Gunshot Injuries with Plastic Bullets Treated in a Small Community Hospital in the Gaza Strip

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Over 600 patients, 54.8% of whom were under 18 years old, were treated for "plastic bullet" gunshot wounds at a Spartan, 70-bed community hospital in the Gaza Strip from September 1988 through April 1989 (eight months). Most of the wounds were in the lower extremities and were managed by surgical debridement of the inlet site, exploration of the tract, attempted removal of the bullet, and delayed primary closure in three to five days. Of 63 patients with abdominal wounds, 44 required exploratory laparotomy and 21 had injuries to the gastrointestinal tract. There were 15 patients with major lower extremity vascular injuries. Patients suffering major injuries to the chest, requiring thoracotomy, or to the central nervous system were transferred to another facility. There was no in-hospital mortality in this group of patients. The wound infection rate was 1.5%. These casualties placed a heavy added burden on the already stressed health care system in Gaza. [PSRQ 1992;2:25–32]

As a consequence of the 1967 Arab-Israeli war, Israel assumed control over the West Bank and the Gaza Strip, now commonly known as the Occupied Territories. Both regions have been under military occupation for the past 24 years. In December 1987, the Palestinian uprising, or "intifada," began as a response among the Palestinian population to the perceived unfairness and oppression of military occupation.

In the first months of the intifada, many Palestinians were injured from severe beatings and high-velocity military gunshot wounds [1]. By August and September 1988, the Israeli Army (Israeli Defense Force; IDF) began using plastic bullets as a change in strategy for crowd and riot control in the streets

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of the refugee camps, villages, and towns [2] The IDF hoped that the plastic bullets would be nonlethal when fired from a distance of greater than 70 m [3]. Between September 1, 1988 and April 30, 1989, 617 patients with plastic bullet gunshot wounds were treated at Ahli Arab Hospital in the Gaza Strip.

In presenting and discussing medical data on the incidence and treatment of trauma, it is often necessary, as in this report, to describe issues of access and referral, either between and among institutions or as determined by individual patient behavior. When the trauma arises from civil conflict in a highly polarized and politicized environment, a characterization that applies to the Occupied Territories during the study period, a discussion of access and referral issues inescapably requires some reference to administrative constraints imposed in a political context and popular perceptions shaped by individual and group experience.

The report that follows describes the care received by a specified population of patients injured in a particular manner These injuries occurred as a consequence of the intifada and the Israeli response. The treatment took place in the setting of a health care system whose structure and operation are defined by the occupation. In contrast with debates about the quality and level of development of primary health services and public health in the Occupied Territories, where the argument is vigorous and fueled by the political stance of the participants, there is no substantial disagreement that, at the start of the intifada and continuing through the study period, health services in the Occupied Territories were not equipped to handle major trauma.

STUDY OBJECTIVES

The study was undertaken to assess the nature of injury caused by plastic bullets, to ascertain the incidence of these injuries in a specified study period, and to describe the treatment, outcome, and short-term follow-up in a consecutive series of such injuries seen and cared for in a small community hospital.

PLASTIC BULLETS

Plastic bullets are a combination of plastic and metal. They are 5.56-mm bullets that are 1.4 cm long, are shaped like the tip of a crayon, weigh 0.9 gram (g), and reportedly have a composition of 70% zinc, 20% glass, and 10% plastic [4–7]. They are fired from standard military Galil and M-16 weapons [6,8,9] IDF regulations regarding their use stipulate that they must be fired from a distance greater than 70 m but less than 110 m, that soldiers must first fire into the air and aim below the knees, and that soldiers must avoid shooting women and children under 16 years of age [5,6,8]

Ballistics parameters for the plastic bullets fired from M-16 rifles were computed on the basis of the measured mass of the missile (0.9 g) and the published muzzle velocity of 3,240 ft/s [10]. The calculated kinetic energy is 331 ft-lb. As can be seen in Table 1, this places the force of the plastic bullet between that of a .38 special and a .45 automatic handgun.

