

Role of laparoscopy in the management of abdominal trauma Running Head: laparoscopic management of abdominal trauma

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Abstract: Objective The aim of the work is to study the feasibility, the advantages and the disadvantages of laparoscopy in diagnosis and treatment of abdominal trauma. **Background:** The role of laparoscopy in diagnosis and treatment of abdominal trauma has increased markedly in the last few years. since the use of laparoscopy in diagnosis and management of abdominal trauma The number of negative and/ or nontherapeutic laparotomies performed has decreased. **Patients and methods:** Thirty patients with abdominal trauma 11 blunt traumas (BT), 19 penetrating trauma (PT) were treated by the Trauma Team at the Emergency Units of Menoufia University and Maadi Military Hospital from January 2014 to May 2016 using laparoscopy for diagnosis. All patients underwent a physical examination, Ultrasound, and computed tomography (abdomen and pelvis). Laparoscopy was used in the management of these patients through three trocars: one for 30° scope and two working trocars. **Results:** In our series, we avoided laparotomy in 66.6% (20/30) of cases. Negative and non-therapeutic laparoscopies four patients and therapeutic laparoscopy was performed in ten patients; six patients had assisted splenectomy, three patients need repair of liver tears, three patients need diaphragmatic tear repair, six patients need primary repair for bowel and two patients need stomach repair. **Conclusion:** Laparoscopy can be performed in management of stable patients with abdominal trauma safely and effectively.

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Introductions

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

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 (2).

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 (3). With increasing incorporation of endoscopic surgery into general practice, there will be a solid place for the laparoscopic approach to diagnose and therapeutic modality in abdominal trauma. It may be particularly

beneficial for hemodynamically stable patients that sustained a focal abdominal trauma. We expect that this approach will lead to a decline in on therapeutic laparotomies and its associated complications (4).

The aim of the work is to study the feasibility, the advantages and the disadvantages of laparoscopy in diagnosis and treatment of abdominal trauma.

Here, in our study, we show that laparoscopy can be used safely in the management of stable patients with abdominal trauma and can reduce the rate of negative and nontherapeutic laparotomies in patients with both penetrating (PT) and blunt abdominal trauma (BT).

Patients and methods

Thirty patients with abdominal trauma, 11 with BT and 19 with PT, were treated in the Trauma Unit of Menoufia University and El-Maadi Military Hospital from January 2014 to may 2016.

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. All patients underwent physical examinations, ultrasonography, computed tomography (CT) (abdomen and pelvis) to assess the presence of free fluid and organ injuries. According to our

protocols, laparoscopy is considered only in patients who are hemodynamically stable.

In patients with blunt abdominal trauma, the presence of unexplained free fluid on the abdominal CT, or patients showing deterioration under conservative management (abdominal pain, fever, leukocytosis, abdominal tenderness and rigidity, decreased hemoglobin levels) are typically evaluated by a laparoscopic exploration. Laparoscopic exploration is performed with a patient in a supine position with both arms abducted if possible.

The first access is achieved using a 10 mm trocar at the umbilicus (30° scope) for the videoscopic set; pneumoperitoneum should be slowly and if the blood pressure decreases, the gas pressure should be reduced. Two further trocars of 5–10 mm are introduced on both sides at the level of umbilicus at the mid-clavicular line. Then adding additional trocars as required for each case.

The abdomen is explored systematically, all solid organs and hollow viscus are explored, and even the most hidden parts of the diaphragm can be assessed much better by laparoscopy than with an open technique.

Results

Thirty patients (11 BT and 19PT) who underwent a laparoscopic procedure were identified and reviewed; the characteristics and outcomes of patients undergoing laparoscopy on the basis of the mechanism of injury are as follows:

The mean age was (30.2 ± 10.08) year old and mean BMI was (26.36±3.12). 29 patients (96.7%) of them were males and one patient (3.3%) of them were females.

The preoperative assessment of patients showed that the mean systolic blood pressure (108.33±15.11) mmHg, mean diastolic blood pressure (69±9.23) mmHg, mean heart rate (101.87±18.87) beats/minute and mean hemoglobin was (9.34±1.39) g/dl.

The indications of diagnostic laparoscopy in 23 patients (76.67%) were radiological finding, 6 patients (20%) penetrating wounds (gunshot & stab) to abdominal wall, while 1 patients (3.33%) presented after RTA with negative radiology under observation noticed decrease hemoglobin level (7 g/dl) and hypotension (90/60 mmHg) with tachycardia (100-110 beat/min).

