Demonstration Control Agents

Evaluation of 64 Cases After Massive Use in Istanbul

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Abstract: An uncontrolled use of "demonstration control agents" commonly known as "teargas agents" has recently been a common practice in Turkey. One of the first massive uses of these agents had been during a meeting of the North Atlantic Council and NATO in 2004, in Istanbul. After the demonstrations, 64 patients were evaluated and treated by the Human Rights Foundation of Turkey. Their files have been reviewed retrospectively and were classified regarding age, sex, physical findings related of chemical agents, and other injuries.

The patients were received 1 to 9 days after the chemical gas exposure. The maximum referral was 35 patients on the day of the gas exposure. The last application was 9 days after the exposure. Complaints and physical findings/symptoms were highest during the first 3 days.

This study has been carried out to reveal the short- and long-term aftereffects of "demonstration control agents." The safety and effects of these agents are discussed in this article, based on our findings and existing references.

Key Words: forensic science, forensic toxicology, torture, demonstration control agents, teargas agents, chemicals gas

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Demonstration control agents (DCAs), commonly known as "teargas chemicals," has become familiar to the world. These agents, among chemical weapons, were banned for use in war under the Geneva Protocol[1] and Chemical Weapons Convention.[2] Nevertheless, in recent years, large amounts of these agents have been used in several countries in civil life.[3,4]

Some 15 chemicals have been used worldwide as teargas agents. The most widely used forms of them have been chlorobenzylidenemalononitrile (CS), chloroacetophenone (CN), chlorodihydrophenarsazine, and oleoresin capsicum (OC).[5]

The widespread use of DCA naturally raises the question of their safety. There is information on the effects of them in acute phase. Unfortunately, there is insufficient information about long-term chronic effects.[6–9]

Inhalation, digestion of, or contact with teargas causes an almost instantaneous onset of responses. After the exposure, symptoms begin within 10 to 30 seconds. Toxic risk increase and deaths have been reported in great amounts with prolonged exposure of these agents.[10,11]

This study has been carried out to reveal the short-term aftereffects of "demonstration control agents," mainly OC and CS, and long-term effects of DCAs have been discussed in light of the literature. Concerns of their safety are discussed in this article based on our findings and existing references.

MATERIALS AND METHODS

There were 2 different demonstrations to protest the meeting of the North Atlantic Council and NATO in Istanbul, on June 28 and 29, 2004, where security forces used "teargas bombs and spray forms." These demonstrations were among the first examples of massive use of demonstration control agents.

After the demonstrations, 64 patients applied to the Human Rights Foundation of Turkey (HRFT), Istanbul Branch, for treatment and documentation. The files of these patients have been reviewed retrospectively and were classified regarding age, sex, and physical findings/symptoms related to chemicals, as well as other injuries. The statistical analysis was accomplished using the SPSS 10; $P < 0.05$ was considered to be statistically significant. Ethic principles were complied.

RESULTS

Among 64 cases, 48 (75%) were male, and 16 (25%) were female. The mean age was 24.9 ± 6.6 years (range, 15–45 years). The patients were received 1 to 9 days after the DCA exposure. The exposure duration was not recorded on each case file, but according to the existing data, exposure duration was between a few seconds to 1 hour.

Figure 1 demonstrates a number of patients per each application day. Maximum referral was 35 patients (55%) on the day of the gas exposure. Findings/symptoms could be attributed to the chemical agent observed in 46 patients (72%). No physical findings/symptoms were observed in 6 patients who applied during the eighth and ninth days. Eighteen (28%) of the 64 patients have not had any findings/symptoms due to the chemical agents.

Complaints, symptoms, and physical findings that could be attributed to the chemical agents were highest during the first 3 days. Table 1 demonstrates the complaints of the patients, and Table 2 demonstrates the physical findings/symptoms in the first 3 days. The patients had more than 1 finding/symptom.

