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IP International Journal of Forensic Medicine and Toxicological Sciences

Journal homepage: https://www.ijfmts.com/

Case Report

Corrosive catastrophe: Unveiling a deadly alkali exposure

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Abstract

Chemical burns are commonly encountered accidental burns in both household and workplace areas. While chemical burns are a recognized occupational hazard, fatalities resulting specifically from alkali exposure, particularly in the context of industrial accidents, are relatively rare. This case report details the autopsy findings of a fatal incident involving extensive chemical alkali burns in an industrial setting. The deceased succumbed to extensive chemical burns due to chemicals containing caustic potash (potassium hydroxide) and aluminium sulfate. Autopsy revealed widespread dermal liquefactive necrosis, pulmonary edema. This case underscores the critical importance of inflexible workstation safety protocols in chemical industries, highlighting the need for vigorous personal protective equipment and other safety measures. The rarity of reported autopsy cases related to fatal alkali burns highlights the necessity for detailed documentation and analysis of such incidents to improve preventative measures and enhance worker safety. This report aims to contribute to the limited body of literature on fatal alkali burn injuries and serve as a blatant reminder of the possible danger of chemical exposures in industrial atmospheres.

Keywords: Chemical burns, alkali, Corrosive, Caustic potash, Liquefactive necrosis.

Received: 29-03-2025; **Accepted:** 15-05-2025; **Available Online**: 07-07-2025

1. Introduction

Chemical injuries especially burn injuries occur accidentally, mostly and frequently through misuse of household products. But the incidents which involve chemical injuries occurring at the workplace especially at manufacturing plants although rare but are dangerous and can be fatal.[1]

Chemical burns represent a severe form of tissue damage and mostly result from exposure to corrosive substances. While acids are commonly associated with these injuries, corrosive alkalis pose a particularly insidious threat due to their unique mechanisms of action. These substances, found in various industrial and household products, can cause profound and potentially fatal injuries.

In deaths due to chemical burns, the area of burns has sharply defined edges with presence of trickling and splashing. The burns are corroded with destruction of the superficial layer of skin. There is no red line, blisters, vesication, or singeing over the burn area which are typically common in dry heat burns. There is no any soddening/bleaching with trickling or line of blisters which are present in scalds.[2]

In chemical burns due to corrosives, unlike acids, which typically cause coagulation necrosis, alkalis induce liquefactive necrosis. This process allows for deeper penetration into tissues, as they saponify lipids in cell membranes. Corrosive alkalis, such as sodium hydroxide (lye) and potassium hydroxide, are prevalent in drain cleaners, industrial cleaners, and cement. This widespread availability increases the risk of accidental exposure. The way that alkalis interact with human tissue, the liquefactive necrosis, allows for the substance to continue to burn, and penetrate deeper into the body, more so than many acids.[3]

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http://doi.org/10.18231/j.ijfmts.2025.016

Therefore, understanding the distinct characteristics of alkali burns is crucial for identification of chemical burns due to corrosive alkalis during postmortem examination, and steps for effective prevention and treatment, and suggesting more stringent safety measures at workplace to prevent such accidents due to chemicals.

Exposure to an alkaline agent, the -OH moiety causes injury due to liquefactive necrosis, which leads to often irreversible changes in the protein matrix and therefore causing deeper penetration and a more significant burn. Additionally, there is vascular damage that can create a local or systemic effect. Alkalis include fertilisers (Anhydrous ammonia), oven and drain cleaners (Sodium or Potassium hydroxide) and various detergents.[4]

Acidic agents cause coagulation necrosis which usually limits the depth and penetration of the burn, leading to cytotoxicity. Additionally, there are mucosal or skin changes that may prevent further toxicity and limit absorption. Common household products that contain acids include drain cleaner (hydrochloric acid or sulphuric acid) and toilet cleaner (hydrochloric acid or phosphoric acid). Overall, alkaline agents are more toxic than acidic agents, due to the irreversible changes in protein and tissue damage.[5]

Here we are going to report an autopsy case related with chemical burns due to corrosive alkali in an industrial workplace. The purpose of reporting this rare chemical burns case is to emphasize not only the typical autopsy findings related to alkali burns, but also the importance of safety measures at workplace which involve dangerous chemical compounds.

