

Role of Diagnostic Laparoscopy in Abdominal Trauma

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ABSTRACT

Background: The role of laparoscopy in diagnosis as well as therapeutic interventions has increased markedly in the last few years. In trauma, it has become a viable alternative for the diagnosis of intra-abdominal injury following penetrating and blunt trauma. The number of negative and/or non-therapeutic laparotomies performed has decreased since the use of laparoscopy in diagnosis and management. **Patients and Methods:** Fifty patients with abdominal trauma (ten with blunt trauma, and forty with penetrating trauma) were selected from those attending the general surgery department of El-Maadi Military Hospital during period from 1/1/2013 to 1/1/2015. All patients were subjected to thorough clinical evaluation including history & physical examination. Full laboratory work up, ultrasonography, and computed tomography for the abdomen and the pelvis were performed. Diagnostic laparoscopy was done to all of them. **Results:** In the present study, diagnostic laparoscopy was successful in all patients (100%) and it was also therapeutic in seventeen patients (34%), negative in four patients (8%), non-therapeutic in three patients (6%), conversion to mini laparotomy in eight patients (16%) and conversion to full laparotomy in eighteen patients (36%). Patients with therapeutic laparoscopy and mini laparotomy were classified as eight patients with splenic lacerations (16%), seven with bowel injuries (14%), five patients with liver lacerations (10%), four patients with diaphragmatic injuries (8%) and one patient with stomach penetrations (2%). Patients managed by full laparotomy included ten patients with multiple organ injury (20%), four patients with fecal peritonitis (8%), one patient with multiple small bowel injury (2%), two patients with multiple retroperitoneal organ injury (4%) and one patient with uterine injury (2%). **Conclusion:** Laparoscopy can be performed safely and effectively in stable patients with abdominal trauma and it can deal with traumatic injury in a significant number of patients and can help to minimize laparotomy.

Key words: Blunt trauma, Penetrating trauma, Laparoscopy, Laparotomy

INTRODUCTION

Intra-abdominal trauma affects 10% - 15% from whole types of trauma. Although significant intra-abdominal injury is relatively infrequent, the consequences of missed or delayed diagnosis can be significant. Therefore, accurate and timely diagnosis of injuries is essential⁽¹⁾.

Mechanisms of injuries may be penetrating or blunt. The most common cause of mortality in abdominal trauma is secondary to delayed resuscitation or excessive hemorrhage with inadequate volume resuscitation. Also intra-abdominal organ injury and rupture or perforation precipitates gastrointestinal content spillage into the peritoneal cavity, frequently leading to peritonitis and delayed mortality from severe sepsis⁽²⁾.

The initial history and physical examination are of paramount importance. Information

regarding the mechanism of injury and state of patient before arriving in the emergency department can be very helpful in assessment and management of the patient⁽¹⁾.

Despite the high prevalence of patients with abdominal trauma, physical examination may be inaccurate because patients may have altered mental status or distracting injuries. Diagnostic peritoneal lavage was introduced as a diagnostic modality to identify hemoperitoneum but it is invasive method and its role has been almost entirely eliminated because there has been increased reliance on abdominal computed tomography. Focused assessment with ultrasonography in trauma has also been added to the diagnostic algorithm for patients with abdominal trauma⁽³⁾.

In laparoscopy the relative morbidity and mortality, complication rates, and missed injury rates are low and comparable with open

approaches. Additionally, a wide variety of intra-abdominal pathology can be addressed laparoscopically including injuries to the bowel, diaphragm, liver, spleen, and pancreas⁽⁴⁾.

The recent guidelines developed by the Eastern Association for the Surgery of Trauma Practice Management Guidelines Committee recommend selective non-operative management in penetrating abdominal trauma and that routine laparotomy is not indicated in hemodynamically stable patients with abdominal stab wounds without signs of peritonitis or diffuse abdominal pain and in patients suffering tangential gunshot wounds without peritonitis⁽⁵⁾.