According to patients' claims, distance ranges of chemical gas exposure are the following:

- ***Near-contact range:*** using gas sprays in shorter than 1 m, or directly on faces, eyes, ears, and mouths of people,
- ***Close range:*** using gas sprays in 1- to 5-m diameter, or using gas bombs in closed areas (eg, into shop where people squeezed in, or into car), and
- ***Distant range:*** using it in more than 5 m.

Table 3 demonstrates range of distance in correlation with date of exposure and positive findings/symptoms according the

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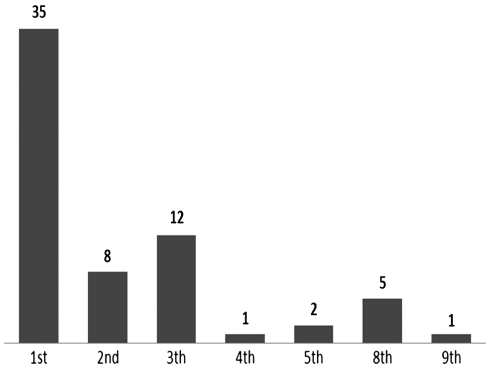

FIGURE 1. Number (n) of patients per day.

application days ($P = 0.32$). There was not any statistical significance between the distance range of chemical gas exposure and the physical findings/symptoms in all patients ($P = 0.56$).

Findings/Symptoms That Could Be Attributed to the Chemical Agents According to Application Days

First day. Maximum referral was 35 patients (55%) on the day of the gas exposure. Thirty-two (86%) of them had more than 1 finding/symptom due to the gas exposure. Five people had no physical findings/symptoms. The most observed findings/symptoms were on eyes, upper respiratory tract, and skin. Figure 2 demonstrates one of the actual patients. Pepper gas induced chemical conjunctivitis that was confirmed by the ophthalmologist.

Second day. Eight of the second-day patients had suffered from beatings and chemical agents. Two patients had no any complications and findings/symptoms due to the gas exposure.

Third day. Twelve of the third-day patients had suffered from beatings and chemical agents. Four patients were not observed to have any physical finding/symptom. One patient who had a history of an allergic dermatitis was found to have vesicle on her face (Fig. 3). One of them suffered from asthma attack after the chemical gas exposure. This patient had a history of asthma and required hospitalization due to chemical toxicity; therefore, she applied to the HRFT 3 days after the gas exposure for documentation.

TABLE 1. Complaints at Time of Application

Organ/System	Complaints
Eye	Stinging, erythema, lacrimation, altered vision
Ear	Tinnitus, pain, temporary hearing loss
Nose	Rhinitis, stingy sensation
RT	Shortness of breath, wheezing, cough, throat irritation, acute crisis of asthma
Skin	Stinging, erythema, pain, vesicle
GIS	Nausea, vomiting, abdominal pain, dysphagia
CNS	Confusion, impaired concentration, numbness, headache
CVS	Acute crisis of hypertension
Psychiatric	Distress, panic, anxiety, agitation

RT indicates respiratory tract; GIS, gastrointestinal system; CNS, central nervous system; CVS, cardiovascular system.

TABLE 2. Findings and Symptoms in First 3 Days

Findings and Symptoms	1st Day (n = 35)	2nd Day (n = 8)	3rd Day (n = 12)
Eyes: conjunctival hyperemia, stinging, lacrimation	15	3	3
RT: mucosal hyperemia, rhinitis, shortness of breath, cough	18	—	2
Skin: erythema, rush, stingy feeling	26	3	2
GIS: nausea, vomiting, abdominal pain	4	1	1
CNS: headache	3	—	2
CVS: hypertension	1	—	—
Psychological: anxiety	—	1	1
No findings related with the chemical agent	5	2	4

RT indicates respiratory tract; GIS, gastrointestinal system; CNS, central nervous system; CVS, cardiovascular system.

Later Days. One patient applied on the fourth day after the exposure. This patient had shortness of breath and cough. Two cases applied on the fifth day. One of them had no physical finding due to the gas exposure; 1 patient who was subjected to chemical gas in near-contact range (direct to ears and mouth) had hearing loss. There were no applicants on the sixth and seventh days. No physical findings were observed with 6 patients who applied during the eighth and ninth days.