METHODS

Between September 1, 1988 and April 30, 1989, 617 consecutive plastic-bullet-injured patients were seen and treated at a 70-bed community hospital in the Gaza Strip All had been wounded in the streets of Gaza by the IDF. All were civilians Charts from all patients seen at Ahli Arab Hospital during this interval were reviewed by several members of the surgical team caring for the patients. The author was one of the three senior general surgeons responsible for the care of all of the surgical patients. Data were collected for all patients with gunshot wounds from plastic bullets During the time of this study, the use of high-velocity ammunition by the IDF was mark-

Table 1. Wound ballistics*

Caliber (in or mm)	Bullet (grains)	Velocity (ft/s)	Energy (ft-lb)
25	45	815	66
22 long rifle	36	1,080	93
32	60	970	125
38 special	148	710	166
M-16 plastic	14	3,240	331
45 automatic	200	917	373
9 mm	95	1,355	387
357 magnum	125	1,450	583
44 magnum	180	1,610	1,036
223 M-16 standard	55	3,240	1,282

* Adapted in part from [10]
1 grain = 0.0648 gram, 14 grains = 0.9072 gram; ft/s = feet per second; ft-lb = foot pounds

edly reduced, and injuries resulting from their use are not included in this series

RESULTS

Of the 617 patients seen in eight months, 603 were male. The average age was 18.1 years (SD, 5.2 years), with a range of 5 to 60 years; there were 338 patients less than 18 years old (54.8%). We treated 452 patients as inpatients and 136 as outpatients. All required a surgical procedure. In the case of an uncomplicated extremity wound, the standard practice was debridement of the inlet under general anesthesia, exploration of the track, removal of the missile if possible, and usually delayed primary closure of the wound three to five days later. Some simple, superficial wounds could be managed under local anesthesia.

Twenty-nine patients were transferred to another facility, either a government hospital in Gaza or an Israeli hospital, shortly after stabilization. We lacked neurosurgery, thoracic surgery, and, for part of the time, orthopedic surgery, so patients with injuries requiring these specialties were sent elsewhere. Of the transferred patients, five had severe head injuries, seven had upper extremity injuries with a fracture or hand involvement, six had unstable chest injuries, seven had lower extremity injuries with fracture, two had back injuries with neurological deficits, and two had abdominal injuries. All of these were from plastic bullets, and we hypothesize that, in order to produce this degree of severity, they may have been fired at close range, as can also be observed with civilian handgun injuries [10,10a]. The abdominal patients, who were very acute, unfortunately arrived on busy days, when both operating rooms were already in use and there was a sizable backlog of injured patients. Transfer was elected to avoid delay in treatment. No follow-up was available for any of these patients. The government hospitals did not communicate with us after transfer, and we did not attempt to learn the outcome of the transferred patients. An American television news crew told us that one of the chest wound victims died at an Israeli hospital.

There was only one death in this series, and that was a prehospitalization case of a 17-year-old boy with a gunshot to the left anterior chest immediately over the heart. He was dead on arrival in the emergency room, cold and unresponsive, with no pulse, respirations, or measurable blood pressure, and with fixed, dilated pupils. He remained refractory to all resuscitation attempts. We infer that he had been wounded at least an hour before arrival at the hospital.

A breakdown of the injuries by anatomic location can be seen in Table 2. Nearly 60% of the injuries were to the lower extremities. Of the 617 patients, 479 (77.6%) had inlet-only injuries and 104 (16.9%) had inlet-outlet injuries. In 34 (5.5%) patients, there was insufficient documentation in the chart to make a determination. The average length of stay for the inpatients was 3.82 days (SD, 2.65 days; n = 438). The bullet was successfully removed in 330 patients, which was 53.5% of the total and 68.9% of the 479 with inlet-only injuries. Several bullets were weighed, and the average mass was 0.9 g. Follow-up was spotty and short. Follow-up data were available for 205 patients (33%); the average length of follow-up for these patients was 16 days (SD, 20 days; range 2 to 140 days).

