Ministry of Education
University of Benghazi
Benghazi – Libya
Directorate Of
Graduate Studies

Faculty of Medicine

Department of
General Surgery

A Perspective Study of Chest and Abdomen Gun-shot and Blast Injuries During the First 3 Months of Libyan Liberation War in Benghazi

By

Hend Abdalla Ibrahim Sharif

Supervisor

Prof. Osama Hassan Senussi

Co-supervisor:

Prof. Azza ELSaddiek Greiw

A dissertation submitted to partial fulfillment of the requirements for the Master degree in General Surgery in 08.08.2016

Ministry of Education
University of Benghazi
Benghazi – Libya
Directorate Of
Graduate Studies

Faculty of Medicine

Department of
General Surgery

A Perspective Study of Chest and Abdomen Gun-shot and Blast Injuries During the First 3 Months of Libyan Liberation War in Benghazi

By

Hend Abdalla Ibrahim Sharif

Supervisor

Prof. Osama Hassan Senussi

Co-supervisor:

Prof. Azza ELSaddiek Greiw

A dissertation submitted to partial fulfillment of the requirements for the Master degree in General Surgery in 08.08.2016

Ministry of Education
University of Benghazi
Benghazi – Libya
Directorate Of
Graduate Studies

Faculty of Medicine

Department of
General Surgery

نظرة على إصابات الطلق الناري على الصدر و البطن خلال الثلاث أشهر الأولى من حرب التحرير في مدينة بنغازي

A Perspective Study of Chest and Abdomen Gun-shot and Blast Injuries During the First 3 Months of Libyan Liberation War in Benghazi

هذا البحث مقدم لكلية الطب البشري جامعة بنغازي استكمالا لمتطلبات الحصول على الأجازة العالية في الجراحة العامة

This Thesis Has Been Submitted To The Faculty Of Medicine, Benghazi University In Partial Fulfillment Of The Requirements For The Degree Of Master In Surgery (M.Sc.).

هند عبدالله ابراهيم الشريف
Hend Abdalla Ibrahim Sharif

بإشراف
Supervised by:
أ.د. أسامة حسن السنوسي
قسم الجراحة العامة - جامعة بنغازي
Prof. Osama Hassan Senussi
Dept. of General Surgery - Benghazi University.

Co-Supervisor:
أ.د. عزة الصديق قريو
طب الأسرة و المجتمع - جامعة بنغازي
Prof. Azza ELSaddiek Greiw
Community Medicine - Benghazi University.

Benghazi
2016

A Perspective Study of Chest and Abdomen Gun-shot and Blast Injuries During the First 3 Months of Libyan Liberation War in Benghazi

This Thesis has been Submitted to the Faculty of Medicine, Benghazi University, Libya in Partial Fulfillment of the Requirements of Master Degree (M.Sc) in General Surgery.

By Dr. Hend Abdalla Ibrahim Sharif

Benghazi_Libya \ 08.08.2016

Certification

THIS THESIS ENTITLED " A PERSPECTIVE STUDY OF CHEST AND ABDOMEN GUN-SHOT AND BLAST INJURIES DURING THE FIRST 3 MONTHS OF LIBYAN LIBERATION WAR IN BENGHAZI" PREPARED BY DR. HEND ABDALLA IBRAHIM SHARIF, HAS BEEN APPROVED FOR SUBMISSION TO THE FACULTY OF MEDICINE, BENGHAZI UNIVERSITY.

Prof. Osama Hassan Senussi

Dept. of General Surgery

Benghazi University

Signature of Prof. Osama Hassan Senussi

Dedication

I dedicate this thesis to the souls of our martyrs.

Acknowledgment

I wish to express my deepest gratitude and thanks to **ALLAH,** whose magnificent help was the main factor in accomplishing this work. I would deeply thank **my parents**, who have been always the source of support and encouragement.

I am sincerely grateful to my supervisors, **Prof. Osama Senussi** and **Prof. Azza Greiw** for the many hours of fruitful discussion. I would like to thank the staff at the Biostatistical departments at Al-Jalla hospital, Al-Hawari Hospital and Benghazi Medical Center for all their efforts and help.

I am also grateful to all people at the department of 'wounded subjects' who helped me in going through the registries of war-wounded subjects and report on their outcomes.

Table of Contents Page

List of Tables Page

List of Figures Page

List of Abbreviations

ATLS: Advanced Trauma Life Support

BMC: Benghazi Medical Center

CNS: Central Nervous System

CXR: Chest X-ray

DPL: Diagnostic Peritoneal Lavage

DVT: Deep Venous Thrombosis

FAST: Focused Assessment with Sonography in Trauma

FWB: Fresh Whole Blood

GSW: Gunshot Wound

ICRC: International Committee of the Red Cross

ICU: Intensive Care Unit

IEDs: Improvised Explosive Devices

KIA: Killed in Action

LAMA: Leaving Against Medical Advice

PAI: Penetrating Abdominal Injury

WHO: World Health Organization

I. Abstract

Background In wars, different types of weapons have been used resulting in variable multiple injuries and deaths.

Aim of Study To describe different types of war-related chest and abdominal injuries due to gunshot and/or blast during the period from Feb. 17th to May 31st 2011 in Benghazi, Libya and to review the Libyan experience in dealing with these wounds.

Methodology The war-related injured subjects were identified using records from various hospital registries at Al-Jalla Hospital, Al-Hawari Hospital and Benghazi Medical Center, in Benghazi.

Results One thousand five hundred and ninety cases were hospitalized. Out of these, 204 patients had thoracic, abdominal, and thoraco-abdominal war-related injuries. Ninety seven per cent were males with ages ranged from 6 to 56 years and a mean ± SD of 29.43 ± 8.93, and 3% of the cases were females with ages ranged from 12 to 55 years and a mean ± SD of 27 ± 13.65. The duration of hospitalization ranged from 1 to 32 days. About 92% of admitted subjects stayed for less than 14 days, irrespective to the type of injury. Gunshot injuries were reported in 76% of the patients, while 24% were due to explosive injuries. The frequent site of injury was the chest (48.5%), followed by the abdomen (41.7%) and the thoraco-abdomen (9.8%). More than 45% of thoracic injuries were non-penetrating. The penetrating injuries were pneumohemothorax (32.7%), pneumothorax (15%), diaphragmatic laceration (4%), fractured ribs (2.5%), flail chest (1%), and heart injury (1%). About 77% of abdominal trauma was penetrating. The penetrating abdominal injuries were: isolated small intestinal injuries (22.8%), small intestine and right-sided colon injuries (8.5%), isolated left-side colon (7.6%), small intestine and left-sided colon injuries (5.7%), isolated right-side colon injury (4.7%) and isolated rectal injuries (2.8%). The other abdominal injuries included: splenic injuries (12.4%), hepatic injuries (12.4%), urinary bladder injuries (3.8%), renal injuries (2.8%) and gall bladder injuries (1.9%). The vascular injuries reported in 5.4% of the cases. The extremities were the most common injured parts of the body in association with the thoracic and abdominal injuries. More than 51% of the cases were managed by debridement of necrotic tissues and dressing. Laparotomy was done in 37.7% of the cases. Thoracotomy was applied to 6.4% of the cases, while thoraco-laparotomy was done in 1% of the cases. A few cases (3.4%) received conservative managements. Single broad-spectrum antibiotics administered in 53% of the cases, while combined antibiotics were administrated in 47% of the cases. Early complications were reported in 17.6% of the cases, while 15% of the cases reported late complications over 2 years of the follow up. About 79% of the cases were discharged in a good condition, 10.3% of them left against medical advice (LAMA), while 8.3% of the patients were transferred for further advanced management in centers outside Libya. The expired cases were 2%.

Conclusions The war-related thoracic injuries were the commonest among our study. In addition to the thoracic and the abdominal injuries, the extremities were the most common associated injured parts of the body. The rate of injuries due to blast trauma was less than that of gunshot trauma. All of the posterior penetrating abdominal and thoraco-abdominal wounds had positive laparotomies. This conflicts other reports that claimed the negativity of laparotomy of the posterior wounds. A low death rate was reflecting the good practice of the inexperienced surgeons in the military trauma.

II. Review of Literature

On Feb. 2011, the Libyan revolution started in Benghazi, the second largest city in Libya. Before this revolution, Al-Jalla hospital in Benghazi was the only referral hospital for trauma cases in the Eastern part of Libya. The surgeons were dealing with civilian trauma cases. The hospital was neither prepared for military casualty nor surgeons were trained for weaponry trauma associated with military operations. On start of the liberation war in Feb. 2011, other hospitals including Benghazi Medical Center (BMC) and Al-Hawari Hospital in the city received a large number of injured people. Surgeons tried to manage war injuries according to their experience in civilian practice.

Wars always result in victims, including casualties and injured, amputees and mutilated, as well as psychological and neurological disorders.

War injuries usually show different patterns with different weapons, accordingly most authors classified firearm injuries as low- or high-velocity injuries (1). In low-velocity wounds, the used projectiles have a muzzle velocity of less than 600 meter per second (1). Thus, usually only organs directly in the path of the projectile will be injured (2), and the injury is usually less severe as compared with high-velocity wounds, which are caused by military weapons with a muzzle velocity of more than 600 m/s, and result in extensive tissue damage (1).

The Red Cross classifies the war injuries according to wound characteristics, not upon weaponry (3). Grade-1 wound does not have a wound cavity. A wound cavity is a cavity that at least two fingers can fit into before wound excision, and there are no comminuted fractures or injuries to vital structures, such as major blood vessels or the central nervous system. Grade-2 and Grade-3 wounds are with various degrees of wound cavities, comminuted fractures, and injuries to vital structures (3). The amount of damage caused by temporary cavitation is clearly affected by the type of tissue as the brain tissue is the most affected (4), followed by the liver (5), and the muscles (6). Highly elastic tissues, such as the lungs, are the least to be affected (6). The affected " target" tissue determines the dimensions of the temporary cavity. Therefore, a cavity may be small in the lung, but large in the liver. Moreover, the cavity size can be

impressive—as much as 20-fold greater than the diameter of the bullet that caused it (7).

As the Libyan war became more aggressive, blasts were used. Rozen and Dudkiewicz (8) consider blast injuries as energy related and mainly dependent upon the distance from the blast, the energy released from the bombing device, the media and the environment in which the blast takes place. Moreover, blast injuries are thought to be more dirtier than gunshot wounds and carry a higher potential for infection (9).

Military trauma has been found to be associated with polytrauma caused predominantly by high-velocity weaponry and fragment wounds with multiple associated injuries that include significant energy transfers to adjacent tissue and even coexistent burns (10,11). The lungs and gastrointestinal tract are at greatest risk for blast effects (11).

Lichte, et al considered low-energy injuries are associated with minimal soft tissue damage and low risk of wound infection, while high-energy and shotgun injuries are associated with severe soft tissue damage and require an aggressive debridement with several second-look surgeries (1). However, Santucci and Chang advised to treat each wound individually, as guided by clinical observation (6), and to avoid the “Idolatry of Velocity" as was suggested by Lindsey (12).

The lethality of weapons and the speed of the evacuation from the battlefield have played a role in the outcome of an injury. The anatomical location of wounds in addition to the lethality of the weapons affect the ratio of the killed in action (KIA) to the wounded subjects (13). The extremities are the most common anatomic location for gunshot wounds (14). While the head and torso are the most vulnerable areas, with incapacitation due to CNS disruption or massive organ destruction and hemorrhage (15).

In warfare, abdominal injuries occur in 10-15% of all casualties (16) and approximately 10% of those killed in action (17). Wounding agents are most often either bullets or fragments from various detonating devices. Severity of pathology induced by these agents and prolonged lag time between injury and treatment constitute major differences between peace and war abdominal injuries (18). In addition wound contamination and wounding potential of firearms and ammunition have played a role (1).

Historically, the mortality rate showed dropping in abdominal war wounds from 53% during World War I to 18–36% at the end of World War II (18,19) and 12% in the Iran-Iraq War (20). The developments of efficient ambulance services, triage, resuscitation, blood banks, damage control surgery, and evacuation with concise communication to the next level of care have played a role and achieve a successful outcome (11,21,22).

Although gunshot wounds in the chest occur in about 15% of war injuries (23), wounds can be highly lethal (24). Depending on the injured organ, a large percentage of the wounded subjects die before reaching the hospital (24). When excluding about 10% with only soft tissue wounds of chest injuries, who require only basic wound treatment (23,25), the remainder can be categorized into two populations: about two-thirds will have missile wounds of the heart, great vessels, or pulmonary hilum; and the others will have missile wounds of the pulmonary parenchyma (25).

Injury to the thorax directly accounts for about 25% of all trauma-related deaths (24). Early mortality is usually due to hemorrhage or catastrophic injury associated with head or abdominal trauma; whereas late mortality most often is a result of sepsis and organ failure (24). In penetrating injuries, mortality is more often related to vascular injury and shock than in blunt trauma (26). Loogna et al, found a mortality rate of 45.7% in patients with gunshot wounds (GSWs) to the chest who needed operative intervention for non-mediastinal injury (24). Cooper et al, found that mortality rate of isolated chest injuries was in the range of 4% to 12%, increasing to 13% to 15% when another system was involved and to 30% to 35% when two or more systems were involved (27). However, the most common life-threatening injuries of the thorax are haematothorax, haematopneumothorax, tension pneumothorax and pericardial tamponade (1,24).

As the behavior of all bullets is unpredictable (6), the wounding of the thoraco-abdominal region, which is roughly distributed between the nipples superiorly, the costal margins inferiorly and mid axillary lines posteriorly; raises the suspicion of a two cavity injury with involvement of the ‘intra-thoracic’ abdominal viscera (28,29). Historical data showed that penetrating missile wounds of the trunk were responsible for about one third of combat deaths (30).

II.1. Chest Injuries

II.1.1. Anatomy of the chest

The chest begins superiorly at the thoracic inlet which is bounded anteriorly by the clavicles and posteriorly by the junction of the C7-T1 vertebral bodies. At this region major vessels (common carotid arteries, vertebral arteries, anterior veins and internal jugulars veins), trachea, esophagus, and spinal cord are traversing. While the chest is ended inferiorly by the diaphragm that attached at T6 level anteriorly and gradually sloping to the T12 level posteriorly. The thoracic cavity in between the inlet and diaphragm contains organs (heart, distal trachea, main stem bronchi, lungs and esophagus) and major vessels (aorta, inominate artery, subclavian arteries and common carotid arteries, superior and inferior vena cava, azygous vein, brachiocephalic vein, pulmonary arteries and veins) (23). Therefore, trauma to the chest is very critical since important organs and vessels may become affected.

II.1.2. Evaluation of thoracic injury

The immediate survey applied for the trauma of the chest based on the principles of Advanced Trauma Life Support (ATLS) (31) includes:

1. Establishment of a secure airway and provision of high concentrations of oxygen,
2. Establishment of adequate ventilation, and
3. Control of hemorrhage.

In a stable subject, the chest X-ray is applied to show the expansion of the lungs and mediastinum (32). Pneumothorax, hemothorax, subcutaneous or mediastinal emphysema, widened mediastinum, and the presence of retained missiles are sought and detected on the chest film (33). The amount of blood that can be detected on chest X-ray is about 150 to 200 ml (26).

The second standard investigation is an ultrasound examination that is helpful in identifying a pericardial tamponade (34). The other diagnostic tool is a CT scan, which allows the delineation of the precise injuries (1), and it can show the trajectory of mediastinal injuries in 75% (35). Angiography, esophagoscopy, barium swallow, and bronchoscopy are further investigations that may play a role (36).

In unstable subjects, treatment should not wait for chest radiographic (CXR) or other investigation confirmation (37). The clinical evidence be sufficient for initial management of critical cases (37).

II.1.3. Types of thoracic injury

In wars, penetrating chest injuries represent 28% of the total chest injuries (38). Parenchymal lung injury is the most common, and represents about 34 % to 36 % of gunshot injuries to the chest (39). Parenchymal lung injury is the most common cause of bleeding from penetrating chest injuries, which is followed by injury to the internal thoracic or the intercostal vessels as suggested by Clake, et al (40). The usual form of presentation is hemo- or pneumohemothorax (24). Pneumothorax is a very common complication caused by both blunt and penetrating trauma to the chest, and occurs in the great majority of individuals with transpleural penetration of the chest (41).

Pulmonary contusion is another form of injury, which is much more common in blunt than in penetrating trauma, but it is quite common with the use of high-velocity weapons, because of the shock wave created on impact (41).

Cardiac injury is mostly presented in the form of cardiac tamponade and excessive hemorrhage (42,43). Around 60-81% of patients with a penetrating injury to the heart die before reaching the hospital (43).

The incidence of injury to the thoracic great vessels has been estimated as 5% of gunshot wounds (44,45,46), with the prehospital mortality is overwhelming (24).

Most chest injuries are associated with rib fractures (26,47). While rib fractures are not usually lethal, but the pain from the fractures may have a negative impact on the pulmonary function (24). The pathophysiologic findings including ventilation/perfusion abnormalities, increase of respiratoric work, hypoxemia and decrease in the functional residual capacity are associated with the multiple fractured ribs (48).

Flail chest is one of the serious chest injuries (47). During inspiration lung segment collapse may occur with a larger flail segment (48). Large contusions either of the chest wall or the lung may be associated with atelectasis and shunting of blood. Trapping of blood within the pleural space impairs its own absorption and acts as an ideal media for bacterial proliferation (48). The chest wall defect plays a role in

compliance decrease and increase in airway resistance, associated decrease in pulmonary diffusion and increase of respiratory work (48).

Diaphragm is often involved in the lower chest injury (41), and represents up to 15% of all penetrating wounds to the chest (33) and around 59% of thoraco-abdominal wounds as reported by Murray and Demetriades (49). Isolated diaphragmatic injuries are uncommon; while penetrating thoracic injuries below the T4 level (nipple line) have a high probability of involving abdominal structures (23). Demetriades, et al reported that 75% of patients with penetrating injuries to the diaphragm had associated intraabdominal injuries (50). The formation of late diaphragmatic hernias, is inevitable (24).

In thoracic trauma, thoracic duct injury and tracheobronchial tree injury are uncommon (24). The injury of tracheobronchial tree often goes unrecognized until the development of tracheobronchial fistula, mediastinitis or empyema (41). The esophageal injury is another uncommon injury with no specific clinical signs or chest X-ray findings (41). A combination of CT scan, contrast esophagram and esophagoscopy are usually recommended (24,26).

II.1.4. Management of thoracic injuries

The violence of firearm incidence is rising globally (51). The algorithms of management for gunshot injuries to the chest are very similar in most trauma centers where the management of gunshot injuries can be done successfully without explorative thoracotomy (24,52,53,54). Since the basis of management of chest injuries includes treatment of respiratory insufficiency and haemorrhagic shock, with prevention of infection (55).

Ideally, war injuries should be treated by surgeons having military surgery experience (56) and need good transportation system to reduce the mortality rate (24). However, civilian surgeons may find themselves trapped in wars practicing military surgery without prior training or experience in this field (57). Therefore, the initial evaluation at the hospital needs to be quick and well practiced in order to rush the most critical patients to treatment and surgery without delay (24). Since most war wounds of the lung can be successfully managed by "conservative" surgical treatment (55).

In all cases of pneumothoraces larger than 2 cm and haematothoraces extending over

the seventh rib (39), the insertion of a chest tube (53,58,59) and local excision of injured soft tissue surrounding the wound (60), while avoidance the primarily closure (61) were found to be the most important therapeutic intervention. However, the chest tube may be badly positioned or blocked by a clot. Therefore, chest drain output alone is not a reliable sign, and it must be interpreted together with the overall clinical picture (40).

The management of lung contusion associated with rib fractures, consists of analgesics, early mobilization, chest physiotherapy and fluid administration, while most severe cases require intubation and mechanical ventilation (24). Eighty percent of penetrating chest injuries can be managed with a tube thoracostomy (26), since most of pulmonary parenchymal injuries are self-limited. This is partially due to the low-pressure circuit in the lungs. However, the parenchymal injuries can be treated successfully by pneumonorrhaphy (suture of the lung), tractotomy or wedge resection for good homeostasis (24,62). The recovery of lung function will be achieved in both conservatively and operatively treated patients (55).

A clinical or echocardiographic evidence of cardiac tamponade, unstable cardiac circulation, or a chest tube delivering more than 1 to 1.5 liters of blood immediately after the insertion or continued bleeding of more than 200 ml/h for 3 hours will be indications for Thoracotomy (29,39,60). Other indications include a massive or persistent pleural air leak over 24 hours or earlier, or if there is a major defect of the chest wall (63).

Diaphragmatic injuries less than 2 cm in diameter are managed by re-approximation with interrupted non-absorbable 0 or 1-0 horizontal mattress sutures. While lacerations larger than 2 cm are approximated as for simple small lacerations, then reinforced with a running suture to assure an airtight closure (23). Patients with left thoraco-abdominal or anterior right thoraco-abdominal injuries should be evaluated laparoscopically even if there are no signs of diaphragmatic injury, since 31% of proven diaphragmatic injuries show no signs of peritonitis and in 40% of chest films appear normal (46).

II.2 Abdominal injuries

II.2.1. Anatomy of the abdomen

The abdominal cavity is the largest hollow space in the body (64). It is bounded cranially by the trans-nipple line, caudally by the inguinal ligaments and pubic symphysis, and the anterior axillary lines laterally. Posteriorly it extends from the tips of the scapulae down to the gluteal folds and around to the posterior axillary lines (28). The flanks lie between the sixth intercostal spaces above and the iliac crests below (28).

II.2.2. Evaluation of abdominal injuries

Patients with abdominal gunshot injury are evaluated with priority to airway, breathing and circulation (65,66). In 1997, the American College of Surgeons, recommended that initial management of the patients should proceed along the standard ATLS lines of 'ABCDE' and an obvious abdominal wound must not distract from the basic assessment nor from the potential for co-existing life threatening extra-abdominal injury that must be immediately addressed (28).

