

How Can Humans be Damaged from Sulfuric Acid?

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Abstract

Purpose: This study was conducted to identify the clinical characteristics associated with sulfuric acid injury evaluated in emergency department.

Method: This study was retrospective multicenter study with sulfuric acid injured patients who were visited in 3 emergency departments during 10 years in South Korea. Data were collected retrospectively from Jan 2006 to Dec 2015 on all sulfuric acid injuries presenting to the 3 emergency departments. Collected data were those of demographic, exposure site, injury mechanism, final diagnosis and hospital care.

Result: A total of 46 patients were enrolled. Most of the patients were male (88.5%). The face and eye were the most commonly injured body parts (53.4%) and most commonly injured mechanism was splashing injury (69.5%) in sulfuric acid burn patients. A total of 25 (54.3%) patients were identified as having lesions more than second degree burn.

Conclusion: sulfuric acid can cause severe burns to the skin. When working with sulfuric acid, have to wear acid proof protect clothing, goggle and glove. And it is need to pay close attention when working with sulfuric acid.

Keywords: Sulfuric acid; Chemical burns; Occupational injuries

Introduction

Sulfuric acid is a strong acidic compound in the state of viscous liquid that is colorless and odorless and has been used a lot for industrial and experimental purposes, for example manufacturing of phosphoric acid or fertilizer, petroleum industry, metal process, and battery manufacturing and even used at home for cleaning a drainpipe [1]. Also, it is used as a material for committing a terrorist act against others in addition to hydrochloric acid, because it causes fatal damages to human body as a strong acid. According to the researches that have been conducted so far, sulfuric acid, among various chemical substances that causes chemical damage is one of the causative agents that occupy the highest frequency following the hydrofluoric acid [2,3]. However, there are very few studies on major exposure mechanism of sulfuric acid damage, area of damage, and severity. Accordingly, this study was conducted to understand the exposure routes of sulfuric acid-damaged patients and the clinical features and contribute to the prevention and treatment of sulfuric acid damage later.

Material and method

Subjects and period

This study was conducted in patients who were injured by sulfuric acid among the chemical injury patients visited in Gumi Soonchunhyang university hospital, Bucheon Soonchunhyang university hospital and Ulsan university hospital emergency department, Korea, from Jan 2006 to Dec 2015 for 10 years.

Study method and contents

This study was done retrospectively by reviewing medical records and variables related to patients included age, gender, injured body part, mechanism of injury, diagnosis and disposition. We excluded from this study that compound chemical materials and unknown chemicals. Injured sites were classified and recorded as face, eye, hand, arm, leg, neck, trunk, respiratory system, digestive system and other body regions. And mechanism of injury was recorded as splash, explosion, contact, inhalation, ingestion and others. Additionally, diagnosis, hospitalization, discharge from hospital, and transfer of hospital were recorded after treatment in an emergency department.

Analytical methods

In statistical analysis, SPSS window 21.0 (SPSS Inc., Chicago, IL, USA) was used for data collect and continuous variable was indicated with mean (\pm standard deviation), and frequency and percentage were obtained for nominal variable and categorical variable.

Results

A total of 46 patients visited the 3 hospital emergency departments due to sulfuric acid injury during the study period. In gender, males (39 individuals: 84.7%) were more than females (7 individuals: 15.2%), average age was at 40.1 years, which suggested that those in their 40s (15 individuals: 32.6%) occupied the most, followed by those in their 30s (12: 26%), those in their 20s (9: 19.5%), those in their 50s (5: 10.8%), and those in their 60s (4: 8.6%) (Table 1). 22 patients were injured in two or more lesions and 24 patients were injured in one lesion. In injured site, face occupied the most at 22 individuals (30.9%),

among which, the number of those whose eyes were injured was 16 individuals (22.5%).

Characteristics	N (%)
No. of patients	
Gender	
Male	39 (84.7%)
Female	7 (15.2%)
AGE (years)	
<20	1 (2.1%)
20-29	9 (19.5%)
30-39	12 (26.0%)
40-49	15 (32.6%)
50-59	5 (10.8%)
>60	4 (8.6%)

Table 1: General characteristics of the patients.

To look at other injury sites, arm was injured in 10 individuals (14%), trunk in 6 (8.4%), leg in 5 (7.0%), hand in 4 (5.6%), respiratory system in 4 (5.6%), neck in 3 (4.2%) and digestive system in 1 (1.4%) (Table 2).

Exposure site	N (%)
Face	22 (30.9%)
Eye	16 (22.5%)
Arm	10 (14.0%)
Trunk	6 (8.4%)
Leg	5 (7.0%)
Hand	4 (5.6%)
Respiratory system	4 (5.6%)
Neck	3 (4.2%)
Digestive system	1 (1.4%)
Total	71

Table 2: Sulfuric acid exposure site.

In mechanism of injury, the number of those who injured from splash was 32 patients (69.5%), which occupied the most frequency, followed by explosion injury (9: 19.5%), direct contact (2: 4.3%), inhalation (2: 4.3%), and ingestion (1: 2.1%) (Table 3).

All patients injured sulfuric acid were unintentional injuries. In diagnosis for sulfuric acid injured patients, the number of those who had second degree chemical burn was 23 patients (37.7%), chemical conjunctivitis 18 patients (29.5%), first degree chemical burn 11 patients (18.0%), third degree chemical burn 2 patients (3.2%), and inhalation burn 2 patients (3.2%) (Table 4).

Injury Mechanism	N (%)
Splash	32 (69.5%)
Explosion	9 (19.5%)
Contact	2 (4.3%)
Inhalation	2 (4.3%)
Ingestion	1 (2.1%)
Total	46

Table 3: Classification of sulfuric acid exposure mechanism.

