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# Civilian abdominal gunshot wounds in Durban, South Africa: a prospective study of 78 cases

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ABSTRACT

INTRODUCTION Violence has become part and parcel of the daily routine of living in South Africa. This prospective study of 78 patients who sustained abdominal gunshot wounds was undertaken to evaluate the pattern of injuries, treatment outcome and the role of selective conservative management.

PATIENTS AND METHODS All patients with abdominal gunshot wounds admitted into the accident and emergency department of Prince Mshyeni Memorial Hospital (PMMH) between January 2005 and June 2005 were included in this prospective study. Case notes were reviewed and data entered on a standard proforma by a single observer (IC).

RESULTS A total of 78 patients who sustained abdominal gunshot wounds were included in the study. There were 68 males and 10 females with an age range of 16–60 years (median age, 25 years). Of these, 59 (76%) underwent emergency laparotomy and 19 (24%) were initially observed. Two patients in the observed group needed a delayed laparotomy, both with positive findings. Fifty-five (71%) patients had one entrance wound each and 23 (29%) had multiple entrance wounds. Forty-one (53%) patients had exit wounds and in 37 (47%) the bullet remained lodged in the body. The entrance wounds were in anterior abdominal wall in 50 patients, posterior trunk in 13, gluteal region in 11 and thorax in 4 patients, respectively. Twelve patients died, all from the emergency laparotomy group. There were two negative laparotomies from the laparotomy group.

CONCLUSIONS Management of gunshot wounds is expensive and requires a variety of surgical skills. We recommend that a national database to which all gunshot wounds must be reported is required in order to assess the magnitude of the problem nationally as well as funding of research in injury control. This study along with many others shows that selective conservative management is feasible without the use of expensive investigations.

KEYWORDS

Abdominal gunshot wounds – Selective conservative management

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South Africa embraces a diverse collection of races and cultures and it has become apparent that the country is battling with what has been described as 'a malignant trauma epidemic'.[1] In the 1980s, penetrating trauma in South Africa was predominantly stab wounds and the late 1980s saw an escalation of politically motivated crimes as youth militia from opposing political groups began fighting for township domination. The use of guns became dominant, as AK47s had an impact on the death toll. With the termination of neighbouring liberation movements (*e.g.* Mozambique, Angola), the availability of guns in the townships escalated fast. Following the first democratic election in South Africa in 1994, there has been no more politically motivated violence, but trauma caused by crime is overwhelming. There is an estimated 8 million legal and illegal weapons in circulation in South Africa. Hand-gun violence has become a public health priority and needs to be addressed as such. The availability of firearms is directly related to the assault, homicide and suicide rates.[2]

Mandatory laparotomy, irrespective of abdominal signs, was the treatment of choice before the proposal of selective conservatism by Shaftan in 1960.[3] The policy of selective conservatism in gunshot wound injury has now been accepted and adopted in the management of such patients. This approach, based on clinical examination, has undergone repeated re-appraisal and has been shown to be a safe and reliable form of patient management.[4] About 70–80% of patients with abdominal gunshot wounds present with signs

of acute abdomen necessitating emergency laparotomy. The remaining 20–30% of patients can be safely managed by selective conservatism thereby reducing unnecessary and negative laparotomy. The purpose of this prospective study was to evaluate the pattern of injuries, treatment outcome and the role of selective conservative management in patients with abdominal gunshot wounds.