The hemodynamic status of the injured patient may vary from absolute stability to complete collapse (28), therefore, it plays an important role of treatment strategy (1). Patients with stable hemodynamic status are evaluated by a complete secondary physical examination with a comprehensive abdominal examination, while hemodynamically unstable patients are taken directly to the operating room for controlling hemorrhage and contamination (65,67). However, patients come in shock due to abdominal injuries and internal organ involvement have an increased incidence of death (21).

Abdominal signs of gunshot injuries may vary from complete absence to frank peritonism (28). Peritoneal irritation revealing rebound tenderness and non voluntary guarding, is an evidence of intra-abdominal organ injury and an indication for

immediate laparotomy, irrespective of the location of the penetrating wound (65,67,68). As the intra-abdominal viscera may be injured without evidences of external transabdominal penetration since the missile may breach peritoneum via the buttocks and groins inferiorly and the diaphragm superiorly (28).

Velmahos and Degiannis (69) reported that wound track estimation was found to be 10% false positive for posterior GSWs; and Demetriades, et al (70) reported that only 75.4% sensitivity in predicting an intraperitoneal injury requiring surgical repair in anterior gunshots.

The protocol for Focused Assessment with Sonography in Trauma (FAST), and the CT-scan (only for stable patients) are generally accepted diagnostic tools for patients with abdominal gunshot injuries (71,72). While, the ultrasonography is the most sensitive and least invasive procedure (1), the use of ultrasonography should not be the basis for decision making whether to operate or not (73).

The diagnostic peritoneal lavage (DPL) is much less frequently used in the evaluation of presence of blood in the peritoneal cavity of trauma patients (1,74). This diagnostic procedure shows sensitivities of 84% to 97% for the detection of intestinal injury, and should remain as an adjunct in the management of abdominal trauma, especially in the combat setting (75,76), nevertheless it gives no information on specific injuries (65).

II.2.3. Management of abdominal injuries

In 1882, Simms (77) emphasized the need of laparotomy in abdominal wounds, while the mortality rate remained 72%. By the end of World War I, the mortality rate showed reduction as the operative management had placed (77). During World War II, approximately 90% of the deaths related to penetrating abdominal injuries (PAI) were caused by GSW. Nevertheless, it was shown that early laparotomy improved survival (73). Over the past century, great advances in the management of abdominal war wounds have been developed (60), hence mortality rate had dropped to 12% in Korean conflict, reaching 8% at present (77).

The optimal management of the open abdomen remains controversial (60,78). In general consensus, laparotomy is indicated in patients with abdominal gunshot injuries who are hemodynamically unstable or show signs of peritonitis or

evisceration (72,79,80,81). A low threshold exploratory laparotomy is warranted in those patients (29) with posterior truncal penetrating injuries causing retroperitoneal and intraabdominal trauma (29). In hemodynamic stable patients with penetrating wounds on the left thoraco-abdominal region, laparoscopy is the preferred diagnostic tool with its specialty in detecting smaller diaphragmatic or intraabdominal injuries (82).

In recent years, the selective non-operative treatment has gained acceptance (71,79), since unnecessary laparotomies in patients with abdominal trauma were found to have complication rates as high as 41% (83,84).

In battlefield trauma, hypotension and shock from blood loss remain common problems. Replenishment of blood either as components or fresh whole blood (FWB) is fundamental to the successful treatment of these patients (11). In a retrospective comparison of red cell and plasma transfusion patterns and mortality, a packed red cell to plasma unit ratio of 1–2:1 was associated with the lowest mortality (11). Recent studies have shown that Ringer's lactate solution and normal saline increase reperfusion injury and leukocyte adhesion (85,86). Moreover, coagulopathy of trauma may present at a very early stage after injury (87,88,89,90,91,92). Hypotension should be allowed until definitive (operative) hemorrhage control (85). Furthermore, a cardiovascular collapse unresponsive to resuscitation with either abdominal signs or an abdominal GSW necessitates resuscitative laparotomy (with or without adjunctive thoracotomy) without delay or further investigation (93).

Nonetheless, an appropriate resuscitation is recommended postoperatively, with the avoidance of over-resuscitation, as excessive fluid volumes (> 10.5L within the first 72 hours) have been associated with a fivefold increased risk of anastomotic leak in retrospective studies (94).

II.2.4. Management of Hollow Viscous Injuries

Stomach Injuries

The stomach is a well vascularized organ. Its injury requires minimal debridement and closure in two layers. It usually heals well with primary closure (7). Injuries of

the stomach represent about 10-15% of abdominal wounds. It is often associated with lesions of adjacent organs: liver, spleen, colon, pancreas, duodenum, great vessels and kidney, resulting in a high mortality rate (95).

Duodenal injuries

The duodenal injury should be closed primarily if feasible and narrowing of the lumen less than 50% can be obtained (7,86). All duodenal injuries should be drained (7). Missed injuries to the duodenum have devastating morbidity and are associated with high mortality (7).

Small bowel injuries

They are present in about 30% of penetrating abdominal wounds and are often multiple (95). Small perforations are closed by suture in one or two layers, while a bigger one might need excision of edges before suturing. Small bowel resection will be necessary when:

- There is major disruption of the lumen;
- There are multiple small perforations over a short area;
- There is disruption on the mesenteric border; or
- The blood supply to a segment has been compromised (95).

Colon injuries

The colon is the second most frequently injured organ as a result of PAI (95). Traumatic injuries to colon are associated with significant morbidity. In reports of the Civil War, most colon injuries were fatal; not simply from the battlefield injuries themselves but also from secondary infection and sepsis (10).

During World War II, the United States Office of the Surgeon General mandated surgeons either perform exteriorization or proximal stoma placement with an elective closure at a later date, or suffer a potential court martial (96,97). From the military experience during World War II, surgeons returned to civilian practice from the battlefield with the understanding and practice of universal fecal diversion (98), which is remained the standard practice for the next 40 to 50 years before the reemergence of primary repair, when feasible, as the treatment of choice (99,100,101,102,103).

High mortality rates have drastically fallen, since mandatory stoma placement has seen increasing trend toward in continuity management of colon injuries have been challenged (104). In addition, advances in perioperative care such as decreased evacuation time from battlefield (or civilian) point of injury, more aggressive fluid resuscitation, improved antibiotics, and safe banked blood use have led to profound decrease in overall mortality rates of 22 to 35% (105,106).

Isolated colon injuries should be repaired primarily (107) especially in young healthy patients who are hemodynamically stable (7). A study at Medina Hospital; a Police Hospital in Mogadishu, South Somalia, proposed that factors influencing the decision for the operative procedure of colon repair include:

- Experience of the surgeon (probably the most important).
- Delay from injury.
- Degree of fecal contamination.
- Size and type of injury, related to terminal ballistics.
- Age and general conditions of the patient (nutritional status).
- Number of abdominal organs injured (108).

In complex colonic injuries strongly consider colostomy/diversion (107), especially when associated with:

- Massive blood transfusion requirement.
- On-going hypotension.
- Hypoxia (severe pulmonary injury).
- Reperfusion injury (vascular injury).
- Multiple other injuries.
- High-velocity injuries.
- Extensive local tissue damage (107), and gross fecal contamination, as in a left colon or rectal injury (7).

The development of anastomotic leaks following primary repair in the trauma setting has been associated with multiple risk factors; including severe fecal contamination, shock, excessive blood loss, multiple transfusions, concomitant intra-abdominal organ injuries, and delayed presentation or time to surgical treatment (99,109). Moreover, the degree of colon injury (destructive vs. nondestructive) has a higher potential risk for anastomotic breakdown (110).

In severe colon injuries requiring resection, the method of colon management does not influence the incidence of colon-related abdominal complications, irrespective of the presence or absence of any risk factors. The intensive care unit and hospital stays were shorter in the primary repair group, although not statistically significantly. In view of these findings and the fact that colon diversion is associated with worse quality of life and requires an additional operation for closure, colon injuries requiring resection should be managed by primary repair, irrespective of risk factors (73).

Stomal reversal shows complication rates from 25 to 44%, with mortality rates being lower at 0.65 to 4.3%, though they have been reported as high as 4.7% following a Hartman procedure reversal (111,112,113,114). Specific complication rates vary even more widely, such as minor wound infections (21.8%), ileus (5.7%), anastomotic leak (13%), small bowel obstruction (11.5%), anastomotic leak with enterocutaneous fistula formation (3.8%), and intraabdominal abscess (1.1%) (10). Furthermore, colostomy closure following traumatic colon injuries has morbidity rates of 5 to 55%, with no differences in complication rates between early and late closure (97,115,116,117,118). While, the exact timing of closure that will minimize morbidity rates still needs further elucidation, some patients benefit from early closure versus the traditional wide variation of 3 to 12 months. At this time, without adequate studies, it must be left up to the surgeon's judgment and experience (10).

Rectal injuries

Rectal involvement is suspected in nearly all settings of penetrating buttock wounds and ruled out with rigid proctoscopy (119). The management of both civilian and military penetrating rectal injuries has seen a dramatic shift in the last few decades (120,121). Since Lavenson and Cohen's article regarding their experiences in the Vietnam War purporting the benefits of diverting stoma, distal rectal washout, presacral drainage, and rectal repair (when feasible), this has remained the standard management for rectal trauma (122). However, these edicts of rectal injury treatment have been questioned not only in the civilian literature (123), but in recent military conflicts as well (124). Colostomy is mandatory in rectal injuries (ICRC), and colostomy closure performed in four to six weeks (95).

II.2.5. Management of Solid Organ Injuries

Liver Injury

The liver tissue is a very well vascularized and even major tears heal without primary debridement (125). The major concern in the treatment of liver injuries is hemostasis. Simple lacerations or perforations through the periphery of the liver that have stopped bleeding require no specific therapy, while deeper wounds that continue to bleed need to obtain hemostasis either by cautery, clips, or ligature, which are equally effective. For significantly devitalized tissue; resectional debridement is required while a formal hepatic lobectomy is never indicated (126).

Injuries to the gallbladder is treated by cholecystectomy. Injuries to the hepatic artery or the portal vein need to repaired, if possible. Injuries to the common bile duct should be repaired over a small tube with a closed suction drain (126).

Splenic Injury

The spleen remains a common injured solid organ through wartime. Injuries to the spleen represent approximately one quarter of all blunt and penetrating thoraco-abdominal injuries (127). Most studies of splenic injuries have found that penetrating and blunt trauma were about equal in etiology of splenic rupture (128,129). Splenic injuries are recognized into four types namely: intraparenchymal laceration, subcapsular haematoma, splenic rupture and delayed rupture (130).

The management of splenic injury over the last century has turned to salvage of the spleen rather than splenectomy to preserve as much as we can the immunologic function of the spleen (131). Splenic repair by splenorrhaphy or partial splenectomy was always attempted if three criteria were met: hemodynamic stability, lack of multiple associated injuries mandating expeditious splenectomy, and injuries less extensive than a shattered or devascularized spleen (132).

Renal Injury

Penetrating renal injuries can be managed by debridement and drainage. There should be a low threshold for nephrectomy in the unstable patient (7). Grades I to III renal

injuries involve varying degrees of laceration and hematoma with no disruption of the major vessels or collecting system. Grade V represents avulsion of the pedicle and is almost always managed operatively. Grade IV involves varying degrees of collecting system and/or vascular injury. Management of grade IV injuries can involve either immediate operative exploration or a trial of aggressive resuscitation with crystalloid and blood products, depending on the availability of resources and the level of expertise of available surgeons (7). Nephrectomy may be the best solution for major renal injuries when other life-threatening injuries are present. Determining the function of the contralateral kidney (confirmed by contrast study) is desirable prior to nephrectomy (7).

Pancreatic Injury

The superficial injuries of pancreas is managed efficiently by closed suction drainage, while deeper injuries that involve the major pancreatic ducts, require more aggressive therapy. Moreover, transection or near-transection of the mid-body of the pancreas can be treated by ligation of the distal end of the proximal duct and a Roux-en-Y anastomosis of the distal remnant into the gut. If there is severe destruction of the head of the pancreas and duodenum, a pancreaticoduodenectomy may be required to save the patient which is uncommon situation (126).

II.3. Management of vascular injuries

Major vascular injuries occurred in 10% of hospitalized war injured patients (56). Abdominal vascular injuries are among the most fatal injuries sustained by trauma patients (133,134). The management of vascular injuries was ranged from a simple repair, ligation, to autologous and prosthetic graft use (56).

In extremities but not in an abdomen, the arterial repair with autologous vein graft remains the most durable and effective means of vascular repair (135,136).

II.4. Prophylactic use of antibiotic

As the belief of sterilization of bullets by the heat of firing is false (144**,**145); the wound induced by gunshot may superimposed by bacterial infections of non-sterile bullet (144). During management it has been recommended to use antibiotics as prophylaxis in high-velocity shotgun, but not in injuries caused by a low-velocity gunshot, in which proper wound care is essential for achieving a satisfactory result (146).

The recommendation for high-energy gunshot injuries with moderate soft tissue destruction is 48 hours intravenous administration of a first-generation cephalosporin. Penicillin must be added in patients with gross contamination and Gentamicin may be added in grossly contaminated wounds, such as those with bowel communication or grossly dirty skin or clothing, where the administration of a broad spectrum antibiotic for 1 to 2 weeks is recommended (147).

War wounds of the chest have had a higher infection potential than civilian injuries because of the high velocity weapons, the contaminated wound environment and the delay to definitive surgery compared with civilian low velocity injuries (148). The concepts for preventive antibiotic usage for penetrating chest trauma are controversial. Some authors showed benefits for antibiotic prophylaxis for patients from the insertion of a chest tube until its removal (149,150). Other studies showed the same results for single shot therapy with antibiotics (151).

There is general consensus that gunshot injuries with bowel injury, or high-energy gunshot injuries with moderate to severe soft tissue destruction require intravenous antibiotic treatment (146,148,152,153). Current guidelines recommend a single preoperative dose of prophylactic antibiotics with broad-spectrum aerobic and anaerobic coverage as a standard of care for trauma patients sustaining penetrating abdominal wounds (1). Absence of a hollow viscus injury requires no further administration (154).

Data from civilian trauma centers demonstrated that antibiotics administered postoperatively resulted in infectious complications that ranged from 30% with any intra-abdominal injury up to 70% when the colon is injured, compared with 11% when antibiotics were given preoperatively (155,10). In a recent review of all combat injuries, a multidisciplinary panel recommended that implementation of broad spectrum antibiotics to include anaerobic activity should be instituted upon arrival

following identification of the hollow viscus injury, and continued for 24 hours after definitive control of all enteric contamination (156).

II.5. Prognosis

The prognosis of abdominal wounds by ICRC experience depends on three factors:

- The type of missile and amount of energy transferred;
- The organs hit and their number;
- The time since injury (95).

The rapid transfer of gunshot victims to the hospital within less than 30 min (137), availability of type specific blood within 15 min of request (138), surgical intervention time of less than 2 h (137,139), use of appropriate surgical techniques (140,141,142) and intensive postoperative care (143) would largely counteract the adverse effects of these risk factors on mortality and morbidity (143).

Teams at each level of care, as well as the entire team of the military healthcare system extending from the battlefield to stateside medical centers, are critical to patient survival and outcome (11).

III. Aim of the Study

1- To describe different types of war-related chest and abdominal injuries due to gunshot and/or blast during the period from Feb. 17th to May 31st 2011 in Benghazi, Libya.

2- To review the Libyan experience in dealing with these wounds .

IV. Materials and Methods

Study design

A retrospective study of medical records of all cases with gunshot and blast wounds that admitted to the surgical departments during the wartime in Benghazi City, from 17th Feb. till the end of May 2011 was conducted. Out of one thousand five hundred and ninety subjects with gunshot wounds, 204 cases with thoracic, abdominal and thoracoabdominal injuries were included in the study.

Study Setting

Three hospitals (Al-Jalla Hospital, Benghazi Medical Center and AL-Hawari Hospital) were the emergency hospitals receiving emergency cases during that period.

Subjects

All cases admitted to the above mentioned hospitals and diagnosed as thoracic, abdominal or thoracoabdominal injuries during the period of study were included.

Tools

Collected data from the medical records including personal data (age, gender), the pattern of injury, the management of injuries, the prognosis, and early and late complications were recorded on a special proforma (Appendix-1).

Ethical Consideration

A formal request for reviewing the patients' records was approved by the authorities of the three hospitals.

Statistical Analysis

Collected data were analyzed statistically using the Social Package of Scientific Statistics (SPSS version 11.5). Analysis of data was applied as descriptive analysis; percentages of different variables, mean and standard deviation of quantitative variables were presented in the form of tabular and graphical presentation.

V. Results

One thousand five hundred and ninety cases of war-related injuries were admitted in the surgical departments in Benghazi city during the period from February 17th to May 30th, 2011. Out of these, 204 patients had thoracic, abdominal and thoracoabdominal injuries. One hundred and thirty (64%) of those patients were treated at Al-Jalla Hospital, while 45 (22%) and 29 (14%) were treated at Al-Hawari and BMC Hospitals respectively (Fig. 1).

One hundred and ninety seven (97%) were males with ages ranged from 6 to 56 years with a mean ± SD of 29.43 ± 8.93, and 7 (3%) females with ages ranged from 12 to 55 years with a mean ± SD of 27 ± 13.65 (Fig. 2).

Sixty one percent of cases were received through the emergency departments of the above mentioned hospitals in Benghazi, while the remaining 39% of patients were transferred from other hospitals outside Benghazi where the war took place (Fig. 3).

Figure 4 shows the admitted cases during February and the following months. Fifty two (25%) patients were admitted in February, 77 (38%) were admitted during March, 41 (20%) in April and 34 (17%) in May.

The length of hospitalization ranged from 1 day to 32 days with a mean of 6.3 days. However, most of the admitted subjects (92%) stayed at the hospitals for less than 14 days, whether the type of injury was gunshot or blast.

The distribution of subjects according to the cause of trauma is represented in Figure 5. Gunshot injuries were seen in 155 (76%) patients, while injuries due to an explosion were found in 49 (24%) of the injured subjects. During the Feb. 17th revolution, most of injured cases were due to gun-shot injuries, particularly in February and March, however, since the month of March a significant increase in blast injuries was observed (Fig. 6). Then after, the number of injured subjects due to either weapons was decreased.

Figure 7 shows the distribution of subjects according to the site of injury. Thoracic injury was seen in 48.5% of patients, while abdominal and thoracoabdominal injuries were seen in 41.7% and 9.8% of patients respectively.

The general condition of injured patients at admission is represented in Figure 8. One hundred and seventy nine (88%) patients were in a stable condition with normal blood pressure (BP), pulse (P) and respiratory rate (RR), while 25 (12%) of injured subjects were in shock with systolic blood pressure less than 90 mm Hg and pulse rate greater than 100 per min.

On admission and during examination, the bullet entry was reported. The bullet entry through the anterior chest wall was seen in 66 (32.4%) of the cases, while the bullet entry through the posterior chest wall was seen in 37 (18%) of the cases. The bullet entry through the anterior abdominal wall was reported in 75 (36.8%) cases, while the bullet entry through the posterior abdominal wall was found in 14 (6.9%) of the cases. The thoraco-abdominal region showed a bullet entry anteriorly in 9 (4.4%) cases and posteriorly in 3 (1.5%) cases (Fig. 9).

Different types of war-related thoracic injuries were observed (Fig. 10). Superficial non-penetrating wound injuries were found in 54 (45.3%) of the injured subjects. The pneumohemothorax and pneumothorax were found in 39 (32.7%) and 18 (15%) of the cases respectively. Diaphragmatic laceration was present in 4% of the thoracic cases. The other injuries that occurred were flail chest in 1%, heart injury in 1%, and fractured ribs in 2.5% of the cases, which were caused by gunshot injury (Table 1).

The kind of trauma either by gunshot or blast had an inflict on the type of thoracic injury (Table 1). Superficial non-penetrating wound injuries were more marked with gunshot trauma (36 (30.2%)) than blast trauma (18 (15.1%)). Pneumothorax was reported in 12 (10%) of the thoracic cases caused by gunshot injuries, while in blast injury, pneumothorax was reported in 6 (5%) of the thoracic cases. Pneumohemothorax was more significantly occurred by gunshot injury (26.8%) than blast injury (5.8%). Diaphragmatic lacerations was reported in 4 (3%) cases by gunshot while blast injury resulted in 1% of the cases of diaphragmatic laceration. Gunshot injury claimed for the occurrence of flail chest (1%), heart injury (1%) and ribs fracture (2.5%) in our study.

The distribution of abdominal cases according to the penetration of abdominal walls are represented in Figure 11. The abdominal wall was penetrated in 77% of the cases with involvement of internal organs. However, in 23% of the injured cases, wounds were superficial and non-penetrating.

Hollow viscous injuries are represented in Table 2. Small intestinal injuries were found in 22.8% of the cases. Injuries to small intestine and right-sided colon were reported in 8.5% of abdominal cases, while injuries to small intestine and left-sided colon were occurred in 5.7% of abdominal cases. Isolated injuries to left-side colon and right-side colon were reported in 8.5% and 3.8% respectively. Isolated rectal injury was reported in 2.8% of all abdominal cases. Urinary bladder injuries were found in 3.8%, while injuries to gall bladder were reported in 1.9% of the abdominal cases.

Large bowel injuries were affected by the site of bullet entry (Table 3). A bullet entry through the anterior abdominal wall was associated with 22 (78.5%) cases of colonic injuries and 2 (67%) cases of rectal injuries. On the other hand, posterior abdominal injuries were reported in 6 (21.5%) cases of colonic injury and one case (33%) of rectal injury.

Injuries to solid organs are displayed in Table 4. Splenic and hepatic injuries were found each in 13 (12.4%) of the abdominal cases, while renal injuries were reported in 3 (2.8%) of the cases. As pancreatic injury is less common to occur, only one case (0.9%) of pancreatic injury was reported.

Vascular injuries were occurred in 5.4% of all the admitted cases. Different types of vessels were injured (Table 5). The reported injured vessels were internal iliac artery (1.5%), subclavian artery (1%), internal mammary artery (0.5%), mesenteric vessels (0.5%), femoral artery (0.5%), and common iliac artery (0.5%). The retroperitoneal hematoma was reported in about 10% of the abdominal cases (Fig.12).

