



# Abdominal versus pelvic gunshot injuries in terms of postoperative outcomes: A cohort representing the experience of 406 cases in seven years

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## ABSTRACT

**Objective:** Gunshot injuries have become a significant problem globally. This study aimed to assess the differences between abdominal versus pelvic gunshot injuries in terms of postoperative outcomes to determine which type of injury is more lethal.

**Material and Methods:** This was a cohort study carried out to compare patients who had abdominal versus pelvic gunshot injuries, to analyse the differences in the impact of the anatomical site of injury on morbidity, mortality, and disabilities in all patients who had been admitted to the hospital due to torso gunshot injuries from February 2011 to December 2018.

**Results:** During the study period, 406 patients suffered from torso gunshot injuries. 391 were males and 15 were females; 343 (84.4%) patients had abdominal gunshot wounds, which were considered the first group, while in the second group, there were 63 (15.6%) patients who had pelvic gunshot wounds. In the first group, 328 (95.6%) patients required urgent explorative laparotomy, complications were observed in 83 (24.2%) patients, while re-operations were reported in 51 (14.9%) patients and 11 (3.2%) patients had permanent functional disabilities, and 46 (13.4%) patients passed away. In the second group, all patients were treated with urgent explorative laparotomy, 17 (27%) patients suffered from complications, re-operation occurred in 13 (20.6%) patients, permanent functional disability occurred in 17 (27%) patients, and mortality was seen in 16 (25.4%) patients.

**Conclusion:** Our clinical experience has shown that mortality rates and long-term disability occur at a higher rate in pelvic gunshot injuries therefore early senior surgeon input is mandatory for the potential poor outcome to be minimized.

**Keywords:** Gunshot, abdominal wound, pelvic wound, torso injury

## INTRODUCTION

In recent years, gunshot injuries have started to be considered common emergency cases, and many studies have documented that it is becoming a significant problem globally (1,2). Due to the widespread availability of weapons in the Libyan community during the last ten years, the incidence of firearm-related violence has dramatically increased (3).

The effect of a gunshot injury depends on missile calibre, velocity, and trajectory. The high velocity of a bullet can cause both penetration to an organ, as well as a blast injury to nearby organs, in addition to thermal injuries; therefore, higher mortality rates occur due to the greater energy transmitted to tissues (4). Torso gunshot injuries can cause significant bleeding, and subsequently septic consequences according to the nature of the injured organs, which may both lead to a significant rate of morbidity and mortality; and therefore, early diagnosis and early surgical intervention of an injured patient are essential to improve outcomes. Urgent explorative laparotomy has been the definitive traditional care for torso gunshot injuries; while recently with the more understood mechanism of injuries and with the advent of the new diagnostic and therapeutic modalities, non-operative management has become increasingly gaining acceptance for the selected cases (5,6).

The human trunk is formed by the abdominal and pelvic cavity, whereas there is no true separation between both cavities. The abdominal cavity contains many solid rich vascular organs, which significantly bleed when injured, as well as hollow organs that are responsible for septic complications after injury, while the

**Cite this article as:** Mansor S, Ziu N, Almissmary H, Alawami M, Bujazia A, Eltarhoni A. Abdominal versus pelvic gunshot injuries in terms of postoperative outcomes: A cohort representing the experience of 406 cases in seven years. Turk J Surg 2024; 40 (1): 36-46.

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Received: 10.11.2023

Accepted: 07.03.2024

Available Online Date: 23.03.2024

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DOI: 10.47717/turkjsurg.2024.6303

pelvic cavity is the narrow overcrowded space inside the pelvic bones, which is divided into the lesser and greater pelvis, contains the reproductive organs, the lower part of the urinary tract, rectum, and major pelvic blood vessels protected by the pelvic bone, the superior edge of the pelvic bone considered the border between the abdominal and pelvic cavity. The diaphragm forms the superior border of the abdomen while the inferior border of the pelvic cavity is the pelvic diaphragm. The vertebral column and strong posterior abdominal wall muscles support the trunk posteriorly, while the remaining part is covered by an anterior lateral abdominal wall muscle. The retroperitoneum is located behind the peritoneal layer of the abdominal and pelvic cavity and contains the pancreas, urinary tract organs, and the major blood vessels.

The aim of the current study was to assess and analyse the differences between abdominal versus pelvic gunshot injuries in terms of short-term postoperative complications, long-term disabilities, and the mortality rates to determine which type of injury is more lethal and needs aggressive resuscitative measures.