## Patients and Methods

During the 6-month period January 2005 to June 2005, 78 patients with abdominal gunshot wound were admitted to PMMH, Durban. There were 68 males and 10 females with an age range of 16–60 years (median age, 25 years); overall, 55% were aged of 20–30 years. The surface anatomical definition of the abdomen was from the nipple line to the pubis anteriorly and from a line joining the inferior angles of the scapulae to the lower buttock crease posteriorly.[5] Patients with entrance wounds outside these surface landmarks and clinical features of abdominal injury or radiological evidence of missiles in the abdomen were also included in the study. The posterior trunk or back was defined as the area between the inferior angles of the scapulae, the iliac crest and both mid-axillary lines.[6] The patient data were recorded on proforma sheets by a single observer. Patients' characteristics, events during assault, symptoms, signs, entry and exit wounds, operative findings, postoperative complications, number of days in intensive care unit (ICU) or general wards were noted. Pre-operative investigations, such as chest and abdominal radiography and urinalysis, were performed only on haemodynamically stable patients. Shock, generalised peritonitis, leakage of intestinal contents through the wound, haematemesis, proctorrhagia and frank haematuria with an infra-umbilical entrance wound indicating bladder trauma were all indications for abdominal exploration. Through-and-through gunshot wounds of the abdomen were not absolute indications for surgery. Patients with tenderness confined to the wound or wound track and without evidence of cardiovascular instability underwent serial examinations and assessment at 2-hourly intervals.

Radiological indications for operative intervention were the presence of free intraperitoneal gas and radio-opaque missiles within the peritoneal cavity associated with supradiaphragmatic entrance wounds, the latter indicating diaphragmatic injury. The presence of missiles within the peritoneal cavity associated with an infradiaphragmatic entrance wound and an absence of physical signs was an indication for observation. In these patients, an intravenous line was established, Foley's catheter, nasogastric tube was inserted. Radiographs of the chest (erect, anteroposterior views) and abdomen (supine, erect, lateral views) were obtained together with a urinalysis. The likely path of the bullet or pellets and peritoneal penetration were assessed using a combination of physical examination and radiographs of the chest and abdomen. Shock was defined as systolic blood pressure of less than 100 mmHg and pulse rate > 100 per min. A positive laparotomy was defined as one in which repair or drainage of a damaged viscus was required to prevent complications. A laparotomy was considered negative if there was no peritoneal penetration, penetration without visceral injury, or visceral injury not requiring repair or drainage. A third-generation cephalosporin was started during induction and continued for 24 h postoperatively. Antibiotic prophylaxis was continued for 48 h if there was colonic involvement. No antibiotic prophylaxis was given to the patients managed conservatively.

## Results

Seventy-eight patients who sustained abdominal gunshot wounds were included in the study; of these, 59 (76%) underwent emergency laparotomy and 19 (24%) were initially observed (Table 1). Two patients in the observed group needed a delayed laparotomy for peritonitis and pyrexia. Only 36 (46%) of patients could identify the type of assault weapon used. The wounding weapon was the pistol in 15, shotgun in 12, rifle in 6, machine gun in 3 and unknown in 42 patients, respectively. Only 35 (45%) of patients had a reliable recollection of time of events. The time between injury and arrival in hospital ($n$ = 35) ranged from 35–480 min with a median of 180 min. Car hijacking and home robberies were the commonest reasons behind the events. One 16-year-old patient was accidentally shot by his uncle apparently playing and ended up paraplegic.

**Table 1 Clinical findings in 78 patients with abdominal gunshot wounds**

| | Positive laparotomy group ($n$ = 61) | Observed group ($n$ = 17) |
|---|---|---|
| Peritoneal penetration | 59 | 8 |
| No peritoneal penetration | 0 | 11 |
| Entrance wound only | 25 | 12 |
| Entrance and exit wounds | 34 | 7 |
| Multiple wounds | 23 | 0 |
| Indications for laparotomy | | |
| Clinical | 61 | – |
| Radiological | 1 | – |
| Mortality | 12 | 0 |

Other circumstances of injury included civil strife, stray bullets, struggle for gun possession, and armed robberies; assailants could not be categorised in the rest. Fifty-five patients (71%) had one entrance wound each, while 23 (29%) had multiple entrance wounds. Maximum number of entrance wounds in the study group was six. Forty-one (53%) patients had exit wounds; in 37 (47%), the bullet remained lodged in the body. The entrance wounds were in anterior abdominal wall in 50 (64%) patients, posterior trunk in 13 (17%), gluteal region in 11 (14%) and thorax in 4 (5%) patients, respectively. Table 2 shows the clinical features of abdominal gunshot wounds. Paresis of one lower limb, usually ipsilateral to the entrance or exit wounds in posterior trunk occurred in two patients. Evisceration was found in five patients (6%), bowel in two and omentum in three. Four of the patients required intercostal drain for haemoperitoneum and one of them complicated into an empyema. The total number of deaths was 12, all from the emergency laparotomy group. There were no negative laparotomies in this series.