2. Case History

A 32 year old deceased male was brought to the casualty of GMC Chhatrapati Sambhajinagar (Aurangabad) and was declared as brought in dead before treatment. As per history, given by the police, the deceased was working in a chemical industry of caustic potash and he had history of accidental fall into a tub of chemical containing liquid caustic. His whole body was submerged into the chemical which is considered to be a corrosive alkali and sustained chemical burns. As per the initial investigation report, the police were of the opinion that the deceased had died due to chemical burns.

Figure 1: Whitish stains with precipitate of alkalis over clothes

Figure 2: Oozing of whitish froth from angles of mouth and nostrils, whitish chemical precipitate over beard, burns over forehead and nose.

Figure 3: Distinctively and sharply demarcated chemical burns as a bright reddish area with corroded appearance of burns.

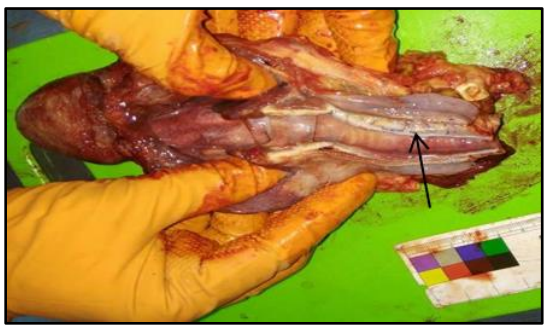

Figure 4: Whitish fluid with froth present within the tracheal lumen

A case was recorded under IPC section 284, 287 (now BNS Section 286 & 289 respectively) considering negligent conduct with respect to poisonous substance and negligent conduct with respect to machinery.

3. Autopsy Findings

On external examination, all the clothes were stained with whitish color precipitate (**Figure 1**). The exposed body parts and hair were stained with whitish stains with bleaching of the exposed skin at places. Body was of average built and cold to touch. Rigor mortis had appeared in upper and lower limbs, but was partial in fingers and toes. Postmortem lividity

was present over the back, appreciated over the unburnt areas, fixed, reddish purple in color.

Face showed areas of burns at places but facial featureswere identifiable. Eyelids were closed, with whitish stains over the orbital region and bleaching of the eyelids. Mouth was partly open with oozing of whitish froth from angles of mouth and nostrils **(Figure 2).** Tongue was intact, inside oral cavity with whitish stains over the anterior part of tongue. Skin over the limbs showed whitish precipitates with bleaching of the skin..

Dermo-epidermal burn injuries were present over the body with reddening, peeled off skin, and ulceration at places. There was evidence of splashing burns over the forehead along with multiple areas of trunk. Burn injuries were distinctively and sharply demarcated as a bright reddish area with corroded appearance of burns without evidence of singeing of body hair or scalp hair, or any blister formation, suggestive of chemical burns (**Figure 3**). The distribution of burns was noted as per Wallace rule of 9 with a total area of 59% burns, and was as follows: Head neck face- 3%, Chest -4%, Abdomen- 4 % ,Back -12%, Right upper limb- 6%, Left upper limb -4%, Right lower limb- 13%, Left lower limb-13%, Genital area-0%.

On internal examination- No underscalp injuries or skull fractures were seen. Patchy subarachnoid hemorrhage was seen with cerebral edema in the form of flattened sulci and gyri with obliteration of the convolutions. On dissection of the upper respiratory tract, whitish fluid with froth was present within the tracheal lumen (**Figure 4**) Both lungs-were congested and edematous; on cut section- reddish frothy fluid was oozing out on pressure. Hila of both lungs, showed whitish frothy fluid oozing out of bronchi. Stomach contained 50 cc of whitish fluid with intermixed yellowish semi digested food material with some abnormal smell perceived, and gastric mucosa was congested. All other organs were intact and congested.

After autopsy all tissue samples of major organs, pharyngolaryngotracheal block, and skin piece from area of burns and control sample from unburnt skin were preserved for histopathological examination and also for chemical analysis for detection of origin of burns. Routine viscera was preserved for toxicological analysis.

The cause of death after autopsy was given as “Shock due to 59% dermo-epidermal chemical burns.” Samples preserved for histopathology examination and chemical analysis.

Later, a crime scene visit to the chemical industry was done, which showed evidence of corrosive effects over the floor and splashing with whitish stains over walls near the tub containing alkali- caustic potash.

