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Acute mass burns caused by *o*-chlorobenzylidene malononitrile (CS) tear gas

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The use of tear gas in controlling riots has been an accepted practice in many countries for the past four decades. In a recent event, a large quantity of tear-gas canisters were used during a situation of unrest in a Hong Kong Refugees' Detention Centre. We report 96 cases of acute burn injury as an unpredicted side effect of o-chlorobenzylidene malononitrile (CS) tear gas.

There were 47 females and 49 males with an age ranging between < 1 to 51 years. These burns were categorized as minor burns, with the total body surface area (TBSA) ranging from 1 to 8 per cent with mean percentage of 3. Most of the patients sustained superficial or partial-skin thickness injuries. Only two patients were admitted to the Prince of Wales Hospital Burns Centre because of deeper burns; debridement and skin grafting was required in one of them. The mechanism of burn injury was due to the flame generated from the grenade explosion, direct contact between the hot canister and the victim's skin, and the effect of the chemical powder inside the canisters when it splashed onto the victim's body. We suggest that the noxious transient effects of tear gas are underestimated, furthermore varying cutaneous effects and deep burns may result from its uncontrolled use during riots. There is a continuing need to reassess the potential toxic effects of CS tear gas as a riot control agent and to debate whether its future use can be condoned under any circumstances.

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Introduction

Tear gas, as a harassing agent, has gained widespread acceptance in controlling civilian unrest situations and subduing barricaded criminals. The most widely used form of tear gas has been *o*-chlorobenzylidene malononitrile (CS) gas.

Proponents of its use claim that, if used correctly, the noxious effects of exposure are transient and mainly in the form of irritation of the mucous membranes of the eyes and respiratory passages. Hardly a week goes by without press reports of tear gas being used in a public setting in different countries. Recently, in a Hong Kong refugees' detention centre, 96 cases of acute burn injury occurred resulting from the use of large quantities of the CS tear gas to control a riot situation among the detainees.

Patients

As a result of exposure to CS gas, 96 cases of acute burn injuries were diagnosed at the British Red Cross Clinic, who contacted The Prince of Wales Hospital Burns Centre.

There were 47 females and 49 males with ages ranging from < 1 to 51 years and a mean age of 19 years. Besides burns, these patients initially presented with other symptoms typical of exposure to CS gas, such as excessive lacrimation, shortness of breath, severe cough, eye pain, chest pain and sore throat.

Mechanisms of burn injury

A large quantity of CS gas was used, in the form of bombs or grenades and canisters which need to be fired by special guns. According to the history and the clinical presentation collected from the patients, the burn injuries were classified into:

- Flame burns caused by the fire resulting from the explosion of the tear-gas grenades near the victims (44 cases) (*Figure 1*).
- Contact burns caused when the hot canisters touched the victims' bodies (39 cases) (*Figure 2*).
- Chemical burns caused by the effect of the chemical powder inside the canisters and a spray (called mace). These chemicals splashed the nearby victims' clothes and their skin by contact (13 cases) (*Figure 3*).

Description of the burn injuries

All burns were considered to be minor burns, ranging between 1 and 8 per cent of the TBSA, with an average of 3 per cent. The lesions varied from small round patches, a reaction to the chemicals, to large patches of flame burn. These burns were distributed on different anatomical sites involving the face in eight patients, the arms in 31 patients, the hands in 13 patients, the chest in two patients, the abdomen in four patients, the back in eight patients and the lower limbs in 56 patients. The depth of these burns was a mixture of superficial in 16 patients, partial skin thickness in 78 patients and deep partial thickness in 22 patients. The largest deep burn surface area measured 7 × 5 cm. Two patients were admitted to the burns unit, the first was a 7-year-old girl presenting with 8 per cent deep partial

Figure 1. A flame burn injury of the leg from the explosion of a CS grenade.

Figure 2. Contact burns of the forearm caused by the hot canisters.

thickness flame burn of both legs, and she was treated conservatively. The other patient was a 5-year-old boy who sustained a 4 per cent chemical burn involving the hand and the thigh, he required debridement and skin grafting of a 7 × 5 cm deep burn of the thigh (*Figure 4*).

Most of these burn patients were seen in the first 3 days after injury. The majority of them presented with several burns of varying depth and in different anatomical sites. Close examination of those who had chemical burns resulted in eye irritation of the treating medical staff. Traces of white powder were evident at the burn sites and on the contaminated clothing, notably on the extremities. Apart from the two admitted cases, the patients in the detention centre were managed by removing their contaminated clothes, showering and simple saline–tulle gras dressings or silver sulphadiazine cream for certain hand and deep burns.

Other symptoms, besides burns, related to tear gas

The patients initially presented with other symptoms, typical of exposure to CS gas, commonly, cough, tearing eyes and running nose. Headache (29 per cent), shortness of breath (21 per cent), chest pain (19 per cent), sore inflamed throat (27 per cent) and fever (13 per cent) were also documented. Haemoptysis occurred in 8 per cent and does not appear to have been previously reported.