The mean operative time was (73.5±32.17) minutes, the diagnostic laparoscopy found that 13.33% were non-therapeutic, 26.7% were therapeutic, 20% were mini-laparotomy and 30% were laparotomy.

Therapeutic procedure was done totally laparoscopically in 13 cases (6 PT & 4 BT). Three patients with diaphragmatic tear repaired laparoscopically by intracorporal suturing using silk zero. In one patient with liver tear control of bleeding

by cautery and topical hemostasis using surgicell and hepatorrhaphy by vicryl zero. Application of Ligaclips to control mesenteric bleeding stapling or suturing of small intestinal wounds if single small tear. Stapling or suturing of stomach tear. Stapling or suturing Primary repair of ascending and transverse colon if single small non soiling tear.

Conversion from laparoscopy to laparotomy after identify the pathology done in 10 cases (8PT & 2BT) due to multiple organ injuries (5 pt.), fecal peritonitis due to descending and sigmoid tears (2pt), multiple small bowel injuries need resection anastomosis (1pt) and retroperitoneal organ injuries (1pt) kidney and urinary bladder. Female pt with uterine tear undergoes laparotomy for repair.

The laparoscopic technique depends on the findings. Hand assisted splenectomy in splenic tears (20%), repair of liver tears (6.67%), primary repair of small bowel (6.67%), while (10%) need laparotomy for resection anastomosis in multiple small bowel injuries, primary repair in ascending and transverse colon (6.67%), primary repair of diaphragm (6.67%).

The intraoperative bleeding occurs in one patient (3.33%). Female patient presented after lower abdominal stab wound (BP 90/50 -HB 8 -HR 120) after resuscitation diagnostic laparoscopy find uncontrolled bleeding from uterine tear.

In the post-operative period the mean first bowel motion (1.36±0.57) days, mean first oral intake (2.84±1.78) days, mean ICU stay (2.2±1.39) days and the mean hospital stay (6.41±3.04) days. The first bowel motion in post-operative period depend on procedure and affect in the first oral intake. Whatever oral intake delayed in bowel anastomosis (small & large). In diagnostic laparoscopy return to bowel motion and oral intake (1-2 days) faster than laparotomy (2-4 days).

Post-operative complications occur in 9 patients (31%), 4 patients (13.3%) suffer from chest infection and pneumonia treated by broad spectrum antibiotics. Three patients (10%) post laparotomy one of them aggravate respiratory failure and need mechanical ventilation and one patient (3.3%) post laparoscopy.

One patient (3.3%) suffered from wound infection treated by antibiotics according to culture and sensitivity and regular wound dressing post laparotomy.

One patient (3.3%) complicated by biliary leakage post laparoscopic hepatic tear repair undergo ERCP which find CBD injury that need biliary stent. Another patient (3.3%) after laparoscopic diaphragmatic tear repair complicated by intra-abdominal collection and fever undergo another look diagnostic laparoscopy and find transverse colon and stomach missed tears and repaired laparoscopically.

One patient (3.3%) complicated by fecal fistula post laparoscopic ascending colon tear repair undergo laparotomy and ileostomy. Spontaneous closure of the fistula after one month.

Female patient presented by lower abdominal stab wound with sever hypotension. After resuscitation diagnostic laparoscopy find uterine tear with uncontrolled bleeding. Blood transfusion and laparotomy was done for bleeding control. Post-operative aggravates DIC and need fresh frozen plasma.

The mean time to return to daily activity was (5.98±2.17) days and the mean time to return to work was (18.60±6.73) days.

In our study we notice that patients undergo laparotomy delayed in return to daily activity (8-9 days) and to work (12-24 days) due to time of

operation, length of incision and occurrence of complication and depend on age, BMI, power of healing and intraoperative technique. While in laproscopic cases return to daily activity was after (5-7 days) and return to work was after (8- 15 days).

In our study mortality occurs in 6 cases (mortality rate 20%). The causes of death are Chest infection and pneumonia in 2 cases. Low saturation and ventilation in one case. Septic shock in one case. Hypovolumic shock in one case. DIC in one case.

Laparoscopy in BT and PT was nontherapeutic in 4 cases (13.33) and Also, 10 patients were managed with laparoscopy (two cases with BT and eight cases with PT). Overall, because of the use of laparoscopy, laparotomy was avoided in 20 cases (66.6) of the patients in this study.