In association with thoracic, abdominal and thoracoabdominal injuries, the extremities were found to be the most common injured parts of the body, which were reported in 31 (15.2%) cases. Soft tissue injuries were involved in 15 (7.4%) cases. Peripheral nerve injuries were significantly reported in 9 (4.4%) injured subjects, while vertebral column, genitalia, and head and neck injuries were found in 2.5%, 1.5% and 1.5% of the cases respectively (Fig. 13).

Figure 14 shows the distribution of associated injuries in relation to the cause of trauma. In 11.7% of the patients, injuries to extremities were due to gunshot, while 3.4% of the cases were due to blast injuries. Peripheral nerve injuries were more common in gunshot injuries (3.9%) than in blast injuries (0.5%). Soft tissue injury

was caused by gunshot in 4.4%, and by blast injuries in 2.9% of the cases. The other associated injuries did not show significant difference between gunshot and blast trauma.

Through the management of injured cases, about half of the cases (51.5%) were managed by exploration of wounds, debridement of necrotic tissues without extensive tissue excision, and dressing. Laparotomy was done for 77 (37.7%) of the injured subjects. Thoracotomy was applied to 13 (6.4%) while about 1% of the cases were subjected to thoraco-laparotomy. A few cases (7 (3.4%)) were received a conservative management without any surgical intervention and they were kept under closed medico-surgical observation (Fig. 15).

Majority of the thoracic cases (50%) were managed conservatively, while more than one third (46 (38.6%)) of the cases were managed by chest tube insertion. Pulmonary lacerations were managed by suturing and insertion of a chest tube in 7 (5.8%) of the cases, while suturing of diaphragmatic lacerations was done in 5 (4.2%) of the cases in addition to insertion of a chest tube. Cardiac wounds were uncommon and managed by suturing in 0.8% of the cases (Fig. 16).

As laparotomy was done for 72.3% of the abdominal and thoraco-abdominal injured subjects, positive intra-abdominal injuries were present in the majority of cases (85%), while the rest of operated cases had no intra-abdominal injuries (15%) (Fig.17).

The relation between the site of entry of bullets or fragments of used weapons and the intra-abdominal laparotomy findings is represented in Table 6. Positive laparotomy findings were found in 55 (86%) of the cases with anterior abdominal and anterior thoraco-abdominal wall injuries. On the other hand, all the cases of posterior abdominal and posterior thoraco-abdominal injuries showed positive laparotomy findings in 100% of the cases.

Ninety five per cent of small intestinal injuries in our study were managed by resection and anastomosis. About 2.5% of cases were managed by simple repair, while Roux en Y gastro-jejunostomy was done for 2.5% of the intestinal injuries (Fig. 18).

The management of war-related injuries to colon and rectum is demonstrated in figure 19. Right hemicolectomy has done for 9 (29%) cases, while left hemicolectomy made for 2 (6.4%) of injured subjects. About one quarter of the cases (25.8%) were managed by resection and anastomosis of injured parts of the colon. Hartman's procedure performed in 12 (38.7%) of the cases.

Majority of the right colon injuries (69%) were managed by right hemicolectomy. While resection and anastomosis has done to 31% of the cases. For the left colon injuries, about 60% of the cases were managed by Hartman's procedure, while 27% of the cases managed by resection and anastomosis. Left hemicolectomy was done in 13% of the cases of left sided colonic injuries (Table 7).

The management of war-related hepatic injuries is shown in Table 8. Most of the hepatic cases (76.9%) were managed by suturing and gel foam application, while 17.7% of the cases were managed conservatively without any surgical repair.

Most of the splenic injuries (92.3%) were managed by splenectomy. Splenorrhaphy was done in 7.6% of the injured cases (Table 9).

The demand of blood transfusion for those with splenic injuries was based on the type of splenic managements (Table 10). About 42% of splenectomy cases received blood transfusion. The amount of transfused blood was ranged from 1 to 7 units. On the other hand, all of the splenorrhaphy cases did not receive blood. Through the duration of stay at hospital, about 58% of the cases that subjected to splenectomy stayed for one week, while 25% of the cases stayed for two weeks. In 17% of cases with splenectomy, the maximum duration of stay at the hospital was four weeks. However, all of the splenorrhaphy cases stayed for just one day duration (Table 11).

Table 12 shows the type of management of war-related renal injuries. Nephrectomy was done for all cases of the renal injuries.

Figure 20 shows the different types of management of the vascular injuries. Vascular ligation was applied to 4 (44%) cases. While primary repair was done in 3 (33.3%) cases. Autologous graft with long saphenous vein was used in 2 (22.2%) of the injured cases.

Blood transfusion in our study is reported in figure 21. One hundred and sixty four (80.4%) cases did not receive blood while 40 (19.6%) cases had blood transfusion. The number of transfused blood units was ranged from 1 to 22 units with a mean ± SD of 3.66 ± 4.41.

Prophylactic antibiotics were administered to all of the injured subjects. One hundred and nine cases (53%) received single broad-spectrum antibiotics, while combined antibiotics including Rocephin, Gentamicin and Flagyl were administered in 95 (47%) injured patients (Fig. 22).

Thirty six (17.6%) of the cases reported early complications within the first two weeks of hospitalization. Wound infections occurred in 12 (33.3%) of them, complicating abdominal injuries more than thoracic injuries. Primary hemorrhage occurred in 2 (5.5%) of the cases with thoracic injuries. While secondary hemorrhage occurred in 1 (2.7%) case of abdominal injury. Pneumonia as a complication occurred in 5 (13.8%) of patients with thoracic injuries. Empyema and atelectasis were found in 7 (19.4%) of the cases; four thoracic cases (11.1%) were complicated by empyema and atelectasis, and three of the abdominal cases (8.3%). Hemopneumothorax occurred in 2 (5.5%) of the patients. While, bilothorax was reported in 1 (2.7%) case. One case of thoracic injury reported deep venous thrombosis of the common femoral vein. The other reported complications including wound dehiscence, anastomotic dehiscence, low output intestinal fistula, prolapsed colostomy and subacute intestinal obstruction, where they occurred in a percentage of 2.7% for each and they reported through the abdominal injuries (Table 13).

Out of 204 cases, only 34 patients had a regular follow-up over a period of 2 years. Late complications were reported in 31 (15%) cases (Table 14). Hypertrophic scars were the most common complications, which occurred in 8 (25.8%) of the cases. Residual subcutaneous pellets were found in 4 (12.9%) cases. Incisional hernia reported in 7 (22.5%) of the abdominal cases. Urine and fecal incontinence occurred in 2 (6.4%) cases. Sinus discharge of iliac fossa was found in 1 (3.2%) case. Chest deformity was found in 1 (3.2%) case. Chronic thoracic sinus discharge found in 1 (3.2%) case. The other complications that reported in the injured cases were; hearing loss, neuroma, chorioretinal scarring, suicidal attempts, joint stiffness, post-traumatic

scar, contracture of the injured limbs. These complications were reported in a percentage of 3.2% for each case.

Figure 23 shows the prognosis of admitted cases in our study. One hundred and sixty two (79.4%) of the cases were discharged after completion of their management and were advised to come for regular follow-up in the Surgical Outpatient Clinics. Twenty-one (10.3%) patients left against medical advice (LAMA), while 17 (8.3%) patients were transferred for further advanced management in centers outside Libya. The number of expired cases were 4 (2%).

Tables

Table 1. Types of Thoracic Injuries in Relation to Gunshot and Blast Trauma, Benghazi-2011.

Thoracic Injury	Diagnosis		Total
	Gunshot Trauma	Blast Trauma	
Superficial Wound Injury	18 (15.12%)	36 (30.2%)	54 (45.3%)
Pneumohemothorax	7 (5.8%)	32 (26.8%)	39 (32.7%)
Pneumothorax	6 (5%)	12 (10%)	18 (15%)
Diaphragmatic Laceration	1 (1%)	4 (3%)	5 (4%)
Ribs Fracture	0	3 (2.5%)	3 (2.5%)
Flail Chest	0	1 (1%)	1 (1%)
Cardiac Injury	0	1 (1%)	1 (1%)

Table 2. Types of War-Related Hollow Viscous Injuries, Benghazi-2011

Types of Hollow Viscous Injuries	Frequency (%)
Small Intestinal Injury	24 (22.8%)
Small Intestine and Right Sided Colon Injuries	9 (8.5%)
Small Intestine and Left Sided Colon Injuries	6 (5.7%)
Right Sided Colon Injury	4 (3.8%)
Left Sided Colon Injury	9 (8.5%)
Rectal Injury	3 (2.8%)
Urinary Bladder Injury	4 (3.8%)
Gall Bladder Injury	2 (1.9%)
Total	58 (52.3%)

Table 3. Large Bowel Injuries in Relation to the Site of Bullet Entry, Benghazi 2011.

Mode of Entry / Site of Injury	Anterior Abdominal Wall Frequency (%)	Posterior Abdominal Wall Frequency (%)
Colon	22 (78.5%)	6 (21.5%)
Rectum	2 (66.6%)	1 (33.3%)

Table 4. Types of Solid Organ Injuries, Benghazi-2011.

Types of Solid Organ Injury	Frequency (%)
Splenic Injury	13 (12.4%)
Hepatic Injury	13 (12.4%)
Renal Injury	3 (2.8%)
Pancreatic Injury	1 (0.9%)

Table 5. Types of War-Related Vascular Injuries, Benghazi-2011.

Vascular Injury	Number (%)
Internal Iliac Artery Injury	3 (1.5%)
Subclavian Artery Injury	2 (1%)
Mesenteric Vessels Injury	1 (0.5%)
Internal Mammary Artery Injury	1 (0.5%)
Femoral Vessels Injury	1 (0.5%)
Common Iliac Artery Injury	1 (0.5%)

Table 6. The Incidence of Intra-abdominal Injuries in Relation To the Site of Bullet Entry, Benghazi-2011.

Laparotomy	Bullet Entry Through			
	Anterior Abdominal Wall	Posterior Abdominal Wall	Anterior Thoraco-abdominal walls	Posterior Thoraco-abdominal walls
Positive	49 (86%)	10 (100%)	6 (85.7%)	2 (100%)
Negative	8 (14%)	0	1 (14.3%)	0

Table 7. Types of Management of War related Colon Injuries, Benghazi-2011.

Management of Injury / Type of Injury	Resection and Anastomosis	Hemicolectomy	Hartman's Procedure
Right Colon Injury	4 (31%)	9 (69%)	0
Left Colon Injury	4 (27%)	2 (13%)	9 (60%)

Table 8. Types of Management of War-related Hepatic Injuries, Benghazi-2011.

Type of Management of Liver Injury	No. of Cases
Suturing of Hepatic Injury	10 (76.9%)
Conservative Management	3 (17.7%)

Table 9. Types of Management of War-related Splenic Injuries, Benghazi-2011.

Type of Splenic Injury Management	No. of Cases
Splenorrhaphy	1 (7.6%)
Splenectomy	12 (92.3%)

Table 10. The Demand of Blood Transfusion for Those with Splenic Injuries was Based on the Type of Splenic Managements, Benghazi-2011.

Blood Transfusion	Type of Management of Splenic Injury	
	Splenectomy	Splenorrhaphy
Yes	5 (42%)	0
No	7 (58%)	1 (100%)

Table 11. The Type of Splenic Managements has an impact on the Duration of Patient's Stay at Hospital in Wartime, Benghazi-2011.

Duration of Stay	Type of Management of Splenic Injury	
	Splenectomy	Splenorrhaphy
≤ 3	0	1 (100%)
1 wk	7 (58%)	0
2 wk	3 (25%)	0
2-4 wk	2 (17%)	0

Table 12. Types of Management of War-related Renal Injuries, Benghazi-2011.

Type of Management of Renal Injuries	No. of Cases
Nephrectomy	3(100%)

Table 13. Early Complications of Thoracic and Abdominal War Injuries, Benghazi-2011.

No. of Cases Early Complications	**Thoracic Injuries**	**Abdominal Injuries**	Total
Wound Infection	4 (11.1%)	8 (22.2%)	12 (33.3%)
Empyema and Lung Atelectasis	4 (11.1%)	3 (8.3%)	7 (19.4%)
Pneumonia	4 (11.1%)	1 (2.7%)	5 (13.8%)
Primary Hemorrhage	2 (5.5%)	0	2 (5.5%)
Hemopneumothorax	1 (2.7%)	1 (2.7%)	2 (5.5%)
Secondary Hemorrhage	0	1 (2.7%)	1 (2.7%)
Bilothorax	1 (2.7%)	0	1 (2.7%)
Wound Dehiscence	0	1 (2.7%)	1 (2.7%)
Anastomotic Dehiscence	0	1 (2.7%)	1 (2.7%)
Deep Venous Thrombosis (DVT)	1 (2.7%)	0	1 (2.7%)
Low Output Intestinal Fistula	0	1 (2.7%)	1 (2.7%)
Prolapsed Colostomy	0	1 (2.7%)	1 (2.7%)
Subacute Intestinal Obstruction	0	1 (2.7%)	1 (2.7%)
Total			36 (100%)

Table 14. Late Complications of Thoracic and Abdominal War-Related Injuries, Benghazi-2011.

Late Complications	No. of Cases
Hypertrophic Scar	8 (25.8%)
Incisional Hernia	7 (22.5%)
Residual Subcutaneous Pellets	4 (12.9%)
Urine and Fecal Incontinence	2 (6.4%)
Chest Deformity	1 (3.2%)
Sinus Discharge of Thoracic Granuloma	1 (3.2%)
Sinus Discharge of Iliac Fossa	1 (3.2%)
Others	7 (22.5%)
Total	31 (100%)

Figures

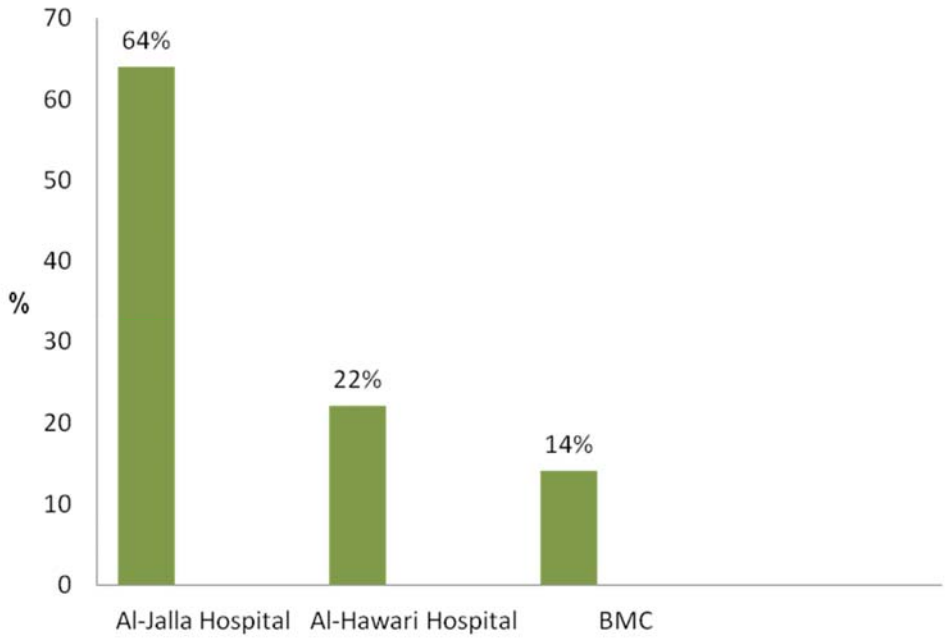

Figure 1. Distribution of Patients through the Hospitals of Admission, Benghazi 2011.

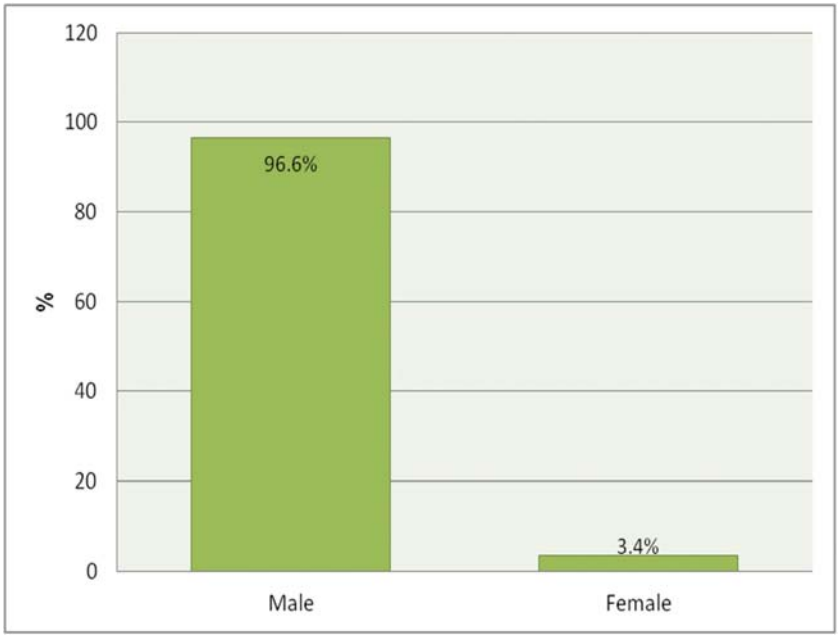

Figure 2. Gender Distribution of War-Injured Subjects, Benghazi 2011.

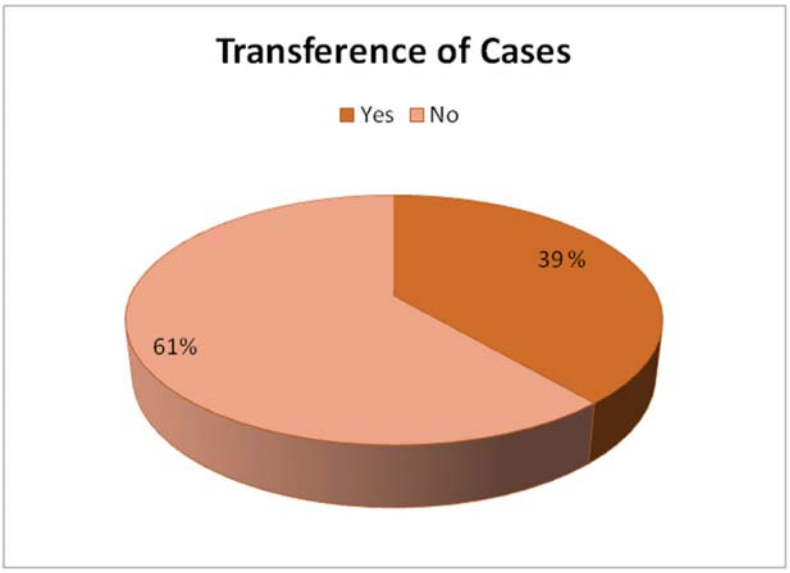

Figure 3. The Referral of Admitted Cases Either From Benghazi or Other Areas Where the War Took Place, Benghazi 2011.

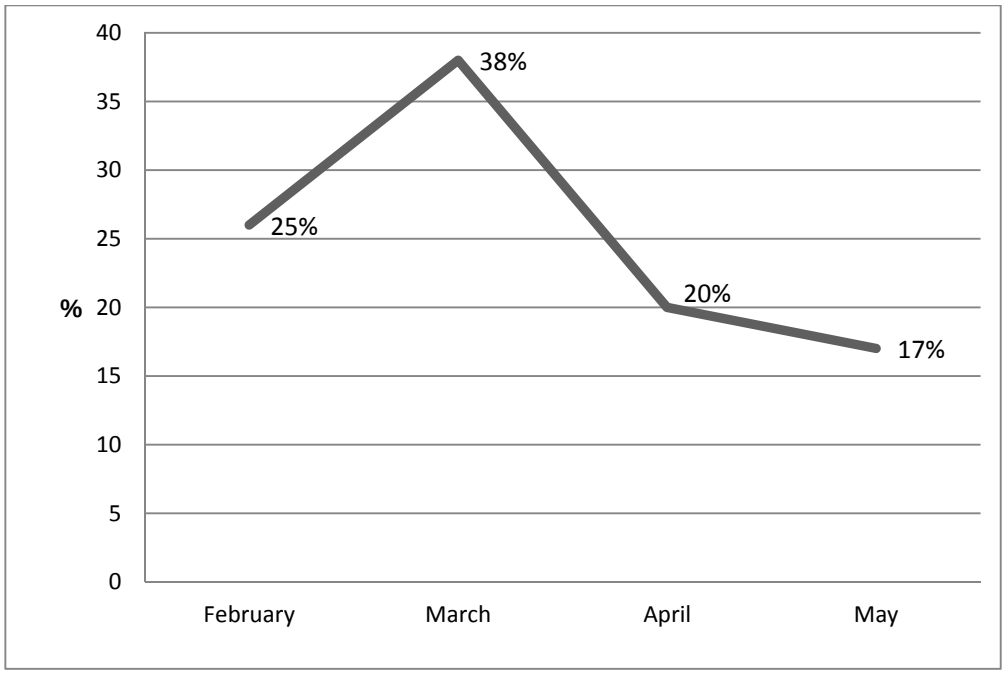

Figure 4. Distribution of Cases During February and the Following Months where the War Took Place, Benghazi 2011.

