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Case Report

The Utility of a Portable X-ray System

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A B S T R A C T

Fujifilm (Tokyo, Japan) developed a portable X-ray system called the CALNEO Xair. We herein report our experience in using this portable X-ray system at the scene after transportation by a doctor helicopter (DH). An explosion suddenly occurred while a 42-year-old man was handling toluene in a factory, causing his clothes to catch on fire. When the staff of a physician-staffed helicopter (DH) equipped with a portable X-ray system checked the man at the rendezvous point, he had second- and third-degree flame burns to > 70% of his total body surface area. A chest X-ray obtained using the portable X-ray system showed clear lung fields. A noninvasive carboxyhemoglobin monitor indicated a carboxyhemoglobin value of 6%. He was transferred to a special burn center by the DH. This is the first reported case in which a portable X-ray system was used to evaluate blast injuries in the prehospital setting. This system may be useful for performing prehospital medical treatment for blast injury victims.

Blast injuries are typically categorized by the mechanism of injury.[1] Primary blast injuries occur as a result of the overpressurization wave of the explosion and typically affect gas-filled body structures of the body (eg, the lungs, gastrointestinal tract, and middle ear), resulting in injuries such as blast lung, tympanic membrane rupture, abdominal hemorrhage, and concussion. Secondary blast injuries result from flying debris propelled by the blast wind and may affect any body part. Blunt force or penetrating injuries are possible. Tertiary blast injuries occur when the body is accelerated by the blast wind or pressure gradients. Any body part may be affected, and typical injuries include fracture and traumatic amputation, closed and open brain injuries, and crush injuries. Quaternary blast injuries occur because of other products of the explosion (eg, heat and light) and exposure to toxins or gases. Any body part may be affected, and injuries include burns, blindness, and respiratory problems induced by the inhalation of toxic gases. Quinary blast injuries include illnesses, injuries, and diseases resulting from postexplosion environmental contaminants (eg, bacteria and radiation). Factors such as the type of explosive, the distance from the explosion, and body orientation relative to the explosion influence the impact of the explosion on the body. Radiologic studies are an essential part of the evaluation of patients with blast injuries because of the complex, severe, and multiple injuries that they may suffer.[2,3]

Fujifilm (Tokyo, Japan) developed a portable X-ray system called the CALNEO Xair. The X-ray radiation machine weighs 3.5 kg. Its dimensions are as follows: height of 144 mm, length of 148 mm, and width of 258 mm—without the skin guard or the hand strap. The radiation dose of a chest X−ray performed with this system is approximately 45 μGy. The system requires a special cassette and notebook-type personal computer to operate and display X-ray images (Fig. 1).

Our hospital is the physician-staffed helicopter (called a doctor helicopter [DH] in Japan) base for eastern Shizuoka Prefecture.[4] We herein report our experience using a portable X-ray system transported by a DH, which was used for the evaluation of a patient with blast injuries in a prehospital setting.

Case Presentation

An explosion suddenly occurred while a 42-year-old man was handling toluene in a factory, causing his clothes to catch on fire. Although he remained standing after the blast, his clothes caught on fire. His colleague rescued him and extinguished the fire. The man was the only victim. A colleague called the fire department. When emergency medical technicians checked him, he had extensive burns; thus, they requested the DH be dispatched, and he was transported to a rendezvous point. When the staff of the DH equipped with a portable X-ray system checked him at the rendezvous point, his vital signs were as follows: Glasgow Coma Scale of E4 V5 M6, systolic blood pressure of 140/80 mm Hg, pulse rate of 80 beats/min, percutaneous

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Figure 1. CALNEO Xair developed by Fujifilm. (Left) The system carried by a physician. (Right) The system carried in the helicopter. (1) The X-ray radiation apparatus, (2) the special cassette, and (3) a notebook-type personal computer.

oxygen of saturation of 100% under 10 L per minute of oxygen with a reservoir mask, respiratory rate of 20 breaths/min, and body temperature of 36.2°C. He had second- and third-degree flame burns to > 70% of his total body surface area, which were contaminated with soot (Fig. 2). His hearing was intact. A focused sonography assessment for trauma was negative. The portable chest X-ray revealed clear lung fields (Fig. 3). A noninvasive carboxyhemoglobin monitor (a pulse co-oximeter) indicated a carboxyhemoglobin value of 6%. The DH staff judged that the blast had induced an extended flame burn injury with carboxyhemoglobinemia. He was transferred to a special burn center by the DH.

Discussion

This is the first case in which a portable X-ray system was used to evaluate a patient with blast injuries in a prehospital setting. An explosion occurs when "energy is released over a sufficiently small time and in a sufficiently small volume so as to generate a pressure wave of finite amplitude travelling away from thesource."[5] This pressure wave (blast wave) that caused the primary blast injury is considered to predominantly affect gas-containing organs such as the larynx, middle ear, bowel, and lungs. Thus, exposure to the blast wave can cause life-threatening primary blast injury syndrome in which lung injury is predominant.[5] A chest X-ray should be included as a routine part of the examination of patients with blast injury because many develop respiratory insufficiency within 24 hours, even when they show mild (or no) primary symptoms.[6] Because the portable X-ray system showed no sign of lung injury, the patient was transported to a special burn center for treatment. In a mass casualty event, this portable X-ray system may be useful as a triage tool to evaluate the severity of victims' injuries.

Figure 2. The upper body of the patient. The patient suffered second- and third-degree flame burns to > 70% of the total body surface area, which were contaminated with soot.

Figure 3. The chest X-ray. The X-ray was negative.

Accordingly, the algorithm for the management of blast injury victims in the prehospital setting may change in the future.

Conclusion

We reported the usefulness of a portable X-ray system transported by a DH in the examination of a blast injury victim. This system may be useful for performing prehospital medical treatment for blast injury victims.

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