Of the 63 patients with abdominal wounds, 44 required exploratory laparotomies. All but one were male. The average age was 19.1 years. Table 3 shows the distribution of organs injured. The largest group included the gastrointestinal tract; the liver and spleen were also frequently involved. All of the injured spleens were removed. In 27% of the cases, no injury was found at laparotomy. There were 41 inlet-only injuries and no inlet-outlet wounds, and in three cases a determination could not be made. Patients received an average of 0.8 units of blood (range, 0 to 5 units). All of the patients received antibiotics, usually some combination of a first-

Table 2. Anatomic location of injuries

Region	Number of injuries	Percent of total
Head	14	2.2
Neck	2	0.3
Arm	74	11.7
Chest	46	7.2
Abdomen	63	9.9
Back	43	6.8
Genitalia	5	0.8
Leg	379	59.8
Unknown	8	1.3
Total number of injuries	634*	100.0

* Some of the 617 patients had multiple regions wounded

Table 3. Distribution of abdominal organ injuries

Organ	Number of patients injured
Stomach	5
Small bowel	13
Colon	11
Liver	5
Spleen	5
Pancreas	2
Mesentery	4
Kidney	2
Diaphragm	2
Bladder	1
No organ injured	12
Total	62 injuries in 44 patients

generation cephalosporin or penicillin plus an aminoglycoside for an average of five days. There were 21 patients (48%) with injuries to the gastrointestinal tract. All were repaired by debridement or resection with primary repair or anastomosis. The skin was closed primarily in 18 cases, and retention sutures were used in 14. The bullet was removed in 12 patients (27%). None had a diverting colostomy. There were no postoperative leaks, abscesses, or wound infections.

There were 15 patients with vascular injuries of the lower extremities in this series. The details of this group have been submitted for publication. The limb salvage rate was 100% using primary arterial repair or reconstruction with reversed saphenous vein grafts.

DISCUSSION

Data Quality

The results reported here describe a consecutive series of plastic bullet injuries seen and treated at Ahli Arab Hospital by the only surgical team caring for these patients during the study period. No other patients with plastic bullet injuries were seen and treated for this condition at this hospital during this period because there were no other providers on staff with surgical skills assigned to this role. Consequently, complete ascertainment of the defined denominator population was possible. Because the hospital was small and self-contained, the information systems (paper charts) were straightforward, and sufficient data were available on all patients to complete the study.

Similarly, because all follow-up evaluations were conducted by the same surgical team, information on postdischarge course and outcome was readily gathered. To the best of our knowledge, these patients received all of their follow-up care at the Ahli Hospital. Follow-up data were available for 205 patients (33%). We hypothesize that it is unlikely that the remainder of the patients sought follow-up care elsewhere. One external factor influencing patients to return for follow-up was the universally expressed concern that they would fall under closer political scrutiny if they visited the government hospitals or clinics.

Mortality

The very low mortality seen in this series most likely reflects prehospital selection. Patient transport systems were primitive and disorganized. (See Health Care Delivery System for fuller discussion.) Most patients with potentially fatal head, chest, or abdominal wounds probably died in the field before they could be brought to the hospital. In our series, patients who did arrive with serious head or chest wounds required transfer to another facility. Early on in the series, we were permitted to refer these patients directly to the nearest Israeli hospital in Ashkelon (a 30- to 40-minute drive by ambulance), but later the military authorities required that all such patients be transferred first to a government hospital inside Gaza (none of which was equipped to handle these patients either) for consideration of possible transfer to a facility in Israel. The implications of this type of delay on the outcome of patients with life-threatening injuries are obvious.

Wound Infection

The very low wound infection rate is more difficult to explain. Sterile technique and infection control measures inside the hospital were primitive at best. Although surgeons, nurses, and aides all used the standard surgical gown and glove technique, prepared the surgical area with povidone-iodine, and used surgical sheets that were reported to have been sterilized, it was unclear whether instruments or materials were adequately sterilized because the sterilizing equipment inside the operating room was ancient. Cats roamed freely through the wards, and

screens were largely absent, allowing flying insects continuous access. Nevertheless, a serious wound infection was extremely rare. We hypothesize that this young, basically healthy, resilient population possesses some form of herd immunity.