PATIENTS AND METHODS

1- Patient selection

Our study was a prospective study. It included 50 patients with abdominal trauma of any type whether blunt (ten patients 20%) or penetrating (80%). Trauma was either road traffic accident (RTA), stab wound, gunshot or explosion.

Patients were selected from those attending the general surgery department of El-Maadi Military Hospital during period from 1/1/2013 to 1/1/2015.

According to our protocols, laparoscopy is considered only in patients who are hemodynamically stable with equivocal abdominal signs and Glasgow coma score (GCS) more than 13. We excluded unstable patients required urgent laparotomy, severe head injuries, limited cardiovascular reserve and severe chest restriction.

In patients with blunt abdominal trauma, the presence of free fluid more than 500 ml on the abdominal CT or patient received more than 2 units blood, according to Pachter et al.⁽⁶⁾, and patients showing deterioration under conservative management (abdominal pain, fever, leukocytosis, abdominal tenderness and rigidity, or decreased hemoglobin level) are typically evaluated by a laparoscopic exploration.

2- Methods:

All patients were subjected to the following:

1. Preparation, Triage, Primary survey, Resuscitation, Secondary survey and Definitive care.
2. All patients underwent physical examinations, ultrasonography, computed tomography (CT) for abdomen and pelvis to

assess the presence of free fluid and organ injuries.

3. Laparoscopy was always performed under general anaesthesia. We had used low insufflation pressure (8-12 mmHg) however, in some incidents, pressures up to 15mmHg had been used without untoward events.
4. Pneumoperitoneum was done slowly and special attention was given to avoid the possibility of a tension pneumothorax caused by the pneumoperitoneum due to an unsuspected diaphragmatic rupture.
5. The pneumoperitoneum was created in all patients through a periumbilical incision using open technique.
6. Diagnostic laparoscopy was achieved through a 10mm umbilical port. A30 degree laparoscopic camera (10mm in diameter) that allowed optimal visualization of abdominal wall, diaphragmatic dome, liver and spleen. Tilting the bed in Trendelenburg position or reverse Trendelenburg position allowed visualization of lower and upper abdomen.

For paracolic gutters exploration lateral tilting was required in most cases, visceral handling was necessary and easily carried out with 5mm non-traumatic bowel graspers through two paramedian 5mm ports placed on both sides at the level of the umbilicus (**fig. 1**).

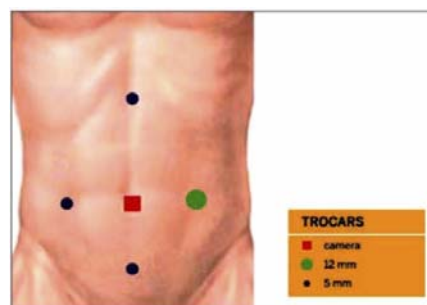


Fig. (1): Choice of trocar site for diagnostic laparoscopy in trauma⁽⁷⁾

Performing a full laparoscopic exploration of the abdominal cavity in search for injuries requires a systematic approach which follows all principles of open exploratory laparotomy. Indirect signs of bowel injury such as digestive fluids or purulent liquids was carefully looked for. Methylene blue administered IV or via the nasogastric tube was used to identify suspected urologic or proximal bowel injuries.

Check for hollow viscous injury from stomach to rectum. The bowel requires to be examined using the hand-over-hand technique with small traumatic bowel graspers from the ligament of Treitz to the terminal ileum (ileocec valve) by crossing the graspers. The colon is inspected from the caecum to the rectum and the supramesocolic space is inspected from the abdominal esophagus to the duodenum including spleen, liver and gall bladder.

A laparoscopic full Kocher maneuver is accomplished in right lateral decubitus. The hepatic flexure of the colon is mobilized to the left side using the harmonic scalpel. The peritoneum is incised lateral to duodenum and blunt dissection mobilizes the duodenum medially in order to explore its dorsal aspect.