## MATERIAL and METHODS

A cohort study of 406 patients was conducted to compare patients who had abdominal gunshot injuries (the first group) and the second group of patients, who were those with pelvic gunshot injuries, to analyse the differences in the impact between abdominal versus pelvic gunshot injuries, on short-term post-operative complications, which is considered the primary end point. Moreover, there are long-term disabilities and mortality rates, which are considered the secondary end point of the study to determine which type of injury is more lethal and needs aggressive resuscitative measures in all consecutive, non-selected patients, who were resuscitated by a

trauma team following the protocols of the Advanced Trauma Life Support of the American College of Surgeons, and had undergone urgent explorative laparotomy in our department, during the time period from February 17, 2011, to December 31, 2018. Table 1 demonstrates the baseline characteristics of the patients in both groups included in the study.

Patient data such as age, sex, past medical history, injured anatomical area, vital signs upon admission, blood transfusions, concomitant organs injuries, the grade of organs injury, injury severity score, methods of diagnosis, types of surgical procedures, postoperative complications, the indication of re-operation, procedures in the re-operation, length of hospital stay, long-term functional disability, and mortality rates of patients were all collected and prospectively reviewed. The data were collected and entered to the database, in which all documents and records were updated over the course of the study through medical staff reports.

According to intraoperative findings, which determined whether the injured organs were in the abdomen or pelvis, the patients were classified into one of the two study groups, while the small bowel was treated as an abdominal organ because of its mesentery and the fact that the majority of it is located inside the abdomen, as well the true pelvis is occupied by the rectum, the urinary bladder and reproductive organs in the normal anatomical state. On the other hand, all cases of gunshot wounds with intrathoracic organ injuries that required thoracoabdominal exploration, patients with injuries to the abdominal and pelvic organs, and patients with multiple gunshot wounds to other areas, such as the head and extremities, were excluded because they might present more challenging circumstances. Similarly, all cases of non-penetrating gunshot wounds were excluded.

**Table 1.** Baseline characteristics of the patients in both groups included in the study

Basic Characteristic	Abdominal Gunshot Wounds	Pelvic Gunshot Wounds	p value
Mean age (Years)	29	27.4	0.685
Body mass index (Mean)	22.7	21.4	0.732
Male: Female ratio (No)	25:1	30:1	0.812
History of cigarette smoking (No, %)	305 (88.9%)	51 (80.9%)	0.076
History of hypertension (No, %)	2 (0.58%)	1 (1.5%)	0.392
History of diabetes mellitus (No, %)	4 (1.1%)	1 (1.5%)	0.780
History inflammatory bowel disease (No, %)	2 (0.58%)	1 (1.5%)	0.392
Multi injured organs (No, %)	183 (53.5%)	43 (68.2%)	0.028
Shock on admission (No, %)	190 (55.4%)	44 (69.8%)	0.032
Blood transfusion (No, %)	219 (63.8%)	51 (80.9%)	0.008
Therapeutic laparotomies	296 (86.2%)	60 (95.2%)	0.047
Negative laparotomies	32 (9.3%)	3 (4.7%)	0.235
Total cases (No)	343	63	

In statistical analysis, all continuous variables were expressed as mean  $\pm$  standard deviation (SD) to evaluate the distribution of data, and the categorical data were expressed as frequency and percentage. Comparisons between the groups were made using the  $\chi^2$  test or Fisher's exact test for categorical variables as appropriate. Statistical analyses were performed using the SPSS v21 statistical software, and p values of less than 0.05 were considered statistically significant. We also conducted both unadjusted and adjusted logistic regression analyses to determine variables associated with a statistically significant study result. Initially, univariable analyses were conducted to identify factors (i.e. shock, postoperative complications, multi-organ injury, therapeutic laparotomy, and postoperative bleeding) associated with a significant study result. In adjusted analysis, we evaluated the risk of mortality and disability after abdominal and pelvic gunshot injury in a multivariable logistic regression model.

In addition, informed consent was obtained as the hospital is a teaching university hospital, and thus, written informed consents are routinely signed and from all admitted patients or legally authorised representatives during the hospital stay and before the studies, for all research to use patients' data and to be published in academic activities and researches, and ethics approval was also received, as this study was approved by the Al-Jalaa teaching hospital, Benghazi University Institutional Review Board (IRB).