Histopathology examination report of skin flap was suggestive of corrosion of superficial skin, with liquefactive necrosis with separation of keratinous layer. There was evidence of cerebral edema, subarachnoid hemorrhage and congested leptomeninges. Larynx at tracheal end, epiglottis and cricoid showed superficial ulceration of lining epithelium with congestion and hemorrhages with engorged vessels.

The chemical analyzer’s report was suggestive of presence of aluminum and sulphate radicals with potassium hydroxide in all exhibits preserved for toxicological analysis. Thus, the result from chemical analysis report with associated histopathological findings were confirmatory of death due to corrosive chemical burns.

The final cause of death was given as “Shock due to 59 % dermo-epidermal corrosive alkali burns.”

4. Discussion

It is a common scenario, where chemical burns though rare and mostly accidental, but occur in connection with household chemicals, cleaning liquids containing mostly acids. However, even more uncommon is the chemical injuries that occur due to alkalis with corrosive effects. And very rarely industrial accidents related to chemical burns do occur, but are mostly fatal due to their corrosive effects on the skin causing deep burns. Eftekhari H et al could report only 6 cases of alkali burns of the 126 cases of chemical burns of their total 10133 cases of all types of burns.[6] This signifies how rare the chemical burns are amd even rarer are the deaths occurring due to chemical burns.

Hakan Akelma et al have reported rare chemical burns due to alkalis, with 2 cases aged 2 and 5 years in their study with cyanoacrylate burns and in both cases, full thickness burns occured.

They also reported alkali chemical burns due to cement over feet and soles in 2 cases of their study, but neither of them were fatal. [7]

In another case related to household chemical alkali burns, reported by Boutefnouchet T et al, where an a 48 year old female presented with full thickness chemical burns over wrist caused by applying concoction containing coal ash which is a noxious alkali. However the burns were localised and didn’t result in any fatality. [8]

Chemical burns related to airbag deflation injuries were reported by Akelma et al.[9] Airbag consists of alkali i.e. sodium hydroxide. When deflating airbag gases, such as nitrogen, carbon monoxide, carbon dioxide, ammonia, various hydrocarbons, and alkaline aerosols, are released from the airbags. Burns are caused by alkaline corrosives, especially sodium hydroxide.

Knowledge of chemical burn cases, their characteristics, and autopsy findings is crucial for addressing medicolegal

issues related to their manner of occurrence. While many chemical burns are accidental, ambiguities can arise regarding negligence by the deceased or employer, which must be clarified for compensation under Workmen's Compensation Act. Furthermore, crimes may be registered if the death or injury suggests negligence involving chemicals.

According to Workmen`s Compensation Act,1923- employers are liable to compensate their employees for injuries or death arising out of and in the course of employment. Considering this act, chemical burns caused in workplace are liable for compensation from the employers.[10]

Section 286 of BNS (previously 284 of the Indian Penal Code) addresses negligent conduct with respect to poisonous substances, punishing individuals who act rashly or negligently with such substances, potentially endangering human life or causing harm, or who knowingly or negligently fail to take adequate precautions. Chemical burns occurring in industries due to negligent act with respect to poisons, even if accidental, are liable to be booked under section 286 of BNS.[11]

The chemical burns rate among workers was higher than in other occupational groups.[6] In large chemical industries where chemicals are manufactured, it is mandatory to specify safety measures that must be implemented and the ideal neutralizing agent. Unfortunately, these rules are sometimes not respected.[12] It is especially important to draw attention to the importance of prevention in working environments and in home environments.[13]

5. Conclusion

The autopsy findings revealed extensive and severe alkali chemical burns, ultimately resulting in the decedent's death. Given the industrial workplace setting and the presence of caustic substances, this case raises significant medicolegal concerns. Further investigation is warranted to determine whether adequate safety protocols were in place and followed. If negligence is established, both workers' compensation claims and potential criminal charges may be pursued. It is strongly recommended that a comprehensive review of workplace safety procedures be conducted to prevent future similar incidents.

6. Source of Funding

None.

7. Conflict of Interest

None.

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Cite this article: Patekar MB, Pathak AM, Shinde AB, Zine KU. Corrosive catastrophe: Unveiling a deadly alkali exposure. *Int J Fotren Med Toxicol Sci.* 2025;10(2):58-61.