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Case Series
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Severe Burn Injury Caused by Carbon Monoxide Poisoning: Two Case Reports

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Abstract

CO poisoning is the most common cause of injuries and deaths after poisoning worldwide. Exposed charcoals and furnaces are often used for heating in parts of world. When CO poisoning occurs in a coma, people may faint on burning charcoal and furnace, and suffer severe burns. This article reports two cases of severe burns caused by CO poisoning, and the first patient even required amputation of his left leg. Besides, the long and painful treatments and irreversible changes in appearance and function have brought huge economic pressure and serious psychological barriers to patients. Therefore, education and prevention of CO poisoning are indeed worthy of attention.

Keywords: CO poisoning; Coal and furnace; Severe burn; HD

Abbreviations

CO: Carbon Monoxide; TBSA: Total Burn Surface Area; HD: Hospital Day; NPWT: Negative-Pressure Wound Therapy; USA: The United States of America

Introduction

Carbon Monoxide (CO) is an imperceptible gas generated from incomplete burning of hydrocarbons, which is odorless, colorless, tasteless and non-irritating [1]. CO poisoning is the most common cause of injuries and deaths after poisoning worldwide, which kills thousands and leaves many more seriously ill annually [2]. Insufficient combustion of carbonaceous substances can produce carbon monoxide. After being inhaled into the human, it forms carboxyhemoglobin with hemoglobin. CO's affinity for hemoglobin is approximately 200 to 300 times higher than that of oxygen, resulting in the formation of carboxyhemoglobin by replacing the bounded oxygen even exposure to relatively low concentration of CO [3]. Reduced binding of oxygen and hemoglobin causes hypoxemia and primarily affects tissues and organs with high metabolic needs. There are no special signs and symptoms in the patients with CO poisoning. Mild exposure can lead to fatigue, headache, anxiety or depression, malaise, nausea, and vomiting [4]. Moderate exposure can lead to confusion, dizziness, and convulsion. Severe exposure can lead to ataxia, loss of consciousness, myocardial infarction, brain infarction, and even death [5]. The main reason for CO poisoning is open fires, followed by work-related exposure in industry and faulty furnaces [6]. Especially in airtight room in winter, CO poisoning is more likely to occur when emissions from the burning of coal and furnace for heating are not timely. Exposed charcoals and furnaces are often used for heating in parts of world. When CO poisoning occurs in a coma, people may faint on burning charcoal and furnace and suffer severe burn. This article reports 2 rare cases of severe burn injury caused by CO poisoning coma. The patients signed informed consent forms and authorized the authors to publish their clinical data and images in this article.

Case Series

Patient 1

A healthy 68-year-old woman lapsed into unconsciousness and fell into the fiery charcoal due to CO poisoning while burning charcoal for heating in airtight room (Figure 1a). After being rescued, four hours later he was sent to our department for treatment. When he was admitted, she was lethargic, and was able to communicate correctly. The patient's vital signs were stable and visual analogue pain scale was 2, and her carboxyhemoglobin level was 15.3%. Physical examination

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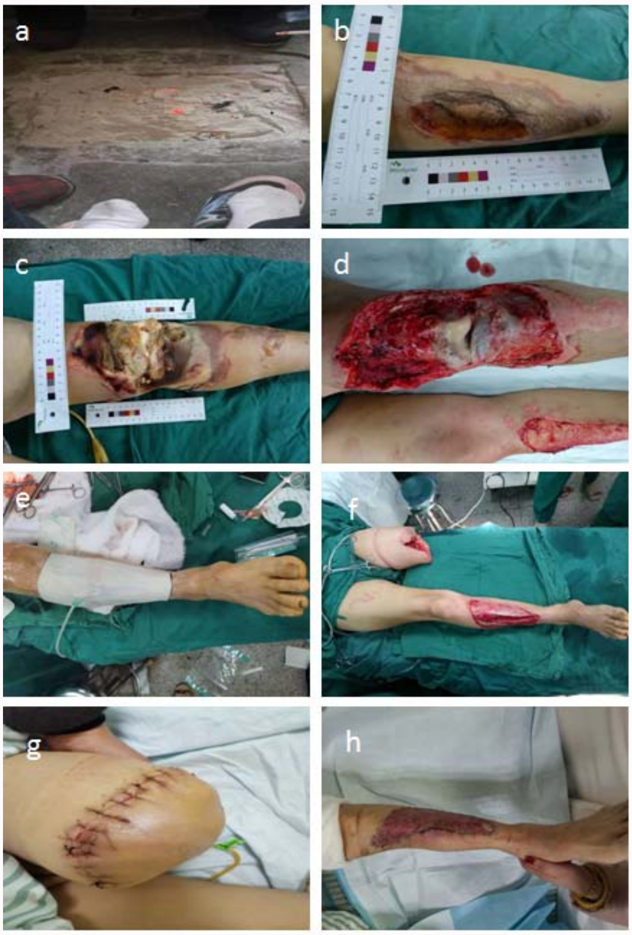