The lesser sac is opened through the gastrocolic ligament, this allows visualization of the posterior wall of the stomach as well as the body and tail of pancreas.

Laparoscopy was classified as negative if there was no injury, as nontherapeutic if there was an injury but did not require a surgical intervention, therapeutic if an injury was identified and repaired, and positive if there was an injury that required conversion to open exploration for repair.

We analyzed outcome measures including mechanisms of injury, radiological findings, operative procedures, and injuries that were treated. In addition, postoperative outcomes including length of stay, complications, and mortalities were assessed.

RESULTS

Our study was a randomized prospective study. It includes 50 patients with a mean age (29.26 ± 8.55 years) and a mean BMI (26.36 ± 3.12). Ninety eight percent of them were males and (2%) of them were females (Table 1).

Table (1): Patients demographic data

		Mean	Range
Mean Age (Years)		29.26 ± 8.55	(15-62)
Mean BMI		26.36 ± 3.12	(21-35)
Gender	Male	49	98%
	Female	1	2%

These patients were exposed to abdominal trauma, 20% of them were Road Traffic Accident (RTA), 60% were gunshot, 14% were stab wound and 6% were explosion (Table 2)& (Fig. 2).

Table (2): Mechanism of Trauma

	Frequency	Percent
RTA	10	20%
Gun Shoot	30	60%
Stab Wound	7	14%
Explosion	3	6%

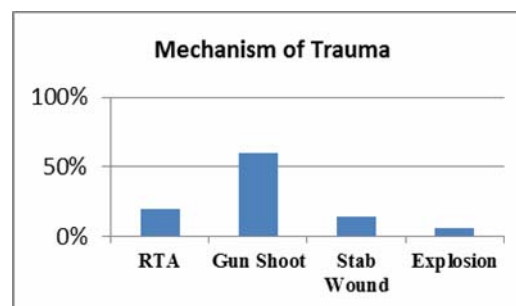


Fig. (2): Mechanism of trauma

The mean operative time was (71.40 ± 29.34 minutes). By diagnostic laparoscopy, we found that 8% of patients were negative, 6% were non-therapeutic, 34% were therapeutic, 16% were mini-laparotomy and 36% were laparotomy (table 3).

Table (3): Findings of Diagnostic Laparoscopy

	Frequency	Percent	Bunt trauma	Penetrating Trauma
Negative	4	8%	1	3
Non-therapeutic	3	6%	1	2
Therapeutic	17	34%	3	14
Mini-Laparotomy	8	16%	4	4
Laparotomy	18	36%	1	17

Therapeutic procedures were done totally laparoscopic in 17 cases, (14 penetrating trauma & 3 blunt trauma) (**table3**). Three patients with diaphragmatic tear repaired laparoscopically by intracorporal suturing using silk zero. Five patients with liver tear, bleeding was controlled by cautery or topical hemostasis using surgicell and hepatorrhaphy by vicryl zero. Application of ligaclips to control mesenteric bleeding. Stapling or suturing small intestinal wounds if tear is single and small. Stapling or suturing of stomach tear. Primary repair of ascending and transverse colon tear by stapling or suturing, if the tear is single small non-soiling.

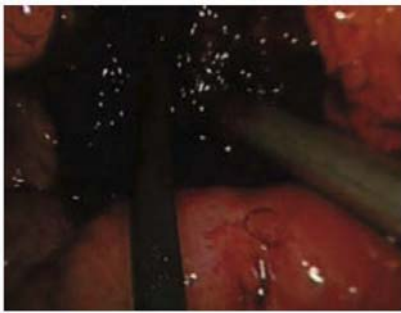


Fig. (3): Mesosigmoidal hematoma diagnosed by laparoscopy: Removal of the clots



Fig. (4): Laparoscopic capture showing 30 ml free blood in the Douglas pouch.



Fig. (5): Laparoscopic capture showing the contusion and ischemic appearance of the descending colon.