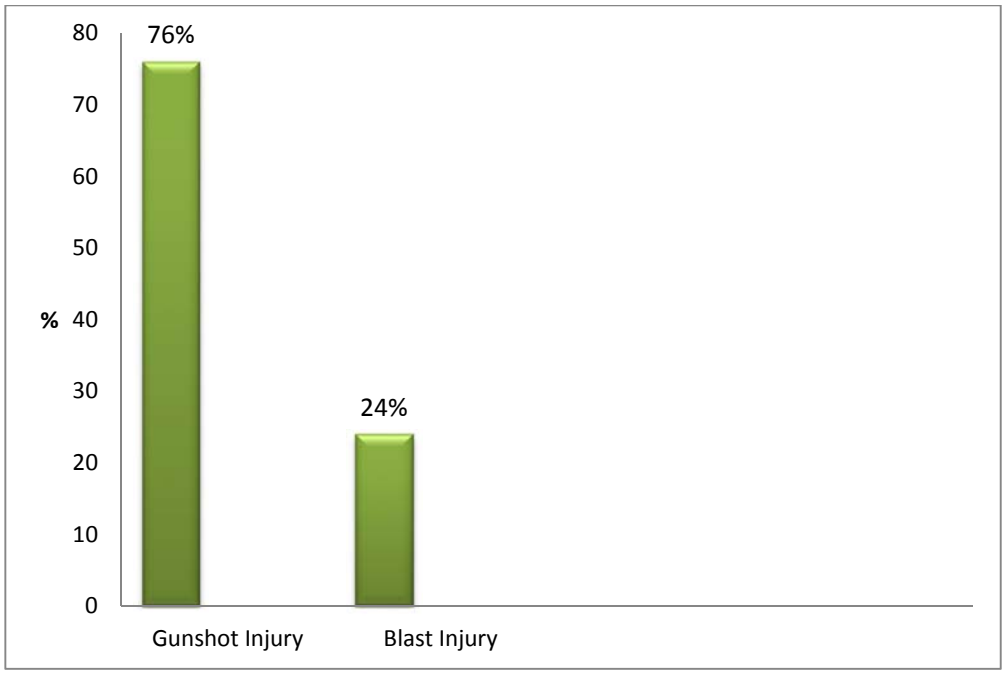

Figure 5. Types of Trauma that Reported During the Libyan War, Benghazi 2011.

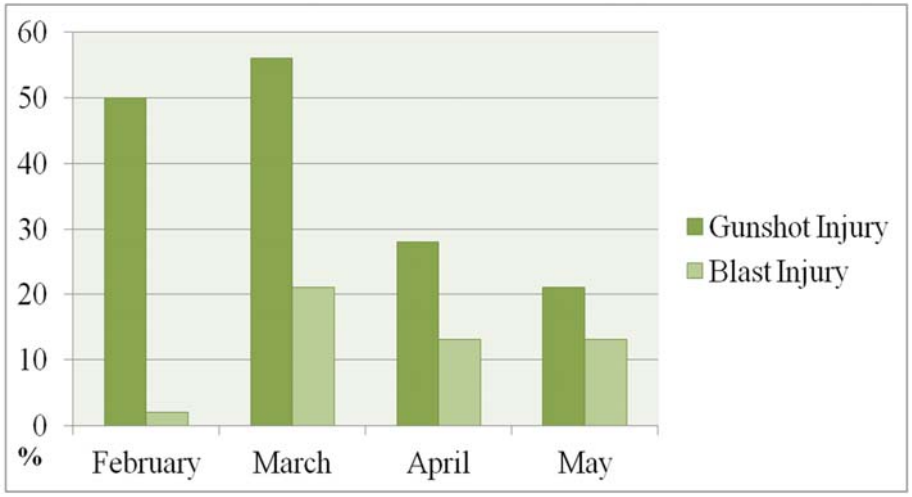

Figure 6. The Change of Weapon Type was Noticed Over the Start of War and the Following Months of War, Benghazi 2011.

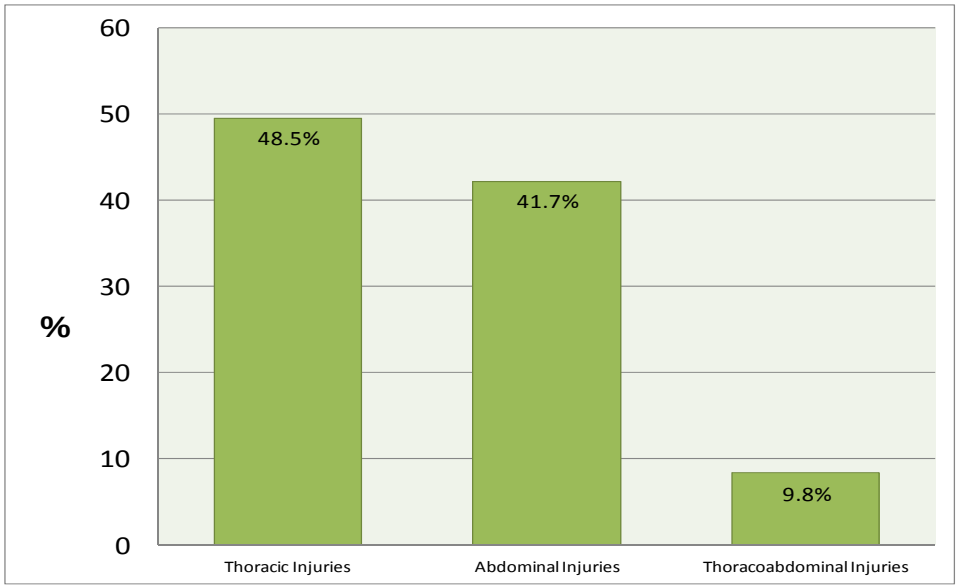

Figure 7. Distribution of Cases According to the Site of Injury, Benghazi 2011.

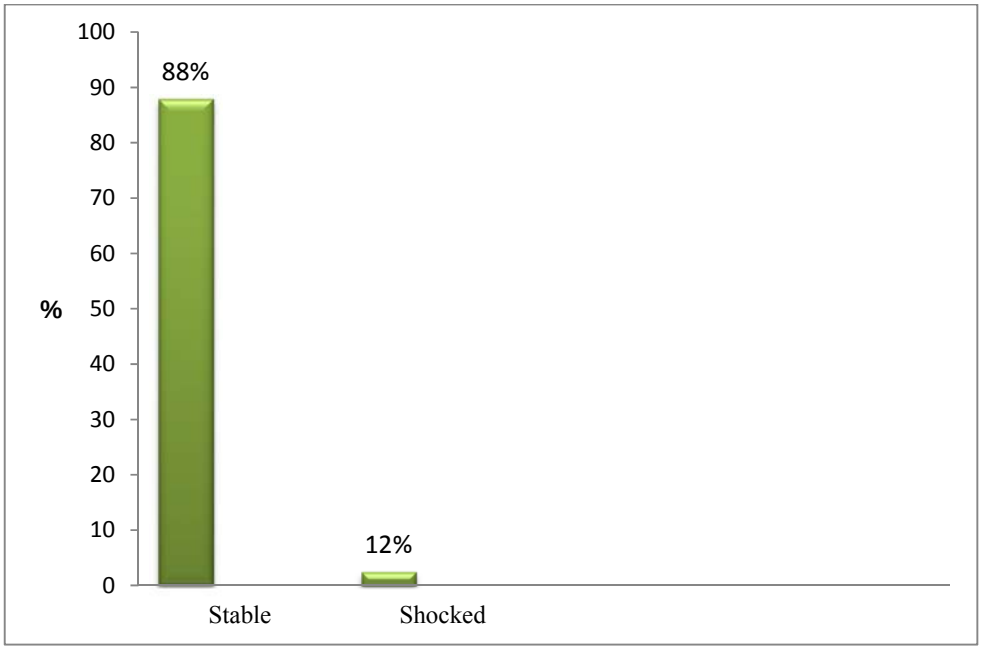

Figure 8. General Condition of Injured Cases at Admission, Benghazi 2011.

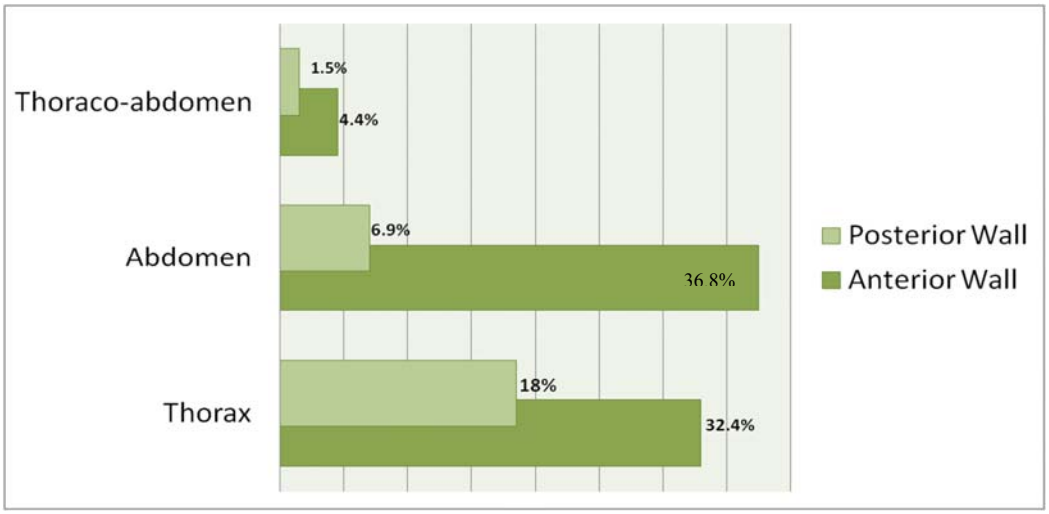

Figure 9. Site of Bullet Entry Through the Thoracic and Abdominal Walls, Benghazi 2011.

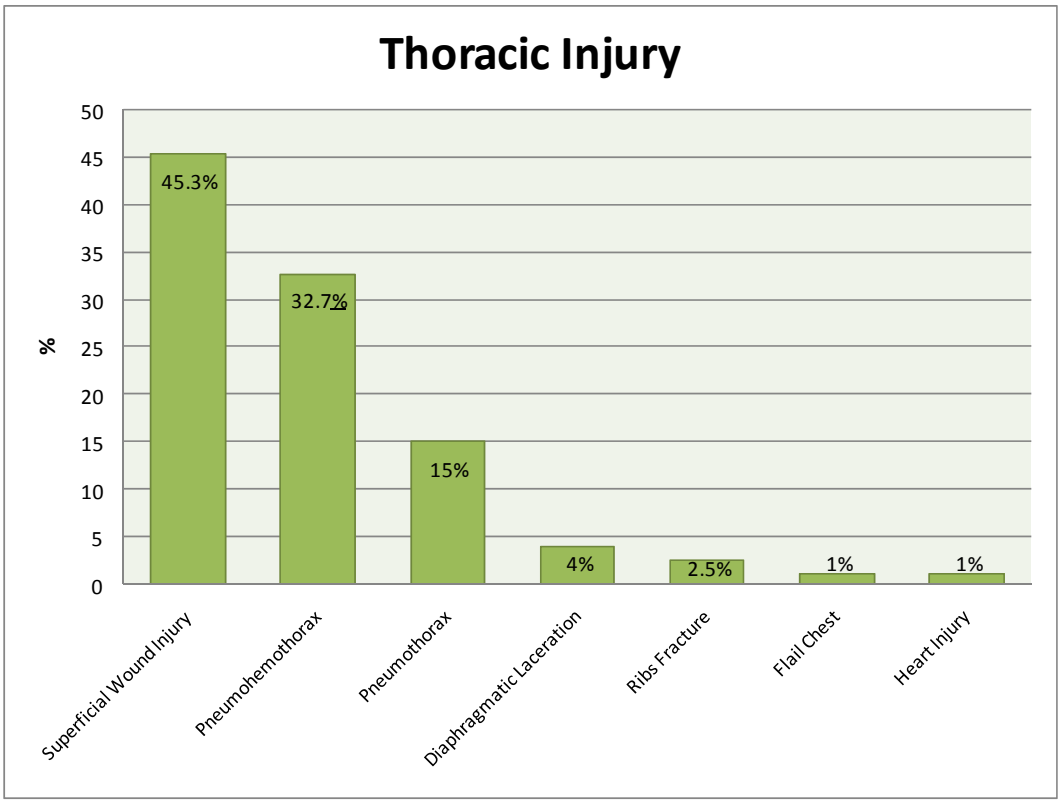

Figure 10. Different Types of Thoracic Injuries, Benghazi-2011.

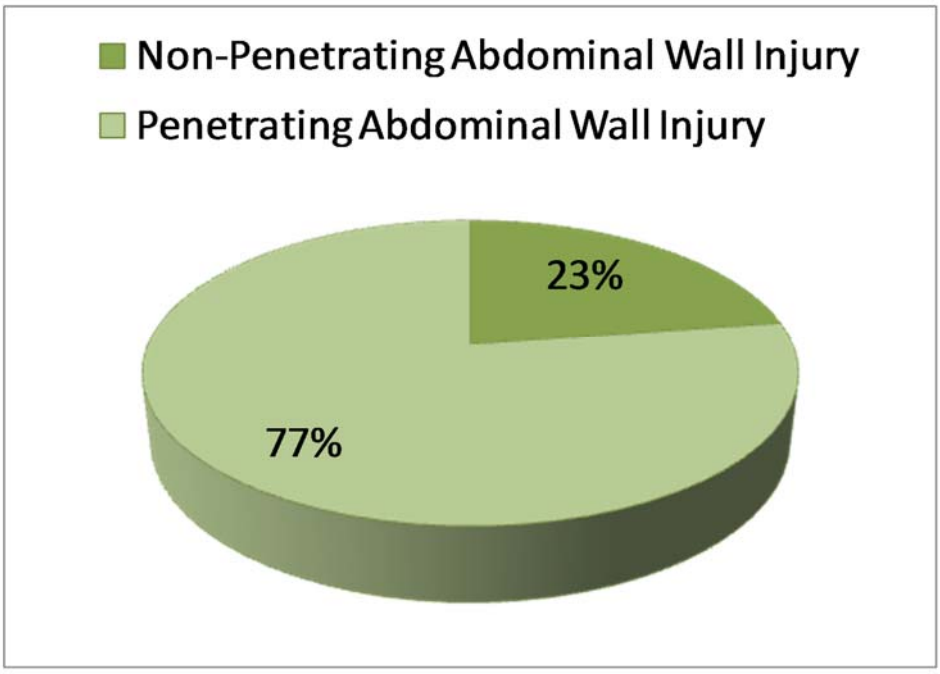

Figure 11. The Distribution of Abdominal Cases According to the Penetration of Abdominal Walls, Benghazi-2011.

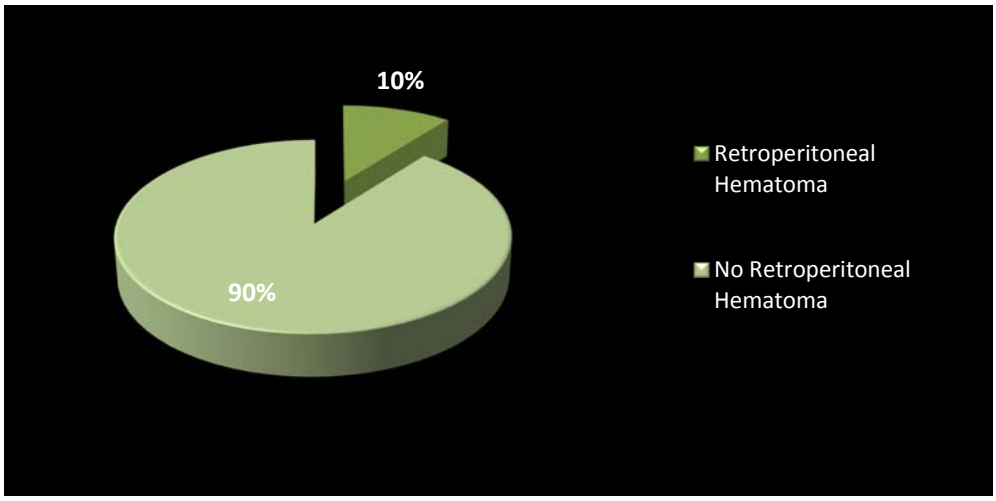

Figure 12. Retroperitoneal Hematoma of Affected Abdominal Cases, Benghazi-2011.

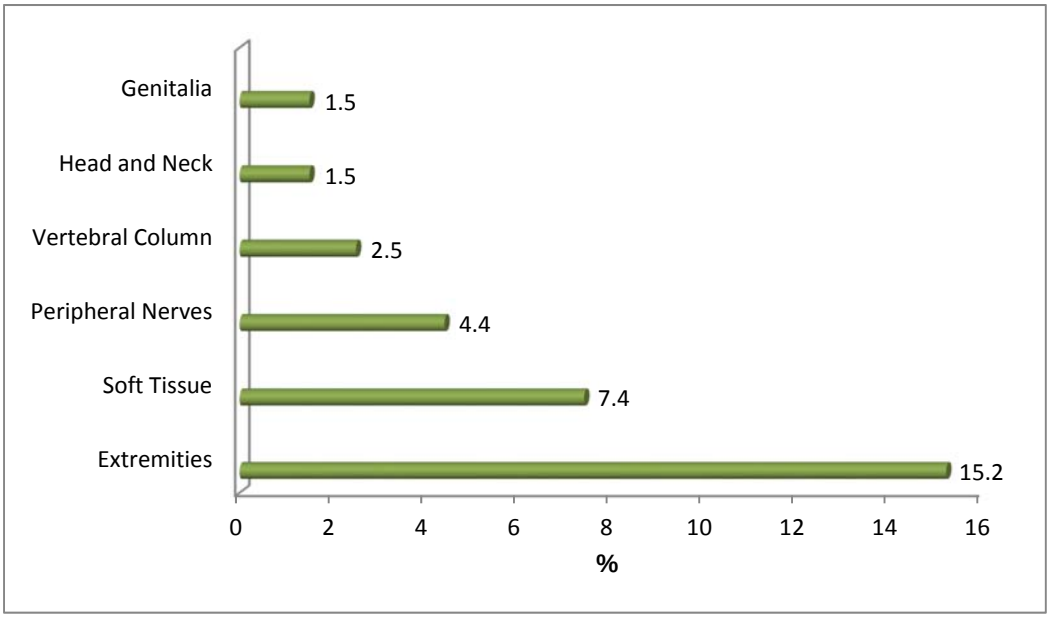

Figure 13. Distribution of Associated Injuries to the Thoracic, Abdominal and Thoraco-abdominal Cases, Benghazi-2011.

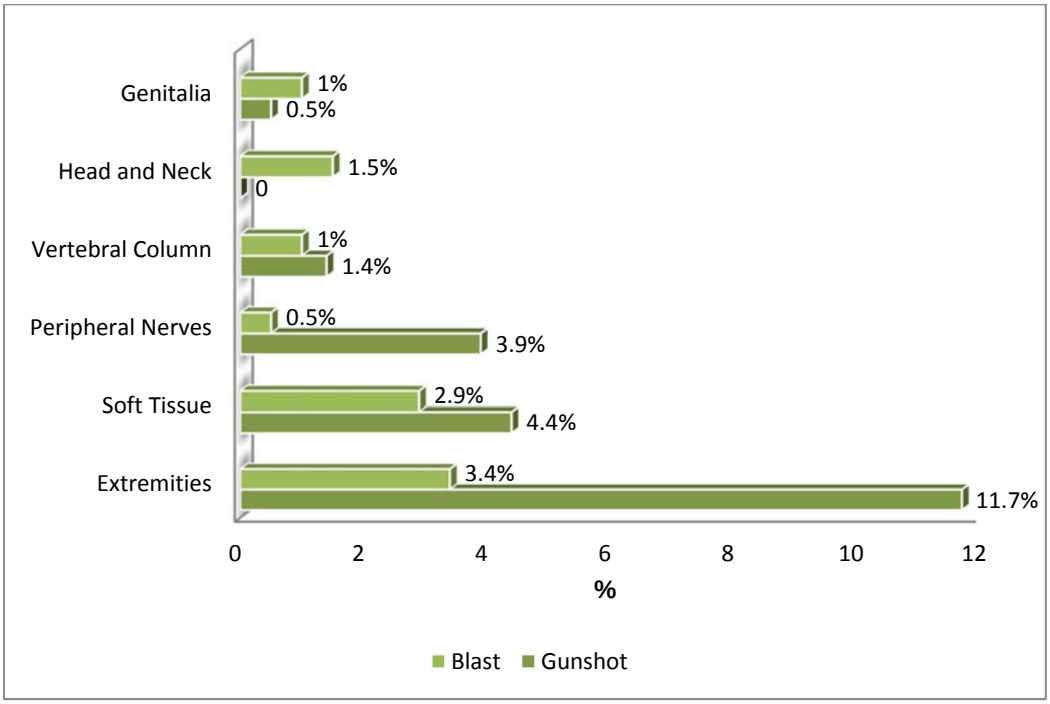

Figure 14. Distribution of Associated Injuries in Relation to the Mechanism of Trauma either by Gunshot or Blast, Benghazi-2011.

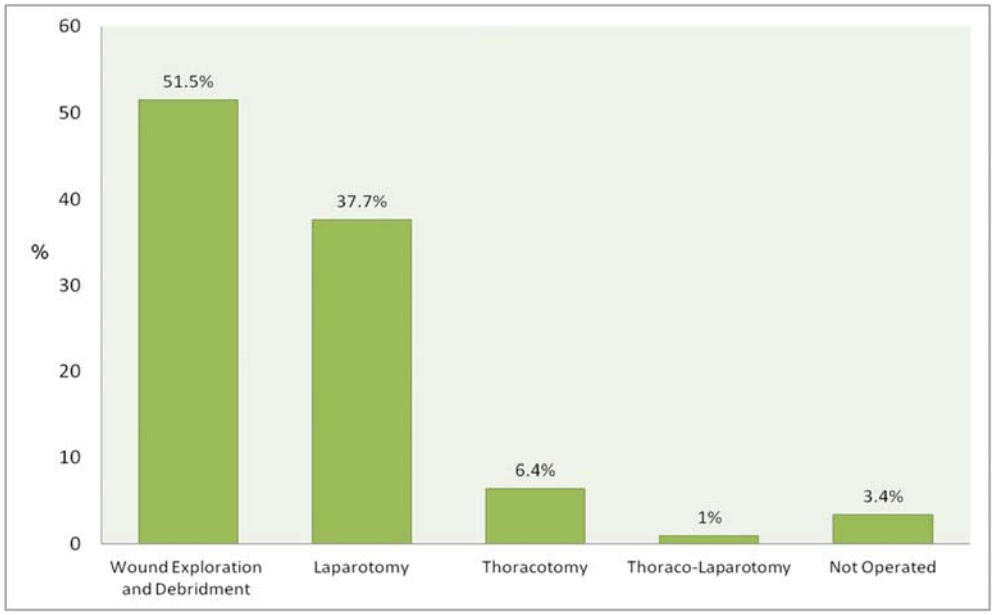

Figure 15. Different Types of Operations of War Related Injuries Benghazi-2011.