## RESULTS

During the study period, 406 urgent explorative laparotomies were conducted for patients who suffered from torso gunshot injuries, and Table 2 shows details of the actual operative interventions performed in both groups. There were 391 (96.3%) male and 15 (3.7%) female patients. Mean age was 28.7 years while standard deviation was 9.0 (range= 18-70 years). Three hundred and forty-three (84.4%) patients who had abdominal gunshot injuries were considered the first group in the study, while in the second group, there were 63 (15.6%) patients who had pelvic gunshot injuries.

In the first group, there were 183 (53.5%) patients who had multi organ injuries, while 117 (34%) patients suffered from a single organ injury. One hundred and ninety (55.4%) patients were in shock at the time of admission. Three hundred and twenty-eight (95.6%) patients required urgent explorative laparotomies, 32 (9.3%) of them had no intra-abdominal organ injuries which were considered negative laparotomy, two (0.6%) patients were treated with delay explorative laparotomy, and 15 (4.3%) patients were treated conservatively. Post-operative complications were observed in 83 (24.2%) patients, and Table 3 shows a comparison of postoperative complications in both groups, while Table 4 shows the rest of the complications in each group separately. Re-operations were reported in 51 (14.9%) patients and 11 (3.2%) patients who had post-operative

long term permanent functional disability (Table 5); meanwhile, 46 (13.4%) patients passed away in the post-operative period.

In the second group, 43 (68.3%) patients sustained multi organ injuries, while 17 (27%) patients had single organ injuries; 43 (68.3%) patients were hemodynamically unstable at time of admission. All patients in this group were treated with urgent explorative laparotomy, and three of them (4.7%) had a negative laparotomy. Seventeen (27%) patients suffered from post-operative complications in this group (Tables 3,4), while re-operation occurred in 13 (20.6%) patients. Post-operative permanent functional disability was significantly clear throughout the long-term follow-up in 17 (27%) patients (Table 5), and mortality in this group of patients occurred in 16 (25.4%) patients. Further, a significant statistical difference was determined between the abdominal gunshot and pelvic gunshot injured patients with respect to both long-term disability and mortality ( $p= 0.015$  and  $p= 0.0001$ , respectively), while there was also a non-significant difference in short-term postoperative complications, as well as re-operation rates ( $p= 0.637$  and  $p= 0.248$ , respectively).

After adjustment for potential confounders, the risk of mortality was 1.5 times higher after pelvic gunshot injury than after abdominal gunshot injury. As compared to postoperative complications, shock, multi-organ injury, and postoperative bleeding were associated with an increased risk of death. The risk did not differ significantly for therapeutic laparotomy. Moreover, there is a much higher risk of long-term postoperative disability related to pelvic gunshot injuries. After relevant confounders were adjusted for, pelvic gunshot injuries were found to have a 13 times higher risk of postoperative disability than abdominal gunshot injuries. Kidney, pelvic nerve plexus, anal canal, and spinal cord injury were related to a higher risk of disability. On another side, post-operative bleeding and therapeutic laparotomy both carried a similar level of risk.

## DISCUSSION

Gunshot injuries represent a unique surgical and public health challenge worldwide. Many studies have documented that gunshot injuries are a common surgical condition and have become a significant problem globally (1,2). Correspondingly, incidences have dramatically increased in the last ten years in Libya (3). Until now, there has been controversy in the management of gunshot injuries despite the huge number of research in medical institutes around the world. Military gunshot wounds are high energy penetrating injuries, and the nature of the penetration depends upon the trajectory of the missiles and the amount of energy that is transmitted through the affected tissue, which leads to an unpredictable wide variation in the severity of the injuries, while additional tissue damage may occur due to the cavitation wave of gas and fluid of surrounding tissue or from the fragmentation of the bullet and adjacent bone.

