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Hyperkalemia in electrical burns: A retrospective study in Colombia

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ABSTRACT

Introduction: Classically, hyperkalemia has been regarded as a complication in patients with electrical burns. The etiology of hyperkalemia includes metabolic acidosis, destruction of red blood cells, rhabdomyolysis and the development of renal failure. The purpose of this study was to determine the prevalence of hyperkalemia within the first 24 h after electrical burn injury and to evaluate the possible association of serum potassium concentration with cutaneous burn size (%TBSA) and serum creatine phosphokinase (CPK) concentration.

Methods: A retrospective, cross-sectional study was conducted, based on review of medical records of adult patients hospitalized in the first 24 h post electrical injury. Serum potassium (K^+) levels were divided into low, normal, and high groups, with breakpoints at 3.5 mmol/L and 5.0 mmol/L and normal 3.6–4.9 mmol/L. To assess potential differences according to the time elapsed between the time of the injury and the sampling time, data were grouped as follows: t1: samples obtained in the first 6 h post-injury; t2: samples taken at 6–12 h; t3: samples taken at 12–24 h.

Results: 336 patients were studied. The median age was 32 years old (IQR: 25–43). 95.2% of patients were men. Low and normal values of K^+ were observed in 13.7% and 85.1%, respectively. The prevalence of hyperkalemia was only 1.2%, and was not related to previously-administered medications or to simple blood gas pH value during admission. CPK > 10,000 IU/L was observed in 22.6%. No association was found between the serum potassium concentration and either %TBSA burned or the highest CPK value.

Conclusions: First, patients admitted to our burn unit with electrical injury accompanied by significant skin and muscle injury rarely exhibit hyperkalemia. Secondly, the presence of hyperkalemia is independent of the severity of rhabdomyolysis or the extent of the burn.

1. Introduction

In much of the developed world, electrical injuries account for 3–4% of all admissions to burn units. In contrast, almost 20% of admissions to the Burns Services of Hospital Simon Bolivar in Bogota are due to electrical injury, reflecting the fact that electrical injuries are a prevalent problem in Colombia (South America), which account for the majority of deaths due to burn injury [1].

Typically, hyperkalemia has been regarded as a complication in patients with burn injuries [2,3] as a result of extensive superficial tissue destruction [4], erythrocyte destruction [5] and metabolic acidosis [6,7]. Patients sustaining an electrical

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injury, in addition, may suffer hyperkalemia secondary to rhabdomyolysis [8–10] and consequent pigment nephropathy [11–13].

Hyperkalemia has clinical relevance since it can potentially increase the risk of fatal arrhythmias. The objective of the study was to determine the prevalence of hyperkalemia within the first 24 h after receiving an electric injury and to assess the possible relation of serum potassium (K^+) with total body surface area burned (%TBSA) or Creatine phosphokinase (CPK) as a severity marker of muscular injury.

2. Materials and methods

2.1. *Research design and study setting*

A retrospective, analytical, observational study was conducted in the Burns ICU of Hospital Simon Bolivar in Bogota, Colombia, South America. Our institution is the largest national referral center for burned patients in Colombia. Our burn center has 53 rooms, of which 10 are Burn Intensive Care Unit (BICU) rooms.

2.2. *Study participants and data source*

Data was obtained after a medical chart review for all adult patients (age > 15 years) with electrical burns (including lightning injuries) admitted within the first 24 h of electrical burn injury, between January 2007 and December 2013. A new Admissions Record Form was implemented in 2011, which contains all the information regarding the type of current involved during the event, wound location and depth.