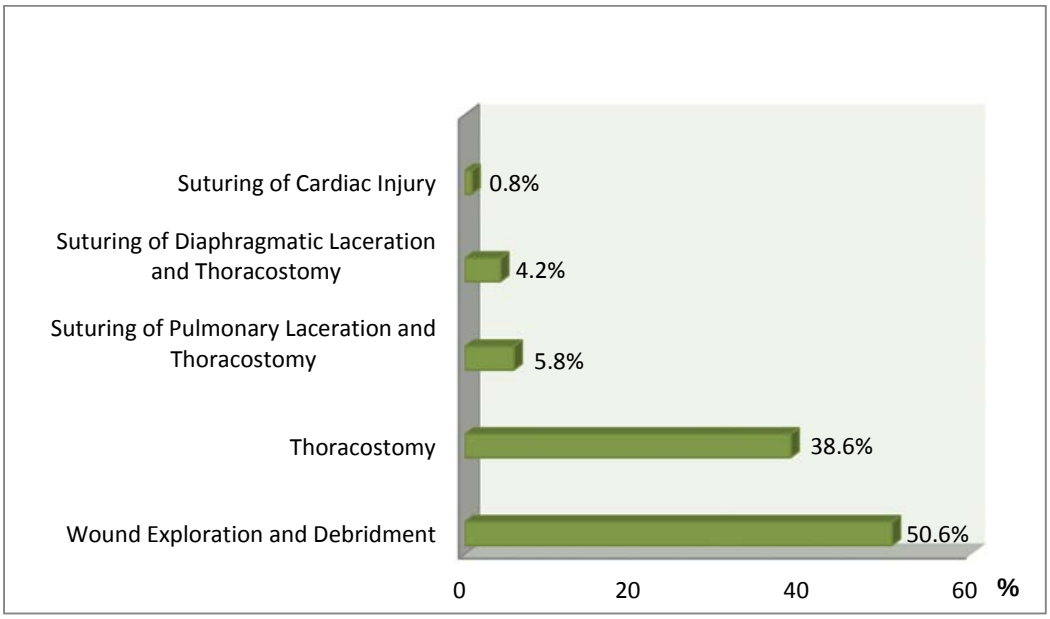

Figure 16. Types of Management of War Injuries of the Chest, Benghazi-2011.

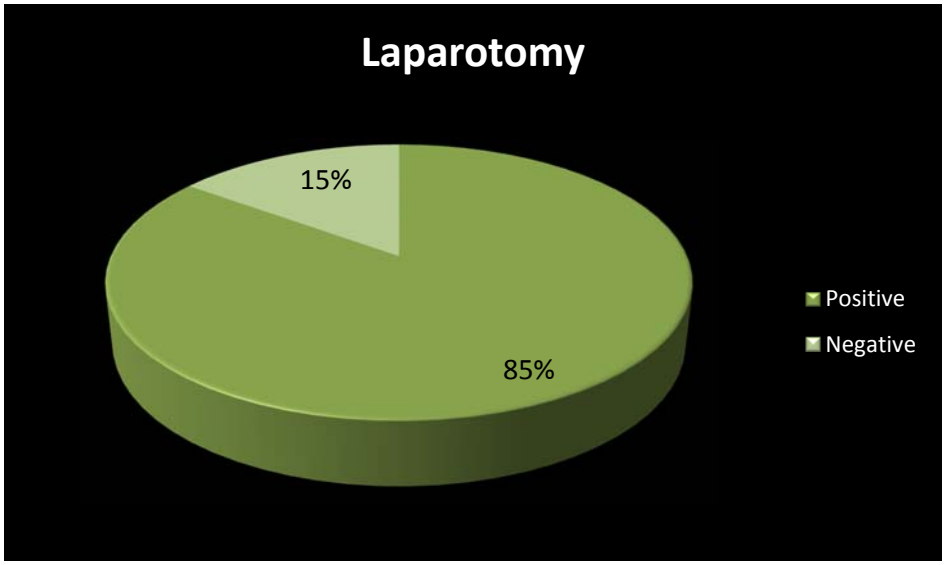

Figure 17. Laparotomy Findings of Intra-abdominal Injuries, Benghazi-2011.

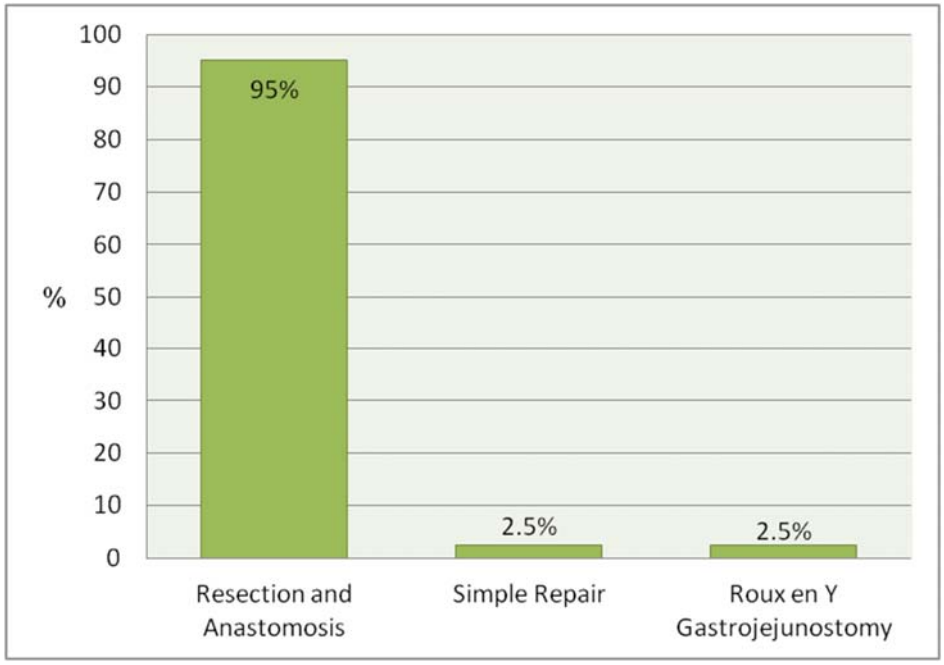

Figure 18. Types of Management of Small Intestinal Injuries, Benghazi 2011.

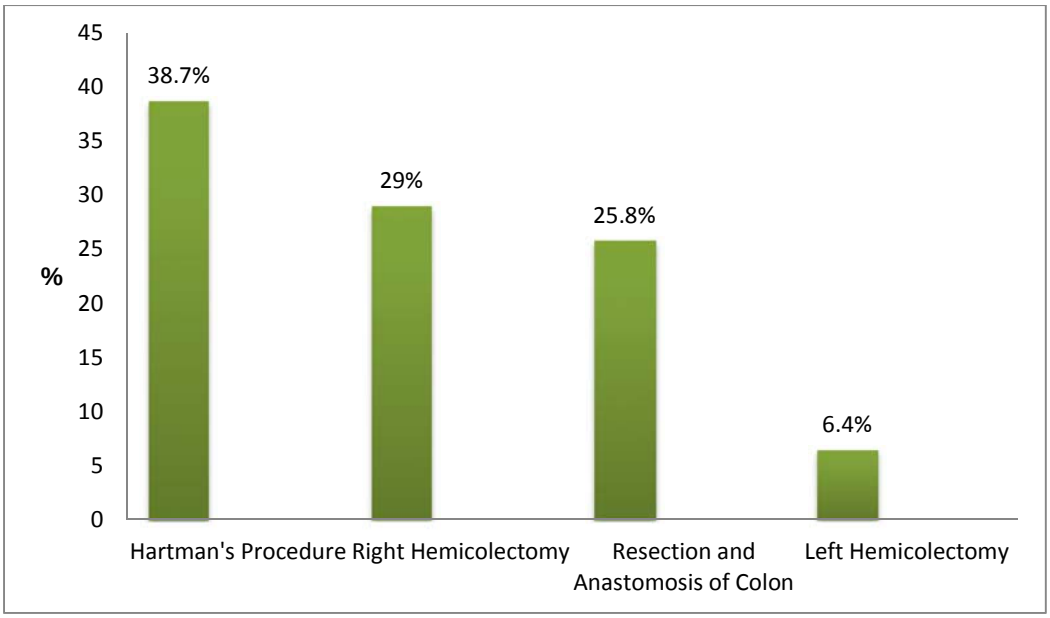

Figure 19. Types of Management of War Related Colonic and Rectal Injuries, Bengazi-2011.

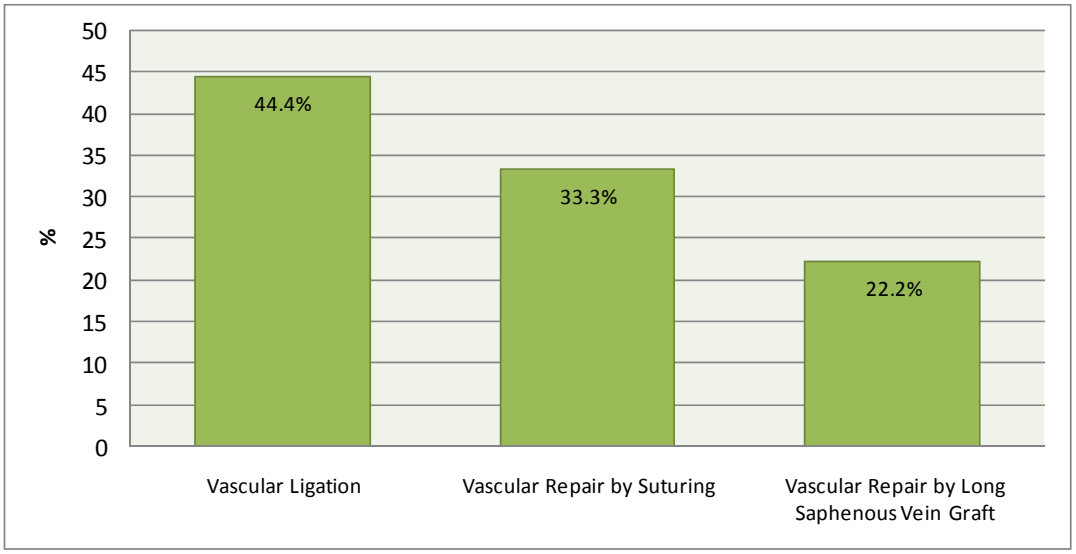

Figure 20. Types of Management of War-related Vascular Injuries, Benghazi-2011.

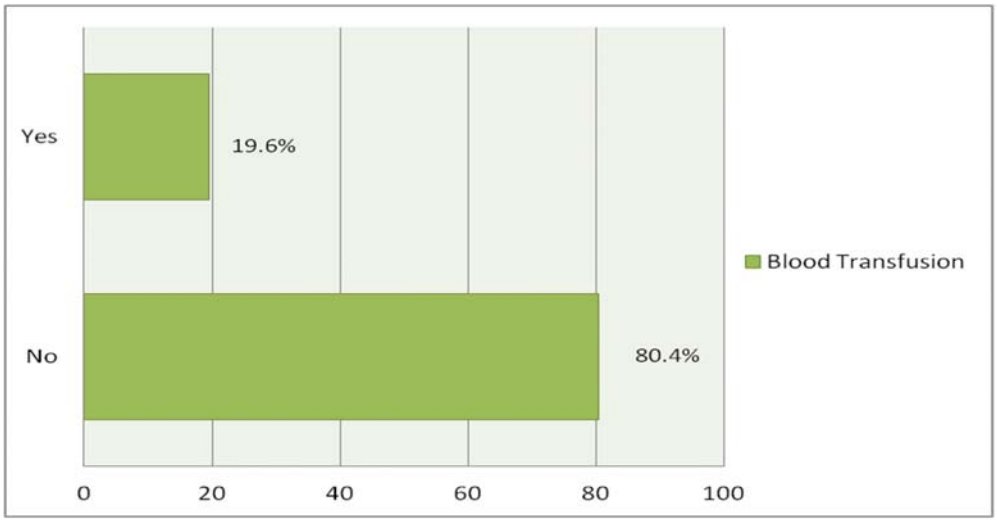

Figure 21. The Demand of Blood Transfusion in War Injuries of The Chest and Abdomen, Benghazi-2011.

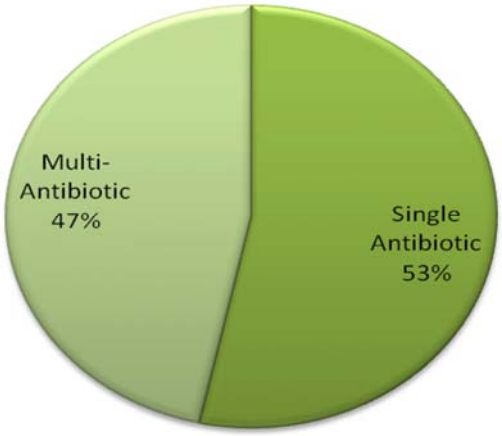

Figure 22. Regimen of Prophylactic Antibiotics for the Treatment of War-Related Injuries, Benghazi-2011.

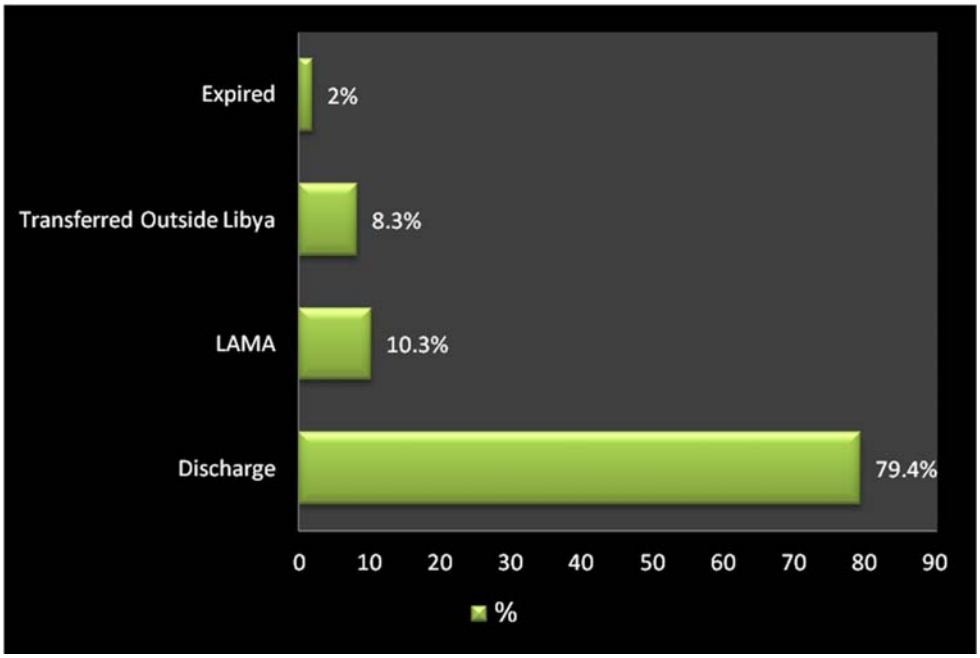

Figure 23. The Prognosis of War-related Cases (Thoracic, Abdominal and Thoraco-abdominal), Benghazi-2011.

VI. Discussion

According to the World Health Organization (WHO), war injuries found to be the first surgical cause of death and the first cause of surgical diseases in Africa (157). During the Libyan revolution in 2011, several rebels were died, and many others were wounded with a variety of trauma ranged from minor to serious injuries, including amputation of limbs and mutilation, as well as psychological and neurological trauma. Wounded rebels were initially treated in the fronts and then transferred for further management in surgical departments at hospitals in Benghazi. In fact the battlefield medical help was made by either medical personals with minimal resources or non medical helpers. Evacuation of injured people was late that was complicate the condition of cases.

While all of the killed and injured warriors were adult males, as civilians or soldiers, who participated in the revolution, few females were accidentally wounded and were included in our study. The ages of the participated subjects in the war were ranged between 20 and 40 years. Trauma has been reported to be the leading cause of hospitalization, long-term disabilities and death in the first four decades of life (160).

Different patterns of injuries were reported with different weapons that were used. Gunshot injuries were obtained at the beginning of the war, then after most injuries were due to implication of the blasts at the peak till the end of war. Most reports classified firearm injuries as low- or high-velocity injuries (1). In low-velocity injuries, only organs directly in the path of the projectile will be affected (2), and the injury is usually less severe as compared with high-velocity injuries, which result in extensive tissue damage (1). Rozen and Dudkiewicz (8) consider blast injuries as energy related, and mainly dependent upon the distance from the blast, the energy released from the bombing device, the media and the environment in which the blast takes place. Moreover, blast injuries are thought to be more dirtier than gunshot wounds and carry a higher potential for infection (9). Lichte et al considered low-energy injuries are associated with minimal soft tissue damage and low risk of wound infection, while high-energy and gunshot injuries are associated with severe soft tissue damage and require an aggressive debridement with several second-look surgeries (1). However, Santucci and Chang suggested treatment of each wound

individually, as guided by clinical observation (6), and to avoid the “Idolatry of Velocity" as was suggested by Lindsey (12).

In the 17-Febrauary revolution, polytrauma found in most of the injured cases whether caused by gunshot or blast. Although multiple associated injuries and fragment wounds in military trauma were reported to be caused predominantly by high-velocity weaponry (10,11).

The injured subjects were treated initially at war scene, then after they were transferred to the surgical departments of the main three hospitals in Benghazi. Sudden arrival of those injured people was creating a demand of resources that caused a dilemma in operation rooms, diagnostic images, ICU and subspecialty staff of surgery. Furthermore, the lethality of weapons and the speed of the evacuation from the battlefield have played a role in the outcome of an injury (13). The anatomical location of wounds in addition to the lethality of the weapons affected the ratio of the killed in action (KIA) to the wounded subjects (13).

While the chest was the most injured site with all types of used weapons in our study, blast has greatest risk of injury to lungs and gastrointestinal tract (11). Thoracic trauma has registered in 7.5% of injured casualties during the Libyan war compared to 15% of thoracic war injuries reported by other investigators (23). Wounds to the chest can be highly lethal (24); depending on the injured organ. A large percentage of the wounded subjects die before reaching the hospital (24).

Superficial non penetrating wounds were the most common presentation of thoracic injuries in the enrolled cases. While it was observed to be less in other war studies (23,25). Although trauma to the chest is very critical since important organs and vessels may become affected, hemopeumothorax was the commonest presentation of parenchymal injury in our study followed by pneumothorax. Significant incidence of hemopneumothorax was reported more in gunshot injuries than in blast injuries. Although, pneumothorax occurred in a significant incidence in a transpleural penetration of the chest (41). It was doubled more in gunshot injuries than blast injuries and it was reported in about 15% of penetrating thoracic injuries and this was in good agreement with other studies (63). Furthermore, the parenchymal injury with usual forms of presentation (hemo- or hemopneumothorax) was found to be the most

common cause of bleeding from penetrating chest injuries (24), and this followed by injury to the internal thoracic or the intercostal vessels (40).

The cardiac injury was uncommon in our study. As an injury to the heart is usually presented in the form of cardiac tamponade and excessive hemorrhage (42,43). However, around 60-81% of patients with a penetrating injury to the heart die before reaching the hospital (43). The incidence of thoracic vascular injuries in our patients was 4.2% of all thoracic cases, and it was similar to other reports (40,44,45,46). Perhaps the pre-hospital mortality is overwhelming (24).

Ribs fracture had a low occurrence in our study. Nevertheless, most chest injuries were found to be associated with rib fractures (26,47). Rib fractures are not usually lethal, but the pain from the fractures may have a negative impact on the pulmonary function (24). The pathophysiologic findings including ventilation/perfusion abnormalities, increase of respiratoric work, hypoxemia and decrease in the functional residual capacity are associated with the multiple fractured ribs (48).

One of the serious condition of thoracic injuries was the flail chest. It was reported significantly in gunshot injuries of the chest in our study. During inspiration lung segment collapse may occur with a larger flail segment (48). Large contusions either of the chest wall or the lung may be associated with atelectasis and shunting of blood. Trapping of blood within the pleural space impairs its own absorption and acts as an ideal media for bacterial proliferation (48). The chest wall defect plays a role in compliance decrease and increase in airway resistance, associated decrease in pulmonary diffusion and increase of respiratory work (48).

Diaphragm is often involved in the lower chest injury (41), and represents up to 15% of all penetrating wounds to the chest (33) and around 59 % of thoraco-abdominal wounds as reported by Murray and Demetriades (49). In our study, the diaphragmatic injury was found mostly in association with the trauma to the thoraco-abdominal region. Its incidence was observed more in gunshot injuries than in blast injuries. As isolated diaphragmatic injuries are uncommon (23), Demetriades et al reported that 75% of patients with penetrating injuries to the diaphragm had associated intraabdominal injuries (50).

There was no documented thoracic duct injury or tracheobronchial tree injury in our series of thoracic cases, which they were known to be uncommon (24). The injury of tracheobronchial tree often went unrecognized until the development of tracheobronchial fistula, mediastinitis or empyema (41). The other undocumented trauma through our study was the esophageal injury, as it has no specific clinical signs or chest X-ray findings (41).

The abdominal injuries were reported in about 6.6% of all admitted cases at Libyan war time, compared to other warfare occurrence of abdominal injuries that represented in 10-15% of injured cases (16). Approximately 10% of those killed in action (17). Wounding agents are most often either bullets or fragments from various detonating devices (18). Severity of pathology induced by these agents and prolonged lag time between injury and treatment constitute major differences between peace and war abdominal injuries (18). In addition wound contamination and wounding potential of firearms and ammunition have played a role (1).

