INTRODUCTION

Trauma is the most paramount public health risks in conflicts and wartime. Every minute, more than nine people incur trauma-related death globally representing about 15,000 daily lives loss. Violence accounts for about 4400 trauma-related deaths every day with warfare and communal conflicts representing about a fifth of all violent deaths. Worldwide, the most prevalent form of conflicts has shifted from external or interstate wars that dominated in the past into local and regional or internal conflicts manifesting mainly in the mode of terrorism, guerrilla warfare, counter-insurgency operations, and civil uprisings. Currently, internal conflicts result in three folds deaths over external wars. About 90% of all violent

ABSTRACT

Background: Abdominal injuries contribute significantly to battlefield trauma morbidity and mortality. This study sought to determine the incidence, demographics, clinical features, spectrum, severity, management, and outcome of abdominal trauma during a civilian conflict. Materials and Methods: A prospective analysis of patients treated for abdominal trauma during the Jos civil crises between December 2010 and May 2012 at the Jos University Teaching Hospital. Results: A total of 109 victims of communal conflicts with abdominal injuries were managed during the study period with 89 (81.7%) males and 20 (18.3%) females representing about 12.2% of the total 897 combat related injuries. The peak age incidence was between 21 and 40 years (range: 3–71 years). The most frequently injured intra-abdominal organs were the small intestine 69 (63.3%), colon 48 (44%), and liver 41 (37.6%). Forty-four (40.4%) patients had extra-abdominal injuries involving the chest in 17 (15.6%), musculoskeletal 12 (11%), and the head in 9 (8.3%). The most prevalent weapon injuries were gunshot 76 (69.7%), explosives 12 (11%), stab injuries 11 (10.1%), and blunt abdominal trauma 10 (9.2%). The injury severity score varied from 8 to 52 (mean: 20.8) with a fatality rate of 11 (10.1%) and morbidity rate of 29 (26.6%). Presence of irreversible shock, 3 or more injured intra-abdominal organs, severe head injuries, and delayed presentation were the main factors associated with mortality. Conclusion: Abdominal trauma is major life-threatening injuries during conflicts. Substantial mortality occurred with loss of nearly one in every 10 hospitalized victims despite aggressive emergency room resuscitation. The resources expenditure, propensity for death and expediency of timing reinforce the need for early access to the wounded in a concerted trauma care systems.

Key Words: Abdominal trauma, conflicts, Jos, mortality, Nigeria, war

INTRODUCTION

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deaths occur in the resources poor, low, and middle income countries where diseases and tribalism are rife with uncontrollable crime, overpopulation, refugee migration, and empowerment of private armies.\cite{1,7} War-related death rate is highest in sub Saharan Africa at about 52.9/100,000 population yielding the highest mortality within the productive age between 15 and 29 years among males.\cite{1,7}

Abdominal war wounds constitute one of the most serious forms of combat injuries with severe negative impact on survival.\cite{8,9} Despite the scientific advances made after the first and second World Wars including modern deployment of body protective mechanisms, the incidence of abdominal wounds has been on the rise.\cite{10,11} Whether blunt or penetrating, abdominal trauma generates intricate and diverse wounds with formidable threats to life.\cite{12} These injuries pose major therapeutic challenges with potential for complications that often surpass that of other regions.\cite{10,13}

Knowledge gained through a comprehensive appraisal of the magnitude, trends, and distribution of etiologic factors of war injuries constitutes the first step of a scientific approach to decreasing the burden of injuries and improving casualties’ survival.\cite{13} Plateau State in North-Central Nigeria, particularly Jos, the State Capital, has been engulfed by a protracted civil strife dating back to September 2001.\cite{14,15} Within the 15 months under review, the city witnessed escalating outbursts of the lingering and unresolved crises that resulted into 3 major mass casualty events with sporadic attacks in-between. The aim of this prospective study was to determine the incidence, demographics, clinical features, spectrum, severity, management, and outcome of care of abdominal trauma from the Jos communal crises during the period under review.