**Table 2.** Types and numbers of performed operative procedures in both groups

<b>Abdominal Gunshot Wound Group</b>				
	<b>Organ</b>	<b>Procedure</b>	<b>No</b>	<b>Percent %</b>
1	Diaphragm	Diaphragm primary repair with chest tube insertion	32	9.3%
2	Spleen	Splenectomy	33	9.6%
3	Stomach	Gastric wall primary repair	42	12.2%
4	Duodenum	Duodenal primary repair	8	2.3%
5	Liver	Topical liver parenchymal hemostasis Liver parenchymal primary repair Direct blood vessel ligation Perihepatic packing Non-anatomic liver resection	19 29 17 24 4	24.1%
6	Gall bladder	Cholecystectomy	12	3.4%
7	Pancreas	Pancreatic debridement Distal pancreatectomy	12 3	4.3%
8	Small bowel	Small bowel primary repair Small bowel resection & anastomosis	90 38	37.3%
9	Large bowel	Ascending colon primary repair Ileocecal resection Right hemicolectomy Transverse colon primary repair Transverse colon resection & anastomosis Transvers loop colostomy Descending colon primary repair Sigmoid colon primary repair Sigmoid colon resection and anastomosis Sigmoid loop colostomy Hartmann operation	16 2 40 44 9 13 8 14 2 10 11	49.2%
10	Kidney	Kidney primary repair Nephrectomy	6 21	7.8%
11	Ureter	Ureter primary repair Ureter anastomosis with DJ stent	2 5	2%
12	Blood vessels	Aorta primary repair IVC primary repair Superior mesenteric artery primary repair Inferior mesenteric artery ligation Inferior epigastric artery ligation	1 5 3 1 2	3.3%
<b>Pelvic Gunshot Wound Group</b>				
	<b>Organ</b>	<b>Procedure</b>	<b>No</b>	<b>Percent %</b>
1	Rectum	Rectal primary repair with proximal loop colostomy Rectal primary repair	19 9	44.4%
2	Urinary bladder	Urinary bladder primary repair	24	38%
3	Urethra	Urethral primary repair with supra pubic catheter insertion	5	7.9%
4	Anal canal	Anal canal debridement with proximal loop colostomy	7	11%
5	Blood vessels	External iliac artery primary repair External iliac artery graft placement External iliac artery end-to-end anastomosis External iliac vein ligation Internal iliac artery primary repair Internal iliac artery ligation Internal iliac vein ligation	3 2 1 3 1 2 1	20.1%

**Table 3.** A comparison of postoperative complications in both groups

Postoperative Complication	Abdominal Gunshot Wound	Pelvic Gunshot Wound	p value
Postoperative bleeding	32 (9.3%)	13 (20.6%)	0.008
Wound infection	24 (6.9%)	5 (7.9%)	0.790
Incisional hernia	23 (6.7%)	1 (1.5%)	0.113
Postoperative abscess	12 (3.4%)	3 (4.7%)	0.625
Septic shock	9 (2.6%)	3 (4.7%)	0.357
Pneumonia	9 (2.6%)	2 (3.1%)	0.804
Postoperative ileus	6 (1.7%)	2 (3.1%)	0.454
Acute renal failure	3 (0.8%)	2 (3.1%)	0.128
Mortality	46 (13.4%)	16 (25.3%)	0.015

**Table 4.** The rest of the complications in each group separately

Abdominal Gunshot Wound Group		
Postoperative Complication	No of Cases	%
Anastomosis leak	12	3.4%
Burst abdomen	7	2%
Biliary leak	5	1.4%
Atelectasis	4	1.1%
Missile tract infection	3	0.8%
Pancreatic fistula	3	0.8%
Gangrenous colon	2	0.5%
Missed colon injury	2	0.5%
Acute respiratory distress syndrome	2	0.5%
Small bowel fistula	2	0.5%
Colostomy abscess	2	0.5%
Gastro-cutaneous fistula	1	0.2%
Postoperative gastric leak	1	0.2%
Aspiration pneumonia	1	0.2%
Colonic fistula	1	0.2%
Duodenal fistula	1	0.2%
Erosion of superior mesenteric artery	1	0.2%
Pulmonary embolism	1	0.2%
Fistula after colostomy closure	1	0.2%
<b>Pelvic Gunshot Wound Group</b>		
Recto-cutaneous fistula	3	4.7%
Urinary tract infection	2	3.1%
Colostomy necrosis	1	1.5%
Urine leak	1	1.5%
Disseminated intravascular coagulation	1	1.5%
Deep venous thrombosis	1	1.5%
Pleural effusion	1	1.5%

**Table 5.** Type of long-term disability in abdomen and pelvic gunshot injuries

No	Injury Mechanism	Disability	No (%)
<b>First Group (Abdominal Gunshot Wounds)</b>			
1	Complete spinal cord injury	Paraplegia	5 (1.4%)
2	Shattered kidney	Single kidney	4 (1.1%)
3	Destructive small bowel injury	Short bowel syndrome	1 (0.3%)
4	Massive bleeding	Myocardial infarction	1 (0.3%)
<b>Second Group (Pelvic Gunshot Wounds)</b>			
1	Anal canal injury	Anal incontinence	7 (11%)
2	Urethral injury	Urethral stricture	3 (4.7%)
3	Pelvic nerve plexus injury	Foot drops Sexual erectile dysfunction Retrograde ejaculation Neurogenic bladder	4 (6.3%) 2 (3.1%) 2 (3.1%) 1 (1.5%)
4	Fracture head of femur	Total hip replacement	1 (1.5%)