Penetrating abdominal wounds were significantly high in comparison to the superficial non penetrating wounds of the abdomen in our study. Most of the abdominal wounds were through the anterior abdominal wall while few cases had posterior abdominal wall wounds. Thoraco-abdominal cases showed 4.4% of bullet entry through anterior abdominal wall while 1.5% of cases, bullet entry was through the posterior abdominal wall. Analysis of these data showed that all admitted patients with posterior abdominal wall wounds subjected to laparotomy with positive findings of intra-abdominal injuries. Whitfield and Garner claimed that thick musculature of the back and the vertebrae confer a degree of protection against peritoneal violation by a penetrating missile (28). Velmahos et al. (162) differentiated between anterior and posterior gunshots. Twice as many posterior gunshot wounds were managed conservatively as anterior ones. In other patient series, especially with gunshot wounds to the back, the incidence of significant intra-abdominal injury was much lower - prompting many trauma centers to consider selective management (163,164,165).

Small intestinal injuries were common intra-abdominal findings in our study, where they often occurred in multiple injuries. As this was similar to other studies (95). The

colon was the second hollow viscus that frequently injured in our series of cases, which was similar to the documented results of penetrating abdominal trauma by other investigators (95). Although, simple isolated colon injuries are uncommon (7); in our study, the isolated left and right colon injuries were found in 8.5% and 3.8% of patients respectively. Traumatic injuries to the colon are associated with significant morbidity. In reports of the Civil War, most colon injuries were fatal; not simply from the battlefield injuries themselves but also from secondary infection and sepsis (10). In our study, the rectal injuries were reported in 2.8% of abdominal cases. Its involvement was suspected in nearly all settings of penetrating buttock wounds (7). In penetrating abdominal trauma; injuries to colon and rectum accounts for up to 20% to 35% (166), while in wartime series during Operation Iraqi Freedom, had reported an incidence of 5 to 10% of colonic injuries and 5.1% of patients revealed colon and rectal injuries (167,168,169).

The other hollow viscus involved in the abdominal trauma was the urinary bladder, which badly presented in the wartime cases. The percentage of bladder cases was about 4% of all abdominal injuries. The least injured hollow viscus was the gallbladder, which occurred in a few cases in association with liver trauma.

The hepatic and splenic injuries were reported equally with different degrees of trauma, ranging from capsular hematoma to severe shuttering of the injured organ. They were observed in 12.4% of abdominal cases for each. In other reports, hepatic injuries were reported in about 5% of abdominal wounds (95), while injuries to the spleen represent approximately one quarter of all blunt and penetrating thoraco-abdominal injuries (127). In the present study, the injuries of liver and spleen were caused mainly by gunshot more than blast trauma. Although, other studies of splenic injuries have found that penetrating and blunt trauma were about equal in the etiology of splenic rupture (128,129).

The renal injuries were reported in a low percentage in our study. The other solid organ that showed less occurrence was the pancreas. Injuries to pancreas was reported in one case of penetrating abdominal injury, and this was in good agreement with other reports (95).

Abdominal vascular injuries found to be among the most fatal injuries sustained by trauma patients (133,134). The vascular abdominal injuries were reported in about 5%

of the abdominal cases, while in other reports, they occurred in 10% of hospitalized war injured patients (56).

A low incidence of retroperitoneal hematoma was found in our study in comparison to other studies. However, there is a lack of documentation to the specific type of retroperitoneal hematoma in operation notes of those patients.

All wounded subjects of the Libyan war received an immediate evaluation and first aid managements at the frontline hospitals. Thereafter patients were transferred to the surgical departments at the hospitals in Benghazi to receive further medico-surgical care. The injured subjects received an immediate survey based on the principles of Advanced Trauma Life Support (ATLS) (31) including:

- Establishment of a secure airway and provision of high concentrations of oxygen,
- Establishment of adequate ventilation, and
- Control of hemorrhage.

As the majority of injured subjects were initially received a surgical care in the war zone, eighty eight per cent of the injured cases in our study were admitted in a stable condition. The remaining of cases were received in a shock. On admission; shock was defined as systolic pressure of less than 90 mm Hg and pulse rate greater than 100 per min (9). Most of shocked cases received an initial survey in ICU with maintained airway, fluid transfusion and controlling of bleeding while others were transferred directly to the operating rooms as a life saving management.

In stable subjects, chest X-ray was applied. It showed the expansion of the lungs and mediastinum (32). Pneumothorax, hemothorax, subcutaneous or mediastinal emphysema, widened mediastinum, and the presence of retained missiles were sought and detected on the chest film (33). The amount of blood that can be detected on chest X-ray is about 150 to 200 ml (26).

The second standard investigation was an ultrasound examination. It was helpful in identifying a pericardial tamponade (34). The other diagnostic tools as CT, angiography, esophagoscopy, barium swallow, and bronchoscopy didn't used as emergency diagnostic tools at the time of Libyan war where a huge gush of injured subjects faced for the first time. The application of CT scan allows the delineation of the precise injuries (1), and it can show the trajectory of mediastinal injuries in 75%

(35). Angiography, esophagoscopy, barium swallow, and bronchoscopy may play a further role in identification of injuries (36).

During the Libyan war, most of the thoracic injuries were managed conservatively, and about one third of them were managed only by a chest tube insertion. The algorithms of management for war injuries to chest were similar to most trauma centers. Where the management of gunshot injuries can be done successfully without explorative thoracotomy (24,52,53,54). Since the basis of management of chest injuries includes treatment of respiratory insufficiency and haemorrhagic shock, with prevention of infection (55).

Most of pulmonary parenchymal injuries are self-limited. This is partially due to the low-pressure circuit in the lungs (24,62). Therefore, most war wounds of the lung can be successfully managed by "conservative" surgical treatment (55). In our series of cases, seventy per cent of penetrating thoracic injuries were managed by a tube thoracostomy. This was similar to other reports (26).

In all cases of pneumothoraces larger than 2 cm and haematothoraces extending over the seventh rib (39), insertion of a chest tube (53,58,59) and local excision of injured soft tissue surrounding the wound (60), while avoidance the primarily closure (61), were found to be the most important therapeutic intervention. However, the chest tube may be badly positioned or blocked by a clot, therefore, chest drain output alone is not a reliable sign, and it must be interpreted together with the overall clinical picture (40).

The management of lung contusion associated with rib fractures, consists of analgesics, early mobilization, chest physiotherapy and fluid administration, while most severe cases require intubation and mechanical ventilation (24). The parenchymal injuries can be treated successfully by pneumonorrhaphy (suture of the lung), tractotomy or wedge resection for good hemostasis (24,62). The recovery of lung function will be achieved in both conservatively and operatively treated patients (55).

In our enrolled cases, thoracotomy was reported in 6.4% of injured subjects, while 1% of cases had thoraco-laparotomy. O'Connor and Adamsk, reported that thoracotomy was required in less than 15% of the cases of hemothorax (26). Thoracotomy has been indicated when there is a clinical or echocardiographic

evidence of cardiac tamponade, unstable cardiac circulation, or a chest tube delivering more than 1 to 1.5 liters of blood immediately after the insertion or continued bleeding of more than 200 ml/h for 3 hours (29,39,60). Other indications include a massive or persistent pleural air leak over 24 hours or earlier, or if there is a major defect of the chest wall (63).

Diaphragmatic injuries less than 2 cm in diameter are managed by re-approximation with interrupted non-absorbable sutures. While lacerations larger than 2 cm are approximated as for simple small lacerations, then reinforced with a running suture to assure an airtight closure (23). Patients with left thoracoabdominal or anterior right thoracoabdominal injuries should be evaluated laparoscopically even if there are no signs of diaphragmatic injury, since 31% of proven diaphragmatic injuries show no signs of peritonitis and 40% of chest films appear normal (46).

Most of our patients have subjected to a physiotherapy; as it was of paramount importance (66).

Patients with abdominal gunshot injury are evaluated with priority to airway, breathing and circulation (65,66). In 1997, the American College of Surgeons, recommended that initial management of the patients should proceed along the standard ATLS lines of 'ABCDE' and an obvious abdominal wound must not distract from the basic assessment nor from the potential for co-existing life threatening extra-abdominal injury that must be immediately addressed (28).

In the present study, most of the injured subjects were received in a stable condition as an immediate management was applied to them at frontline hospitals. The importance of hemodynamic status reflects the treatment strategy of injuries (1). The general condition of the patients may vary from absolute stability to complete collapse (28). Patients with a stable hemodynamic state are evaluated by a complete secondary physical examination with a comprehensive abdominal examination, while hemodynamically unstable patients are taken directly to the operating room for controlling hemorrhage and contamination (65,67). However, patients come in shock due to abdominal injuries and internal organ involvement have an increased incidence of death (21).

On clinical examination, abdominal signs of gunshot injuries may be present in complete absence of signs to frank peritonism (28). Peritoneal irritation revealing rebound tenderness and non voluntary guarding, is an evidence of intra-abdominal

organ injury and an indication for immediate laparotomy, irrespective of the location of the penetrating wound (65,67,68).

Ultrasonography was the most common diagnostic tool used for most of abdominal war injuries in our study, as it was the most sensitive and the least invasive procedure (1). However, the use of ultrasonography should not be the basis for decision making whether to operate or not (73). The protocol for Focused Assessment with Sonography in Trauma (FAST), and the CT-scan (only for stable patients) are generally accepted diagnostic tools for patients with abdominal gunshot injuries (71,72). Although, the use of CT in diagnosing abdominal injuries at Libyan war time was inaccessible for every wounded patient. The diagnostic peritoneal lavage (DPL) is much less frequently used in the evaluation of presence of blood in the peritoneal cavity of trauma patients (1,74). However, this diagnostic procedure shows sensitivities of 84 to 97% for the detection of intestinal injury, and hence, should remain as an adjunct in the management of abdominal trauma, especially in the combat setting (75,76), in spite that it gives no information on specific injuries (65).

In some trauma centers, up to 90% of patients with gunshot wounds were associated with higher intra-abdominal injuries that require repair (170,171), however, the optimal management of an open abdomen remains controversial (60,78). In general consensus, laparotomy is indicated in patients with abdominal gunshot injuries who are hemodynamically unstable or show signs of peritonitis or evisceration (72,79,80,81).

In our study, Laparotomy was reported in 72% of abdominal cases. About 15% of the operated cases had negative laparotomies. While in other reports, a negative laparotomy was reported in up to 27% of abdominal gunshot injuries (10).

All enrolled posterior abdominal wall wounds in our study were subjected to laparotomy with positive findings of intra-abdominal injuries. While in other patient series with gunshot wounds to the back, the incidence of significant intra-abdominal injury is much lower; prompting many trauma centers to consider selective management (29,163,164,165). Velmahos and Degiannis, (69) reported that wound track estimation was found to be 10% false positive for posterior GSWs; and Demetriades et al. (70) reported that only 75.4% sensitivity in predicting an intraperitoneal injury requiring surgical repair in anterior gunshots.

In the present study, injuries to stomach were reported in 3% of abdominal cases and were managed by gastrojejunostomy. Injury to the stomach has often associated with lesions of adjacent organs: the liver, spleen, colon, pancreas, duodenum, great vessels and kidney, resulting in a high mortality rate (95).

Few cases of duodenal injuries were reported in our study. Their management ranged from simple repair to gastrojejunostomy according to the associated injuries. Primary repair of duodenal injuries is preferred if feasible and narrowing of the lumen less than 50% can be accepted (7,86). All duodenal injuries were drained (7). Missed injuries to the duodenum have devastating morbidity and are associated with high mortality (7).

In the present study, most of the small bowel injuries were managed by resection and anastomosis. Gastrojejunostomy was done in few cases of small bowel injuries. Furthermore, it has been suggested that small bowel resection will be necessary when there is major disruption of the lumen; multiple small perforations over a short area; disruption on the mesenteric border; or the blood supply to a segment has been compromised (95).

The management of colon injuries through the Libyan crisis showed different patterns. More than half of the right colon wounds were managed by primary repair versus to only 13% of the left colon wounds that managed by primary repair. This was similar to other studies (173). One quarter of colonic injuries managed by resection and anastomosis. This had an equal incidence in both left and right colon injuries.
Hemicolectomy was reported more in right colon wounds rather than left colon wounds. As left colon injuries were more sever. Fecal diversion was reported in more than quarter of left colon injuries. Furthermore, no registered cases of right colon diversion has been registered. In Operation Iraqi Freedom found a trend, though not statistically different, in diversion rates based on location with left colon versus right colon injuries (169).
In posterior abdominal wall injuries, colon injuries were reported in 5.7% of the patients in our series, while some other investigators claimed that injuries to the colon by posterior wounds are rare (175). Overall, gunshot wounds of the colon have been demonstrated to be an important predictor of increased mortality and morbidity

(176). In our series, all rectal injuries were managed by Hartman's procedure. As they presented in a severe form.

The major concern in the treatment of liver injuries is hemostasis (126). As liver tissue is a very well vascularized, even major tears heal without primary debridement (125). In the present study, most of the hepatic injuries were managed by suturing and gel foam application. Although, the conservative management was applied in few cases of liver injuries without any surgical intervention. Furthermore, simple lacerations or perforations through the periphery of the liver that have stopped bleeding require no specific therapy, while deeper wounds that continue to bleed need to obtain hemostasis either by cautery, clips, or ligature, which are equally effective. (126). For significantly devitalized tissue; re-sectional debridement is required while a formal hepatic lobectomy was never indicated (126).

Injuries to the gallbladder were uncommon in our series of cases and all were treated by cholecystectomy. Furthermore, injuries to the common bile duct should be repaired over a small tube with a closed suction drain (126).

The management of splenic injuries over the last century has turned to salvage of the spleen rather than splenectomy to preserve as much as possible the immunologic function of the spleen (131). However, most of splenic injuries in the present series of cases were managed by splenectomy. On the other hand, management of splenic injury by suturing of the wound and salvage of the spleen was rare in our series of cases. As splenic repair by splenorrhaphy or partial splenectomy was always attempted if three criteria were met: hemodynamic stability, lack of multiple associated injuries mandating expeditious splenectomy, and injuries less extensive than a shattered or devascularized spleen (132).

The demand of blood transfusion for those with splenic injuries was based to some extent on the type of splenic managements. More than one third of the splenectomy cases were received blood. The amount of the transfused blood was ranged from 1 to 7 units. On the other hand, the splenorrhaphy case did not receive blood. Through the duration of stay at hospital, about half of cases that subjected to splenectomy stayed for one week, while one quarter of them stayed for two weeks. The maximum stay at the hospital was four weeks and this reported in few cases with splenectomy. However, the splenorrhaphy case stayed for just one day duration.

All of reported renal injuries in our series were managed by nephrectomy. As nephrectomy was the best solution for major renal injuries when other life-threatening injuries present. Nevertheless, determining the function of the contralateral kidney (confirmed by contrast study) is desirable prior to nephrectomy (7). However, there should be a low threshold for nephrectomy in the unstable patient where penetrating renal injuries can be managed by debridement and drainage (7). Furthermore, management of grade IV injuries can involve either immediate operative exploration or a trial of aggressive resuscitation with crystalloid and blood products, depending on the availability of resources and the level of expertise of available surgeons (7).

As the pancreatic injury was rare, the reported management in our study was a Roux-en-Y gastrojejunostomy. However, the superficial injuries of pancreas is managed efficiently by closed suction drainage, while deeper injuries that involve the major pancreatic ducts, require more aggressive intervention. Moreover, transection or near-transection of the mid-body of the pancreas can be treated by ligation of the distal end of the proximal duct and a Roux-en-Y anastomosis of the distal remnant into the gut. If there is severe destruction of the head of the pancreas and duodenum, a pancreaticoduodenectomy may be required to save the patient which is uncommon situation (126).

In our enrolled cases, the incidence of vascular injuries was 5.4% compared to 10% of hospitalized war injured patients as reported by other investigators (56). Less than half of cases were managed by vascular ligation, while about one third of them were managed by primary repair. The remaining of vascular injuries were repaired by long saphenous vein graft.

During the Libyan war, most of the injured subjects presented with multiple injuries of different parts of the body. The extremities were found to be the most common injured part of the body in association to the thoracic, abdominal and thoracoabdominal cases. As gunshot injuries of the extremities are rarely life-threatening but can be associated with severe morbidity (1). More than two third of injuries to extremities were due to gunshot while the remaining were due to blasts. Since World War II, several reports pointed at a relative decrease in lower extremity and torso wounds and an increase in head/neck and upper-extremity wounds (161). A trend attributed to the advent of improved personal protective equipment as well as

the use of improvised explosive devices (IEDs) (161). The soft tissue injuries were frequently reported in association to thoracic and abdominal cases. As they found more in gunshot than in blast trauma. The other associated injured organs were peripheral nerves, vertebral column, genitalia, and head and neck. They did not show a significant incidence between gunshot and blast trauma. However, all the teams of subspecialties were encouraged in the management of those injuries.

In our enrolled cases, early complications were reported within the first two weeks in less than one quarter of admitted cases. As war wounds carried a high risk of infection. The commonest complication was wound infection either in gunshot or in blast injuries. However, wounds were considered infected if discharged pus, had local erythema, stitch abscess, or a culture-positive discharge (21). Risk factors for the infection included a delay in wound management, lack of adequate wound management, a wound size between 1-2 cm, and failure to comply with the instructions on wound care (178). On the other hand, wound dehiscence was uncommon in our study.

Other reported complications were empyema and atelectasis which occurred more in thoracic cases than in abdominal cases. A few patients with thoracic injuries got pneumonia while others complicated by hemopneumothorax. Bilothorax was rare in the present study. DVT is another non-specific complication that got in the thoracic cases.

In our series of cases, primary hemorrhage was reported through the thoracic injuries, while secondary hemorrhage was reported through the abdominal injuries. As hemorrhage was considered primary when occurred within 24 hours of wounding; intermediate when occurred between the first and tenth days; and secondary when occurring after the tenth day (179).

The other complications that reported less frequently in the abdominal cases were: anastomotic dehiscence, low output intestinal fistula, prolapsed colostomy and subacute intestinal obstruction. Those relatively less than in other reports (181).

The outcome of thoracic, abdominal and thoraco-abdominal cases through 2-years of follow up reported different complications related to the war injuries. Non specific complications were reported, including: hypertrophic wound scars and residual subcutaneous pellets . Other serious complications that developed were

incisional hernia, fecal and urine incontinence and sinus discharge of the iliac fossa. Some patients got chest deformity and others had chronic thoracic sinus discharge. The other complications were related to the impact of war trauma on different parts of the body. Those were: hearing loss, neuroma, chorioretinal scarring, suicidal attempts, joint stiffness, post-traumatic scar contracture of injured limbs.

As the belief of sterilization of bullets by the heat of firing is false (144,145); the wound induced by gunshot may superimposed by bacterial infections of non-sterile bullets (144). During the management of war wounds, the prophylactic use of antibiotic has been recommended in high-velocity shotgun, while in injuries caused by a low-velocity gunshot, proper wound care is essential for achieving a satisfactory result (146).

In our series of cases, every patient received antibiotics irrespective of the cause of injury; gunshot or blast. About half of cases were treated with a single broad spectrum antibiotic, while the others received a combination of broad spectrum antibiotics. Those antibiotics were Rocephin, Gentamicin and Flagyl.

The recommendation for high-energy gunshot injuries with moderate soft tissue destruction was a 48-hour intravenous administration of a first-generation cephalosporin. Penicillin must be added to patients with gross contamination and Gentamicin may be added in grossly contaminated wounds, such as those with bowel contamination or grossly dirty skin or clothing, where the administration of a broad spectrum antibiotic for 1 to 2 weeks is recommended (147).

War wounds of the chest have had a higher infection potential than civilian injuries because of the high velocity weapons, the contaminated wound environment and the delay to definitive surgery compared with civilian low velocity injuries (148). The concepts for preventive antibiotic usage for penetrating chest trauma are controversial. Some authors showed benefits of antibiotic prophylaxis for patients from the insertion of a chest tube until its removal (149,150). Others suggested a single shot therapy with antibiotics (151).

There is general consensus that gunshot injuries with bowel injuries, or high-energy gunshot injuries with moderate to severe soft tissue destruction require intravenous antibiotic treatment (146,148,152,153). Current guidelines recommend a single preoperative dose of prophylactic antibiotics with broad-spectrum aerobic and anaerobic coverage as a standard of care for trauma patients sustaining penetrating

abdominal wounds (1). Absence of a hollow viscus injury requires no further administration of antibiotics (154).

Data from civilian trauma centers demonstrated that antibiotics administered postoperatively resulted in infectious complications that ranged from 30% with any intraabdominal injury up to 70% when the colon is injured, compared with 11% when antibiotics were given preoperatively (10,155). In a recent review of all combat injuries, a multidisciplinary panel recommended that implementation of broad spectrum antibiotics to include anaerobic activity should be instituted upon arrival following identification of the hollow viscus injury, and continued for 24 hours after definitive control of all enteric contamination (156).

The prognosis of abdominal wounds by ICRC experience (95) depends on three factors:

- The type of missile and amount of energy transferred;
- The organs hit and their number;
- The time since injury.

The rapid transfer of gunshot victims to the hospital within less than 30 minutes (137), availability of type specific blood within 15 min of request (138), surgical intervention time of less than 2 hours (137,139), use of appropriate surgical techniques (140,141,142) and intensive postoperative care (143) would largely counteract the adverse effects of these risk factors on mortality and morbidity (143). Teams at each level of care, as well as the entire team of the military healthcare system extending from the battlefield to stateside medical centers, are critical to patient survival and outcome (11).

In our study, one hundred and sixty two (79%) were discharged and were followed up through the outpatient clinics. About 21 (10.3%) patients were left against medical advice (LAMA) while 17 (8.3%) cases were transferred abroad outside Libya for advanced treatment. About 2% of the cases were expired.

Early mortality from thoracic injuries is usually due to hemorrhage or catastrophic injury associated with head or abdominal trauma; whereas late mortality most often is a result of sepsis and organ failure (24). In penetrating injuries, mortality is more often related to vascular injury and shock than in blunt trauma (26). Historical data

showed that penetrating missile wounds of the trunk were responsible for about one third of combat deaths (30).

Prolonged prehospital time, inadequate supply of blood for transfusions and the high rate of colon injury contribute to a relatively high incidence of postoperative infectious complications and death (182,183).