Conversion from laparoscopy to laparotomy after identifying the pathology was done in 18 cases (17 with penetrating trauma & one with blunt trauma). Cause of conversion was due to multiple organ injuries in 10 patients, fecal peritonitis due to descending and sigmoid tears in four patients, multiple small bowel injuries that need resection anastomosis in one patient and retroperitoneal organ injuries (kidney and urinary bladder) in 2 patients. Female patient with uterine tear underwent laparotomy for repair (**table 4**).

The intraoperative bleeding occurs in one patient (2%). This patient presented by lower abdominal stab wound and shock. She was resuscitated and then diagnostic laparoscopy was done and revealed uncontrolled bleeding from uterine tear. Conversion to laparotomy was done to control bleeding.

In the post-operative period the mean first bowel motion (1.26 ± 0.491 days), mean first oral intake (2.76 ± 1.08 days), mean ICU stay was (2.04 ± 1.19 days) and the mean hospital stay was (5.94 ± 2.70 days) (**Table 5**).

In diagnostic laparoscopy return of bowel motion and start of oral intake was faster than open laparotomy, the former started after 1-2 days while the latter started after 2-4 days.

Table (4) Conversion to laparotomy

<i>No of patients</i>	<i>18</i>
Type of trauma	
Penetrating	17
Blunt	1
Cause of conversion	
1-Multiple organ injuries	10
2-Fecal peritonitis	4
3-Kidney & bladder injury	2
4-Retroperitoneal injury	1
5- Uterine tear	1

Table (5): First bowel motion, oral intake, ICU stay and hospital stay.

	<i>Mean (Days)</i>	<i>(Min- Max) (Days)</i>
First bowel motion	1.26	(1-3)
First oral intake	2.76	(1-7)
ICU stay (days)	2.04	(1-5)
Hospital Stay (days)	5.94	(2-13)

Post-operative complications occurred in 11 patients (22%) (**Table 6**). 4 patients (8%) suffered from chest infection and pneumonia treated by broad spectrum antibiotics. Three of them (6%) were post laparotomy and one of them developed respiratory failure and needed mechanical ventilation and one patient (2%) was post laparoscopy.

Three patients (6%) suffered from wound infection, two of them (4%) post laparotomy and one (2%) post laparoscopy. All treated by antibiotics according to culture & sensitivity and regular wound dressing with complete recovery with full recovery.

One patient (2%) complicated by biliary leakage post laparoscopic hepatic tear repair. He underwent ERCP, CBD injury detected and biliary stent was applied. Another patient (2%)

was complicated by intra-abdominal collection and fever following laparoscopic diaphragmatic tear repair. He underwent another look diagnostic laparoscopy, where transverse colon and stomach missed tears were detected and repair was done laparoscopically.

One patient (2%) complicated by fecal fistula post laparoscopic ascending colon tear repair. He underwent laparotomy and ileostomy was done. Spontaneous closure of the fistula occurred after one month.

Female patient presented by lower abdominal stab wound with severe hypotension. After resuscitation diagnostic laparoscopy find uterine tear with uncontrolled bleeding. Blood transfusion and laparotomy done for bleeding control. Post-operatively she developed DIC and needed fresh frozen plasma and recovered.

Table (6): post-operative Complications

	<i>Frequency</i>	<i>Percent</i>	<i>Management</i>
Pneumonia	3	6%	Antibiotics
Pneumonia and respiratory failure type 2	1	2%	Mechanical ventilation
DIC	1	2%	Fresh frozen plasma
Fecal fistula	1	2%	Laparotomy & ileostomy
Wound infection	3	6%	Dressing & antibiotics
Biliary leak	1	2%	ERCP & stent
Missed injury	1	2%	Laparotomy & repair

In our study we notice that patients undergo laparotomy returned to daily activity after 8-9 days and started to return work after 12-24 days. This is attributed to length of incision, occurrence of complication, age, BMI, power of healing and intraoperative technique.