Abdominal and pelvic gunshot injuries most commonly lead to the rupture of solid organs, lacerations of hollow organs, and eviscerations of abdominal contents. Ruptured solid organs can cause considerable bleeding with an immediate sign of abdominal distension and hemodynamic instability and shock, with mortality due to the persistent bleeding that can be prevented or reduced by the identification of the early signs of shock with simultaneous administration of resuscitative measures. Meanwhile, in the case of hollow organ lacerations, the abdomen may also bleed although they also lead to peritonitis in short periods, or later with septic complications as intra-abdominal abscesses.

The rate of stomach injuries in gunshot wounds has recently increased to 10-15%, with the surgical treatment ranging from the simple primary repair of the wall to gastro-enterostomy or partial gastric resection according to the grade of the gastric injury (7). Moreover, as the stomach is a rich blood supply organ, the simple repair of its wall has a high success rate. Injuries to the stomach often have concomitant injuries to adjacent organs which lead to increased morbidity and mortality. In our study, 12% of patients had gastric injuries, all of which were treated by primary repair, and 87.8% of them had multi-organ injuries. Due to a missing injury, one patient developed a postoperative gastric leak while another patient had high output gastro-cutaneous fistula after the repair.

In addition, small bowel injuries occur in more than 40% of gunshot abdominal wounds (8), in our study, it was 37%, its principles of treatment are by primary repair or resection with re-anastomosis, according to the grade of damage. The colon is the second most frequently injured organ in gunshot patients (8), which has a significant septic complications risk (15-50%) (9); the state of shock and blood transfusion are considered predictive risks for these complications (10).

Despite all recent developments in trauma surgery, some controversies persist in the treatment of colorectal injuries (11). In the current study, it was not possible to observe any advantages of the diversion over the primary repair in hemodynamically stable patients. Therefore, to reduce the risk of psychological trauma, complications of colostomy, unnecessary repeated hospitalisation, a decrease of economic costs, and complications of stoma revision operations, it is necessary to consider that the primary repair of penetrating colon injuries is an acceptable alternative method of treatment over colostomy, which represents our conclusion from two previous studies based on the management of colonic gunshot wounds in our department (8,10).

The liver is the third most frequently injured organ in gunshot abdomen wounds (8), in which 14% of liver injured patients require urgent surgical treatment (12). Control of the bleeding with conserving liver parenchyma is the main goal of surgery, the techniques ranging from topical haemostasis, primary repair of parenchyma, and the balloon tamponed technique in case of bleeding of the deep missile tract through the liver tissue. In high-grade injuries, the direct ligation of bleeding vessels is required, and liver packing is used in damage control surgery which leads to lower mortality rates (13); while hepatic resection is reserved for severe injuries only. In our case, topical liver tissue haemostasis, whether thermal or chemical, was performed in 22% of patients with liver injuries, liver tissue primary repair in 35.2%, direct blood vessel ligation in 21%, perihepatic packing in 29.5% of the patients as part of damage control surgery, and non-anatomic liver resection in 4.2% of the patients. Postoperative liver-related complications, which occurred in 21% of the patients, such as intraoperative and postoperative bleeding, biliary leak, and hepatic abscess, all are considered the most common complications in all surgical techniques (14). Many studies have suggested that the

selective non-operative management of gunshot liver injuries is safely feasible to reduce the incidence of unnecessary laparotomy (15).

Gall bladder injuries are considered rare cases, and our rate was 3.4%; the vast majority are of a penetrated form, and mortality in these cases is induced by the severity of their associated injuries (16). Regardless of injury type, immediate cholecystectomy remains the preferred form of treatment (17). Separately, the spleen is most frequently injured in blunt, rather than penetrating trauma, and penetrating splenic injury is more commonly due to gunshots and not stabbings, and it is associated with intra-abdominal as well as thoracic injuries (18). Urgent splenectomy is still the standard life-saving procedure with low morbidity and mortality, and recently a significant percent of splenic injuries has been managed non-operatively in selected patients (19).