MATERIALS AND METHODS

This prospective analysis of 109 patients treated between December 2010 and May 2012 for abdominal trauma during the Jos civil crises was conducted at the Jos University Teaching Hospital, Jos, which serves as the major trauma referral Centre in North-Central, Nigeria. Patients were evaluated on arrival at the accident and Emergency Department of the hospital where resuscitation with intravenous fluids or blood was carried out and anti-tetanus serum, tetanus toxoid and antibiotics were administered. Clinical evaluation was complemented with focused assessment sonogram for trauma. Patients with hemodynamic instability, eviscerated intra-abdominal viscera, features of peritonitis, or subsequent deterioration in clinical parameters during observation were subjected to laparotomy. At laparotomy, access was via midline incisions under general anesthesia with endotracheal intubation and muscle relaxant. The laparotomy wound was subsequently closed en masse after copious isotonic saline lavage of the peritoneal cavity. The missile tracts within the abdominal wall were debrided, irrigated with normal saline and left open for secondary closure. Patients were admitted to the Intensive Care Unit (ICU), a high dependency unit (HDU) or the general surgical wards subsequently. The demographics of the patients, organ injuries, the interval between wounding and hospital presentation, mechanisms of injury, injury severity score (ISS), treatment and the outcome of the injury were collated with a questionnaire and the data were analyzed using Epi Info 3.5.4 statistical software (Centers for disease control and prevention, Atlanta Georgia (USA)).

RESULTS

During the study period, 109 consecutive patients with abdominal injuries sustained during communal crises were managed representing about 12.2% of the total 897 combat-related injuries. Males 89 (81.7%) were predominantly affected with peak incidence between 21 and 40 years (range: 3–71) \cite Table 1. Blunt trauma occurred in 10 (9.2%) patients and the rest were penetrating gunshot 76 (69.7%), blasts from explosives in 12 (11%) and stab injuries in 11 (10.1%). About 82.6% of the patients were evacuated directly from the site of incidence or conflict to our trauma center and presented during mass casualty events. The interval between injury and arrival ranged from 2 h to 3 days, with 31 (28.4%) patients arriving the hospital within 6 h, 63 (57.8%) between 6 and 12 h, and 15 (13.8%) beyond 12 h.

The indications for laparotomy were the presence of eviscerated bowels in 34 (31.2%), hemodynamic instability in 46 (42.2%), and septic peritonitis in 29 (26.6%) patients who presented late. Small intestine 69 (63.3%), colon 48 (44%), and liver 41 (37.6%) were the most commonly injured organs seen at laparotomy as depicted in Table 2. Majority 70 (64.2%) of the patients presented with multiple intra-abdominal organs injuries as shown in Table 3. Chest injuries were diagnosed in 17 (15.6%), musculoskeletal and spine injuries in 12 (11%), head injuries in 9 (8.3%), and major burns in 3 (2.8%) patients giving rise to 44 (40.4%) patients with extra-abdominal injuries. About 27 (24.8%) patients presented with shock while major vascular injuries were seen in 5 (4.6%) patients. The ISS varied from 8 to 52 (mean: 20.8) with a score <16 (mild injury) in 37 (33.9%), 16–25 (severe injury) in 47 (43.1%), and >25 (critically injured) in 25 (22.9%).

| Table 1: Characteristics of the study population |
|-----------------------------------------------|
| **Patients’ characteristics**                  |
| **Frequency (%)**                              |
| Mean age 27.6 years                            |
| Range 3-71                                     |
| Peak incidence (years)                         |
| 21-40                                         |
| Male:female (89/20)                            |
| 1.4:4.5:1                                     |
| Children ≤18 years                             |
| 19 (17.4)                                     |
| Elderly ≥60 years                              |
| 5 (4.6)                                       |
| Occupation                                     |
| Students 43 (39.4)                             |
| Farmers/cattle herdsmen 21 (19.3)              |
| Artisans 15 (13.8)                             |
| Civil servants 10 (9.2)                       |
| Security personnel 7 (6.4)                    |
| Others 13 (11.9)                               |
The management of the injuries is presented in Table 4. In 20 patients with colonic trauma and three patients with intraperitoneal rectal trauma, the injuries were repaired primarily. Two other patients with extraperitoneal rectal trauma and 25 patients with high-risk colonic injuries (significant peritoneal soilage, ongoing hemorrhage/shock, and multiple organs injuries) had colostomy. No significant statistical difference in complication rate was noted between those managed by primary repair or stoma creation ($P = 0.7031$). All three gallbladder injuries seen were managed with cholecystectomy. Liver injuries were salvaged with nonresectional treatment in 34 patients while the remaining seven patients had major hepatic resectional debridement or segmentectomy. One patient with concomitant urethral injury had suprapubic urinary diversion. Thoracotomy was indicated in two patients with chest trauma, and other extra-abdominal injuries were managed as outlined in Table 4.