Diagnosis	N (%)
1st degree chemical burn	11 (18.0%)
2nd degree chemical burn	23 (37.7%)
3rd degree chemical burn	2 (3.2%)
Chemical conjunctivitis	18 (29.5%)
Chemical pneumonitis	2 (3.2%)
Etc.	5 (8.1%)
Total	61

Table 4: Diagnosis of sulfuric acid injured patients.

Disposition	Total (n=46)
Discharge from emergency room	28 (60.8%)
Admission	4 (8.6%)
Discharge against medical advice	5 (10.8%)
Transfer	9 (19.5%)

Table 5: Disposition of sulfuric acid injured patients.

Among the enrolled patients, the number of patients who discharged from hospital after treatment in an emergency department was 28 patients (60.8%), followed by 9 patients (19.5%) who were transferred to other hospitals, 5 patients (10.8%) who discharged against medical advice and 4 patients (8.6%) who were hospitalized in hospital (Table 5).

Discussion

About 25,000 chemical substances are commonly used for industrial or agricultural or household purposes and most of these materials may cause chemical damage [4]. Especially acidic or basic materials, among chemical substances are particularly harmful to human body and among which, sulfuric acid is one of the major materials that cause chemical burns due to acidity [5]. As a result of analyzing 2,930 accidents that were exposed to chemical substances and had occurred in Poland from 1999 to 2009, it was found that they were exposed to more than 200 chemical substances, and especially sulfuric acid, among non-flammable corrosive liquids occupied the second highest frequency following hydrochloric acid [3].

Shin et al. [2] analyzed the patients who were hospitalized to the emergency center for treating chemical damage occurred due to chemical accidents at industrial places for five years and reported that the high-frequency chemical damage-causing materials include hydrofluoric acid, compound chemicals, sulfuric acid, and magnesium in consecutive order. Sulfuric acid is one of the chemical materials that are the most commonly used. It is also used as basic raw material for chemical industry and further, used widely as material for fertilizers, explosives, and dyes. Sulfuric acid can cause severe damages to all areas of contact and if severe exposure occurs through breathing or ingestion, may cause systemic symptoms [6]. Sulfuric acid is a kind of strong acid, and if contacted with the skin, causes heat in tissues and coagulation necrosis, thus causing thrombosis in capillary and finally it may cause third-degree burns to the skin [7]. If contacted with the eye, it may cause blindness. Also, sulfuric acid is known to cause tissue damage by changing the pH in the areas of contact [8].

Chemical damage largely occurs during work. It is caused largely by chemical materials being splashed to the face or eye. And damage by sulfuric acid occurs a lot due to carelessness at workplaces or at home [9]. According to Bond et al. [10], at the places other than workplace, sulfuric burns occur the most while cleaning a pipeline.

In this study, splash injury caused by carelessness during work or experiment occupied the most and the major damaged areas are face and eye. Also, simple splash injury occupied most of the damage mechanism, and the patients who were damaged by second or higher-degree burns were observed as 25 patients in 46 in total and two patients were found to have third-degree burn, which indicates high severity. This is because if even a small amount of sulfuric acid touches the human body, it causes heat while reacting to the water in tissues, thus causing thermal burns. Also, even a low concentration of sulfuric acid may cause pain in the eye, increased secretion, and conjunctivitis and if highly concentrated sulfuric acid is splashed to the eye, may cause corneal burn, loss of eyesight, and even eyeball rupture [11,12].

Also, since skin burns caused by sulfuric acid often causes full-thickness skin burns accompanied with skin necrosis, skin incision or skin graft is often required [10]. Due to such characteristics, sulfuric acid is used a lot for deliberately damaging purposes against others as reported a lot in the recent press, and similar cases happened many times in foreign countries as well. According to the studies on 38 patients damaged by sulfuric acid that were carried out by Italian medical staffs in Bangladesh in 1998, 33 patients, who were females aged from 13 to 40 years and the major cause of damage was revenge or punishment between men and women, and face was the major area of damage and most of the patients underwent a surgical operation of skin expansion or flap or skin graft [13].

The inhalation of sulphur dioxide without direct contact with sulfuric acid may cause severe stimulus and caustic damage in the respiratory system and if sulfuric acid is inhaled in large amounts, it can be fatal due to pulmonary edema.

Benomran et al. [14] also reported on a 27-year-old male patient who died of bronchus by inhalation of sulphur dioxide occurred during sulfuric acid pipeline work and of severe pulmonary edema. Also in this study a 21-year-old male patient who suffered from chemical pneumonitis caused by inhalation of sulfuric acid was identified (Supplementary Table)

However, this study also has some limitations. This is a retrospective study that was based on the review of medical records. As it just relied on medical records to know a patient's clinical features and damage information, few can be known about the concentration of sulfuric acid and scope of damage. Moreover, the patients whose chemical substances that caused damages were not specified in medical records were excluded from the study. However, it is significant in that more various routes of sulfuric acid damage and extent of damage in many patients who are from three different areas can be known from this study. Most of the damages caused by sulfuric acid were due to careless splash injury during chemical substances-handling work and the areas of damage were largely face and eye, which occupied the highest frequency. In most cases, damages of second or higher-degree burn were observed and often hospital treatment was required. Sulfuric acid is one of the most common materials that cause chemical damage and may cause major burns and severe tissue damage. Therefore, close attention must be paid during sulfuric acid-transporting or handling work or experiment, and face shield, chemical goggle, and chemical glove also needs to be worn. And especially in an emergency department, if a sulfuric acid-damaged patient enters the hospital, skin and eye must be washed immediately by holding appropriate decontamination areas and equipment.

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