Retroperitoneal injuries are common in patients who have abdominal gunshot wounds, with incidence ranging from 20-33% (20). The most commonly injured organs in the retroperitoneal space are as follows; the colon, kidneys, duodenum, and then the pancreas (21); meanwhile, the mortality rates for retroperitoneal injuries depend upon the zone of injury. Pancreatic and duodenal injuries are uncommon (22) due to their anatomical background as a small target surrounded by vital organs, with more than 90% of pancreatic and duodenal injuries associated with injuries to the adjacent major blood vessels (23). Additionally, blurred injury signs lead to delays in diagnoses and treatment, which end with significant morbidity and mortality (24). The pancreatic and duodenal injuries in our study were 4% and 2.3%, respectively. After debridement and distal pancreatectomy, pancreatic fistulas occurred in 21.5% of cases, with a mortality rate of 42.8% primarily attributable to massive bleeding. In contrast, duodenal fistulas occurred in 25% of cases following simple repair and gastro-jejunostomy, with one patient suffering a paraplegic spinal cord injury.

Major blood vessels injuries in torso gunshot wounds are uncommon with high mortality rates despite perioperative resuscitation and damage-control strategies, which do not substantially result in a reduction (25). Hemodynamic instability with abdominal distention is a clinical sign of vascular injuries. During trauma laparotomies, the proximal control of aortic injuries can occur with an aortic cross-clamp, sponge stick, or manual compression, while the primary repair remains feasible (26). Injury to the superior mesenteric artery carries significant morbidity due to small bowel ischemia; and therefore, patients do not tolerate superior mesenteric artery ligation (27). Comparatively, inferior vena cava injuries remain highly lethal, which have a high mortality rate. Even though the primary suturing was the most common method of repair, some

literature has concluded that ligation of the inferior vena cava is an acceptable damage control technique (28). Only once did we observe aortic damage that required re-exploration to treat postoperative bleeding, while inferior vena cava injury was seen in 1.4% of abdominal gunshot wounds, and bleeding was the primary cause of death in 60% of the cases.

Kidneys are the most injured organs in the urinary tract (29). This can cause bleeding or urine extravasation, while selective observation and/or various operative techniques can offer high renal salvage rates following gunshot injuries (30). Nine percent of our patients experienced renal damage as a result of a penetrating injury. Sixteen percent of them underwent non-operative management, 19.3% underwent primary parenchymal repair, while nephrectomy was necessary for 64.5% of the patients due to high-grade injury.

Despite the last upgrade of highly sophisticated diagnostic modalities, gunshot pelvic wounds are still a big challenge to trauma surgeons, which represent a potentially life-threatening condition. A high-energy penetrating trauma increases the likelihood of pelvic bone fractures with the risk of profuse bleeding, which also cause concomitant pelvic viscera injuries. Furthermore, life-threatening bleeding can occur from the presacral venous plexus in 80-90% of cases, while arterial bleeding can stem from the iliac arteries (31). Nerve injury in pelvic gunshots can be due to the penetrating effect of the bullet through the pelvic cavity at the time of trauma or due to surgical manipulation at the time of laparotomy, which may occur in 50% of cases, and manifest with pain, paraesthesia, sensory deficit, and motor weaknesses, which is often permanent (32).

The vast majority of penetrating rectal injuries are caused by pelvic gunshots (33), with rectum bleeding considered a clinical diagnostic sign. In hemodynamically stable patients, computer tomography imaging and rigid sigmoidoscopy can confirm the diagnosis. Some international literature has considered the anatomical site of penetrating rectal injury as a predictive risk factor for post-operative complications (34). Accordingly, Lavenson and Cohen have described the principles of treating rectal injuries by the primary repair, proximal colon diversion, presacral drainage, and distal rectal washout (35). In our study, 44.4% of patients with pelvic gunshot wounds had rectal injuries with a morbidity of 25%. On the other hand, anal canal injuries from gunshots are rare and have not yet received enough research (36). The best way to treat anal injuries, however, is still up for debate. Some research suggested tissue debridement and faecal diversion, followed by delayed sphincter repair, but other studies found early sphincter repair is superior (37). Eleven percent of our patients suffered from gunshot wounds to the anal canal, and they all ended up permanently disabled with anal incontinence.

About 25% of all urinary bladder injuries are caused by gunshot wounds, and these wounds are frequently accompanied by rectal injuries (38). In 50% of cases, haematuria is present, which provides a high index of suspicion of the diagnosis (39). In our study, urinary bladder injury occurred in 38% of the patients with pelvic gunshot wounds, all of whom were treated by primary wall repair, and 7.9% of the patients experienced urethral injury treated by urethral primary repair with supra pubic catheter insertion, 60% of whom developed ureteral strictures.