### Laparotomy group (*n* = 59)

Immediate laparotomy was undertaken in 59 (76%) patients with signs of an acute abdomen. The organs injured are listed in Table 2. There were a total of 115 organ-system injuries, the majority being in the small bowel (59%), colon (37%), liver (25%) and stomach (22%). Injuries to the small bowel were perforations and tangential lacerations, with the number of perforations ranging from 2 to 9. Of the small bowel injuries, 26% required resection and 74% simple closure. Colon injuries were treated by debridement with simple closure of perforations in 20 patients, resection of the segment containing perforations followed by anastomosis in two patients. None of the colonic injuries required simple closure of perforations with proximal colostomy, exteriorisation of injured colon as colostomy or resection of injured segment followed by exteriorisation as colostomy. Five of the 22 patients with colon injuries died in the postoperative period of systemic sepsis, intra-abdominal abscesses, faecal fistula and one aspirated at extubation. One of the colonic injury patients who died had an associated inferior vena cava injury. Fifteen (25%) patients sustained hepatic injuries. Of these, 9 were superficial or deep lacerations, three were through-and-through penetration, one was complex with associated hepatic veins and inferior vena cava injury. Two lacerations were not bleeding at the time of laparotomy. Hepatic injuries were managed by a combination of drainage, packing and application of surgical haemostats. Five of the patients with hepatic injuries died; of these, two had complications of colonic injury. A recent study has shown that ERCP, biliary sphincterectomy and internal stenting together with percutaneous drainage of intra-abdominal or intrahepatic bile collections, represent a safe and effective strategy for the management of bile leaks following both blunt and penetrating hepatic trauma.[7] Six patients underwent splenectomy, two because of iatrogenic injuries. Simple lacerations of stomach, bladder and diaphragm were managed by simple suture repair. One patient had cholecystectomy for perforated gallbladder. Five patients had extraperitoneal rectal injuries which were all managed by proximal colostomies. All three patients with inferior vena cava injuries died immediately postoperatively. The clinical signs and symptoms of patients with abdominal gun shot wounds are shown in Table 3.

**Table 2** Type of organ injured (*n* = 61)

| Organ | *n* | % |
|---|---|---|
| Small bowel | 35 | 57 |
| Colon | 22 | 36 |
| Liver | 15 | 25 |
| Stomach | 13 | 21 |
| Bladder | 4 | 7 |
| Diaphragm | 6 | 10 |
| Spleen | 4 | 7 |
| Kidney | 4 | 7 |
| Gallbladder | 1 | 2 |
| Rectum | 5 | 8 |
| Major vessel | 3 | 5 |
| Pancreas | 3 | 5 |

The vast majority of patients suffered two or more organ injuries and the mortality rate was proportional to the number of organs injured. Twelve patients in the immediate laparotomy group died – three from inferior vena cava injuries, two associated liver injuries, six from associated colonic perforations and one patient had a colonic injury but aspirated on extubation and died from ARDS. Two patients underwent nephrectomy for shattered kidneys. Of the laparotomy group, two patients had a negative laparotomy. The hospital stay of survivors ranged from 5–120 days (median, 13 days) in the positive laparotomy group and from 4–8 days (median, 6 days) in the negative laparotomy group. One patient underwent ureteric re-implantation for ureteric injury. Twenty-three patients required ICU stay ranging from 2–10 days (median, 6 days). Postoperative complications included wound infection (10%), septicaemia (8%), pneumonia (6%), intra-abdominal abscess, burst abdomen, disseminated intravascular coagulation and anastomotic breakdown. Nine patients needed a relaparotomy (5 unplanned and 4 planned), four for removal of peri-