The majority of patients recovered with 2 weeks and required only two or three visits to the Local Red Cross Clinic. One patient had an abnormal low peak flow, but he was a known asthmatic.

Complications

Three patients presented at 2 weeks postinjury with raised hypergranulation tissue patches of 1.5 × 1 cm. They were treated by shaving and cauterization with silver nitrate sticks.

Another five patients were followed for hypertrophic scar formation and treated by pressure garments and local steroid injections.

Discussion

Tear gas is, in fact, a common term for a family of chemical compounds that have been otherwise referred to as 'harassing agents' because of their ability to cause temporary disablement. Some of these chemicals have been used worldwide, such as ω-chloroacetophenone (CN), dibenz [b,f] oxazepine (CR) and o-chlorobenzylidene malononitrile (CS), the latter has been employed most widely as a riot control agent for the past four decades[1]. Its effectiveness in riot control is derived from its properties as an extremely severe mucous membrane and skin irritant, even in minute doses.

Proponents of CS-gas use claim that, if used correctly, the noxious effects are transient and have no long-term consequences. It is important to ensure that the gas is never used indoors or in places from which those who have been exposed cannot readily escape[2]. Also, the firing of grenades and canisters must be from a distance to avoid traumatic injuries[1]. Unfortunately, there have been several incidents in various countries, for example, Northern

Figure 3. Chemical burns of the buttock and the thigh caused by the powder splashing clothes and the skin in contact.

Figure 4. CS chemical burn injury on the thigh and the hand of a 5-year-old boy, requiring debridement and skin grafting.

Ireland, South Korea, South Africa, the Gaza Strip and the West Bank in Israel, which have illustrated that the use of tear gas is not easy to control and is indiscriminate, especially in situations of civil unrest when it involves groups of people[1,2]. The main acute toxic effects of CS gas are: burning discomfort of the eyes, conjunctival hyperaemia, blepharospasm and excessive lacrimation, acidic taste in the mouth, sore tongue and throat, nasal congestion and rhinorrhoea, severe cough, bronchorrhoea and bronchospasm in asthmatics, erythema and a burning sensation of the skin[2,3]. In a Hong Kong refugee's detention centre, the security forces used a total of 510 rounds of tear gas to control a riot and unrest situation among 1500 detainees[4]. Certainly, the effects of the CS gas used went beyond all expectations, resulting in 96 acute burn cases and eight cases of alleged haemoptysis, which does not appear to have been reported before.

Evidence gathered from this incident proves clearly that CS gas can also be a powerful burning agent beside its other noxious effects. It can produce direct chemical and indirect contact and flame burns. Claims for the proper uses of the CS gas seem to be invalid and impractical, particularly in the generalized panic among both victims and those who used it.

The following treatment of burns associated with CS exposure is recommended. Patients should be well aerated, and contaminated clothes must be changed. Washing the skin lesions with contaminated water may exacerbate the symptoms, and the use of a mild alkaline solution (6 per cent sodium bicarbonate, 3 per cent sodium carbonate and 1 per cent benzalkonium chloride) is recommended[5]. However, these alkalis may not always be available and the use of ordinary showers have proved to be sufficient. Nevertheless, with the diagnosis of acute burn injuries, patients will be dealt with according to the depth and the surface area as usual.

In 1969, eight countries voted to ban the use of tear gas and other chemical weapons under the Geneva Protocol, but unfortunately this issue has not been implemented[1].

Acute burn injuries are to be added to the serious toxic effects of CS gas, which include reactive airway dysfunction syndrome (RADS)[6], miscarriage and stillbirths[1]. It is clearly apparent that CS tear gas is not only a harassing riot control agent, but also a harmful chemical weapon under certain circumstances.

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References

1 Hu H, Fine J, Epstein P et al. Tear gas: harassing agent or toxic chemical weapon? *JAMA* 1989; **262:** 660–663.

2 Flob PI, Talmud J. Tear gas: its toxicology and suggestions for management of its acute effects in man. *S Afr Med J* 1989; **76:** 295.

3 Himsworth H, Black DAK, Crawford T et al. *Report of the Enquiry into the Medical and Toxicological Aspect of CS (Orthochlorobenzylidene Malononitrile): Part II. Enquiry into toxicological aspect of CS and its use for civil purposes.* London: HMSO, 1971.

4 Inquiry Reveals Widespread Assaults During Raid on Camp, 9 June 1994. South China Morning Post, Press Report.

5 Wiegand DA. Cutaneous reactions to the riot control agent CS. *Milit Med* 1969; **134:** 437–440.

6 Brooks SM, Weiss MA, Bernstein IL. Reactive airways dysfunction syndrome (RADS). *Chest* 1985; **88:** 376–384.

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