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S. R. Jones,[1] Major, USAF, VC; P. E. Besant-Matthews,[2] Lieutenant Colonel, MC, USA; F. J. Williams,[3] Second Lieutenant, MSC, USA; and C. J. Stahl,[4] Captain, MC, USN

Injury Potential of a Reloaded Tear Gas Pen Gun

Injuries resulting from the discharge of conventional threaded metallic tear gas cartridges and similar devices loaded with chloroacetophenone (CN) or ortho-chlorobenzalmalononitrile (CS) have been reported recently [*1-4*]. Wounds caused by the firing of illegal pen guns loaded with fixed metallic ammunition have also been reported [*5*].

The potential of tear gas pen guns to produce serious injuries, including permanent blindness [*1,2,4,5*] and even death [*5*], is the basis for this study. This report describes the ballistic characteristics, wounding potential, pathologic lesions, and other hazards associated with the discharge of threaded aluminum alloy tear gas cartridges reloaded so as to simulate miniature shotgun cartridges.

Materials and Methods

Interchangeable threaded aluminum alloy tear gas cartridges having an outside diameter of 1.2 cm in magnum (4.8 cm long) and super magnum (5.8 cm long) sizes and originally loaded with CN gas were discharged. These were then reloaded by means of a battery-cup primer, 2.5 grains of smokeless pistol powder, 28 pellets of BB shot (totaling 158 grains), and overpowder and closing cardboard wads of 1.5-mm thickness (Figs. 1 and 2). The tear gas pen gun used in this study consisted of a metallic cylinder 10.2 cm long and 1.2 cm in diameter, with a spring-loaded metal rod 4 cm in length (Fig. 1). The tip of the metal rod acted as a firing pin when released. The open end of the cylinder was threaded to accept tear gas cartridges.

Velocity studies were conducted by the use of a ballistic chronograph[5] with the entry point of the system located 18 in. from the muzzle of a reloaded magnum cartridge and the exit point at 42 in.

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[1]Acting chief, Wound Ballistics Section, Forensic Sciences Division. Armed Forces Institute of Pathology (AFIP), Washington, D.C. 20306.

[2]Formerly chief, Wound Ballistics Section, AFIP; present address: P.O. Box 3352, Tacoma, Washington 98499.

[3]Formerly clinical clerk, Forensic Pathology Branch, AFIP; present address: Meharry Medical School, Nashville, Tenn. 37208.

[4]Chief, Forensic Sciences Division, AFIP.

[5]ECI, computing chronograph, Model 4001, Electronic Counters Inc., Englewood, N.J.

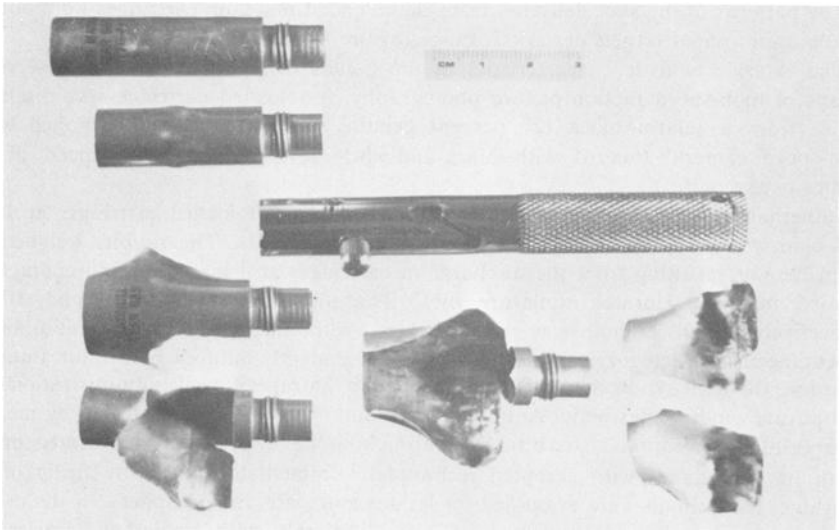

FIG. 1—*Tear gas pen gun and threaded aluminum alloy super magnum* (top) *and magnum* (all others) *cartridges that have been reloaded to simulate miniature shotgun cartridges and fired. Note bulges from force of pellets in walls of intact cartridges* (above) *and fragmentation of other cartridges* (below). (*AFIP Neg. No. 73-10788-6*).