Applied methods in all patients were seen as beatings and chemical gas exposure. In addition, the gas bomb canister injury for 2 patients, plastic bullet injury for 1 patient, and gunshot injury for 1 patient were found. Figure 4 demonstrates that the shooting bomb canister caused a typical abrasion ring on the back, under the right scapula, and the bomb canister.

DISCUSSION

Extensive use of DCAs in demonstrations has been increased all over the world and resulted in deaths and severe injuries.[12–14] Recently, an uncontrolled use of these chemicals has been a common practice in Turkey.

In this study, 64 patients were consulted to the HRFT, Istanbul Branch between the first and ninth days from 2 different demonstrations in which security forces used chemical gas widely. Therefore, only the early findings of these chemical agents were evaluated. According to the government's description, OC and CS were used as the DCAs in Turkey.[15]

TABLE 3. Distance Range of Chemical Agents' Exposure in Only the Patients Who Have Positive Findings/Symptoms

Distance Ranges	1st Day, n (%)	2nd Day, n (%)	3rd Day, n (%)	Later Days, n (%)	Total, n (%)
Near-contact range	7 (15)	3 (6.5)	2 (4)	2 (4)	14 (30)
Close range	11 (24)	3 (6.5)	4 (10)	—	18 (40)
Distant range	12 (26)	—	2 (4)	—	14 (30)
Total	30 (65)	6 (13)	8 (18)	2 (4)	46 (100)

$P = 0.32$, not significant.

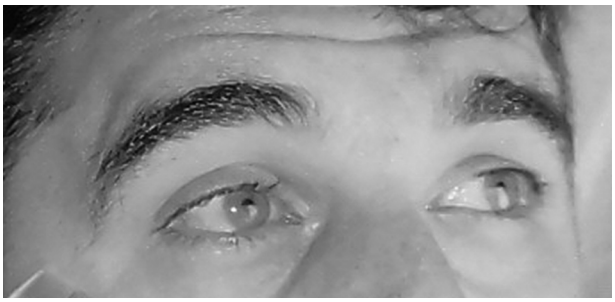

FIGURE 2. Pepper gas-induced chemical conjunctivitis. Figure 2 can be viewed online in color at www.amjforensicmedicine.com.

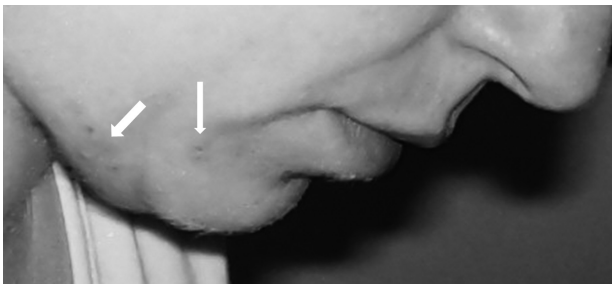

FIGURE 3. Vesicle on the face, after the chemical gas exposure. Figure 3 can be viewed online in color at www.amjforensicmedicine.com.

Oleoresin capsicum is a naturally occurring substance derived from the cayenne pepper plant and other varieties of peppers. It is classified as an inflammatory agent. On contact with OC, the mucous membranes of the eyes, nose, and upper way of the respiratory tract immediately become inflamed and swollen.[16–18] After the exposure, the symptoms start within 10 to 30 seconds. Capsaicinoids cause inflammation and epithelial cell death through activation of vanilloid receptors.[18] Effects on the eyes include severe stinging, involuntary closure, lacrimation, conjunctival inflammation, redness, swelling, and blepharospasm. Skin contamination causes itching, stinging, edema, erythema, and occasional blistering. Respiratory symptoms include nasal irritation, bronchoconstriction, a stingy sensation in the throat, severe coughing and sneezing, and shortness of breath.[16–21] The teargas agent CS also causes painful tearing and respiratory discomfort and dermal reactions.[3,22–24] Persistent multisystem hypersensitivity reaction is also reported.[22] Systemic and acute effects of these chemicals include disorientation, panic, and loss of motor coordination and irritation of the stomach, with the induction of vomiting and possibly diarrhea, bronchospasm, respiratory arrest, pulmonary edema, hypertensive crisis, and hypothermia, as well as serious respiratory and cardiovascular effects and permanent damage to the sensory nervous system.[25,26] At the same time, the cardiovascular and respiratory problems may also cause anxiety and panic attacks.[25,26]