Figure 1: (a) People burned charcoal for heating in airtight room. (b, c) The wound before first operation, the skin of basal layer in front of tibia in the right lower limb is pale with poor elasticity (b). Left knee was scorched with around 10 cm × 15 cm skin defects, deep necrotic bones and muscles, accompanied by dissociative patella, were visible (c). (d, f) The wound after the first operation, on Hospital Day (HD) 4, she underwent left femoral shaft amputation + expanded debridement of right lower limb + artificial Dermal Regeneration Matrix + negative-pressure wound therapy (NPWT) under general anesthesia. (g, h) On HD 40, the patient was discharged when all wounds had healed.

revealed that the burn wounds were distributed on bilateral lower limbs with a 12% Total Burn Surface Area (TBSA), which including 11% third-degree burns. The skin of basal layer in front of tibia in the right lower limb is pale with poor elasticity (Figure 1b). Left knee was scorched with around 10 cm × 15 cm skin defects. Deep necrotic bones and muscles, accompanied by dissociative patella, were visible (Figure 1c). The left dorsalis pedis arterial pulse was weak, and corresponding skin was cool. The patient had monitoring of vital signs and was given high concentration of oxygen (Oxygen concentration is 100%), anti-infection, symptomatic relief and supportive treatments. On Hospital Day (HD) 4, she underwent left femoral shaft amputation + expanded debridement of right lower limb + artificial Dermal Regeneration Matrix (made in Landu Biomaterials Co., Ltd, China) + Negative-Pressure Wound Therapy (NPWT) under general anesthesia (Figures 1d-1f). The intraoperative findings revealed the following, (1) left knee joint was completely damaged and exposed, (2) left patella was carbonized and free, (3) left distal femur and proximal tibia were necrotic, (4) when bending left knee, completely necrotic meniscus and anterior and posterior cruciate ligaments were visible, (5) left distal femur quadriceps muscle and tibial periosteum were necrotic, (6) anterolateral deep fascia of the right lower limb was necrotic, and (7) part of right extensor pollicis longus and tibial periosteum of extensor digitorum longus were necrotic (Figure 1c). The necrotic tissues and muscles were then removed. On HD 28, she accepted operation of extended debridement of the right calf + dead bone removal + pedicled flap metastasis + autologous skin grafting (autologous skin is derived from the right thigh) + NPWT under general anesthesia. On HD 40, the patient was discharged when all wounds had healed (Figure 1g, 1h).

Patient 2

A healthy 75-year-old woman lapsed into unconsciousness and fell into the fiery charcoal due to CO poisoning while burning charcoal for heating in airtight room (Figure 2a). After being found, five hours later he was sent to our department for treatment. When he was admitted, she was conscious and able to communicate easily, the patient's vital signs were stable and visual analogue pain scale was 2, and her carboxyhemoglobin level was 19.6%. Physical examination revealed that the burn wounds were distributed on the right anterior and posterior torso, right hip and right lower limb with a 16% TBSA, which including 11% third-degree burns. The wounds were covered