In this study, we identified the presence of shock, multi-organ injury, post-operative bleeding, and injured area as significant risk factors for mortality in patients with gunshot injuries. We also found an overall Odd's ratio of 1.5 for the effect of a pelvic injury on the rate of mortality. However, establishing sufficient ambulance services, blood banks and regional trauma centres decreased mortality rates to 9.5% in the 1990s. Delayed admission time, insufficient blood support, and the high rate of large intestine injuries affected the post-operative infectious complications and the death incidence. Risk factors related to postoperative infections for abdominal gunshot injuries are uncontrolled shock, duration of surgery, transfusion requirement, and the number of injured organs (40). Whereas previous studies have shown that in military and civilian torso gunshot wounds, the mortality rate rises with the number of intraabdominal organs injured (41). Like others, we demonstrated a positive correlation between the number of organs injured and mortality. However, the number of organs injured does not accurately quantify the overall severity of the injury. For example, a patient with an isolated 3 cm superficial hepatic laceration is not as severely injured as another with extensive hepatic parenchyma destruction, but both have one organ injured (41).

Since penetrating wounds are a common cause of vascular injuries, emergency exploration for these wounds is gaining high importance, and since the percentage of complications in penetrating injuries is related to the amount of energy transferred through the tissue, and neurovascular injury is considered its complications (42), vascular examination on the part of the clinician in gunshot injuries is very important (40). In studies in which the mortality rate for pelvic fracture patients in shock is reported, the rate varies from 21 to 50 percent (43,44). However, in a well-controlled prospective cohort study carried out at a level I trauma centre, 54% of trauma patients who presented in shock died (blood pressure less than or equal to 90 mmHg). Thus, it appears that for pelvic fracture patients who arrive in the emergency room in shock, the chances of survival are roughly 50 percent (45). However, by using multivariable analyses, we observed that the most important factor was the presence of shock with (Odd's ratio 5.85).

On the other hand, although permanent effects can be anticipated, the long-term impact of gun violence, particularly in terms of physical function and occupational handicap, is still poorly understood (46-48). For instance, difficulty with daily activities and chronic pain that remained for up to two years after injury among patients treated for gunshot wounds has been under investigation in recent research (46). However, we sought to examine the effect of abdominal and pelvic gunshot injury on long-term disability. We investigated several possible risk factors such as spinal cord, kidney, anal canal, pelvic nerve, and urinary bladder injuries. The researchers reported that particular damage patterns were associated with persistent disabilities. For instance, neurological impairment was linked to chronic pain (49). Studies on long-term functional outcomes provide analysis without considering the cause of late disability. The severity of the initial anatomic soft tissue injury pattern may not be accurately determined by looking back at files to locate past complaints and observations.

Urogenital injuries can be associated with erectile dysfunction and urinary incontinence, and urethral strictures have been reported in 31% to 69% of complete urethral transactions (50). Due to the high energy necessary for pelvic bony fracture, 60 to 90% of patients presenting bone fracture have urinary bladder injury, while 6-8% of patients with bladder injury will have pelvic fracture (51). Also, as a result of gunshot wounds, traumatic nerve laceration is more common than was previously thought, and delaying treatment for patients who have partial or total nerve lacerations could lead to worse clinical results and higher morbidity (52). Most injuries to the spinal cord after a gunshot result in complete paraplegia.

In the presence of multiple war hotspots internationally, gunshot injuries need to be studied in detail, as gunshot injuries differ in their salient features and outcome based on the anatomical area. Our multivariate analysis reveals that the kidney and the pelvic nerve injury are the most important factors for long-term disability in this study. In simple terms, the complicated nature of anatomical features of the pelvis has a clear impact on the difficulty in controlling haemorrhage as well as increasing the risk of permanent disability. Therefore, trauma surgeons need to be aware of these differences and prepare accordingly. Moreover, a specialized triage system could be set up to minimize the time spent by injured people waiting for the proper specialist. More investigations are required to compare these phenomena in other conflicts and circumstances because there have not been many studies comparing the impact of this injury in these anatomical locations on the features of the injured patient.

## CONCLUSION

Our clinical experience has shown that mortality rates and long-term disability occur at a higher rate in pelvic gunshot injuries

when compared to abdominal gunshot wounds therefore early senior surgeon input is mandatory for the potential poor outcome to be minimized.

**Ethics Committee Approval:** This study was approved by Benghazi University Al-Jalaa Teaching Hospital Ethics Committee (Decision no: 361/2022, Date: 10.12.2023).