In this study, the early findings/symptoms and also complaints of 46 chemical-exposed cases were similar to what is described in the literature (Table 2). One patient suffered from acute crisis of asthma, and 1 patient suffered from acute crisis of hypertension after the chemical gas exposure. These symptoms in the first 3 days after the exposure would perhaps be the most serious symptoms for this retrospective study. However, we could not follow up with the patients; therefore, we do not know about the other results. Although OC can cause deep corneal and conjunctival erosion,[27,28] in the recent study, chemical agents' related corneal damage and the follow-up information were not observed.

Reports of injuries and deaths associated with DCA exposure have appeared in the popular press and medical literature and have raised questions about the safety of these chemicals.[11,29–31] Many studies have concluded that the agents have a genotoxic potential with mutagenic and tumorigenic effect.[32–35] Severe traumatic injuries and deaths caused by bomb canisters as well as chemicals toxicity were observed in Turkey as in other countries.[36–38] Medicolegal evaluation of these deaths have not been reviewed and published yet in Turkey, but the media quoted several of them. Figure 4 demonstrates that the shooting bomb canister caused a typical abrasion ring on the back, under the right scapula, and the bomb canister. It was very remarkable that the canister diameter (37 mm) was consistent with the diameter of the abrasion ring, and small white circular area in the middle of the lesion was consistent with the hole on the mouth of the canister. Unfortunately, we did not know the type of weapon used, as there was no penetration; it can be said that distance range was more than 5 m. But the patient declared that it was a near-contact range.

According to the General Purpose Criterion of the Chemical Weapons Convention, DCAs are not accepted as chemical weapons.[39] However, the convention declared that if the DCAs are either used uncontrolled or misused (in terms of types and quantities or usage at near contact and close range), they should be considered to be chemical weapons.

Unfortunately, analytic epidemiologic investigation of an exposed person is difficult because of what the nature of its use renders, and there were some limitations of this retrospective study. There were not enough data on exposed features (such as concentration, distance exposure, and frequency) in every patient's file. Some files had incomplete data; therefore, the role

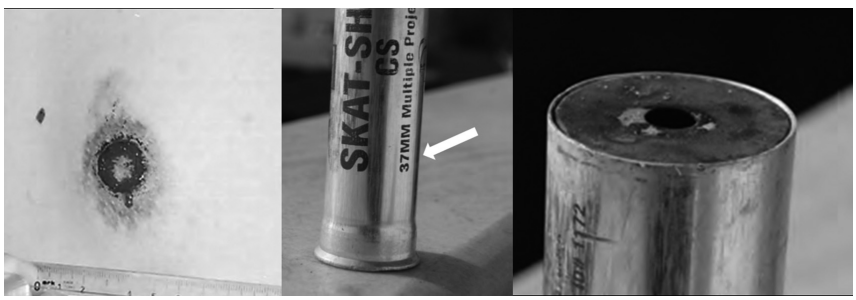

FIGURE 4. Typical abrasion ring and bomb canister. Figure 4 can be viewed online in color at www.amjforensicmedicine.com.

of other contributing factors (such as previous diseases, family history, and pre-exposure) was not clear. We were not able to use a control group of individuals with the same age and sex distribution or follow up with any patient because of the retrospective study. We are aware that well-organized prospective studies are needed.

CONCLUSIONS

This study is important that it demonstrates the effects of DCAs on exposed persons not on experimental animals and early findings/symptoms related to chemical exposure consistent with the experimental animal studies.

