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Serum phosphate level in burn patients

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ABSTRACT

Introduction: Despite plasma phosphate imbalance being rare, it is a relatively common finding in certain subsets of burn patients. It may occur due to the burn itself or as a result of the treatment. Severe hypophosphataemia (<1.0 mg dl^{-1}) is associated with a significant morbidity and a fourfold increase in mortality. In this study, the relation between serum phosphate level and the total body surface area (TBSA) of the burn was compared.

Methods: According to the percentage of TBSA of the burn, the patients ($n = 155$) were divided into three groups: group A with 20–29% TBSA burns, group B with 30–39% and group C with more than 40% TBSA burns (62, 48 and 45 patients, respectively).

Analysis of variance (ANOVA)-repeated measure was used to detect any statistically significant difference in the three post-burn time-points of 3rd, 6th and 9th days and the mean score of the serum phosphate level between the three groups.

Results: The incidence of hypophosphataemia at 9th post-burn day in the three groups was 6.1%, 32.4% and 73.5%, respectively. There were significant differences ($p < 0.05$) between mean serum phosphate levels of groups A and C, B and C and A and B as well. We found significant differences between the three post-burn follow-up time stages.

Discussion: We have shown that hypophosphataemia, defined as mean serum phosphate levels below 3.0 mg dl^{-1}, was very common following burn, based on 75.6% of patients with more than 40% burn at the 3rd post-burn day. As the percentage of TBSA of burn increases, the incidence of hypophosphataemia significantly increases. We suggest that phosphate level be routinely measured after a major burn, especially in patients with a complicated course, so that appropriate replacement therapy may be started in a timely manner.

Phosphorus is an essential mineral that is usually found in nature combined with oxygen as phosphate [1,2]. The intracellular:extracellular ratio of phosphate is estimated to be 100:1. Most intracellular phosphate exists as creatine phosphate and adenosine triphosphates (ATPs), and 2,3-diphosphoglycerate (2,3-DPG) [1–5].

Normal plasma phosphorus ranges between 3.0 and 4.5 mg dl^{-1} in adults and between 3.7 and 5.6 mg dl^{-1} in children [2,5]. Hypophosphataemia can occur in the presence of low, normal or high total body phosphate. In the latter two instances, there is a shift from the extracellular pool into the intracellular compartment [6–9].

Low serum phosphate concentrations (<2.0 mg dl^{-1}) are present in 5–10% of hospitalised patients [2]. Severe hypophosphataemia (<1.0 mg dl^{-1}) is associated with a significant morbidity and a fourfold increase in mortality [1,3,6]. Myalgia,

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muscle weakness and anorexia, usually the earliest symptoms, typically occur at serum levels below 1.5–2.0 mg dl^{-1}. At phosphate levels below 1.0 mg dl^{-1}, the neurological, haematological and cardiological symptoms may progressively develop [7,10–13].

Plasma phosphate imbalance, although rare in the general population, is a relatively common finding in certain subsets of patients with burns. It may occur due to the burn itself or as a result of the treatment [14–16]. The following factors are potentially involved in the burn patient: a poor dietary intake of phosphate and vitamin D, increased urinary loss due to secondary hyperparathyroidism induced by vitamin D deficiency, intravenous therapy with 5% glucose, the development of respiratory alkalosis due to sepsis, starting re-feeding therapy and high levels of circulating catecholamines [15–18].

Thermal injury induces a precipitous decrease in serum phosphate concentration that reaches its nadir between the second and fifth post-burn days [17]. The reported incidence of hypophosphataemia in burn patients varies between 0.2% and 2.2% for all admitted patients but can be 21.5% or even higher in some patient groups such as those with higher percentages of TBSA burn (%TBSA) [14,16]. During hospital stay the incidence increases; a single measurement often underestimates the disorder [1,4,6,19]. In this study, the relation between serum phosphate level and TBSA of burn was evaluated and compared.

1. Methods

1.1. Subjects

Following the institutional research committee approval, in a cohort study 155 consecutive burn patients were selected from the patients admitted to Imam Musa-Kazem Burn Hospital between December 2007 and May 2008.

From them, the number lessened by 19 before the 6th day and by 17 before the 9th day, due to discharge from hospital or death.

Patients with co-existing medical conditions such as chronic renal disease and severe malnutrition were excluded from this study. Patients who could not tolerate enteral feeding and received TPN were excluded from this study.

1.2. Study design

In each patient, 2 ml of coagulated blood was drawn from the antecubital vein and centrifuged immediately for a maximum of upto 20 min at 2500 rpm (700 g) for 10 min and then the serum was separated. In order to decrease bias, the separated serum samples were stored at −20 °C and assayed at the same time with the same laboratory kits.

Serum phosphate levels were measured by an auto-analyser (Hitachi 717 Automatic Analyzer, Boehringer Mannheim, Germany) on the 3rd, 6th and 9th days after the burn. The rationale for choosing these days is as following: the Emam Mousa Kazem Hospital is a referral burn hospital. Admission of patients is occasionally on the second post-burn day, so the first phosphate measurement is taken on the 3rd day. Serum phosphate levels gradually reach normal levels after the 10th post-burn day [19], so the last checking is done on the 9th day. The normal value for serum phosphate at our institution ranges from 3.0 to 4.5 mg dl^{-1} in adults and between 3.7 and 5.6 mg dl^{-1} in children.

As most of the burn patients with <20% of TBSA burns were managed as outpatients, and nutritional disturbances are minimal in this group, they were excluded from the study. According to the percentage of TBSA of burn, the patients were divided in three groups:

group A: 20–29%TBSA burnt (62 patients);
group B: 30–39%TBSA burnt (48 patients); and
group C: more than 40%TBSA burnt (45 patients).

The diet regimen was the same in all the groups. The protein-rich diet given to the patients provides more than 1500 mg phosphate daily. At the time of this study, our centre did not have a standardised nutrition protocol and the patients did not receive supplemental phosphate. Hence, we assume that phosphorus intake was approximately the same among the groups.

All the third-degree burn patients who were haemodynamically stable were operated during the second post-burn week. There were no considerable differences in the sessions of surgery or perioperative fasting between the groups. Due to insufficient facility, the daily phosphorus balance was not checked in the patients.

1.3. Data analysis

The data were analysed using SPSS 13.0 software. The repeated measured analysis of variance (ANOVA-repeated measure) was used to detect any statistically significant difference in the three post-burn time-points of mean score of the serum phosphate level between the three groups. A P-value <0.05 was considered statistically significant.

2. Results

A total of 155 burn patients, of which 86 (55.48%) were women aged 1–90 years with a mean (SD) of 24.5 (17.7) years, and were admitted to Imam Musa-Kazem Burn Hospital, were enrolled in this study. There were no significant differences in sex between the three groups of TBSA of burn (results not shown). Fig. 1 shows incidence and prevalence of hypophosphataemia in the three groups of patients based on percentage of TBSA of burn. Serum phosphate level was recorded as mg dl^{-1}. Table 1 presents the mean serum phosphate level score over the 3rd, 6th and 9th post-burn days in the three groups of patients using the statistical model of ANOVA-repeated measures.

The overall mean in the serum phosphate level between the three groups was examined and statistical significance was detected (Wilks' lambda = 0.87, $F_{(2,115)} = 8.3$, P-value <0.001). Using Bonferroni's method for comparing pairs of groups, we found that there were significant differences between mean serum phosphate levels of the groups A and C and also between the groups B and C. There were noteworthy differences between mean serum phosphate levels of the groups A and B (results not shown). There were considerable