**Table 3 Clinical features of abdominal gunshot wounds (*n* = 78)**

| Symptoms | *n* | % | Signs | n | % |
|---|---|---|---|---|---|
| Abdominal pain | 78 | 100 | Peritonitis | 59 | 76 |
| Abdominal distension | 18 | 23 | Shock | 15 | 19 |
| Vomiting | 21 | 27 | Paresis | 2 | 3 |
| Haematemesis | 5 | 6 | Evisceration | 5 | 6 |
| Exit wound bleeding | 25 | 32 | Haemothorax | 4 | 5 |
| Haematuria | 6 | 8 | Fractures | 7 | 9 |
| Nausea | 30 | 38 | Paraplegia | 3 | 4 |
| Urinary retention | 3 | 4 | | | |
| Rectal bleeding | 5 | 6 | | | |

hepatic packs, two for intra-abdominal abscesses, one for missed colonic injury and two for abdominal compartment syndrome and insertion of Bogota bags.

### Initially observed group (*n* = 19)

Nineteen (24%) patients had minimal or equivocal abdominal signs and were selected for observation. Again, the wounding weapons were not clearly documented. Twelve patients sustained entry wounds only, four patients had both entry and exit wounds, and three had tangential wounds of the anterior abdominal wall. Using a combination of anatomical assessment of the likely path of the bullet in through-and-through wounds and radiological assessment of those with entrance wounds only, penetration of the peritoneal cavity was either strongly suspected or confirmed in six patients. Penetration was thought to be unlikely in the remaining 13 patients. One posterior trunk entrance wound was associated with paraplegia in a 16-year-old boy, apparently shot by his uncle while 'playing'.

On hospital admission, all these patients were haemodynamically stable and the patients had soft abdomen with mild tenderness around entrance, exit and tangential wounds. Two patients in the observed group developed signs of peritonitis and both had a positive laparotomy. One had a suprapubic entry wound with the bullet lodged in the peritoneal cavity as confirmed on lateral radiographs. Intraoperatively, he had two small bowel perforations which were primarily repaired. The other patient also sustained small bowel perforations with minimal peritoneal contamination. No immediate complications were incurred from failure to debride the wound track or from retained missiles, although long-term follow-up is poor in this setting. Hospital stay ranged from 1– 120 days (median, 2 days), prolonged admission being required for spinal injuries. There was no mortality in this group and no patients needed re-admission.

## Discussion

Violence has become part and parcel of the daily routine of living in South Africa and yet, even in 2005, it is extremely difficult to obtain the true magnitude of the problem. Official Government statistics for the 12-month period 2002–2003 listed the homicide rate at 47 deaths per 100,000 population. However, in the past, Government statistics have been severely criticised by medical researchers for being inaccurate.[8] The one source that does reflect the extent of violence is the National Injury Mortality Surveillance System (NIMSS) data, which produces information on non-natural deaths from 37 mortuaries in six provinces. The fifth annual report of NIMSS for 2003 lists Cape Town as having the highest homicide rate (66 deaths per 100,000 population), followed by Durban (61 deaths per 100,000), Johannesburg (52 deaths per 100,000) and finally Pretoria/Tshwane (24 deaths per 100,000). Of major concern is the extremely high murder rate and the fact that in all these cities, approximately 50% of homicides are committed with firearms. Today, injuries are the most serious health problem facing this country, whether measured in Rand costs, physician contacts, premature deaths, or lost productive years of life.

Trauma and interpersonal violence are escalating in many countries, a situation referred to recently as the neglected epidemic.[9] In South Africa, the problem is widespread throughout all ethnic groups and is increasing exponentially.[10] The availability of firearms is directly related to the assault, homicide, and suicide rates and the minimal laws governing the possession of firearms in this country is the prime reason for the increasing problem. In contrast to other continents where the average delay from injury to hospital admission is in the region of 30 min,[11] patients in this country suffer a prolonged delay before medical care is reached, thus providing a study of a unique population

group. The prolonged delay before medical care is reached may have affected the proportion of severe injuries presenting to trauma centres as critically injured patients possibly died during transit. It could also be detrimental in patients with non-fatal injuries as blood loss and faecal contamination of the peritoneal cavity becomes prolonged. This may partly explain why systemic sepsis was a common cause of death in our patients with colon injuries. However, a previous study in this country showed that delay in operative intervention in patients without critical injury, whether due to delayed presentation to hospital or following a period of observation in hospital, is not detrimental.[5]