Bodalal and Mansor reported recent cases of injured persons who admitted to Al-Jalla hospital during 2011; and they have blamed the injuries on the wide spread of arms by young untrained persons during the war and afterwards (184).

The economic impact of gunshot trauma is high, it is the third most costly etiology of injury and the fourth most expensive form of hospitalization (185). Gunshot wounds impose a continuous burden on community and hospital resources (186). Bowyer GW recommends a hard work in identification of conservative management of war wounds in the future (187).

VII. Conclusions

The war-related thoracic injuries were the commonest among our study. In addition to the thoracic and the abdominal injuries, the extremities were the most common associated injured parts of the body. The rate of injuries due to blast trauma was less than that of gunshot trauma. All of the posterior penetrating abdominal and thoraco-abdominal wounds had positive laparotomies. This conflicts other reports that claimed the negativity of laparotomy of the posterior wounds. A low death rate was reflecting the good practice of the inexperienced surgeons in the military trauma.

VIII. Recommendations

1- Proper registration of clinical data in detailed form.

2- Follow the global guidelines of management of wartime injuries.

IX. References

1. Lichte P, Oberbeck R, Binnebösel M, Wildenauer R, Christoph Pape, KobbeP. A civilian perspective on ballistic trauma and gunshot injuries. Scand J Trauma Resusc Emerg Med. 2010; 17;18:35.

2. Bellamy RF, Zajtchuk R (Eds). Conventional Warfare: Ballistic, Blast and Burn Injuries. Washington, DC: Office of the Surgeon General, Department of the Army; 1990.

3. Coupland RM. The Red Cross classification of war wounds: The E.X.C.F.V.M. scoring system. World J Surg. 1992;16(5):910-917.

4. Oehmichen M, Meissner C, Konig HG. Brain injury after gunshot wounding: morphometric analysis of cell destruction caused by temporary cavitation. J Neurotrauma. 2000;17:155.

5. AmatoJJ, Billy LJ, Gruber RP, Rich NM. Temporary cavitation in high-velocity pulmonary missile injury. Ann Thorac Surg. 1974;18:565.

6. Santucci RA, Chang Y-J. Ballistics for Physicians: Myths About Wound Ballistics and Gunshot Injuries. J Urol. 2004;171(4):1408-1414.

7. Nessen SC, Lounsbury DE, Hetz SP. Abdominopelvic Trauma. In: Nessen SC, Lounsbury DE, Hetz SP (Eds). War Surgery in Afghanistan and Iraq: a series of cases, 2003-2007. Textbooks of Military Medicine. Washington, DC: Department of the Army, Office of the Surgeon General, Borden Institute 2008; pp:157-204.

8. Rozen N, Dudkiewicz I. Wound Ballistics and Tissue Damage. In: Lerner A, Soudry A (Eds). Armed Conflict Injuries to the Extremities, DOI: 10.1007/978-3-642-16155-1_2, © Springer-Verlag Berlin Heidelberg 2011.

9. Covey DC. Blast and Fragment Injuries of the Musculoskeletal System. J Bone Joint Surg [Am]. 2002;84:1221–1234.

10. Causey MW, Rivadeneira DE, Steele SR. Historical and Current Trends in Colon Trauma. Clin Colon Rectal Surg. 2012;25(4):189–199.

11. Nessen SC, Lounsbury DE, Hetz SP. Acute Resuscitation and Critical Care. In: Nessen SC, Lounsbury DE, Hetz SP (Eds). War Surgery in Afghanistan and Iraq: a series of cases, 2003-2007. Textbooks of Military Medicine. Washington, DC: Department of the Army, Office of the Surgeon General, Borden Institute 2008; pp:17-49.

12. Lindsey, D.: The idolatry of velocity, or lies, damn lies, and ballistics. J Trauma. 1980; 20:1068.

13. Bellamy RF. Are We Doing Better? Assessing Combat Casualty Data. In: Nessen SC, Lounsbury DE, Hetz SP (Eds). War Surgery in Afghanistan and Iraq: a series of cases, 2003-2007. Textbooks of Military Medicine. Washington, DC: Department of the Army, Office of the Surgeon General, Borden Institute 2008; pp:1-13.

14. Dougherty PJ, Najibi S, Silverton C, Vaidya R. Gunshot wounds: Epidemiology, Wound ballistics, and Soft-tissue Treatment. Instr Course Lect. 2009;58:131-139.

15. Maiden N. Ballistics reviews: Mechanisms of Bullet Wound Trauma. Forensic Sci Med Pathol. 2009;5(3):204-209.

16. Becker HP. The Open Abdomen 2011 in War and Catastrophes: Indication, Strategies, and Modern Temporary Closure Techniques. In: Lupi GA, Bosse H-E, Centre of Excellence for Military Medicine (Eds). Emergency Management of Battlefield Injuries. Course Catalogue. Bonn/Germany, Beta Verlag & Marketinggesellschaft mbH 2011; pp:30-31.

17. Rozin RR, Pfefferman R. Management of Abdominal Injuries. In: Reis ND, Dolev E (Eds). Manual of Disaster Medicine. Civilian and Military 1989; Part 4, pp:446-455.

18. Rignault DP. Abdominal Trauma in War. World J. Surg. 1992;16(5):940-946.

19. Adams DB. Abdominal Gunshot Wounds in Warfare: A Historical Review. Mil Med.1983;143:15-19.

20. Nissan F. Penetrating Abdominal Injuries. Int Rev Armee Forces. 1988;61: 132-134.

21. Adesayna AA, Da Roch-Afodu JT, Ekanem EE, Afolabi IR. Factors Affecting Mortality and Morbidity in Patients with Abdominal Gunshot Wounds. Injury. 2000;31(6):397-404.

22. Manring M, Hawk A, Calhoun J, Andersen R. Treatment of War Wounds: A Historical Review. Clin Orthop Relat Res. 2009;467(8):2168–2191.

23. Cubano MA, Lenhart MK. Thoracic Injuries. In: Cubano MA, Lenhart MK (Eds). Emergency War Surgery. 3rd united states revision. U.S. Department of Defense, U.S. Army, Office of the Surgeon General 2004; pp:16.3-16.15.

24. Holmen LB. Gunshot Wounds To The Chest. 2013. Available at: http://urn.nb.no/URN:NBN:no-42756 (Accessed on September 2014)

25. Emergency War Surgery. Nato Handbook. Working Draft. Second United States revision 2000;pp:XXVIII-1-XXVIII-8.

26. O'Connor JV, Adamski J. The Diagnosis and Treatment of Non-Cardiac Thoracic Trauma. Journal of the Royal Army Medical Corps. 2010;156(1):5-14.

27. Cooper C, Militello P. The Multi-Injured Patient: the Maryland Shock Trauma Protocol Approach. Seminars in Thoracic and Cardiovascular Surgery. 1992;4(3):163-7.

28. Whitfield C, Garner JP. The Early Management of Gunshot Wounds Part II: the Abdomen, Extremities and Special Situations. Trauma. 2007;9:47–71.

29. Nessen SC, Lounsbury DE, Hetz SP.Thoracic Trauma. In: Nessen SC, Lounsbury DE, Hetz SP (Eds). War Surgery in Afghanistan and Iraq: a series of cases, 2003-2007. Textbooks of Military Medicine. Washington, DC: Department of the Army, Office of the Surgeon General, Borden Institute 2008;pp:117-154.

30. Bellamy RF. Combat Trauma Overview. In: Zaitchuk R, Grande CM (Eds). Anesthesia and Perioperative Care of the Combat Casualty. Textbook of Military Medicine. Washington, DC: Department of the Army, Office of The Surgeon General, Borden Institute1995;pp:1–42.

31. American College of Surgeons Committee on Trauma. Advanced Trauma Life Support Course. American College of Surgeons. 1997.

32. American College of Surgeons Committee on Trauma: Advanced Trauma Life Support for Doctors, ATLS Student Course Manual. Chicago, American College of Surgeons 2008.

33. Bowley DM, Degiannis E, Westaby S. Thoracic Injury. In: Mahoney PF, Ryan JM, Brooks AJ, Schwab CW (Eds). Ballistic Trauma 2005; pp:241-269.

34. Plummer D. Principles of Emergency Ultrasound and Echocardiography. Ann Emerg Med. 1989;18:1291-1297.

35. Hanpeter DE, Demetriades D, Asensio JA, Berne TV, Velmahos G, Murray J. Helical Computed Tomographic Scan in the Evaluation of Mediastinal Gunshot Wounds. J Trauma. 2000;49:689-694.

36. Nagy KK, Roberts RR, Smith RF, Joseph KT, An GC, Bokhari F, Barrett J. Trans-Mediastinal Gunshot Wounds: Are "Stable" Patients Really Stable? World J Surg. 2002;26(10):1247-1250.

37. Kirkpatrick AW, Ball CG, D'Amours SK, Zygun D. Acute resuscitation of the unstable adult trauma patient: bedside diagnosis and therapy. Can J Surg. 2008;51(1):57–69.

38. Howard IN, Ravdin IS. Surgery Principles and Practice. Philadelfia, Lipnicnot Company 1957.

39. Madiba TE, Thomson SR, Mdlalose N. Penetrating Chest Injuries in the Firearm Era. Injury. 2001;32(1):13-6.

40. Clarke DL, Quazi MA, Reddy K, Thomson SR. Emergency Operation for Penetrating Thoracic Trauma in a Metropolitan Surgical Service in South Africa. The Journal of thoracic and cardiovascular surgery. 2011;142(3):563-8.

41. Initial Evaluation and Management of Penetrating Thoracic Trauma in Adults. Available at: http://www.uptodate.com/contents/initial-evaluation-and-management-of-penetratingthoracic-trauma-inadults?detectedLanguage=en&source=search_result&search=initial+evaluation+and+management+of+penetrating+thoracic+trauma+in+adults&selectedTitle=1%7E150&provider=noProvider

42. Degiannis E, Loogna P, Doll D, Bonanno F, Bowley DM, Smith MD. Penetrating Cardiac Injuries: Recent Experience in South Africa. World journal of surgery.2006;30(7):1258-64.

43. Godwin JD, Tolentino CS. Thoracic Cardiovascular Trauma. Journal of thoracicimaging. 1987;2(3):32-44.

44. Demetriades D. Penetrating Injuries to the Thoracic Great Vessels. J Card Surg.1997;12(2 Suppl):173–179.

45. O'Connor JV, Scalea TM. Penetrating Thoracic Great Vessel Injury: Impact of Admission Hemodynamics and Preoperative Imaging. The Journal of trauma. 2010;68(4):8347.

46. Demetriades D, Velmahos GC. Penetrating Injuries of the Chest: Indications for Operation. Scandinavian journal of surgery SJS : official organ for the Finnish SurgicalSociety and the Scandinavian Surgical Society. 2002;91(1):41-5.

47. Keel M, Meier C. Chest Injuries - What is New? Current Opinion in Critical Care.2007;13(6):674-9.

48. Pellek S. Multiple and Chest Injuries - Surgical Principles of Treatment. In: Lupi GA, Bosse H-E, Centre of Excellence for Military Medicine (Eds). Emergency Management of Battlefield Injuries. Course Catalogue. Bonn/Germany, Beta Verlag & Marketinggesellschaft mbH 2011;PP:8-17.

49. Murray JA, Demetriades D, Cornwell EE 3rd, Asensio JA, Velmahos G, Belzberg H, Berne TV. Penetrating Left Thoracoabdominal Trauma: the Incidence and Clinical Presentation of Diaphragm Injuries. The Journal of trauma. 1997;43(4):624-6.

50. Demetriades D, Kakoyiannis S, Parekh D, Hatzitheofilou C. Penetrating Injuries of the Diaphragm. Br J Surg. 1988;75(8):824–826.

51. Persad IJ, Reddy RS, Saunders MA, Patel J. Gunshot Injuries to the Extremities: Experience of a U.K. Trauma Centre. Injury. 2005;36:407e11.

52. Bastos R, Baisden CE, Harker L, Calhoon JH. Penetrating Thoracic Trauma. Semin Thorac Cardiovasc Surg. 2008;20:19-25.

53. Meyer DM. Hemothorax Related to Trauma. Thorac Surg Clin. 2007;17:47-55.

54. Demetriades D, Velmahos GC. Penetrating Injuries of the Chest: Indications for Operation. Scand J Surg. 2002;91:41-45.

55. Ilić N, Petricević A, Tanfara S, Mimica Z, Radonić V, Tripković A, Frleta Ilić N. War Injuries to the Chest. Acta Chir Hung. 1999;38(1):43-47.

56. Jawas A, Abbas AK, Nazzal M, Albader M, Abu-Zidan FM. Management of War-Related Vascular Injuries: Experience from the Second Gulf War. World Journal of Emergency Surgery. 2013;8:22.

57. Behbehani A, Abu Zidan F, Hasaniya N, Merei J. War Injuries in the Gulf War: Experience of a Teaching Hospital in Kuwait. Ann R Coll Surg Engl. 1994;76:407–411.

58. Asensio JA, Arroyo H Jr, Veloz W, Forno W, Gambaro E, Roldan GA, Murray J, Velmahos G, Demetriades D. Penetrating Thoracoabdominal Injuries: Ongoing Dilemma-Which Cavity and When? World J Surg. 2002;26:539-543.

59. Mulligan CR. Commentary Approaches to the Chest Cavity. In: Nessen SC, Lounsbury DE, Hetz SP (Eds). War Surgery in Afghanistan and Iraq: a series of cases, 2003-2007. Textbooks of Military Medicine. Washington, DC: Department of the Army, Office of the Surgeon General, Borden Institute 2008; pp:117-155.

60. Kandil A. Gunshot Wounds of the Abdomen. Available at: http://www.moh.gov.ps/pmj/GUNSHOT.htm (Accessed on September 2014)

61. Cubano MA, Lenhart MK. Soft-Tissue Injuries. In: Cubano MA, Lenhart MK (Eds). Emergency War Surgery. 3rd united states revision. U.S. Department of Defense, U.S. Army, Office of the Surgeon General 2004;pp:22.1-22.10.

62. Petrone P, Asensio JA. Surgical Management of Penetrating Pulmonary Injuries. Scand J Trauma Resusc Emerg Med. 2009;17:8.

63. Betrancourt B, Dufour D, Jensen SK, Friberg O, Lounavaara A, Owen-Smith M, Salmela J, Silvonen E, Stening GF, Zetterstom B.In: Dufour D, Jensen SK, Owen-Smith M, Salmela J, Stening GF, Zetterstrom B (Eds). Surgery For Victims of War. Geneva, International Committee of the Red Cross 1998;pp:91-101.

64. Janz BA, Johnson J, Angelos TM. Regions and Planes of the Abdomen. Available at: http://emedicine.medscape.com/article/1923166-overview#a1 (Accessed on December 2014)

65. Pryor JP, Reilly PM, Dabrowski GP, Grossman MD, Schwab CW. Nonoperative Management of Abdominal Gunshot Wounds. Ann Emerg Med. 2004;43:344-353.

66. Baldan M, Giannou CP. Basic Surgical Management Of Wars Wounds: The ICRC Experience. East And Central African Journal Of Surgery.2003;8(1):35-38.

67. MacLeod JBA. Penetrating Injuries to the Abdomen – I. 2009. Available at: https://ptolemy.library.utoronto.ca/sites/default/files/reviews/2009/February%20-%20Penetrating%20Injuries%20to%20the%20Abdomen.pdf (Accessed on September 2014)

68. Chicago IL. American College of Surgeons 2008. American College of Surgeons. Advanced trauma life support.

69. Velmahos GC, Degiannis E. The Management of Urinary Tract Injuries After Gunshot Wounds of the Anterior and Posterior Abdomen. Injury. 1997;28(8):535–38.

70. Demetriades D, Velmahos G, Cornwell E, et al. Selective nonoperative management of gunshot wounds of the anterior abdomen. Arch Surg. 1997;132:178–83.

71. Velmahos GC, Constantinou C, Tillou A, Brown CV, Salim A, Demetriades D. Abdominal Computed Tomographic Scan for Patients with Gunshot Wounds to the Abdomen Selected for Nonoperative Management. J Trauma. 2005;59:1155-1160.

72. Nicholas JM, Rix EP, Easley KA, et al. Changing Patterns in The Management of Penetrating Abdominal Trauma: The More Things Change, The More They Stay The Same. J Trauma. 2003;55:1095-1108.

73. Butt MU, Zacharias N, Velmahos GC. Penetrating Abdominal Injuries: Management Controversies. Scand J Trauma Resusc Emerg Med. 2009;17:19.

74. Fakhry SM. The Resident Experience on Trauma: Declining Surgical Opportunities and Career Incentive? Data From a Large Multi-Institutional Study. J Trauma. 2003;54:1-7.

75. Otomo Y, Henmi H, Mashiko K, et al. New Diagnostic Peritoneal Lavage Criteria for Diagnosis of Intestinal Injury. J Trauma. 1998;446991–997.997, discussion 997–999.

76. Henneman PL, Marx JA, Moore EE, Cantrill SV, Ammons LA. Diagnostic Peritoneal Lavage: Accuracy in Predicting Necessary Laparotomy Following Blunt and Penetrating Trauma. J Trauma. 1990;30(11):1345–1355.

77. Feliciano DV. Abdominal Trauma. Maingot's Abdominal Operations, vol 1, ed 9. New York, Appleton and Lange 1989;pp:457-512.

78. Vertrees A, Greer L, Pickett C, Nelson J, Wakefield M, Stojadinovic A, Shriver C. Modern Management of Complex Open Abdominal Wounds of War: A 5-Year Experience. J Am Coll Surg. 2008;207(6):801-9.

79. Pryor JP, Reilly PM, Dabrowski GP, Grossman MD, Schwab CW. Nonoperative Management of Abdominal Gunshot Wounds. Ann Emerg Med. 2004,43:344-353.

80. Inaba K, Demetriades D. The Nonoperative Management of Penetrating Abdominal Trauma. Adv Surg. 2007;41:51-62.

81. Isenhour JL, Marx J. Advances in Abdominal Trauma. Emerg Med Clin North Am. 2007;25:713-33.

82. Becker HP, Willms A, Schwab R. Laparoscopy for Abdominal Trauma. Chirurg. 2006;77:1007-1013.

83. Morrison JE, Wisner DH, Bodai BI. Complications After Negative Laparotomy for Trauma: Long-Term Follow-Up in a Health Maintenance Organization. J Trauma. 1996;41:509-513.

84. Renz BM, Feliciano DV. Unnecessary Laparotomies for Trauma: A Prospective Study of Morbidity. J Trauma. 1995;38:350-356.

85. Holcomb JB. Commentary: Damage Control Resuscitation. In: Nessen SC, Lounsbury DE, Hetz SP (Eds). War Surgery in Afghanistan and Iraq: a series of cases, 2003-2007. Textbooks of Military Medicine. Washington, DC: Department of the Army, Office of the Surgeon General, Borden Institute 2008; pp:17-51.

86. Cotton BA, Guy JS, et al. The Cellular, Metabolic, And Systemic Consequences of Aggressive Fluid Resuscitation Strategies. Shock. 2006;26:115–121.

87. Schreiber MA, Perkins J, et al. Early Predictors of Massive Transfusion in Combat Casualties. J Am Coll Surg. 2007;205:541–545.

88. Niles SE, Mclaughlin DF, et al. Increased Mortality Associated with the Early Coagulopathy of Trauma in Combat Casualties. Forthcoming.

89. Moore EE, Thomas G. Orr Memorial lecture. staged laparotomy for the hypothermia, acidosis, and coagulopathy syndrome. Am J Surg. 1996;172:405–410.

90. Faringer PD, Mullins RJ, et al. Blood Component Supplementation During Massive Transfusion of AS-1 Red Cells in Trauma Patients. J Trauma. 1993;34:481–485.

91. Brohi K, Singh J, et al. Acute Traumatic Coagulopathy. J Trauma. 2003;54:1127–1130.

92. Macleod JB, lynn M, et al. Early Coagulopathy Predicts Mortality In Trauma. J Trauma. 2003;55:39–44.

93. Botha A, Brooks A, Loosemore T (Eds). Definitive Surgical Trauma Skills. Royal College of Surgeons of England 2002.

94. Schnüriger B, Inaba K, Wu T, Eberle B M, Belzberg H, Demetriades D. Crystalloids after Primary Colon Resection and Anastomosis at Initial Trauma Laparotomy: Excessive Volumes are Associated with Anastomotic Leakage. J Trauma. 2011;70(3):603–610.

95. Betrancourt B, Dufour D, Jensen SK, Friberg O, Lounavaara A, Owen-Smith M, Salmela J,Silvonen E, Stening GF, Zetterstom B. In: Dufour D, Jensen SK, Owen-Smith M, Salmela J, Stening GF, Zetterstrom B (Eds). Surgery For Victims of War. Geneva, International Committee of the Red Cross 1998;pp:103-124.

96. Imes PR. War Surgery of the Abdomen. Surg Gynecol Obstet. 1945;81(2.1005308E7):608–616.

97. Miller PR, Fabian TC, Croce MA, Magnotti LJ, Pritchard FE, Minard G, Stewart RM. Improving Outcomes Following Penetrating Colon Wounds: Application of a Clinical Pathway. Ann Surg. 2002;235(6):775–781.

98. Vannix RS, Carter R, Hinshaw DB, Joergenson EJ. Surgical Management Of Colon Trauma in Civilian Practice. Am J Surg. 1963;106:364–371.

99. Stone HH, Fabian TC. Management of Perforating Colon Trauma: Randomization Between Primary Closure and Exteriorization. Ann Surg. 1979; 190(4):430–436.

100. Burch JM, Feliciano DV, Mattox KL. Colostomy and Drainage for Civilian Rectal Injuries: Is That All? Ann Surg. 1989;2095600–610.610, discussion 610–611.

101. Al-Qasabi QO, Katugampola W, Singh ND. Management of Colon Injuries. Injury. 1991;22(1):32–34.

102. Demetriades D. Penetrating injuries of the colon—changing perspectives. S Afr J Surg. 1991;29(1):25–25.

103. Pachter H L, Hoballah JJ, Corcoran TA, Hofstetter SR. The Morbidity and Financial Impact of Colostomy Closure in Trauma Patients. J Trauma. 1990; 30(12):1510–1513.