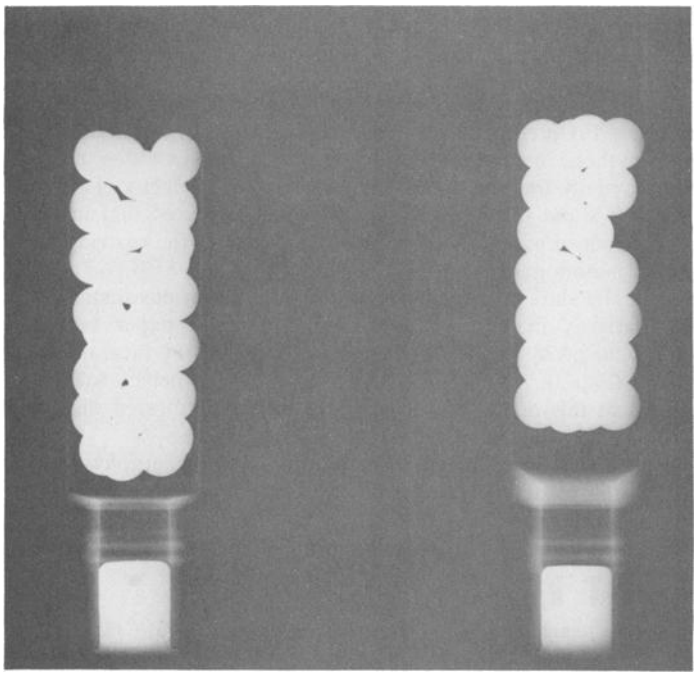

FIG 2—*Roentgenogram of magnum* (left) *and super magnum* (right) *cartridges reloaded with battery-cup primers* (bottom), *pistol powder, overpowder wads, 28 pellets* (*BBs*), *and closing wads.* (*AFIP Neg. No. 73-10788-5*).

The patterns of the shot delivered from the reloaded magnum cartridges were obtained by the use of paper targets at various ranges of fire from contact through 15 ft.

The exterior ballistic characteristics of the pellets (BB shot) were also observed by means of high-speed motion-picture photography. A reloaded cartridge was discharged 18 in. from a gelatin block (20 percent gelatin at 10°C) and photographed with a high-speed camera[6] (loaded with black-and-white reversal film) at a speed of 4000 frames per second.

Sublethal and lethal lesions resulting from discharge of reloaded cartridges at 18, 12, and 6 in. were observed in two New Zealand white rabbits. The rabbits weighed 9 lb each. Lesions resulting from the discharge of cartridges at 6 in., 1 in., and contact were studied in three Hormel miniature pigs. The pigs weighed 40, 62, and 100 lb, respectively. Each animal was premedicated with atropine sulphate administered subcutaneously. Deep surgical anesthesia was subsequently induced by the intramuscular injection of fentenyl-droperidol[7] combined with intraperitoneal administration of a barbiturate general anesthetic. Animals were maintained in deep anesthesia by means of intraperitoneal injection of barbiturates throughout the experiments performed prior to death, in accordance with accepted techniques.[8] Immediately after the firing of each cartridge, the animals were examined for lesions and were photographed. In the event of death, necropsy was accomplished at once. Animals with sublethal injuries were subsequently killed by the administration of an overdose of barbiturate anesthetic and then necropsied.

All reloaded cartridges were discharged by means of a remotely controlled firing device that has been described previously [3]. This device is operated by means of a cord which, when pulled by the operator, who is located in a position of safety, releases the catch holding the firing pin in its cocked (rearmost) position.

Results

The average velocity of the pellets propelled by a discharge was 584 ft/s with a range of 497 to 665 ft/s. Frequent malfunctions occurred during the test firing of reloaded cartridges, and in these instances the walls of the cartridges either bulged outward or burst open and partially fragmented (Fig. 1). The average velocity of the pellets in these instances was 151 ft/s and the range 96 to 215 ft/s. It appeared that in many such cases the BB shot were wedged against each other or the sides of the cartridge, which resulted in some degree of jamming.

The patterns of the shot produced in paper targets at various distances are shown in Table 1. The patterns in adult size, human silhouette paper targets exhibited a maximum hit (28 out of 28 pellets) in a 6 by 4-in. area of the face and neck at a firing distance of 18 in. (Fig. 3). A concentration of 15 of the 28 pellets within a 2 by 1.2-in. area was achieved at this distance. At 36 in. all pellets perforated the silhouette of the face and neck, and 20 pellets fell within a 4 by 3.5-in. area.