Casualty Load

This relatively large influx of casualties in a short period has an enormous impact on a small hospital such as Ahli. Historical data from 1983 to 1987, showing the average number of operations performed per month at this hospital during "ordinary" times, are presented in Figure 1. As can be seen, over this five-year interval, an average of 127 operations were performed per month (slightly over 1,500 per year). This level of activity was fairly stable and predictable, allowing for expected seasonal variation. Beginning in December 1987, the number steadily rose, especially after the introduction of plastic bullets in September 1988. During the eight-month interval of this study, the average number of cases per month nearly doubled to 252, as the direct consequence of operative management of gunshot injuries. Understandably, this led to supply shortages, excessive fatigue of the staff, a large backlog of elective cases, and often severe overcrowding, with bed-occupancy rates during heavy casualty periods of over 100%.

Nevertheless, all of the facilities in Gaza were similarly stressed during this period. Casualty data (according to internal documents of the United Nations Relief and Works Agency in the Gaza Strip seen by the authors in May 1989) for the entire Gaza Strip over this eight-month interval are presented in Table 4. As can be seen, over 11,000 Gazans were reported injured during this interval; 94% of them were refugees. There were 60 Palestinian fatalities in the Gaza Strip during this same period. The data as reported do not distinguish plastic bullets from high-velocity ammunition in assigning cause of death. Nearly a third of all the plastic bullet gunshot victims in the Gaza Strip were treated at Ahli Hospital.

Since the conclusion of the study, the volume of Palestinian casualties caused by the IDF continued at the approximate level observed here until late fall 1989, at which point new efforts were introduced by the IDF to minimize hostile encounters, and the volume of Palestinian casualties caused by the IDF diminished considerably [11].

Health Care Delivery System

Ahli ("community") Arab Hospital is the only private hospital in Gaza, the remainder being under the control of the Israeli Civil Administration for the Occupied Territories. The hospital is staffed predominantly by Palestinians, although there are a handful of foreigners as well. It represents only one small hospital in the Gaza health delivery system, consisting of just 70 beds, vs. the 861 beds in the government hospitals. These hospitals, government and private, serve a population of 650,000, two-thirds of whom are refugees.

Ahli Hospital is currently under the administration of the Anglican Church. Its buildings were

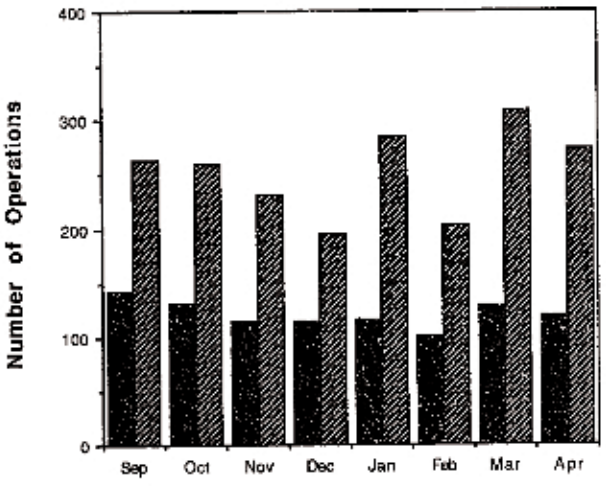

FIGURE 1. Number of operations performed per month at Ahli Hospital. The solid bars represent the average total per month for the five years preceding the intifada. The striped bars represent the number of operations performed per month during the period of this study.

Table 4. Gaza Strip casualties from September 1, 1988 to April 30, 1989*

Type of injury	Number injured
Gunshot (plastic bullets)	1,955
Beating	6,424
Rubber bullets	497
Plastic-covered metal bullets	616
Tear gas	1,553
Total	11,045

