Incidence Of Myoglobinuria In Prolonged Entrapment

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Abstract

Entrapment is commonly seen in patients involved with motor vehicle accidents (MVA) or victims of disasters such as earthquakes or landslides. The exact incidence of rhabdomyolysis and myoglobinuria is not documented in this patient population. The routine use of bicarbonate has been the accepted approach to treatment of myoglobinuria in order to avert renal failure. We found that the incidence of myoglobinuria in entrapped patients is alarmingly high at 25.8 %. We also found that the routine use of bicarbonate does not seem to reduce the incidence of renal dysfunction in patients with documented myoglobinuria.

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INTRODUCTION

Entrapment with prolonged extrication time is commonly seen in trauma patients involved in motor vehicle accidents (MVA) or victims of disasters such as earthquakes or landslides. These patients may be at an increased risk of rhabdomyolysis and acute renal failure in a manner similar to victims of seismic catastrophes. No current data is available regarding the exact incidence of rhabdomyolysis and myoglobinuria in entrapped MVA patients (entrapment as defined by extrication time greater than 30 minutes at the scene). Current management of these patients has been a forced solute alkaline diuresis with vigorous hydration to avoid the potential problems of renal dysfunction or failure. This is based upon the intent to treat myoglobinuria and its well documented association with renal dysfunction [1,2,3]. Animal models have shown that myoglobin related renal toxicity is related to a physical blockage of tubules by precipitation of hematin and the renal damage is reduced by alkalinization of the urine, which prevents precipitation of the hematin [4,5]. Hematin has been shown to have direct toxicity on proximal tubular cells in in-vitro models of kidney injury 4,[6]. The alkaline solute diuresis is achieved by using sodium bicarbonate and mannitol.

However recent clinical studies have reassessed this approach to avoiding kidney injury and found that hydration status and renal blood flow also plays a major role in the prevention of renal failure 3,[7]. A majority of the clinical studies on myoglobinuria deal with crush injury related to beating, war related injury and seismic catastrophe 3,7,[8]. In this age of vigorous fluid resuscitation of these patients the exact value of alkaline diuresis needs to be revaluated. Bicarbonate has potential negative effects including:

1. venous hypercapnia with an increase in mixed venous CO2, leading to a decline of tissue intracellular pH (pHi) 9,
2. a decline in pH of cerebrospinal fluid 10, and
3. tissue hypoxia 11.

The purpose of this study is to document the incidence of myoglobinuria in entrapped patients and to evaluate the need for bicarbonate.

METHODS

We performed a retrospective chart review of 89 consecutive entrapped patients (entrapped for greater than 30 minutes after MVA at the scene) seen by our rural trauma service over a 2 year period. Patient charts were analyzed for injury severity score (ISS), presence of urine myoglobin, presence of renal dysfunction as documented by an increase in BUN/creatinin ratio greater than 20 % or a documented reduction in creatinine clearance within 48 hours after admission both requiring and not requiring dialysis support, and the use or absence of bicarbonate in the acute resuscitation of these patients. A chi squared analysis of renal dysfunction in patients with urine myoglobin (with or without bicarbonate treatment) was performed to assess the need for bicarbonate. A multiple regression analysis was performed to assess the correlation between urine myoglobin and renal dysfunction.

RESULTS

There were 48 men and 41 women in this study. Twenty three out of 89 patients were found to have myoglobinuria (25.8 %). The average injury severity in patients presenting with myoglobinuria was higher than patients with out myoglobinuria (25.5 + 11.5 vs. 16.8 + 7.9 , p=0.05). Renal dysfunction was found more often in patients with myoglobinuria than without myoglobinuria (21.7 % vs. 3.0 %, p=0.01). In a multivariate analysis, the myoglobinuria was independently associated with renal dysfunction (p=0.03). The efficacy of using bicarbonate in the resuscitation of patients with documented myoglobinuria using incidence of renal dysfunction as a primary outcome variable showed no benefit to using bicarbonate (25.0 % vs. 18.2 %., p=n.s) in patients with myoglobinuria.

DISCUSSION

Patients entrapped in Motor Vehicle Accidents or in debris after a disaster such as an earthquake or a landslide are at significant risk for development of rhabdomyolysis syndrome. This includes the development of urine myoglobin and subsequent renal dysfunction. Recent reports of rhabdomyolysis syndrome and myoglobinuria involve patients involved in beatings and seismic activity. Entrapped motor vehicle accident victims are a high risk group with a myoglobinuria incidence of 25.8 %.

It has been generally accepted that myoglobin exerts a nephrotoxic potential under aciduric conditions. The prevailing explanation is that the porphyrin ring is split from myoglobin producing hematin, which has a direct toxic effect on proximal tubular cells by suppressing transport across the cell membrane by lipid peroxidation of the cell membrane. The use of forced alkaline solute diuresis has been accepted as the gold standard for the treatment of myoglobinuria. Alkalinuria in animal models of myoglobin induced injury was shown to confer a certain degree of protection by two mechanisms:

- increased myoglobin solubility in urine at an alkaline pH and
- the induction of a solute diuresis.

The time of exposure of myoglobin to proximal tubular cells has been theorized to be directly related to level of renal toxicity in myoglobinuric models.

Recently several clinical reports have challenged the need for using bicarbonate, and have even used acidifying diuretics such as furosemide for the establishment of forced diuresis. The most relevant issues clinically seem to be adequate hydration and adequate diuresis. Although the use of bicarbonate is not uniform at our institution, vigorous hydration and forced diuresis (using mannitol and furosemide) to maintain a urine output between 1.5 to 2 ml/kg/hr has been the standard of care. This was the common base of treatment for all patients. With the intermittent use of bicarbonate by different staff physicians, (which was not controlled) we were able to retrospectively assess the need for bicarbonate. Our results seem to correlate with other recently published data on the lack of need for alkalinizing urine in patients with myoglobinuria 3,4,7. Our numbers of patients with myoglobinuria are small, however no statistical trend was noticed regarding the use of bicarbonate therapy and renal protection. With the potential detrimental effects of bicarbonate usage [9,10,11], routine use should be discouraged. A controlled prospective randomized study is needed to adequately assess the exact benefit of bicarbonate usage.

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