Pellets were observed by high-speed motion-picture photography and were seen to indent gelatin blocks to depths of about 1.5 cm before rebounding, leaving minimal indentations visible only in oblique light.

Sublethal injuries occurred in the anesthetized rabbits at the various firing distances, as follows (Table 2):

[6] HYCAM (high-speed camera) made by Redlake Corp., Santa Clara, Calif.

[7] Innovar-Vet, Pitman-Moore Co., Fort Washington, Pa.

[8] In conducting the research described in this report, the investigators adhered to the "Guide for Laboratory Animal Facilities and Care," as promulgated by the Committee on the Guide for Laboratory Animal Facilities and Care of the Institute of Laboratory Animal Resources, National Academy of Sciences-National Research Council.

1. At 18 in. moderate multifocal cutaneous contusions were produced.
2. At 12 in. there were marked multifocal cutaneous contusions, including subcutaneous and muscular hemorrhage (Fig. 4) and a slight degree of hepatic laceration that resulted in a small amount of hemorrhage into the peritoneal cavity.
3. At 6 in. cutaneous penetration by the wad was observed in addition to marked multifocal contusions from the pellets.

TABLE 1—*Findings from studies of shot patterns.*

Distance	Total Diameter of Pattern by 28 BBs, in.	Heaviest Concentration	
		Number of BBs	in.
Contact	0.5 × 0.5	28	0.5 × 0.5
1 in.	0.7 × 0.7	28	0.7 × 0.7
6 in.	1.2 × 1.2	28	1.2 × 1.2
12 in.	2.2 × 2.2	28	2.2 × 2.2
18 in.	6.0 × 4.0	15	2.0 × 1.2
3 ft	8.0 × 4.0	20	4.0 × 3.5
5 ft	10.5 × 9.5	15	4.0 × 3.0
7 ft	13.5 × 11.5	11	4.7 × 4.7
9 ft	22.5 × 12.5	14	5.5 × 5.2
11 ft	17.0 × 14.5	5	5.0 × 5.0
15 ft	28.5 × 24.5	widely spaced	

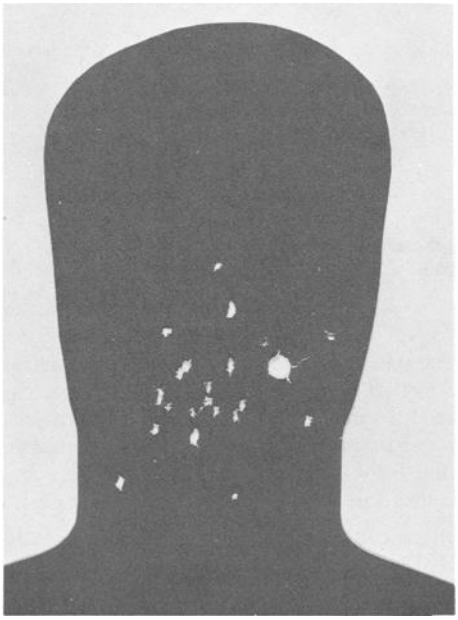

FIG. 3—*Upper portion of a standard human silhouette target following discharge of a reloaded magnum cartridge at a range of 18 in. At this distance all 28 pellets and the wad (large hole) were confined to a 6 by 4-in. area of the face and neck. (AFIP Neg. No. 73-10788-3).*

TABLE 2—*Sublethal and lethal injuries in experimental animals (rabbits) caused by a reloaded tear gas pen gun at various ranges of fire.*

Range, in.	Injuries
18	contusions of skin
12	contusions of skin and laceration of liver
6	contusions of skin from pellets and penetration of skin by wad
6	fatal injury from perforation of skin and chest wall, and laceration of heart by pellets, resulting in hemorrhage

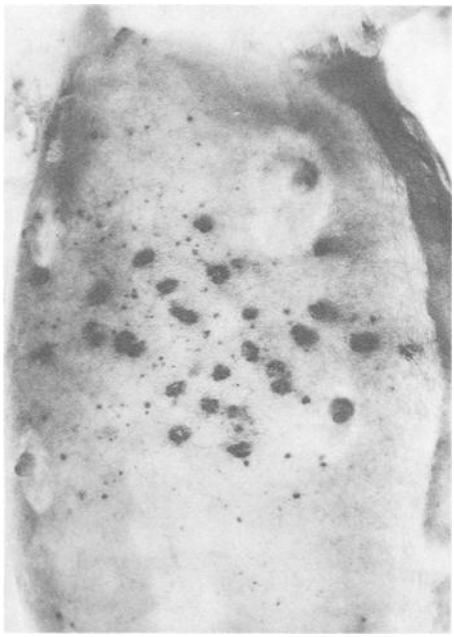

FIG. 4—*Multifocal contusions in the shaved skin of the chest and abdomen of an anesthetized rabbit following discharge of a reloaded tear gas cartridge at a distance of 12 in. (AFIP Neg. No. 73-10788-4).*