* Based on documents of the United Nations Relief and Works Agency in the Gaza Strip

constructed at the end of World War I. It has old-fashioned, open wards (Fig 2), a small, low-technology emergency room (Fig 3), and two small operating rooms (Fig 4). It had no intensive care unit at the time of this series, no ventilator outside of the operating room, no radiologist, no pathologist, and minimal laboratory support. Aside from the capacity for intensive care monitoring provided by the operating room, there was no monitoring available elsewhere in the hospital, including the recovery area, and patients had to be transported outdoors in transit to and from the emergency room, the operating room, the wards, and the radiology area. Despite all this, it is preferred by the local population to the government hospitals because it is perceived as being "better" and "safer." There are very few ambulances in Gaza, no radio network, and a poor communications infrastructure. Most people do not have a telephone or an automobile. Consequently, most of the injured arrived at the hospital on foot, on the back of a donkey cart, in the backseat of a taxi or private car, and rarely by ambulance. Government ambulances were not permitted to come to Ahli, the only nongovernment hospital in the area.

There were eight general surgeons on staff at the time of this study: three senior staff members, two of whom were American and the other Palestinian, two senior resident level surgeons, both Palestinian, and three junior resident level Palestinian surgeons. There were three internists, one of whom was American, and, for part of the time, one orthopedic surgeon from the United Kingdom and one anesthesiologist from Scandinavia. One of the junior residents was on duty at the hospital 24 hours a day and was the first to see casualties in the emergency room. At least one senior resident and senior staff surgeon were always on call. Anesthesia was administered by one of four nurse-anesthetists.

Rounds began each day at 7 A.M. There were two surgical teams alternating call and operating days. The elective operating room schedule began between 7:30 and 8 A.M. and was usually completed by 2 P.M. The other team would spend the morning in clinic seeing referrals, walk-ins, and postoperative patients. Gunshot victims usually began arriving in the afternoon and early evening. The on-call team had the primary responsibility for these patients, and the senior staff rotated call every third night. Depending on the number and severity of the cas-

FIGURE 2. A men's ward at Ahli Arab Hospital. It is a typical, old-fashioned, open ward with few amenities and little privacy. Note the political gesture of the patient in the center bed.

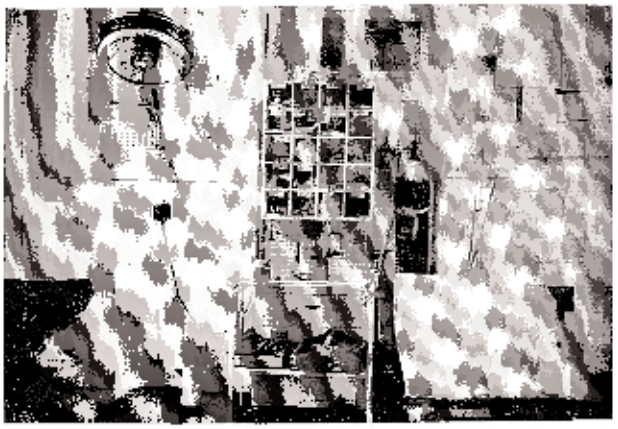

FIGURE 3. The emergency room has space for two stretchers and limited supplies.

FIGURE 4. This is one of two operating rooms in the hospital. Each is equipped with an operating table, an anesthesia machine, and an overhead operating light.

ualties, work in the operating room was usually completed by 9 P M ; late-night cases were very rare.

Power outages were frequent at the hospital, nearly a daily occurrence. The backup generator had to be started manually and was old and worn to the point where it could only run for three to four hours continuously at a time. The entire hospital was frequently without electricity for several hours at a time, but the staff invented ways to manage without it. Shortages of disposable and consumable supplies, particularly suture material, were common, and, by law, the hospitals were permitted to purchase these items, as well as pharmaceuticals, only from Israeli vendors. This regulation contributed to the perception among those in the nongovernmental sector that the prices were not competitive and the supply problems not always unpreventable.

Case Reports

Two case reports from our series of 617 patients illustrate the physical setting and perceptions that help create the current context in which trauma care is taking place.