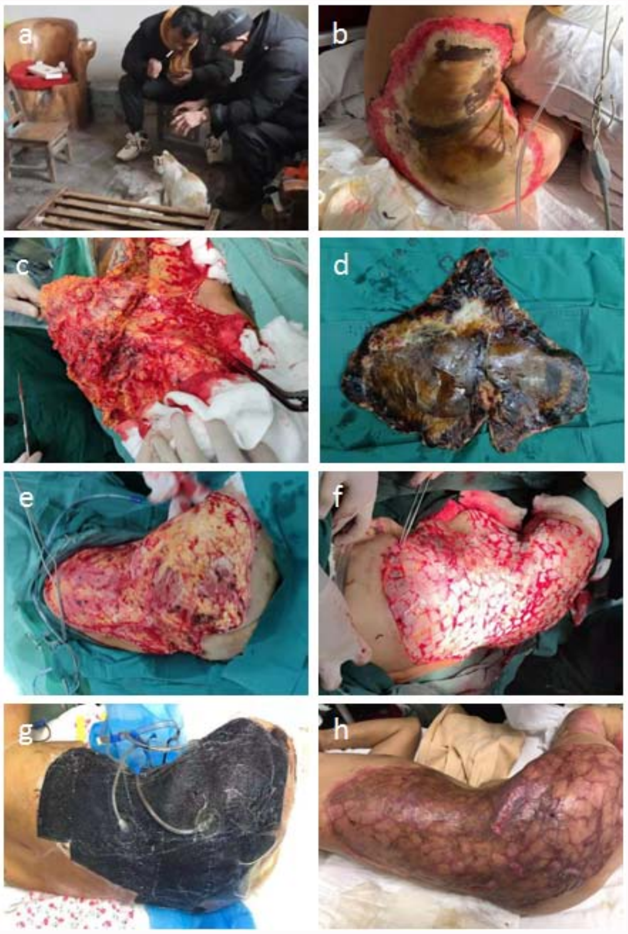

Figure 2: (a) People burned charcoal for heating in airtight room. (b) The wound before operation, the wounds were covered with sallow and leather-like Escher that distributed on the right anterior and posterior torso, right hip and right lower limb. (c-g) During the operation, on HD 6, the patient accepted operation of escharectomy + autologous skin grafting + NPWT under general anesthesia. (h) On HD 53, the patient was discharged when all the wounds had healed.

with sallow and leather-like eschar. The right dorsalis pedis arterial pulse was present, and her skin was warm (Figure 2b). The patient had monitoring of vital signs and was given high concentration of oxygen (Oxygen concentration is 100%), anti-infection, symptomatic relief and supportive treatments. On HD 6, she accepted operation of escharectomy + autologous skin grafting (autologous skin is derived from the left thigh) + NPWT under general anesthesia (Figures 2c-2f). The intraoperative findings revealed the following, (1) Most of the base of the wound showed black eschar, some of the base of the wound was red to red and white, and the surrounding wound was red and swollen, (2) After the resection of the deep wound of the eschar, it was found that part of the blood vessels had been embolized, and some blood vessels and muscles were exposed. On HD 53, the patient was discharged when all the wounds had healed (Figure 2g, 2h).

Discussion

CO poisoning is one of the most common poisoning worldwide with high morbidity and mortality [7]. It is estimated that 50000 people require medical treatment due to CO poisoning and associated societal costs are approximately $3.47 billion in the USA annually [8,9]. The most common symptoms of CO poisoning include nausea, headache, dyspnea and tachycardia. If it is not detected and treated in time, the symptoms will worsen and neurological symptoms, such as hallucinations, dizziness, confusion, seizures and at a maximum extent to respiratory arrest [10]. When the patient is in a coma, the body may be in direct contact with burning coal or a high-temperature furnace. Prolonged contact can cause severe burn, and most of the wounds are third-degree burn. At the same time, tissues including bones, muscles, nerves, blood vessels, etc. will also be irreversibly damaged. This article reports two cases of severe burn caused by CO poisoning. The first patient had to amputate the left lower limb burn wound at the knee joint, which was a destructive change that could not be repaired. Although the second patient also had a deep burn wound, the wound was mostly located in the cadre and could be repaired. Besides, sequela after CO poisoning are another big problem. Previous study reported that delayed neurological sequela occurred in 26.1% of patients with CO poisoning [11]. Therefore, long-term follow-up is required after the patient is discharged. The 2 patients in this study had no obvious neurological sequela after 3 months of follow-up. Burn injury caused by CO poisoning has the following characteristics, (1) it much occurs during the nocturnal sleep or in confined room with burning coal and furnace, (2) smoke and burnt smell appear after injury and are easy to notice. Therefore, clinical symptoms of CO poisoning are mild, local burn is severe, and the amputation rate is high, (3) direct contact with the fiery coal and furnace can damage muscles and bones, and the degree of burn is proportional to the contact time. Patients should be closely monitored for vital signs after admission, and patients with acute severe CO poisoning should also pay attention to prevent pneumonedema, renal failure, and neurological complications. For patients with severe burns, surgical treatment should be performed as soon as possible when the condition is stable and the absolute contraindications of the operation are eliminated. When it is found that the burn wound is damaged, such as the joint has completely lost its normal anatomical structure and the bone, nerve, blood vessel, muscle and other large area necrosis is unable to be repaired, amputation should be performed in time to prevent the wound infection from aggravating the condition and the economic burden of the patient increased by multiple repair operations. Due to the poor prognosis of CO poisoning, most patients have physical and psychological complications even when treated, enhanced prevention efforts are warranted. If possible, it is recommended to use air-conditioning and heating to replace traditional coal and furnace. Otherwise, propaganda and training should be strengthened in order to improve the known-rate of CO poisoning knowledge among population. The two cases described in this article were caused by faulty burning charcoal. The public should be educated to minimize the risk of CO poisoning, including avoiding burning of coal and furnace in confined spaces, reducing CO emission, warning labels of related products, installing CO alarms and regularly inspecting ventilators and alarms.

Conclusion

This article reports two cases of severe burns caused by CO poisoning coma. In the end, the patients recovered and were discharged from hospital. However, the long and painful treatments and irreversible changes in appearance and function have brought huge economic pressure and serious psychological barriers to patients. Therefore, education and prevention of CO poisoning are indeed worthy of attention.

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