(Table1): Findings of Laparoscope

	Frequency	Percent	Blunt	Penetra-ting
Non-therapeutic	4	13.33	2	2
Therapeutic	10	33.33	4	6
Mini-Laparotomy	6	20	3	3
Laparotomy	10	33.33	2	8
Total	30	100	11	19

(Table2) Post-operative Complications.

	Frequency	Percent	Management
Pneumonia	3	10.00	Antibiotics
Pneumonia and respiratory failure type 2	1	3.33	Mechanical ventilation
DIC	1	3.33	Fresh frozen plasma
Fecal fistula	1	3.33	Laparotomy & ileostomy
Wound infection	1	3.33	Dressing & antibiotics
Biliary leak	1	3.33	ERCP & stent
Missed injury	1	3.33	Laparotomy & repair

(Table3): Findings, therapeutic procedures and causes of death

Finding	Type of operation	Cause of death
Intrapertontial Collection,retropertontial, haematoma,sigmoid tear	Open sigmoidectomy, Hartman colostomy.	Septic shock
(Urinary bladder,rectal & Right ureter)tears	Open Hartman colostomy,Urinary bladder and right ureter repair.	Chest infection and pneumonia.
Lt diaphragmatic tear.	Lt diaphragmatic tear repair.	Hypovolumic shock
Uterine tear	Open repair	DIC
(hepatic,diaphragmatic and Left renal)tears	Open repair and Left nephrectomy	Pneumonia
Intrapertontial Bile, bleeding, Gall Bladder and pyloric tears	Open cholecystectomy and pyloric repair	Chest infection-low saturation-ventelation

Discussions

The application of laparoscopy has increased considerably with technical advances and constantly increasing experience with its use in the management of acute surgery cases including trauma surgery. New algorithms have been developed by many trauma centers worldwide for the management of BT and PT

to aid the fast and effective diagnosis of visceral injuries (5).

In the earliest work on laparoscopy in abdominal trauma, **Gazzangia et al., (6)** evaluated 37 patients; in 14 of these patients, laparotomy was avoided because of a negative diagnostic laparoscopy (DL). **In our**

study 2015 we evaluated 30 patients; laparotomy was avoided in 20 patients.

The use of diagnostic laparoscopy in abdominal trauma was useful to decrease the rate of negative laparotomy (7).

The usual diagnostic procedures, diagnostic peritoneal lavage, sonography, and even CT, all have their strengths and weaknesses and none of them are 100% reliable. For this reason, exploratory laparotomy is often performed in the case of stab wounds, but with a high morbidity percentage that reaches up to 40% (8). Therefore, the main benefits of laparoscopy are that it can reduce the rate of nontherapeutic and negative laparotomies, identify diaphragmatic injuries accurately, and even, in some cases, provide a therapeutic option (5).

In the largest study on laparoscopy in PT, Ivatury's group **Zantut et al.**, (9) reported a multicenter retrospective study of 510 hemodynamically stable patients who underwent DL for PT. 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 nontherapeutic laparotomy was avoided in 303 (59.4%) patients, of whom 26 patients received a therapeutic laparoscopic intervention (7).

In our experience of (PT), laparoscopy was beneficial in hemodynamic stable patients; the results of our analysis demonstrated that the use of laparoscopy to evaluate 20 penetrating abdominal trauma patients was able to exclude significant intra-abdominal injuries, and 12 patients of penetrating abdominal trauma patients avoided undergoing a nontherapeutic laparotomy. Conversion to laparotomy was performed in 8 patients because of large splenic lacerations, descending colon tears, small bowel injuries required resection and anastomosis.

Kaban et al., (10) reported that laparoscopy is of particular value in a blunt abdominal trauma patient with isolated free-fluid accumulation. Some reports also have shown that laparoscopy has a good diagnostic accuracy for blunt bowel injury. The algorithm used for patients resulted in a 12.8% nontherapeutic laparotomy rate, mainly from intraperitoneal fluid accumulation caused by a retroperitoneal hematoma. The adoption of diagnostic laparoscopy in patients decreased the nontherapeutic laparotomy rate caused by this condition. A recent study by **Shah et al.**, (11) showed that laparoscopy reduced the non diagnostic laparotomy rate and was effective for the treatment of patients with blunt abdominal trauma and hemoperitoneum, with an overall failure rate of 4%. **Marwan et al.**, (12) also reported similar results in pediatric patients with blunt

abdominal trauma and concluded that laparoscopy is underutilized in cases of pediatric abdominal trauma.

