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Inhalation injury caused by cornstarch dust explosion in intubated patients—A single center experience

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ABSTRACT

Background: Around 10%–20% of burned patients have inhalation injuries, and the severity of these injuries is correlated with mortality. Fiberoptic bronchoscopy is an important tool for the early diagnosis of inhalation injury. This study investigated correlations between the severity of inhalation injury and outcomes of patients involved in a cornstarch dust explosion in northern Taiwan in 2015.

Methods: Patients with burns who were intubated after the explosion were enrolled. Their medical records were reviewed, and data including patient characteristics, percentage of total body surface area (%TBSA) burned, severity of the inhalation injury, mechanical ventilation settings, and outcomes were collected and analyzed.

Results: Twenty patients underwent fiberoptic bronchoscopy during the first 24h toevaluate an inhalation injury. Their mean age was 22.4±5.5 years and the mean %TBSA burned was 55.7±19.4%. Fourteen patients had a grade 1 inhalation injury and six had a grade 2 injury. There was a higher %TBSA burned in the grade 1 group than in the grade 2 group, although the difference did not reach statistical significance (60.0±20.3% versus 45.5±13.5%, p=0.129). Compared to the grade 2 group, the grade 1 group had a significantly higher white blood cell count (29.4±9.3 versus 18.6±4.6, p=0.015) and frequency of facial burns (85.7% versus 33.3%, p=0.037). The overall intensive care unit mortality rate was 10% (n=2), with no significant intergroup difference (grade 1, 14.3% versus grade 2, 0%, p=0.192).

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Conclusion: Although the explosion resulted in a high rate of inhalation injuries in critically ill patients, there was no significant correlation between mortality and the severity of the inhalation injuries.

1. Introduction

Pulmonary complications caused by the inhalation of toxic products or the smoke of combustion are common. Inhalation injury can be caused by thermal injury or chemical irritation to the respiratory tract after the inhalation of toxic agents such as cyanide and carbon monoxide, and this can cause systemic inflammation or a combination of injuries. Around 10%–20% of burned patients also have inhalation injury, the severity of which is associated with morbidity and mortality [1–4]. A meta-analysis on the prognostic factors of patients with thermal burns reported that the mortality rate significantly increased from 13.9% to 27.6% if combined with inhalation injury [5]. Therefore, the severity of inhalation injury is a significant independent factor for predicting mortality in patients with burns [6–8]. In addition, age, percentage of total body surface area (%TBSA) with the cutaneous injury, and the ratio of partial pressure of arterial oxygen to inhaled fraction of oxygen (P/F ratio) have also been reported to be predictors of mortality in patients with burns and inhalation injury [9].

Although mortality among patients with cutaneous burns has been associated with the presence of inhalation injury, the best supportive treatment and prevention of further infection or injury caused by mechanical ventilation also play an important role in improving survival [10–12]. Therefore, how to identify and diagnose inhalation injury and initiate an immediate therapeutic intervention are vital for preventing subsequent pulmonary complications in such critically ill patients. Traditionally, the suspicion of inhalation injury has been based on clinical findings including exposure history, physical examination, and identification of risk factors. In addition to the presence of inhalation injury, the severity of the inhalation injury has been reported to have a significant impact on mortality in patients with burns [2]. Fiberoptic bronchoscopy (FOB) has been used to confirm and classify the severity of inhalation injury. In addition, it has been shown to be an effective tool to identify inhalation injury because of its relative ease of use and applicability for serial follow-up.

On June 27, 2015, a cornstarch dust explosion caused a large number of casualties at a water fun park in New Taipei, Taiwan. To date, this is the worst mass burn casualty incident in Taiwan [13,14]. Some patients were sent to Chang Gung Memorial Hospital, which is around 12 km away from the park, and bronchoscopy was performed quickly in these intubated patients. The purpose of this study was to investigate the correlation between inhalation injury and outcomes among these critically ill patients treated at our intensive care unit (ICU).

2. Patients and methods

This was a retrospective study conducted in Chang Gung Memorial Hospital in Linkou, northern Taiwan. Chang Gung Memorial Hospital is a tertiary medical center with 3700 beds, including a 25-bed burn ICU and a 20-bed microsurgical ICU. This study was approved by the Chang Gung Medical Foundation Institutional Review Board (201600148B0).

2.1. Case selection

The casualties were sent to the emergency department (ED) of Chang Gung Memorial Hospital alive by ambulance, and the prehospital rescue included oxygen therapy, monitoring of vital signs and fluid supplements in some cases performed by emergency medical technicians. Forty-nine patients were sent to our hospital within 4 h after the explosion. These patients received comprehensive assessment at the ED. The indications for intubation included obvious facial involvement with respiratory distress, hypoxemia, dyspnea due to metabolic acidosis or stridor. For the intubated patients, we arranged bronchoscopy to diagnosis and classify the severity of the inhalation injury. Only the patients who received FOB examinations within 24 h after admission were enrolled in this study.

2.2. Data collection

We reviewed the medical records of these patients and recorded the following data: age, gender, body weight, %TBSA burned, presence of facial burns, presence of comorbidities, and Acute Physiology and Chronic Health Evaluation II score. Mechanical ventilation settings and parameters were also recorded, including the mode of ventilation, tidal volume, the P/F ratio, peak inspiratory pressure, and compliance. In addition, the amount of fluid infused daily (recorded as mL/kg/%TBSA) in the first 72 h, total urine volume, and renal function were also recorded every day. Acute kidney injury was defined according to a previous definition as either a level of serum creatinine increase $\geq$0.3 mg/dL within 48 h or an increase of $\geq$1.5 times the baseline value within the previous 7 days [15]. Clinical outcomes included in-hospital mortality rate, pulmonary complications, duration of mechanical ventilator support, and lengths of ICU and hospital stay.

2.3. Severity of inhalation injury

The severity of inhalation injury was graded according to the FOB findings following a previous grading system: grade 0: absence of carbonaceous deposits, erythema or bronchorrhea;