Unfortunately, analytic epidemiologic investigation of an exposed person is difficult because of what the nature of its use renders. There are some limitations of this retrospective study, and well-organized prospective studies are needed. There is an ongoing need for investigation into the full toxicological potential of these chemicals.

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REFERENCES

1. Protocol for the Prohibition of the Use of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare. Geneva, Switzerland; June 17, 1925 [UN Web site]. Available at: http://www.un.org/disarmament/WMD/Bio/1925GenevaProtocol.shtml. Accessed March 12, 2012.
2. Convention on the prohibition of the development, production, stockpiling and use of chemical weapons and on their destruction. Paris, France: January 13, 1993 [ICRC Web site]. Available at: http://www.icrc.org/ihl.nsf/FULL/553?OpenDocument. Accessed March 12, 2012.
3. Olajos EJ, Salem H. Riot control agents: pharmacology, toxicology, biochemistry and chemistry. *J Appl Toxicol*. 2001;21(5):355–391.
4. Olaitan PB, Ubah JN. Accidental tear gas injuries in security agents. *Niger J Med*. 2011;20(2):275–278.
5. Hu H, Fine J, Epstein P, et al. Tear Gas: harassing agent or toxic chemical weapon? *JAMA*. 1989;262(5):660–663.
6. Karagama YG. Short-term and long-term physical effects of exposure to CS spray. *J R Soc Med*. 2003;96:172–174.
7. Krolikowshi JF. Oleo capsicum (O.C.): the need for careful evaluation. *Am J Forensic Med Pathol*. 1994;15:267.
8. Weir E. The health impact of crowd-control agents. *CMAJ*. 2001; 164(13):1889–1890.
9. Carron PN, Yersin B. Management of the effects of exposure to tear gas. *BMJ*. 2009;338:b2283.
10. Chapman AJ, White C. Case report: death resulting from lachrymatory agents. *J Forensic Sci*. 1978;23:527–530.
11. Pollanen MS, Chiasson DA, Cairns JT, et al. Unexpected death related to restraint for excited delirium: a retrospective study of deaths in police custody and in the community. *CMAJ*. 1998;158(12): 1603–1607.
12. Alston P. Extrajudicial, Summary or Arbitrary Executions: Report of the Special Rapporteur of the Commission on Human Rights, Sixty-Second Session, 2006. Available at: https://docs.google.com/viewer?url=http%3A%2F%2Fwww2.ohchr.org%2Fenglish%2Fbodies%2Fhrcouncil%2Fdocs%2F14session%2FA.HRC.14.24.Add6.pdf. Accessed March 12, 2012.
13. Jahangir A. Extrajudicial, Summary or Arbitrary Executions: Note by the Secretary General Interim Report of the Special Rapporteur of the Commission on Human Rights on Extrajudicial, Summary or Arbitrary Execution. United Nations, 2002. Available at: https://docs.google.com/viewer?url=http%3A%2F%2Fwww.icj.org%2FIMG%2FUN_References.pdf. Accessed March 12, 2012.
14. Ozkalipci O, Sahin U, Korur Fincanci S, et al. Atlas of Torture: use of medical and diagnostic examination results in medical assessment of torture. Human Rights Foundation of Turkey Publications, no. 68, Ankara, October 2010.
15. Chemical weapons; demonstration control agents [in Turkish]. Review. 1st ed. Ankara, Turkey: Turkish Medial Association's Publication; 2011.
16. Reilly CA, Crouch DJ, Yost GS. Quantitative analysis of capsaicinoids in fresh peppers, oleoresin capsicum and pepper spray products. *J Forensic Sci*. 2001;46(3):502–509.
17. Watson WA, Stremel KR, Westdorp EJ. Oleoresin capsicum (cap-stun) toxicity from aerosol exposure. *Ann Pharmacother*. 1996;30(7–8): 733–735.
18. Reilly CA, Taylor JL, Lanza DL, et al. Capsaicinoids cause inflammation and epithelial cell death through activation of vanilloid receptors. *Toxicol Sci*. 2003;73(1):170–181.
19. Smith J, Greaves I. The use of chemical incapacitant sprays: a review. *J Trauma*. 2002;52:595–600.
20. Holopainen JM, Moilanen JAO, Hack T, et al. Toxic carriers in pepper sprays may cause corneal erosion. *Toxicol Appl Pharmacol*. 2003; 186:155–162.
21. Fuller RW, Dixon CMS, Barnes PJ. Bronchoconstrictor response to inhaled capsaicin in humans. *J Appl Physiol*. 1985;58(4):1080–1084.
22. Hill AR, Silverberg NB, Mayorga D, et al. Medical hazards of the tear gas CS. A case of persistent, multisystem, hypersensitivity reaction and review of the literature. *Medicine*. 2000;79(4):234–240.
23. Morrone A, Sacerdoti G, Franco G, et al. Tear gas dermatitis. *Clin Exp Dermatol*. 2005;30(4):447–448.
24. Varma S, Holt PJ. Severe cutaneous reaction to CS gas. *Clin Exp Dermatol*. 2001;26(3):248–250.
25. Porszasz R, Szolesanyi J. Circulatory and respiratory effects of capsaicin and resiniferatoxin on guinea pigs. *Acta Biochim Biophys Hung*. 1991–1992;26(1–4):131–138.
26. Chahl LA, Lynch AM. The acute effects of capsaicin on the cardiovascular system. *Acta Physiol Hung*. 1987;69(3–4):413–419.
27. Brown L, Takeuchi D, Challoner K. Corneal abrasions associated with pepper spray exposure. *Am J Emerg Med*. 2000;18(3):271–272.
28. Vesaluoma M, Müller L, Gallar J, et al. Effects of oleoresin capsicum pepper spray on human corneal morphology and sensitivity. *Invest Ophthalmol Visual Sci*. 2000;41:2138–2147.
29. Steffee CH, Lantz PE, Flannagan LM, et al. Oleoresin capsicum (pepper) spray and "in custody deaths". *Am J Forensic Med Pathol*. 1995;16:185–192.
30. Busker RW, Van Helden HPM. Toxicologic evaluation of pepper spray as a possible weapon for the Dutch police forces. Risk assessment and efficacy. *Am J Forensic Med Pathol*. 1998;19(4):309–316.
31. Niemcunowicz-Janica A, Ptaszyńska-Sarosiek I, Wardaszka Z. Sudden death caused by an oleoresin capsicum spray [article in Polish]. *Arch Med Sadowej Kryminol*. 2009;59(3):252–254. (Abstract).
32. Toth B, Rogan E, Walker B. Tumorigenicity and mutagenicity studies with capsaicin of hot peppers. *Anticancer Res*. 1984;4(3):117–119.