The duration of operating time for abdominal procedures ranged from 65 to 365 min (mean: 173.3 min). Overall, a total of 74 patients required blood transfusion with a mean of 2100 ml per patient. Major complications mainly surgical sites and intra-abdominal sepsis occurred in 29 (26.6%) patients [Table 5]. Mortality largely from hemorrhage in 7 (63.6%) and sepsis were seen in 10 males and a female (10.1%) as given in Table 6. Presence of irreversible shock ($P = 0.0046$), 3 or more injured intra-abdominal organs ($P = 0.0188$), severe head injuries ($P = 0.0057$), and delayed presentation beyond 12 h ($P = 0.0436$) were the main factors associated with mortality.

**DISCUSSION**

The abdomen is highly exposed to combat-related wounds and death due to its large size, little bony protection, and the fact that most combative injuries intended to kill are instinctually directed toward the torso.$^{[10,11]}$ In this study, a total of 109 abdominal injured patients representing about 12.2% of a total of 897 combat-related injuries were managed within the period of the study in this trauma center. This incidence is similar to those recorded in Afghanistan (11.8%) and Bosnia (13.4%).$^{[16,17]}$ It however differs from the experiences of the Red Cross field Hospitals on the Cambodian border, Northern Kenya and Peshawar, Pakistan conflicts (15.3%) as well as Vietnam (9.4%).$^{[4,18]}$ This disparity in incidences may portray differences in methods adopted for data collection of combat casualties, promptness of victim evacuation to hospitals, or usage of protective body armor.$^{[9,19]}$

It is increasingly recognized that in recent battles, civilians are the majority of the victims and may constitute over 80% of the wounded compared with 5–19% civilian casualties during the First World War era.$^{[1]}$ In Lebanon and gulf wars, for instance, 70% and 50% of the injured respectively were civilians.$^{[20]}$
Combat related injuries may be sustained during crossfire, torture execution, aerial bombing, or accidental weapon discharges.\textsuperscript{[21]} All firearm arm injuries in our series were sustained during hostile action in sharp contrast to reports from Croatia where 22\% of war injuries among civilians were from accidents while handling weapons or explosive devices; and 42\% were directly from hostile action.\textsuperscript{[21]}

The male preponderance noted in this study is consistent with the adventurous, heroic and thrill seeking lifestyle of the males. The vast majority of the victims were young with a median age of 27.6 years highlighting the loss in man-hour of the most productive and viable segment of the society to violence with serious national and economic consequences. Other reports indicate that these young individuals also suffer several other negative social consequences and devastating effects of modern wars including displacement from their homes and loss of their sources of livelihood.\textsuperscript{[8]}

A high ratio of penetrating to blunt organ trauma approximately 10:1 was observed in this campaign. This overwhelming presence of penetrating wounds was also noted by other authors ranging between 70\% and 100\%.\textsuperscript{[22,23]} In our society, where blunt trauma predominates in peace time, this unprecedented high level of penetrating trauma reflects the magnitude of investment in acquisition of illegal and dangerous weapons preparatory to the resort to violence to settle lingering sociopolitical grievances. Given that modern battle no longer aims primarily at resisting the advancement of opposing army, but at undermining the opponents’ overall political, economic, sociocultural and psychological infrastructure by inflicting devastating injuries; this high investment may hardly be surprising.\textsuperscript{[11]} Terrorist activities largely conducted within and targeted at the civilian population in recent times have further aggravated the flow of sophisticated weaponry into our society facilitating access to dangerous explosive devices. The morbid societal consequences of these weapons particularly explosive devices are now the causes of major concerns among trauma care providers.

Gunshot wounds were the predominant mechanism of injury in keeping with other studies, and their destructive nature is in part due to the ability to traverse body cavities with involvement of several organs, hence the high mean ISS.\textsuperscript{[26]} This destructive nature is only surpassed by blast injuries because of its multiple mechanisms of injury while stab injuries are the least destructive.\textsuperscript{[25]} Multiple organ injuries were diagnosed in 64\% of the patients with a mean of 2.3 intra-abdominal organs injuries per patient. The wide variations in the positioning of the entrance wounds and the unpredictable nature of firearm wound trajectory may explain the propensity for multiplicity of abdominal organ injuries. The random location of the entrance wounds encompassing a wide anatomic area spanning the lower chest, anterior and posterior abdominal walls, upper thighs and perineum with tracts ramifying in various directions made virtually all abdominal organs susceptible to damage. The preferential involvement of the alimentary tracts and the liver noted may be attributed to the wide distribution and mobility of the small bowel as well as the large size of the liver within the peritoneum.\textsuperscript{[10]}