**Peer-review:** Externally peer-reviewed.

**Author Contributions:** Concept - SM, AE; Design - SM, AE; Supervision - SM; Data Collection and/or Processing - NZ, HA, MA, AB; Analysis and/or Interpretation - AE, HA; Literature Search - SM, AB, NZ; Writing Manuscript - AE, AB, NZ, MA; Critical Reviews - SM.

**Conflict of Interest:** The authors have no conflicts of interest to declare.

**Financial Disclosure:** The authors declared that this study has received no financial support.

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## ORJİNAL ÇALIŞMA-ÖZET

Turk J Surg 2024; 40 (1): 36-46

**Postoperatif sonuçlar açısından karın ve pelvik ateşli silah yaralanmalarının karşılaştırılması: Yedi yılda 406 vakanın deneyimini temsil eden bir kohort**Salah Mansor<sup>1,2</sup>, Naman Ziu<sup>1</sup>, Hannibal Almissmary<sup>1</sup>, Mohammed Alawami<sup>1</sup>, Ayoub Bujazia<sup>3</sup>, Ahmed Eltarhoni<sup>4</sup><sup>1</sup> Benghazi Üniversitesi Tıp Fakültesi, Al-Jalaa Eğitim Hastanesi, Genel Travma ve Akut Bakım Cerrahisi Bölümü, Bingazi, Libya<sup>2</sup> Libya Uluslararası Tıp Üniversitesi Tıp Fakültesi, Cerrahi Anabilim Dalı, Bingazi, Libya<sup>3</sup> Benghazi Üniversitesi Tıp Fakültesi, Benghazi Tıp Merkezi, Tanısal Radyoloji Anabilim Dalı, Bingazi, Libya<sup>4</sup> Benghazi Üniversitesi Tıp Fakültesi, Aile ve Toplum Hekimliği Anabilim Dalı, Bingazi, Libya**ÖZET**

**Giriş ve Amaç:** Ateşli silah yaralanmaları tüm dünyada önemli bir sorun haline gelmiştir. Bu çalışmanın amacı, hangi yaralanma tipinin daha ölümcül olduğunu belirlemek için abdominal ve pelvik ateşli silah yaralanmaları arasındaki farkları postoperatif sonuçlar açısından değerlendirmektir.

**Gereç ve Yöntem:** Bu çalışma, abdominal ve pelvik ateşli silah yaralanması olan hastaları karşılaştırmak ve Şubat 2011 ile Aralık 2018 tarihleri arasında ateşli silah yaralanması nedeniyle hastaneye başvuran tüm hastalarda yaralanmanın anatomik bölgesinin morbidite, mortalite ve sakatlıklar üzerine etkisindeki farklılıkları analiz etmek için yapılan bir kohort çalışmasıdır.

**Bulgular:** Çalışma döneminde 406 hasta, gövde ateşli silah yaralanması geçirdi. Hastaların 391'i erkek, 15'i kadındı; 343 (%84,4) hastada abdominal ateşli silah yaralanması vardı ve bunlar birinci grup olarak kabul edilirken, ikinci grupta pelvik ateşli silah yaralanması olan 63 (%15,6) hasta vardı. Birinci grupta 328 (%95,6) hastaya acil eksploratif laparotomi gerekmiş, 83 (%24,2) hastada komplikasyon görülmüş, 51 (%14,9) hastada tekrar ameliyat yapılmış, 11 (%3,2) hastada kalıcı fonksiyonel yetersizlik görülmüş ve 46 (%13,4) hasta hayatını kaybetmiştir. İkinci grupta, tüm hastalar acil eksploratif laparotomi ile tedavi edilmiş, 17 (%27) hastada komplikasyon görülmüş, 13 (%20,6) hastada tekrar ameliyat olmuş, 17 (%27) hastada kalıcı fonksiyonel sakatlık oluşmuş ve 16 (%25,4) hastada mortalite görülmüştür.

**Sonuç:** Klinik deneyimlerimiz, pelvik ateşli silah yaralanmalarında mortalite oranlarının ve uzun süreli sakatlığın daha yüksek olduğunu göstermiştir, bu nedenle potansiyel kötü sonuçların en aza indirilmesi için erken kademeli cerrah müdahalesi zorunludur.

**Anahtar Kelimeler:** Ateşli silah, karın yaralanması, pelvik yara, gövde yaralanması

**DOI:** 10.47717/turkjsurg.2024.6303