104. Steele SR. Colon & Rectal Trauma. Available at: https://www.fascrs.org/ (Accessed on October 2014)

105. Edwards DP, Galbraith KA. Colostomy in Conflict: Military Colonic Surgery. Ann R Coll Surg Engl. 1997;79(4):243–244.

106. Woodhall JP, Ochsner A. The Management of Perforating Injuries of the Colon and Rectum in Civilian Practice. Surgery. 1951;29(2):305–320.

107. Cubano MA, Lenhart MK. Abdominal Injuries. In: Cubano MA, Lenhart MK (Eds). Emergency War Surgery. 3rd united states revision. U.S. Department of Defense, U.S. Army, Office of the Surgeon General 2004;pp:17.2-17.16.

108. Elmi AM, Hassan MY, Baldan M. Abdominal War Wounds With Large Bowel Involvement: The Medina Hospital Experience. East And Central African Journal Of Surgery. 2003;8(1):55-58.

109. Stankovic N, Petrovic M, Drinkovic N, Bjelovic M, Jevtic M, Mirkovic D. Colon and Rectal War Injuries. J Trauma. 1996;40(3, Suppl):S183–S188.

110. Williams MD, Watts D, Fakhry S. Colon Injury After Blunt Abdominal Trauma: Results Of The EAST Multi-Institutional Hollow Viscus Injury Study. J Trauma. 2003;55(5):906–912.

111. Kaiser AM, Israelit S, Klaristenfeld D. et al. Morbidity of Ostomy Takedown. J Gastrointest Surg. 2008;12(3):437–441.

112. Vermeulen J, Coene P P, Hout N M Van. et al. Restoration of bowel continuity after surgery for acute perforated diverticulitis: should Hartmann's

procedure be considered a one-stage procedure? Colorectal Dis. 2009;11(6):619–624.

113. Mileski WJ, Rege RV, Joehl RJ, Nahrwold DL. Rates of Morbidity and Mortality After Closure of Loop and End Colostomy. Surg Gynecol Obstet. 1990;171(1):17–21.

114. Pachter HL, Hoballah JJ, Corcoran TA, Hofstetter SR. The Morbidity and Financial Impact of Colostomy Closure in Trauma Patients. J Trauma. 1990;30(12):1510–1513.

115. Berne JD, Velmahos GC, Chan LS, Asensio JA, Demetriades D. The High Morbidity of Colostomy Closure After Trauma: Further Support for The Primary Repair of Colon Injuries. Surgery. 1998;123(2):157–164.

116. Thal ER, Yeary EC. Morbidity of Colostomy Closure Following Colon Trauma. J Trauma. 1980;20(4):287–291.

117. Bulger E M, McMahon K, Jurkovich G J. The Morbidity of Penetrating Colon Injury. Injury. 2003;34(1):41–46.

118. Crass RA, Salbi F, Trunkey DD. Colostomy Closure After Colon Injury: A Low-Morbidity Procedure. J Trauma. 1987;27(11):1237–1239.

119. Carmody BJ. Commentary Abdominopelvic Trauma, Cases Review. In: Nessen SC, Lounsbury DE, Hetz SP (Eds). War Surgery in Afghanistan and Iraq: a series of cases, 2003-2007. Textbooks of Military Medicine. Washington, DC: Department of the Army, Office of the Surgeon General, Borden Institute 2008;pp:157-204.

120. Halvorsen JF, Vagn Nielson O, Bugge-Asperheim B. Injuries of the Colon And Rectum. Ann Chir Gynaecol. 1981;70:787-91.

121. Cleary RK, Pomerantz RA, Lampman RM. Colon and Rectal Injuries. Dis Colon Rectum. 2006;49:1203-1222.

122. Lavenson GS, Cohen A. Management of Rectal Injuries. Am J Surg. 1971;122:226-30.

123. Wiedeman JE, Rignault DP. Civilian Versus Military Trauma Dogma: Who Do You Trust? Mil Med. 1999;164:256-60.

124. Herr MW, Gagliano RA. Historical Perspective and Current Management of Colonic and Intraperitoneal Rectal Trauma. Curr Surg. 2005;6:187-92.

125. Husum H, Ang SC, Fosse E (Eds). Injury to the Liver and Biliary Tract. War Surgery. Field Manual.Third World Network, Penang 2011;pp:547-552.

126. Emergency War Surgery. Nato Handbook. Working Draft. Second United States revision 2000;pp:XXIX-1-XXIX-16.

127. Al-Taie AD, Al-Sabounchi SW. Splenic Injuries in Mosul Province. Bas J Surg. 2003:31-37.

128. Naylor R, Coln D, Shires GT. Morbidity and Mortality from Injuries to the Spleen. J Trauma. 1974;14:733-8.

129. Rosoff L, Cohen JL, Telfer N, et al. Injuries to the Spleen. Surg Clin North Am. 1972;52:667-85.

130. Horgan GI. The Paediatric Liver and Spleen. In: Rumack CR, Wilson SR, Charboneau J William (Eds). Diagnostic ultrasound. Volume 2. Vol. 59. Mosby year Book 1991;pp:1175–1176.

131. Bjerke HS, Bjerke JS. Splenic Rupture. Available at: http://emedicine.medscape.com/article/432823-overview#a4 (Accessed on April 2015)

132. Pachter HL, Guth AA, Hofstetter SR, Spencer FC. Changing Patterns in the Management of Splenic Trauma. The Impact of Nonoperative Management. Ann. Surg. 1998;227(5):708-719.

133. Asensio J A, Chahwan S, Hanpeter D, et al. Operative management and outcome of 302 abdominal vascular injuries. Am J Surg. 180: 528-534, 2000.

134. Asensio J A, Soto S N, Forno W, et al. Abdominal Vascular Injuries: The Trauma Surgeon Challenges. Surg Today. 2001;31:949-957.

135. Fox C, Gillespie D, O'Donnell S, Rasmussen T, Goff J, Johnson C, Galgon R, Sarac T, Rich N: Contemporary Management of Wartime Vascular Trauma. J Vasc Surg. 2005;41:638–644.

136. Rich NM, Rhee P. AHistorical Tour of Vascular Injury Management: from its Inception to the New Millennium. Surg Clin North Am. 2001;81:1199–1215.

137. Fiedler MD, Jones LM, Miller SF, Finley RK. A Correlation of Response Time and The Results of Abdominal Gunshot Wounds. Archives of Surgery. 1986;121:902±4.

138. Henneman PL. Penetrating Abdominal Trauma. Emergency Medicine Clinics of North America. 1989;7:647±66.

139. Chappuis CW, Frey DJ, Dietzen CD, Panetta TP, Buechter KJ, Cohn I. Management of Penetrating Colon Injuries. Annals of Surgery. 1991;213:492±8.

140. Feliciano DV, Burch JM, Spjut-Patrianely V, Mattox KL, Jordan GL. Abdominal Gunshot Wounds: An Urban Trauma Center's Experience with 300 Consecutive Patients. Annals of Surgery. 1988;208:362±70.

141. Feliciano DV, Rozycki GS. The Management of Penetrating Abdominal Trauma. Advances in Surgery. 1995;28:1±39.

142. Wisner DH, Blaisdell FW. Visceral Injuries. Archives of Surgery. 1992;127:687±93.

143. Abou-Khalil B, Scalea TM, Trooskin SZ, Henry SM, Hitchcock R. Hemodynamic Responses to Shock in Young Trauma Patients: Need for Invasive Monitoring. Critical Care Medicine. 1994;22:633±9.

144. Thoresby FP, Darlow HM. The Mechanism of Primary Infection of Bullet Wounds. Br J Surg.1967;54:359-61.

145. Wolf AW, Benson DR, Shoji H, Hoeprich P, Gilmore A: Autosterilization in Low-Velocity Bullets. J Trauma. 1978;18:63.

146. Simpson B, Robert H, Wilson R, Grant R. Antibiotic Therapy in Gunshot Wound Injuries. Clinical Orthopaedics and Related Research. 2003;408:82–85.

147. Cornwell EE III, Dougherty WR, Berne TV, et al. Duration of Antibiotic Prophylaxis in High-Risk Patients with Penetrating Abdominal Trauma: A Prospective Randomized Trial. J Gastrointest Surg. 1999; 3:648-653.

148. Bayston R, de Louvois J, Brown EM, Johnston RA, Lees P, Pople IK. Use of Antibiotics in Penetrating Craniocerebral Injuries. "Infection in Neurosurgery" Working Party of British Society for Antimicrobial Chemotherapy. Lancet. 2000;355(9217):1813-7.

149. Nichols RL, Smith JW, Muzik AC, et al. Preventive Antibiotic Usage in Traumatic Thoracic Injuries Requiring Closed Tube Thoracostomy. Chest. 1994; 106:1493-1498.

150. Gonzalez RP, Holevar MR: Role of Prophylactic Antibiotics for Tube Thoracostomy in Chest Trauma. Am Surg. 1998;64:617-620.

151. Demetriades D, Breckon V, Breckon C, et al. Antibiotic Prophylaxis in Penetrating Injuries of The Chest. Ann R Coll Surg Engl. 1991;73:348-351.

152. Howland WS Jr, Ritchey SJ. Gunshot Fractures in Civilian Practice. An Evaluation of the Results of Limited Surgical Treatment. J Bone Joint Surg Am. 1971;53:47–55.

153. Patzakis MJ, Harvey JP Jr, Ivler D: The Role of Antibiotics in the Management of Open Fractures. J Bone Joint Surg Am. 1974;56:532-541.

154. Luchette FA, Borzotta AP, Croce MA, et al. Practice Management Guidelines for Prophylactic Antibiotic Use in Penetrating Abdominal Trauma: The EAST Practice Management Guidelines Work Group. J Trauma. 2000;48:508-518.

155. Fullen WD, Hunt J, Altemeier WA. Prophylactic Antibiotics in Penetrating Wounds of the Abdomen. J Trauma. 1972;12:282-9.

156. Hospenthal DR, Murray CK, Andersen RC, et al. Guidelines for the Prevention of Infection After Combat-Related Injuries. J Trauma. 2008; 64(1.8316965E7):211–220.

157. Krug E. Injury. A Leading Cause of the Global Burdenof Disease. World Health Organization Geneva. 1999;19-20.

158. Inci I, Ozçelik I, Tacyildiz O, Nizam N, Eren G, Ozen DB. Penetrating Chest Injuries: Unusually High Incidence of High Velocity Gunshot Wounds in Civilian Practice. World J Surg. 1998;22:438–442.

159. Vasquez TC, Castaneda E, Bazan N. Management of 240 Cases of Penetrating Thoracic Injuries. Injury. 1997;28:45–49.

160. Hoyt DB, Coimbra R, Potenza B. Management of Acute Trauma. In Sabiston Textbook of Surgery. 17 edition. Edited by: Townsend JR. Philadelphia: Elsevier 2004;pp:483-532.

161. Ling GSF, Rhee P, Ecklund JM. Surgical Innovations Arising from the Iraq and Afghanistan Wars. Annu. Rev. Med. 2010;61:457–468.

162. Velmahos GC, Demetriades D, Toutouzas KG, et al. Selective Nonoperative Management in 1856 Patients with Abdominal Gunshot Wounds: Should Routine Laparotomy Still Be the Standard of Care? Ann Surg. 2001;234: 395–403.

163. Lowe RJ, Slietta JD, Read DR, Radhakrishnan J. Moss GS. Should Laparotomy be Mandatory or Selective in Gunshot Wounds of The Abdomen?. J Trauma. 1977;17(12):903-7.

164. Muckart DJ, Abdool-Carrim AT, King B. Selective Conservative Management of Abdominal Gunshot Wounds: A Prospective Study.Br J Surg. 1990; 77(6):6525.

165. Velmahos GC, Demetraides D, Foianini E, Tatevossian R. Cornwell EE 3rd. Asensio J. Belzberg H. Berne TV. A Selective Approach to the Management of Gunshot Wounds to the Back. Am J Surg. 1997;174(3):342-6.

166. Perry LCWB, Brooks MJP, Muskat CPC. The History of Military Colorectal Trauma Management. Semin Colon Rectal Surg. 2004;15:70-79.

167. Hudolin T, Hudolin I. The Role of Primary Repair for Colonic Injuries In Wartime. Br J Surg. 2005;92(5):643–647.

168. Uravi M. Colorectal War Injuries. Mil Med. 2000;165(3):186–188.

169. Steele SR, Wolcott KE, Mullenix PS, et al. Colon and Rectal Injuries During Operation Iraqi Freedom: Are There any Changing Trends in Management or Outcome? Dis Colon Rectum. 2007;50(6):870–877.

170. McCarthy MC, Lowdermilk GA, Canal D, Broadie TA. Prediction of Injury Caused by Penetrating Wounds to the Abdomen, Flank and Back. Arch Surg. 1991;126(8):962-5.

171. Moore EE, Moore Jb, Van Duzer-Moore S, Thompson JS. Mandatory Laparotomy for Gunshot Wounds Penetrating the Abdomen. Am J Surg. 1980; 140(6):847-51.

172. Dellinger EP, Oreskovich MR, Wortz MJ, et al. Risk of Infection Following Laparotomy for Penetrating Abdominal Injury. Arch Surg. 1984;119: 20-27.

173. Adesanya A A, Ekanem E E. A Ten-Year Study of Penetrating Injuries of the Colon. Dis Colon Rectum. 2004;47(12):2169–2177.

174. Murray JA, Demetriades D, Colson M, et al. Colonic Resection in Trauma: Colostomy Versus Anastomosis. J Trauma. 1999;46(2):250–254.

175. Phillips T, Scalafani SJA, Goldstein A, et al. Use of Contrast Enhanced CT Enema in the Management of Penetrating Trauma to the Flank and Back. J Trauma. 1986;26:593-596.

176. Dellinger EP, Oreskovich MR, Wertz MJ, Hamasaki V, Lennard ES. Risk of Infection Following Laparotomy for Penetrating Abdominal Injury. Archives of Surgery. 1984;119:20±7.

177. Pinedo-Onofre JA, Guevara-Torres L, Sánchez-Aguilar JM. Penetrating Abdominal Trauma. Cir Cir. 2006;74(6):431.

178. Ordog GJ, Sheppard GF, Wasserberger JS, Balasubramanium S, Shoemaker WC: Infection in Minor Gunshot Wounds. J Trauma. 1993;34:358-365.

179. Macleod GHB. Notes On The Surgery of The War in The Crimea, with Remarks on the Treatment of Gunshot Wounds. London, England: John Churchill 1858.

180. Malinoski D. Overview of Abdominal Trauma 2013. Available at: http://www.merckmanuals.com/professional/injuries-poisoning/abdominal-trauma/overview-of-abdominal-trauma (Accessed on September 2014)

181. Ivatury R R, Zubowski R, Psarras P, et al. Intraabdominal Abscess After Penetrating Abdominal Trauma. J Trauma. 1988;28:1238-1243.

182. Adesanya AA, Afolabi IR, da Rocha-Afodu JT. Civilian Abdominal Gunshot Wounds in Lagos. Journal of the Royal College of Surgeons of Edinburgh. 1998;43:230±4.

183. Tegegne A. Abdominal Missile Injuries at Gonder Hospital, Northwestern Ethiopia. Ethiopian Medical Journal. 1991;29:81±6.

184. Bodalal Z, Mansor S. Gunshot Injuries in Benghazi Libya in 2011: The Libyan Conflict and Beyond. The Surgeon. 2013;11(5):258-263. http://dx.doi.org/10.1016/j. surge.2013.05.004.

185. Bartlett C. Clinical Update: Gunshot Wound Ballistics. Clinical Orthopaedics and Related Research. 2003;408:28–57.

186. Burg A, Nachum G, Salai M, Haviv B, Heller S, Velkes S, Dudkiewicz I. Treating Civilian Gunshot Wounds to the Extremities in a Level 1 Trauma Center: Our Experience and Recommendations. Isr Med Assoc J. 2009;11(9):546-551.

187. Bowyer GW. Management of Small Fragment Wounds: Experience from the Afghan. bordtr. J Trauma. 1996;40(3):sl70-sl72.

X. Appendix-1

Age …….. Gender …….. Hospital of admission……
Month of admission…… Duration of stay……
Transference of cases ……. Diagnosis…… General condition……...
Distribution of injury …….. Thoracic Injury……..Abdominal wall injury
Hollow viscus injury……Solid organ injury……...Retroperitoneal heamatoma…
Vascular injury……..Operations…… Management of thoracic injuries…….
Management of abdominal injuries…… Administration of antibiotics ……
Blood transfusion…… Number of blood units…… Early complications ……..
Late complications……..... Prognosis.....

XI. ملخص البحث

المقدمة: تستخدم في فترة الحروب الأنواع المختلفة من الأسلحة التى تسفر عن إصابات متعددة و وفيات.

الهدف من الدراسة:

- أجري هذا البحث لدراسة اصابات الصدر و البطن الناتجة عن استعمال الانواع المختلفة من الاسلحة خلال الفترة من 17 فبراير الى 31 مايو عام 2011 في مدينة بنغازي.
- النظر في أداء الجراحيين الليبيين في التعامل مع جرحى الحروب.

المنهجية: تم تحديد الاصابات المتعلقة بالحرب من خلال السجلات الطبية للمستشفيات التالية : مستشفى الجلاء ، ومستشفى الهواري ومركز بنغازي الطبي بمدينة بنغازي.

النتائج: تضمنت هذه الدراسة 204 حالة من أصل 1590 حالة في الفترة الزمنية ما بين 17 فبراير إلى 31 مايو لسنة 2011. تفاوتت أعمار المشاركين واختلفت أجناسهم ، وكان النصيب الأكبر للذكور (97%) المتراوح أعمارهم بين 6 إلى 56 عام ومتوسط ± SD من 29.43 ± 8.93 ، و كانت نسبة الإناث 3% حيث تراوحت أعمارهم بين 12 إلى 55 عام ومتوسط ± SD من 27 ± 13.65 . تراوحت اقامة المصابين مابين اليوم الواحد الى 32 يوما ، حيث أن 92% من المصابين أقاموا بالمستشفى لمدة لا تزيد عن أسبوعين. و حيث ان معظم الإصابات التي كانت نتيجة الطلق الناري حدثت بنسبة (76%) بينما الإصابات الناتجة عن الإنفجارات حدثت بنسبة 24%.

ركزت الدراسة على إصابات منطقتى الصدر و البطن ، حيث كان تجويف الصدر (48.5%) الأكثر إصابة من بينهم تلتها إصابات البطن (41.7%) ثم إصابات تجويف البطن والصدر معا (9.8%). أكثر من 45% من الاصابات الصدرية كانت سطحية ، تلتها اصابات اختراق تجويف الصدر و اصابته بالتجمع الدموي (32.7%) ثم إصابات تجمع الهواء خارج الرئة و داخل التجويف الصدري (15%) , أما الاصابات الاقل حدوثا هي تمزق الحجاب الحاجز (4%) و كسر الضلوع (2.5%) و إصابات القلب (1%).

نسبة اختراق تجويف البطن 77% حيث تنوعت الإصابات ، فكانت الامعاء الدقيقة أكثر إصابة (22.8%) ثم تلتها الأمعاء الدقيقة وإصابة الجانب الأيمن للقولون (8.5%) ، وإصابة الجانب الايسر من القولون (7.6%) ، والأمعاء الدقيقة وإصابات الجانب الايسر من القولون (5.7%) ، وإصابة القولون الأيمن (4.7%) وإصابات المستقيم (2.8%) . شملت إصابات البطن الأخرى: اصابات الطحال (12.4%) وإصابات الكبد (12.4%)، وإصابات المثانة البولية (3.8%) والإصابات الكلوية (2.8%) وإصابات المرارة (1.9%) ، و أما إصابات الأوعية الدموية فكانت بنسبة 5.4% . وكانت إصابات الأطراف العلوية و السفلية هي الأكثر حدوثا مع إصابات الصدر والبطن.

أكثر من 51% من الحالات تم علاجها عن طريق عمليات صغرى لتنظيف الجروح من الانسجة الميتة و الغيارات المستمرة للجروح. بينما خضع 37.7% من الحالات لعمليات فتح البطن. أما 6.4% من الحالات قد خضعت لعمليات فتح الصدر ، في حين تم خضوع 1% من الحالات إلى عمليات فتح البطن والصدر معا.

تلقت 3.4% من الحالات العلاج دون الخضوع الى عمليات جراحية. ولقد تم علاج 53% من الحالات بنوع واحد من المضادات الحيوية واسعة النطاق في حين تم علاج 47% من الحالات بمجموعة من المضادات الحيوية واسعة النطاق. تم تسجيل 17.6% من المضاعفات المبكرة بينما تم تسجيل 15% من المضاعفات المتأخرة خلال عامان من المتابعة. حوالي 79% من الحالات اكملت علاجها بالمستشفى و تم إخراجها بصحة جيدة ، أما حوالى 10.3% غادروا المستشفى دون التصريح بذلك ، وحوالي 8.3% من المرضى تم نقلهم إلى مراكز متقدمة خارج ليبيا لإتمام علاجهم ، أما عدد الوفيات فلم يتجاوز 2% من المصابين.

الاستنتاج: كانت إصابات الصدر الاكثر شيوعا في الدراسة الحالية. بالإضافة إلى اصابات الصدر و البطن ، كانت إصابة الأطراف العلوية والسفلية أكثر أجزاء الجسم حدوثا. كان معدل الإصابات الناجمة من الانفجارات أقل حدوثا مقارنة بإصابات الطلق الناري. جميع الحالات التي تعرضت لطلق ناري من الجهة الخلفية للبطن و الصدر خضعت لعمليات فتح البطن وكانت تحوي اصابات الاحشاء الداخلية و هذا عارض العديد من التقارير التي تدعي سلبية حدوث اصابات الاحشاء الداخلية للبطن نتيجة الجروح الخلفية للبطن. انخفاض معدل الوفيات عكس الممارسة الجيدة للجراحين الليبيين التي تنقصهم الخبرة الطبية في الحروب.