2.3. *Measurements and definitions*

Data abstracted included demographic factors (age, gender), presence or absence of clinically diagnosed compartment syndrome, %TBSA (evaluated using the Lund–Browder diagram), serum potassium concentrations, creatinine, Urea and CPK as marker of rhabdomyolysis severity. CPK, Creatinine and Urea values were recorded during admission (CPK_0, $Creatinine_0$, $Urea_0$) and on the first hospitalization day (CPK_1, $Creatinine_0$, $Urea_0$). CPK_{max} variable was stablished with the highest CPK value obtained during the 2 days mentioned. For the purposes of this investigation, a CPK value greater than five times the normal value (CPK > 1000 IU/L) was used as a criterion for the diagnosis of rhabdomyolysis [14].

Acute kidney injury (AKI) was diagnosed according to the AKI network (AKIN) criteria. AKI is defined as "an abrupt (within 48 h) reduction in kidney function currently defined as an absolute increase in serum creatinine of more than or equal to 0.3 mg/dl (≥26.4 μmol/l), a percentage increase in serum creatinine of more than or equal to 50% (1.5-fold from baseline), or a reduction in urine output (documented oliguria of less than 0.5 ml/kg/h for more than six hours)" [15]. In order to estimate the baseline creatinine, we took the recommendation of the National Kidney Foundation, where the author calculated the value of a theoretical baseline creatinine assuming the patient had a normal glomerular filtration rate prior to the electrical discharge [16]. Subjects with a history of chronic kidney failure were excluded from the study. Since early AKI is an "incident case" that develops during the first week of the post-electrical discharge, it is frequency reported as an indirect description of the patient's medical condition.

Specific medications administered prior to hospital admission that could have had an effect on the serum potassium (including succinylcholine, furosemide, spironolactone, b-blockers, non-steroidal anti-inflammatory drugs (NSAIDs), angiotensin-converting-enzyme (ACE) inhibitors, angiotensin II receptor blockers (ARBs), insulin and oral hypoglycemic agents) were evaluated.

Potassium (K^+) levels were divided into low, normal, and high groups, with breakpoints at 3.5 mEq/L and 5.0 mEq/L. To assess potential differences according to the time elapsed between the time of the injury and the sampling time, data were grouped as follows: t1: samples obtained during the first 6 h post-injury; t2: samples taken between 6–12 h; t3: samples taken between 12–24 h.

2.4. *Blood sample collection and analysis*

Samples were collected using the vacutainer system and immediately sent to the laboratory; then, they were centrifuged at 3500 rpm for 15 min and analyzed after two hours maximum. In most cases, a venous blood sample was obtained by peripheral puncture. Hemolyzed samples were rejected for analysis according to the laboratory standards for sample quality. Serum potassium levels were measured using the ion-selective electrode method (normal range: 3.6–4.9 mmol/L). Urea was measured using the Urease-GLDH: enzymatic UV test (normal range: 7–25 mg/dl). Creatinine was measured by colorimetric enzymatic test (normal range: 0.8–1.5 mg/dl). The CPK was measured by optimized UV-test. On automated systems, the test is suitable for the determination of CPK activities up to 1100 UL (normal ranges: 55–197 IU/L). If such value was exceeded, the samples were diluted following the manufacturer's recommendations. All samples were analyzed in a Beckman Coulter OLYMPUS AU 400.

2.5. *Clinical management*

Our burn unit uses Ringer's lactate during the initial fluid resuscitation phase. The target urine output is >1.5 cc/kg/h in rhabdomyolysis and >2 cc/kg/h in the presence of macroscopic dark urine. The burn service does not use urine alkalization, mannitol infusion or loop diuretics.

2.6. *Statistical analyses*

Data distribution was checked by Shapiro–Wilk test. Continuous variables (age, %TBSA, serum potassium (K^+), and CPK) were not normally distributed; therefore, data was expressed as median and interquartile range (IQR). Categorical variables are expressed as percentages. The difference between the gender proportions was evaluated by the One-sample test of proportion. Significant differences of different parameters (CPK, %TBSA) between the three K^+ level groups (low, normal and high) were found using the Kruskal–Wallis test. Differences between categorical variables were evaluated using the Chi square test. When the size requirements of the chi-square test were not met, the Fisher exact test was used. The