Rare case of compartment syndrome provoked by inhalation of polyurethane agent:
A case report

Choi JH et al. Rare case of compartment syndrome

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Abstract

BACKGROUND
The most common causes of compartment syndrome in the lower extremities include lower limb fractures, trauma-induced crushing injuries, severe burns, and non-traumatic factors. However, there have been no reports of compartment syndrome secondary to toxic inhalation.

CASE SUMMARY
A 59-year-old man, who lost consciousness after applying polyurethane-based paint on a water tank, was brought to the emergency room. The initial blood test showed apparent rhabdomyolysis. One day later, pain and swelling in both legs were observed, and the physical examination confirmed the presence of compartment syndrome. Double-incision fasciotomy was performed on both legs. Frequent dressings and negative pressure wound treatment were done on both legs, and skin grafting was performed after healthy granulation tissue had been identified. No other complications were observed after treatment. However, symptoms of peroneal neuropathy, particularly limited ankle dorsiflexion and reduced sensation on the lower extremities, were observed.
CONCLUSION

Workers using polyurethane agents should wear gas masks and be evaluated for compartment syndrome and rhabdomyolysis secondary to toxic inhalation.

**Key Words:** Compartment syndrome; Polyurethanes; Rhabdomyolysis; Hypoxia; Peroneal neuropathies; Case report

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**Core Tip:** Compartment syndrome secondary to non-traumatic etiology is often diagnostically challenging based solely on history taking and may be misdiagnosed in the absence of comprehensive physical evaluation. Moreover, to date, no study has reported compartment syndrome caused by inhalation toxicity. We report a rare case of compartment syndrome secondary to polyurethane inhalation.
INTRODUCTION

According to Matsen, compartment syndrome occurs when increased pressure within a limited space compromises the circulation and function of tissues within that space\(^2\). It is a medical emergency, that necessitates immediate intervention, to avoid complications, such as muscle ischemia, neuropathy, and necrosis, which may result in limb amputation\(^2\). Compartment syndrome is a common complication of lower extremity fractures, trauma-induced crush injuries, severe burns, and some non-traumatic conditions\(^3\). Compartment syndrome secondary to a non-traumatic etiology is difficult to diagnose based on history taking only, and it may be misdiagnosed, based on an incomplete physical evaluation. Moreover, there have been no studies documenting the development of compartment syndrome secondary to inhalation toxicity. This study reports a rare case of compartment syndrome secondary to polyurethane inhalation.

CASE PRESENTATION

Chief complaints

A 59-year-old man, who lost consciousness after applying polyetherane-based paint to a water tank, was brought to the emergency department.

History of present illness

The patient was found lying prone in the tank one hour after he had entered. He did not wear a mask to protect against the inhalation of harmful chemicals while painting the water tank (a closed space of 32000 L).

History of past illness

The patient denied a history of diseases that could have triggered such a medical condition such as intense physical activities.

Personal and family history
The patient had no previous disease history.

*Physical examination*
There were no noted signs of trauma in the lower extremities and other regions of the body.

*Laboratory examinations*
The initial blood test results suggested rhabdomyolysis with an increased serum creatine kinase of 15250 IU/L and myoglobin greater than 20000 IU/L. The blood urea nitrogen and creatinine values remained within the normal range, but the alanine transaminase and aspartate transaminase reached up to 917 and 3765 IU/L, respectively. The electrocardiogram showed sinus tachycardia with nonspecific T wave abnormalities, which indicated an electrolyte imbalance without significant cardiac injuries.

*Imaging examinations*
No imaging studies were performed.

**FINAL DIAGNOSIS**
One day after admission, the patient developed pain and edema of the lower extremities, and the physical examination confirmed the presence of compartment syndrome. It is characterized by pain, pallor, paresthesia, pulselessness, and paralysis, which are typically referred to as the 5Ps of compartment syndrome (Figure 1). The intracompartmental pressure in the lower extremities ranged from 100 to 130 mmHg in all fascial compartments.

**TREATMENT**
The patient was admitted to the intensive care unit (ICU), and extensive hydration and hyperbaric oxygen therapy were initiated to manage the acute drug intoxication
syndrome, accompanied by rhabdomyolysis. No glucocorticoid or dehydration diuretics were administered during the patient's course in ICU.