One rabbit died immediately following discharge of a cartridge from a distance of 6 in. In this instance, pellets perforated the skin, thoracic wall, pericardium, and epicardium and produced a small laceration in the myocardium at the apex of the heart. These injuries led to pneumothorax, pronounced hemothorax, and hemopericardium with cardiac tamponade.

Sublethal injuries occurred in the anesthetized miniature pigs, as follows (Table3):

1. At 6 in. the pellets caused moderate cutaneous abrasions and some cartridge fragments produced focal lacerations.
2. At 1 in. cutaneous penetration by wad and several pellets produced moderate subcutaneous hemorrhage.
3. The first shot fired in contact with the chest of the 100-lb pig resulted in a focal cutaneous contusion and an area of soiling 2.5 cm in diameter. The cartridge burst, however, and resulted in moderate lacerations of the skin from fragments of cartridge.

TABLE 3—*Sublethal and lethal injuries in experimental animals (miniature pigs) caused by a reloaded tear gas pen gun at various ranges of fire.*

Range, in.	Injuries
6	abrasions of skin by pellets and lacerations of skin by cartridge fragments
1	penetration of skin by pellets and wad and subcutaneous hemorrhage
Contact	contusion of skin by pellets and lacerations of skin by cartridge fragments
Contact	penetration of skin and chest wall by pellets and wads
Contact	fatal injury from perforation of skin and chest wall, and lacerations of heart and pulmonary artery, resulting in hemorrhage

4. The second contact shot over the chest in this same pig functioned properly and resulted in penetration by the wad and pellets through the skin, fat, intercostal muscles, and fascia to a depth of 4 cm, just short of the costal pleura.

5. A shot fired in contact with the skin overlying the sternum of the 40-lb pig resulted in penetration by the wad and pellets for a distance of 2.5 cm to the sternum, where they were effectively blocked from further penetration.

The 62-lb miniature pig died immediately, subsequent to a contact shot positioned over the left fourth intercostal space. In this case, pellets perforated the skin, thoracic wall, pericardium, and epicardium and produced a small laceration in the myocardium and in the pulmonary artery (Figs. 5 and 6). These lesions resulted in severe hemothorax and in hemopericardium and massive hemorrhage around the pulmonary artery and aorta.

Discussion

Some of the variation noted in the velocity studies apparently was caused by the passing of wadding, as well as multiple missiles, through the light field of the chronograph system, thereby precluding a precise or consistent signal to the optical receptors. In common with other shot-loaded devices, the high-speed motion-picture film revealed some separation because of variance in velocity and lateral dispersion of shot pellets.

The hepatic laceration produced in the rabbit following discharge of a cartridge from a distance of 12 in. apparently was due to a combination of blast and the release of kinetic energy caused by the action of the shot and wadding striking against the abdominal wall. In this connection, it is interesting to recall the considerable momentary indentation observed in the gelatin block by means of high-speed photography.

Explosive fragmentation of many of the reloaded cartridges in this study was established as a significant hazard not only to the intended victim of such a discharge but also to a potential operator.

Information obtained during this study tends to confirm our opinion [5] that threaded metallic tear gas cartridges reloaded with metallic ammunition are potentially injurious or possibly lethal weapons. The public, as well as law enforcement officers, should appreciate the full potential of these seemingly harmless devices and take precautions to prevent surprise or injury by a supposedly harmless device that has been modified with malicious intent.

We recommend the selection of an aerosol spray when the use of tear gas is indicated or when this material is carried for self-protection. Aerosol sprays are capable of delivering the chemical agent while, at the same time, presenting less of a hazard by virtue of containing neither an explosive charge nor the potential for driving foreign materials (such as particulate matter and wads) into potentially sensitive tissues.