In our experience of (BT), laparoscopy was beneficial 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 8 patients of blunt abdominal trauma patients avoided undergoing a nontherapeutic laparotomy. 7 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 2 patients.

Zantut et al., (13) who reported a series of 68 victims of trauma. In that cohort, laparoscopy was performed to detect hemoperitoneum, penetration of parietal peritoneum, and injury to abdominal organs. Thus the safety, efficacy, and economic benefits of laparoscopy, such as reduced hospitalization time and avoidance of unnecessary laparotomies, were demonstrated. Although reported, laparoscopy has also served as a therapeutic tool in selected trauma scenarios to include the following:

Autotransfusion of hemoperitoneum, Stapling or suturing of small-intestinal wounds; stapling or suturing of stomach and diaphragmatic injuries, Splenorrhaphy, hepatorrhaphy, cautery, and topical hemostasis of spleen and liver injuries, Laparoscopy assisted sigmoid colostomy, Application of Ligaclips to control mesenteric bleeding.

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 hemorrhage (14). 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 (15).

In our experience, the use of laparoscopy as a diagnostic and therapeutic tool lead to avoidance of an open surgery in more than 66.6% (20/30) of patients. Negative and nontherapeutic laparoscopies were performed in 4 patients and therapeutic laparoscopy was performed in 10 patients: 6 patients hand assisted splenectomy, 3 patients need repair of liver tears, 3 patients need diaphragmatic tear repair, 6 patients

need primary repair for bowel and 2 patients need stomach repair. However, conversion to laparotomy was needed in 10 cases more than 30%. Multiple organ injuries 5 patients (16%), colostomy for descending and sigmoid colonic tears 3 patients (10%), resection anastomosis for multiple small bowel injuries in one patient (3.3%) and repair for uterine injuries in one patient (3.3%).

Although the primary goal of laparoscopy in trauma is to make a diagnosis and/or exclude injury, it may also serve as a therapeutic tool in patients requiring intervention. We found that almost 66.6% (20/30) of the patients requiring surgical therapy were successfully treated laparoscopically. These results are higher than previously reported rates of therapeutic laparoscopy, ranging from 8% to 50%. With increasing surgeon expertise, improved equipment, and enhanced technology, these rates are likely to continue to climb (16).

Trauma laparotomy remains the gold standard for the evaluation of intra-abdominal injury. However, complications following negative or nontherapeutic laparotomy can be as high as 20% (17). Consequently, it is advantageous to avoid a negative laparotomy, provided that a reliable and accurate alternative diagnostic procedure is available. In **Kaban et al., (10)** laparoscopy resulted in sensitivity for abdominal injury exceeding 90%, with a specificity of 100%. Furthermore, it proved to be a safe modality without direct operative or postoperative morbidity. **In our study**, laparoscopy prevented 20 laparotomies in 30 patients.

Kyoung et al., (18) recorded that hospital stay post laparoscopy (9-12 days) shorter than post laparotomy (17-25 days). **In our study** we recorded that hospital stay post laparoscopy (2-5 days) shorter than post laparotomy (10-13 days).

The complications associated with laparoscopy in trauma patients include tension pneumothorax, air embolism, and intracranial hypertension. **Eiriksson et al., (19)** noted that the potential of gas embolism in patients with intraabdominal 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.

In our study, the hospital stay and rate of postoperative complications were high in patients with BT than PT. In cases without conversion to laparotomy, we found one case with chest infection. Conversion to laparotomy, we found one patient 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.

Minimally invasive surgery has become a useful tool in the management of trauma. Laparoscopy can detect and repair injuries to the hollow viscus and diaphragm and exclude the risks of nontherapeutic 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 (5).

Mortality

Amit goel et al., (20) reported that mortality occurs in 20 of 510 cases, **Jeremy et al (21)** reported that mortality occurs in 3 of 131 cases.

In our study mortality occurs in 6 cases (mortality rate 20%). The causes of death are Chest infection and pneumonia in 2 cases. Low saturation and ventilation in one case. Septic shock in one case Hypovolumic shock in one case. DIC in one case.

Conclusion

The routine use of Laparoscopy can reduce the number of unnecessary laparotomies and the related morbidity as it can achieve a sensitivity of 90–100% in abdominal trauma.

No conflict interest

No funds

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