Bilateral lower extremity fasciotomy was performed on the lateral and medial aspects of the extremities to relieve the pressure in the anterior, lateral, superficial posterior, and deep posterior compartments (Figure 2). The pain, pallor, and paresthesia improved in both lower extremities postoperatively. Frequent dressing changes using betadine-soaked gauze and weekly serial debridement were performed for wound management.

One month later, the dressing method was shifted to negative-pressure wound therapy. Growth of healthy granulation tissue within the wound was observed three months later, and meshed split-thickness skin grafting was performed (Figure 3).

OUTCOME AND FOLLOW-UP
The patient showed no other signs of compartment syndrome. However, he developed symptoms of peroneal neuropathy, particularly limited ankle dorsiflexion and sensory loss in areas of the lower extremities innervated by the peroneal nerve. Nerve conduction studies were performed to evaluate the motor and sensory functions of the left and right lower extremities (Table 1). The patient’s symptoms gradually improved, but complete recovery of the nerve functions has not been achieved. Therefore, further physical treatment is required.

DISCUSSION
Polyurethane polymers are highly stable materials that are primarily used in fabrics and paints[4]. Due to its high risk of respiratory toxicity, routine room ventilation or working outside is advised when using polyurethane polymers[5]. Polyurethane inhalation within a closed space without a protective mask possibly resulted in the loss of consciousness and rhabdomyolysis in this patient.

Rhabdomyolysis is associated with traumatic and non-traumatic etiologies, including infections, drugs, and toxin inhalation[6]. Carbon monoxide (CO), one of the most
common environmental toxins, has reportedly caused various medical conditions, including muscle injury and consequent rhabdomyolysis\textsuperscript{[7]}. In this case, the rhabdomyolysis was attributed to polyurethane inhalation-induced injury, which was similar to that associated with CO intoxication. However, a similar clinical presentation has not been reported in previous studies. The underlying mechanism behind polyurethane-induced muscle injury remains unknown. Melandri \textit{et al.}\textsuperscript{[8]} presented a case of prolonged hypoxia due to opiate overdose, resulting in rhabdomyolysis and myocardial damage. This was similar to the present case in that toxic inhalation induced hypoxia, rhabdomyolysis, and compartment syndrome. Acute compartment syndrome of the extremities most commonly results from traumatic injuries, such as long bone fractures, severe burns, and crush injuries\textsuperscript{[9]}. Additional risk factors include age, sex, and bleeding tendency\textsuperscript{[10]}. It is difficult to diagnose, particularly in patients with a vague history and no identifiable cause. In the present case, the causal relationship between polyurethane inhalation and compartment syndrome was not established. However, other attributable causes were not identified for the patient’s disease. Therefore, toxic inhalation was likely involved in the development of rhabdomyolysis and compartment syndrome\textsuperscript{[11]}. Polyurethane-induced asphyxiation likely induced prolonged hypoxia and consequent muscle injury\textsuperscript{[12]}.

The accurate diagnosis and prompt management of acute compartment syndrome are important to avoid permanent neurological and functional injuries of the extremities, fatal necrosis, and even amputation. Eliminating the probable cause by performing an emergency reduction of the long bone fractures, followed by immediate fasciotomy (the only available treatment for compartment syndrome), is indicated in patients suspected of acute compartment syndrome\textsuperscript{[13,14]}. Double-incision fasciotomy is the most frequently used technique because it allows access to all four compartments of the lower extremities\textsuperscript{[15]}. In the present case, an immediate fasciotomy was performed at the time of consultation for surgical intervention. Although nerve injury was not observed intraoperatively, the patient developed peroneal neuropathy later in the course of treatment.
CONCLUSION

Workers, using polyurethane agents in confined spaces, must wear protective gear, including a gas mask. A thorough physical evaluation is essential to avoid a missed diagnosis and to exclude toxic inhalation-induced rhabdomyolysis in patients, presenting with compartment syndrome. Considering other diagnoses and radiological evaluation findings is an appealing option, but the subsequent delay results in unwanted complications. Therefore, rhabdomyolysis and compartment syndrome should be considered in the differential diagnosis, and fasciotomy should be the preferred treatment option in patients with the aforementioned clinical presentation.
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