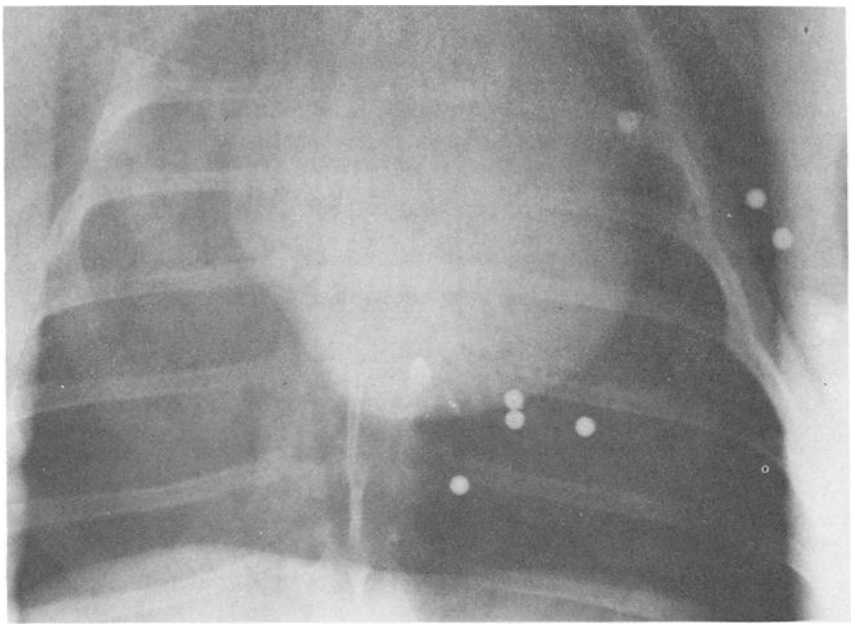

FIG. 5—*Roentgenogram of a pig showing pellets in the chest wall and thoracic cavity following fatal contact shot. (AFIP Neg. No. 73-10790).*

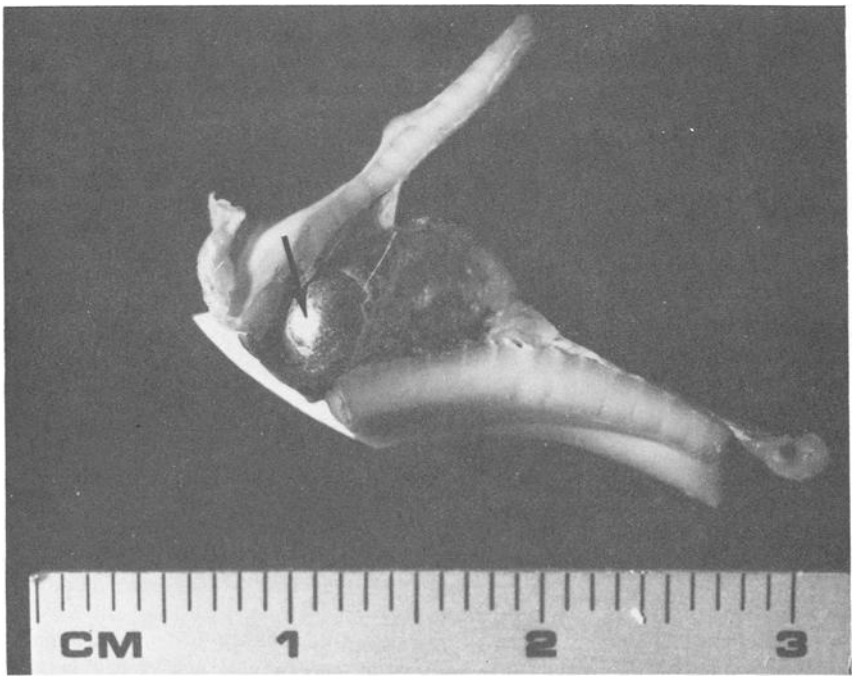

FIG. 6—*Pellet* (arrow) *that perforated the pulmonary artery of the same pig as in Fig. 5 is lodged in the hemorrhagic area between the pulmonary artery* (above) *and the aorta* (below). *(AFIP Neg. No. 73-10787).*

Summary

Threaded aluminum alloy tear gas cartridges loaded with chloroacetophenone were discharged and reloaded with a battery-cup primer, pistol powder, pellets, and wads to simulate miniature shotgun shells. The average velocity of the pellets discharged, established by chronographic studies, was approximately 584 ft/s (range 497 to 665 ft/s). The patterns of the shot in paper targets at various distances are described and illustrated. The reloaded cartridges are capable of producing both sublethal and lethal lesions in anesthetized experimental animals at distances from contact to 18 in. Malfunctions of the reloaded cartridges and potential hazards to both the user and potential victim are discussed.

Acknowledgment

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Armed Forces Institute of Pathology
Washington, D.C. 20306