DISCUSSION

In the earliest work on laparoscopy in abdominal trauma, **Gazzaniga et al.** ⁽⁸⁾ evaluated 37 patients; 14 of them laparotomy was avoided because of a negative diagnostic laparoscopy. **In our study 2015** we evaluated 50 patients; laparotomy was avoided in 32 patients (64%).

In our study we performed a laparoscopic evaluation of 50 patients most of them due to penetrating trauma (80%). Similar to **Jeremy et al.** ⁽⁹⁾, who performed diagnostic laparoscopy for 109 patients post penetrating trauma from 131 patients. While **Kyoung et al.** ⁽¹⁰⁾ perform a

laparoscopic evaluation of 111 patients most of them due to blunt trauma (65%).

Kyoung et al. ⁽¹⁰⁾ recorded that the mean operative time for laparoscopy was 91.20 minutes (range 57-125) and for laparotomy was 97.20 minutes (range 70-140). **In our study** we recorded that the mean operative time for laparoscopy was 59.09 minutes (range 30-120) and for laparotomy was 95.62 minutes (range 60-150).

In the largest study on laparoscopy in penetrating trauma of Ivatury's group **Zantut et al.** ⁽¹¹⁾ reported a multicenter retrospective study of 510 hemodynamically stable patients who underwent diagnostic laparoscopy for penetrating trauma. The inclusion criterion for the study was a hemodynamically stable patient who had penetration of the anterior fascia by a stab wound or a gunshot wound with a possible intraperitoneal injury. Negative or non therapeutic laparotomy was avoided in 303 patients (59.4%)

while 26 patients received a therapeutic laparoscopic intervention⁽¹²⁾.

In the current study for penetrating trauma, laparoscopy was beneficial especially in hemodynamic stable patients. The results of our analysis demonstrated that the use of laparoscopy to evaluate 40 penetrating abdominal trauma patients was able to exclude significant intra-abdominal injuries, and 5 patients (12.5%) of penetrating abdominal trauma patients avoided undergoing a non-therapeutic laparotomy. 18 patients with significant intra-abdominal injuries, use of laparoscopic-based operations also had a high therapeutic success rate (45 %), primarily for repairs to the liver, diaphragm, mesentery, bowel and hand assisted splenectomy. Conversion to laparotomy was performed in 17 patients because of large splenic lacerations, descending colon tears, small bowel injuries required resection and anastomosis.

In the current study for blunt trauma, laparoscopy was beneficial especially in hemodynamic stable patients. The results of our analysis demonstrated that the use of laparoscopy to evaluate 10 blunt abdominal trauma patients was able to exclude significant intra-abdominal injuries, and 2 patients (20%) of blunt abdominal trauma patients avoided undergoing a non-therapeutic laparotomy. Seven patients with significant intra-abdominal injuries, use of laparoscopic-based operations also had a high therapeutic success rate (70%), primarily for repairs to the liver, mesentery, diaphragm, bowel and hand assisted splenectomy. Conversion to laparotomy was performed in one patient because descending colon tear that needed Hartman colostomy.

A 10-year review of laparoscopic intervention from the University of Tennessee showed that the main utility of minimally invasive techniques was as usage of laparoscopy in management of abdominal trauma was effective to avoid negative laparotomy findings. Although some minor injuries were repaired laparoscopically, they were limited to diaphragm repair, repair of serosal tears and coagulation of omental haemorrhage⁽¹³⁾. Nevertheless, a review of the published literature shows an increasing number of case reports showing successful therapeutic interventions in abdominal trauma. This trend will continue to grow as surgeons' comfort with minimally

invasive techniques improves and technology becomes more convenient and advanced⁽¹⁴⁾.