\begin{table}[h]
\centering
\begin{tabular}{|l|l|}
\hline
Complication & Number of patients \\
\hline
Incisional surgical site infection & 9 \\
Intra-abdominal abscesses & 4 \\
Postoperative adhesions & 3 \\
Wound dehiscence & 3 \\
Enterocutaneous fistula & 3 \\
Chest infection & 2 \\
Adult respiratory distress syndrome & 2 \\
Deep venous thrombosis & 1 \\
Pancreatic pseudocyst & 1 \\
Right knee ankylosis & 1 \\
\hline
\end{tabular}
\caption{Major complications}
\end{table}

The thorax was the most common extra-abdominal site of injury. Our experience in this regard is similar to the report on the Bosnian conflict.\textsuperscript{[20]} Chest wounds may by virtue of their close anatomic proximity cause serious injuries to organs below the diaphragm resulting in combined injury in up to 25\% of cases.\textsuperscript{[18]} Pleural space collections (hemothorax, pneumo - or hemopneumothorax) were the most common life-threatening thoracic injuries seen which correspond with the findings of US Army in the Vietnam conflict, the Iran-Iraq wars and the

\begin{table}[h]
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\begin{tabular}{|l|l|l|l|l|}
\hline
Sex & Age (years) & Injuries & Injury time to surgery (h) & Mechanism of injury & Time of death after surgery & Cause of death \\
\hline
Male & 30 & Small bowel, mesentery, SHI, and femoral\textsuperscript{a} & 12 & Gunshot & 7 h & Exsanguination \\
Male & 60 & Small and large bowel, liver, and kidney & 4 & Blast & During surgery & Exsanguination \\
Male & 40 & Diaphragm, stomach, spleen colon, and hemopneumothorax & 6 & Stab injury & 11 h & Exsanguination \\
Female & 33 & Liver, kidney, spleen, colon, and IVC & 5 & Gunshot & 1 h & Exsanguination \\
Male & 30 & SHI and extremity s, bowel perforation & 22 & Gunshot & 7 days & Sepsis \\
Male & 40 & Liver and pelvic\textsuperscript{c} & 4 & Gunshot & 13 h & Exsanguination \\
Male & 35 & SHI, ruptured bladder, RPI, and femoral\textsuperscript{e} & 14 & Blunt & 72 h & Exsanguination \\
Male & 47 & SHI and bowel perforations & 48 & Gunshot & 11 days & MODS \\
Male & 3 & Burns, bowel perforation & 5 & Blast & 7 days & Sepsis \\
Male & 17 & Ileal perforations, multiple ribs, and humeral\textsuperscript{g} & 18 & Blast & 6 days & Sepsis \\
Male & 18 & Diaphragm, spleen, stomach & 3 & Gunshot & 48 h & Exsanguination \\
\hline
\end{tabular}
\caption{Injury mortality, time factor, and causes of death}
\end{table}

\textsuperscript{a}Fractures. SHI: Severe head injury; IVC: Inferior vena cava; MODS: Multiple organs dysfunctional syndrome; RPI: Retroperitoneal hemorrhage
military operation in Lebanon.[27] Since only a minority of chest trauma victims often <10% of the total casualties usually survive to treatment centers, this preponderance of pleural collections may perhaps be attributed to survival of more patients with pulmonary parenchyma injuries resulting in pleural collections to the hospital than the more lethal central thoracic column injuries (heart, pulmonary hilar and great vessels).[28]

A rapid control of bleeding and curtailment of enteric contamination is key to managing abdominal injuries. In this study, the liver was the most frequently injured solid organ and a major source of intra peritoneal bleeding. Our management of these liver injuries was in keeping with the contemporary shift in the management of most liver trauma from major hepatic resection to nonoperative and nonresectional management in the form of inflow vascular occlusions, perihepatic/omenta packing, hepatorrhaphy with ligation of severed vessels and bile canaliculi.[29] Similar to our experience, the therapeutic efficacy of managing combat related hepatic injuries with these techniques has been confirmed during Baghdad invasion and Iraqi civilian conflict.[29] Retrohepatic inferior vena cava injury caused the death of one of our patients. This represents one of the most lethal liver injuries known to mankind with mortality rate up to 78% in other series.[30]