33. Lawson T, Gannett P. The mutagenicity of capsaicin and dihydro-capsaicin in V79 cells. *Cancer Lett*. 1989;48(2):109–113.

34. Surh YJ, Lee SS. Capsaicin in hot chili pepper: carcinogen, co-carcinogen or anticarcinogen? *Food Chem Toxicol.* 1996;34(3):313–316.

35. Kim DK, Lillehoj HS, Lee HS, et al. High-throughput gene expression analysis of intestinal intraepithelial lymphocytes after oral feeding of carvacrol, cinnamaldehyde, or capsicum oleoresin. *Poultry Science*. 2010;89:68–81.

36. Rothschild MA, Vendura K. Fatal neck injuries caused by blank cartridges. *Forensic Sci Int*. 1999;101(2):151–159.

37. Wani AA, Zargar J, Ramzan AU, et al. Head injury caused by tear gas cartridge in teenage population. *Pediatr Neurosurg*. 2010; 46(1):25–28.

38. Clarot F, Vaz E, Papin F, et al. Lethal head injury due to tear-gas cartridge gunshots. *Forensic Sci Int*. 2003;137(1):45–51.

39. Pearson GS. The importance of implementation of the general purpose criterion of the chemical weapons convention. *Kem Ind*. 2006;55(10):413–422.