In this series, 76% of patients presented with indications for emergency laparotomy. Other series have reported similar figures ranging from 69%[9] to 78%.[12] From these figures, it becomes obvious that between 20–30% of patients with abdominal gunshot wounds may be managed without operation. The most commonly injured organs were the small bowel, colon, liver and stomach. The frequency of penetrating injury to intra-abdominal organs is directly related to size, location and the protection offered by the pelvis and spine to these organs.[15] The vast majority of patients will require surgery on the basis of physical examination done within 5 h of injury and absence of physical signs outside this time excludes significant injury. A delay in operative intervention because of equivocal physical findings is not detrimental and surgery may be safely postponed until signs of injury are evident. Intra-abdominal injury without penetration of the peritoneal cavity by the bullet has been documented previously even in the context of low-velocity injuries,[14] but this was not encountered in this series and may be relevant only if the weapon has been fired at close range or with high velocity missiles.

The policy of selective conservative management has been re-appraised by many authors, initially in the context of abdominal stab wounds, then in low-velocity gunshot wounds of the abdomen.[15] The proponents of mandatory exploration often underestimate the importance of a negative laparotomy. Although some authors have reported minimal morbidity and mortality, most have reported significant morbidity and even mortality.[16] Late complications such as adhesive small bowel obstruction and incisional hernias should be borne in mind. Furthermore, medical expenses and lost working days should be taken into account. Diagnostic peritoneal lavage and triple-contrast computed tomography (CT) expected to aid patient selection have been found to be unreliable, expensive and time consuming.[17] CT is useful in patients with blunt abdominal trauma but is of more limited value in patients with penetrating injuries. The major inconvenience is its low sensitivity for the detection of hollow viscus injury, the most common injury among patients with penetrating trauma. In the evaluation of patients with flank and back wounds, CT scanning with triple contrast has an accuracy rate of 97–100%, so the role of CT in penetrating trauma is the evaluation of patients with suspected retroperitoneal injuries. The present study describes selective conservatism, based exclusively on physical examination and has shown that this is possible without use of expensive investigations. A policy of selective conservatism based on careful initial and subsequent serial clinical examinations is advocated. Nineteen patients in the present series were managed by a policy of selective conservatism and only two required a delayed laparotomy for peritonitis and pyrexia. Stretching the policy of selective conservative management to include patients with hepatic injuries who required blood transfusion[18] may be very demanding. The distribution of entrance wounds only and through-and-through wounds, showed no marked difference between the laparotomy and observed groups. However, all patients with multiple wounds, whether entrance only or through-and-through, were found to have significant intra-abdominal injury.

Abdominal radiographs, especially the lateral view, were helpful in assessing peritoneal penetration. Abdominal radiographs should be limited to those patients in whom peritoneal or diaphragmatic penetration is uncertain. In the former, should the bullet be within the peritoneal cavity, close observation is indicated. An estimation of the bullet trajectory has been used in an attempt to predict peritoneal penetration in the stable patient. It is essential in such a situation to make use of bullet markers to show the entry/exit wounds. However, low velocity bullets have an unpredictable trajectory, often following paths of least resistance, *e.g.* fascial planes.

## Conclusions

This study, along with many others, clearly show that the vast majority of patients with significant injury present with obvious clinical signs and that further investigation is superfluous. Furthermore, it demonstrates that a policy of selective conservative management is justifiable and safe for those patients without signs of intra-abdominal injury, and delay in intervention until such signs appear does not seem to increase morbidity or mortality. In South Africa, hand-gun violence has become a public health priority and needs to be addressed as such. A national database to which all gunshot wounds must be reported is urgently required in order to assess the magnitude of the problem nationally as well as funding of research in injury control. If adopted, it could provide the long-awaited resources to intervene in this vicious cycle of ignorance and neglect.

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