The current trend in the management of splenic trauma emphasizes splenic conservation where feasible.[31] Our decision to treat more injuries by splenectomy in this study was informed by the presence of high-grade injuries in the midst of gross peritoneal fecal contamination. Colonic and intra peritoneal rectal injuries were repaired primarily where feasible (hemodynamically stable patients with not more than two additional organs injuries and minimal fecal peritoneal contamination). In previous battles, all colorectal injuries were customarily treated with colostomy because of the high colonic bacterial density and risks for septic complications.[32] Major shift from mandatory colostomy toward primary colonic repair came in recent years from improved bowel handling techniques and better intraoperative control of fecal spillage, improved anesthesia and surgical technique, a wider availability of antibiotics and blood transfusion services. About half of all colonic injuries encountered during the Afghanistan and Bosnia–Herzegovina conflicts were successfully repaired primarily, and a fall in stomas rates was equally noted during the Iraqi war.[33–35] The good outcome with selective primary repair of colonic injury in our study may be attributed to our previous experience in one stage management of colonic injuries coupled with strict adherence to selection criteria.[36]

A significant fatality rate of 10.8% was recorded in this study. This rate is lower than 13% recorded in Afghanistan and 29.8% in Bosnia–Herzegovina wars.[36,37] The reduced mortality may be traced to our hospital being a health service already accustomed to crisis situation over the years with experienced staff and with a level of preparedness that permitted free flow of supplies, guaranteed aggressive resuscitation, judicious broad spectrum antibiotics use, liberal peritoneal saline irrigation and acute care supportive services in the ICU.[14,15] Previous battle wounds analysis by Santy et al. demonstrated a mortality rate of 75% among seriously wounded patients treated after 10 h following injuries compared with 10% among those treated within an hour, therefore, giving credence to early and rapid medical care offered within the first h following injuries.[38] None of our patients, however, arrived the hospital within the first h posttrauma in sharp contrasts with Vietnam, where there were ultrarapid medical evacuation systems including helicopters. Most of our patients were conveyed to the hospital in private, commercial or police vehicles without adequate prehospital care en route the hospital. These might have contributed to twice the 4.5% mortality recorded in Vietnam where rapid evacuation significantly was available.[38] Hemorrhagic shock resulting in early trauma deaths was the prime cause of mortality which underscored the empiric need for rapid evacuation and organized ambulance system.

In this study, the presence of head injuries, 3 or more injured intra-abdominal organs, and delayed presentation were the main statistically significant factors associated with mortality. High mortality of patients with combined abdominal and head injuries highlights the detrimental effect of intraperitoneal bleeding on cerebral perfusion.[37] Most of the morbidity and deaths occurring beyond 48 h occurred from sepsis. This may be traced to heavily contaminated wound from bowel injuries, debris from bullets or fragments of explosives (which consisted mainly of rusty bolts, nuts, or screws).

We observed that battlefield abdominal injuries pose several management challenges. Presentation of most victims in mass casualty events, with arrival of several critically injured patients simultaneously competing for scarce resources placed great demand on the hospital personnel, critical care services, and hospital resources. This served as a litmus test of our level of emergency preparedness. Extensive injuries and widespread tissue damage with significant blood loss mandating blood replacement were responsible for the average 2100 ml of blood transfusion to restore hemodynamic stability.

Consequent upon multiple organ injuries warranting multiple abdominal procedures, Gertsch reported abdominal procedures as the longest interventions during combat surgery and a major source of operating room expenditures.[38] This is also our experience with an average duration of abdominal procedures of 173.3 min which compares favorably with 180 min per patient previously documented.[38] The mean hospital stay was 17.1 days (range: 3–83 days) with 15 (13.8%) patients requiring intensive and HDU care. This long duration of hospitalization which indicates increased cost of care has been attributed to extra time needed to heal complex injuries or treat the resultant complications among combat related abdominal injured casualties.[25] Our data in this study did not capture the number of previous battle wounds.
of death that occurred on the field or in transit to the hospital which is a limitation. Therefore, the inpatient mortality rate of 10.8% recorded in this study is an incomplete representation of the magnitude of lives lost to communal conflicts in this environment.

CONCLUSION
Abdominal trauma constitutes a substantial problem among combat victims. Males and the most vibrant segment of the society are predominantly affected. Hemorrhage was the main cause of death with roughly one of every ten casualties reaching the hospital ultimately dying despite aggressive emergency room resuscitations. The considerable morbidity and mortality from the diverse abdominal organ injuries with high frequency of additional body regions trauma demands an early access to the wounded and a high level of emergency preparedness.

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Conflicts of interest
There are no conflicts of interest.

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