39 ml/kg/h)despite receiving higher fluid volume (P = 0.006).Kahn et al. in their study reported urine output of1.0 ± 0.5 ml/kg/h in RL group and 1.5 ± 0.4 ml/kg/h inVitamin C group.[17] Tanaka et al. reported urine output of1.1 ± 0.3 ml/kg/h in RL group as compared to 1.3 ± 0.6 ml/kg/hin Vitamin C group.[16]

Fluid retention which was inferred from the body weight gain was significantly more in Group A (122.6 ml/kg) after 24 ht than Group B (81.2 ml/kg). This was statistically significant. Tanaka et al. reported more fluid retention in RL group, which was 162 ± 87 ml/kg as compared to 89 ± 97 ml/kg inVitamin C group.[16]

Fluid retention in body signifies, to some extent, the fluid lost in third spaces, i.e., loss to extravascular space.This third space loss contributes to burn shock and also is the reason for complications related to burn resuscitation shock. Patients treated with Vitamin C showed less fluid retention. This again is consistent with the logic that Vitamin C prevents loss of

fluid to extravascular compartment by having protective effect on capillary endothelium.

Demling in his study explained that the antioxidants in the early phase of resuscitation help in the prevention of edema by scavenging the free radicals in circulation.[19]

Hemodynamic status of both the groups was equivalent, i.e., BP, pulse, respiratory rate, oxygen saturation, and body temperature. Patients infused with high dose Vitamin C showed no significant difference in vital parameters and remained stable throughout Vitamin C infusion. This observation again suggests decreased capillary leakage and hence maintaining adequate blood pressure, in Vitamin C group.

CONCLUSION

In our study, we found that when high dose Vitamin C (12-15gram) is given as adjuvant therapy in resuscitating the burn patients in the first 48 h, it decreases fluid requirement, increases urine output, and decreases fluid retention in body. Vitamin C is safe and is excreted out of body within few hours. Vitamin C therapy was associated with reduced in-hospital mortality in patients with severe burns under a minimum threshold of 10 g within the first 2 days of admission.

Although the results presented in this observational study offer unique insight into the controversy surrounding vitamin C administration in burn victims, it is imperative that additional prospective studies be conducted to provide further clarification on this debate.

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