Case 1. A 22-year-old male was brought into the emergency room in profound shock after dark by private car. The entire Gaza Strip was under curfew imposed by the authorities; no one was allowed to step outside of his or her residence. Electricity to all communities, including the hospital, had been cut off. The patient had an inlet gunshot wound to the left mid-abdomen; he was volume resuscitated in the emergency room and taken to the operating room within 30 minutes of arrival. Upon exploration of his abdomen via a generous midline incision, we found over a liter of blood in the peritoneal cavity plus gastrointestinal contents, a severe injury to the spleen that was bleeding profusely, a hole in the tail of the pancreas with lacerations of the splenic artery and vein, a tear of a branch of the left renal vein, and two holes in the stomach. After controlling the bleeding and further volume resuscitation, the bleeding vessels were ligated, the spleen removed, a distal pancreatectomy performed, and the gastric holes repaired primarily in two layers. The patient received five units of whole blood. His abdomen was closed with retention sutures, and the skin was left open. He was treated with a first-generation cephalosporin intravenously and metronidazole per rectum for seven days; he was discharged from the hospital on the 12th postoperative day, following an uneventful postoperative course. He was seen multiple times in the clinic for follow-up, including three months later, and was doing well with no residual impairment.

During his convalescence, at a time when he said he could dare to begin to trust his expatriate caregivers, he reported what he perceived to be the circumstances of his injury. He said that on the night he was shot he had just been released from prison (he did not volunteer the reasons for his imprisonment) and sent out on the streets after dark, during curfew. He stated that he had been shot while walking home.

Case 2. A 16-year-old male resident of a refugee camp was brought to the emergency room in a United Nations ambulance with a gunshot wound to his left thigh. There was an anterior inlet with no outlet wound, with minimal blood loss, and he was neurovascularly completely intact distally. We recognized him immediately because, less than two months previously, he had been brought in with a similar wound to the right leg. In each case, he was taken to the operating room, and under general anesthesia the inlet was debrided, the tract explored, and the bullet removed. Each time he was hospitalized for two days, and he healed without incident and recovered fully.

During his second hospitalization, he was asked with some asperity by a member of the surgical team who had cared for him the first time why he had subjected himself to the risk of injury again by participating in demonstrations in the street of the refugee camp. He stated that the situation had become so bad that he "had nothing to lose."

CONCLUSION

These data support our clinical impression that the severity of wounds and amount of tissue damage with plastic bullets are comparable to those of civilian handgun wounds. The results also support the conclusion that, from a medical and surgical standpoint, in healthy children and adults, 1) lower extremity vascular injuries can be managed by well-trained general surgeons without angiography or synthetic vascular grafts; 2) low-velocity penetrating injuries to the stomach, small bowel, and colon, in which there is minimal soiling and which are treated promptly, can be managed by primary repair without diverting enterostomy; and 3) low-velocity gun-

shot wounds similar to civilian injuries can be treated successfully in a community hospital in an underdeveloped region without advanced technical equipment or facilities.

Although the results of this study demonstrate good outcome from the injuries, the casualties of the intifada have served to highlight deficiencies in the basic health care system in Gaza and have also added new requirements. In a trauma setting, frequent shortages of material and supplies, insufficient ambulance transport, and the absence of technically trained specialists can prove particularly stressful to those providing care and can lead to added morbidity and mortality.

The data presented here cannot yield conclusive information on the survival or recovery of those patients who were transferred to other sites for further care. Nor, on the basis of this Ahli Hospital series of patients with plastic bullet injuries, can we document increased morbidity and mortality arising from these resource deficiencies. It is our assessment, however, that the increased volume and complexity of the clinical load were met by a compensatory increase in the hours and intensity of work provided by the physician, nursing, support, and administrative staff of the Ahli Hospital. Such compensatory increases cannot be sustained indefinitely in any setting without incurring costs on the margin. In this setting, we would predict the costs to be reflected in an increased percentage of cases with poor outcome.

We suggest that improved trauma care in Gaza be focused on 1) developing continuous, reliable supplies of disposable and consumable materials, 2) expanding the ambulance and telecommunications services, and 3) improving education, particularly postgraduate, for physicians, nurses, and other medical personnel. It seems unlikely, however, that any enduring solutions to these problems will be forthcoming until the central issue of military occupation is resolved and the burden of trauma reduced. ❧

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