In our study, the use of laparoscopy as a diagnostic and therapeutic tool leads to avoidance of an open surgery in 32 patients (64%). Negative and non-therapeutic laparoscopies in 7 patients and therapeutic laparoscopy was performed in 25 patients: 8 patients had assisted splenectomy, 5 patients needed repair of liver tears, 3 patients needed diaphragmatic tear repair, 7 patients needed primary repair for bowel and 2 patients needed stomach repair. However, conversion to laparotomy was needed in 18 cases (36%). Those had either multiple organ injuries (20%) that was dealt with, tears in descending and sigmoid colonic (8%) where colostomy was done, retroperitoneal organ injuries (4%) multiple small bowel injuries (2%) where resection anastomosis was done and uterine injury in one patient (2%) that was repaired.

Kyoung et al.⁽¹⁰⁾ recorded that hospital stay post laparoscopy was (9-12 days) shorter than post laparotomy (17-25 days). **In our study** we recorded that hospital stay post laparoscopy was 2-5 days shorter than post laparotomy (10-14 days) and hospital stay post penetrating trauma was shorter than blunt trauma.

Eiriksson et al.⁽¹⁵⁾ noted that the potential of gas embolism in patients with intra-abdominal venous injuries such as liver lacerations is of concern when performing laparoscopy; however, none of our patients in the laparoscopic group developed clinical signs or symptoms of a gas embolism. Most of the lesions of hemodynamically stable liver laceration patients requiring repair were related to rupture of Glisson's capsule, which is not near any major vessels, thus reducing the possibility of gas embolism during laparoscopy. **Josephs et al.**⁽¹⁶⁾ showed that carbon dioxide pneumoperitoneum causes a significant increase in intracranial pressure in a porcine model of head injury. For this reason, we excluded patients with severe head injuries from undergoing laparoscopy.

In our study, the hospital stay and rate of postoperative complications were high in patients with blunt trauma than penetrating trauma. In cases without conversion to laparotomy, one patient developed chest infection and one patient developed wound infection. After conversion to laparotomy, we recorded two patients with wound infection and three patients with chest infection.

However, overall, the rate of hospital stay and postoperative complications was low in comparison with patients managed by laparotomy.

The potential for a missed hollow viscous injury after diagnostic laparoscopy exists and may have devastating consequences. **In the current study**, one patient (2%) had a missed common bile duct injury that required re-intervention. These results are comparable with **Kapan et al.**⁽¹⁷⁾ who showed that laparoscopy yielded a sensitivity of 92% and a specificity of 100% in detecting injuries in patients who suffered blunt abdominal injury while also avoiding 50% of laparotomies in the same population. Earlier reports commonly cited a high missed injury rate as a result of using diagnostic laparoscopy to screen patients with potential abdominal injuries. **Kawahara et al.**⁽¹⁸⁾ reported that using a systematic approach to laparoscopic abdominal exploration resulted in no missed injuries.

Minimally invasive surgery has become a useful tool in the management of trauma. Laparoscopy can detect and repair injuries to the hollow viscous and diaphragm and exclude the risks of non therapeutic laparotomy. Further advantages are reduced morbidity, shortened hospital stay, and lower cost. In the future, there may be exciting advancements for this field of surgery through innovative developments⁽¹⁹⁾.

CONCLUSION

Our study shows that diagnostic laparoscopy can be safely used for patients sustaining both blunt and penetrating abdominal trauma. Diagnostic laparoscopy eliminated non-therapeutic laparotomies for patients sustaining blunt trauma. This diagnostic modality should be widely introduced for the initial evaluation of patients sustaining blunt abdominal trauma.

Although we disclose that laparoscopy gradually has been accepted as a diagnostic and/or treatment modality for penetrating abdominal injuries in patients that are hemodynamically stable. The relative rates of morbidity/mortality, postoperative complications, and missed injury are low and compare favorably with an open approach. However, laparoscopic surgery can be performed safely whether injuries are blunt or penetrating, given hemodynamic stability and proper technique. Patients may thus

benefit from the shorter hospital stays, greater postoperative comfort (less pain), quicker recoveries, and low morbidity/mortality rates that laparoscopy affords.

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