

Use of laparoscopy in the management of abdominal trauma: a center experience

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Received 19 July 2014

Accepted 18 September 2014

The Egyptian Journal of Surgery
2015, 34:11–16

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 nontherapeutic laparotomies performed has decreased since the use of laparoscopy in diagnosis and management.

Patients and methods

Sixty-five patients with abdominal trauma (21 blunt trauma, 44 penetrating trauma) were treated by the Trauma Team at the Emergency Unit of Zagazig University from November 2011 to August 2014 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 81.5% (53/65) of cases. Therapeutic laparoscopy was effective in 15 patients: six patients with stomach penetrations, four with liver lacerations, three with diaphragmatic injuries, and two with splenic lacerations.

Conclusion

Laparoscopy can be performed safely and effectively in stable patients with abdominal trauma.

Keywords:

abdominal trauma, blunt injury, laparoscopy, penetrating injury

Egyptian J Surgery 34:11–16
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1110-1121

Introduction

In the last 30 years, penetrating abdominal injuries have been managed by operative exploration irrespective of the hemodynamic condition of the patient. The majority of clinicians would choose the surgical option for the management of patients with hemodynamic instability [1].

Sometimes, the choice between surgical and conservative management is difficult. This is consistent with cases with injury to the diaphragm or intestines, which cannot be detected by imaging techniques. Thus, this gives rise to a need for other modalities to aid the diagnosis and even management of such cases [2].

To avoid such oversights, indications for exploratory laparotomy have traditionally been generous, to extent that up to 41% of exploratory laparotomies turned out to be non-therapeutic and could be avoided with laparoscopy [2].

Since the early 1990s, the application of laparoscopy in general surgery has increased. Thus, it will not be surprising to expand its use in trauma management and diagnosis [3].

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 abdominal trauma (PT) and blunt abdominal trauma (BT).

Patients and methods

Sixty-five patients with abdominal trauma, 21 with BT and 44 with PT, were treated in the Trauma Unit of Zagazig University from November 2011 to August 2014.

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. All patients with abdominal gunshot wounds were

excluded from our series and underwent immediate surgical exploration.

For patients with other PT without obvious anterior fascia injury, a local wound exploration is performed in the Trauma Unit.

In cases of obvious penetration of the anterior fascia or if it is determined or suspected during the initial exploration or presence of free fluid as a radiological findings, an immediate operative exploration is mandatory.

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 or respiratory pressure suddenly increases, 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.

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. The presence of significant hemoperitoneum or succus entericus requires open exploration (Figs. 1–5).

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.

Results

Sixty-five patients (21 BT and 44 PT) 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 shown in Table 1.

Blunt trauma

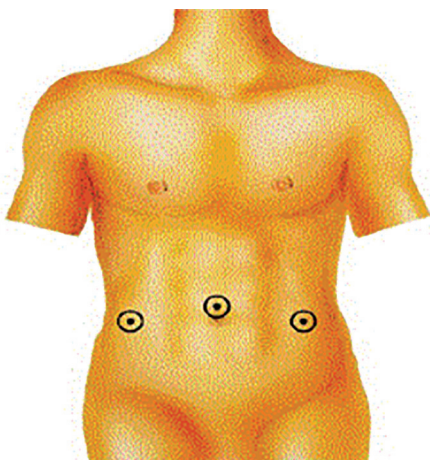
Laparoscopy was used for the evaluation of blunt abdominal injury in 21 patients. Ultrasound findings included free fluid in the pelvis; abdominal CT findings included free fluid in the abdomen in all patients, with suspected injuries in eight patients.

No significant injuries were identified in four patients upon an initial laparoscopic survey.

Nontherapeutic procedures were performed in nine patients; intraoperative findings in these patients included two minor splenic lacerations and hematomas, three minor liver lacerations, two nonexpanding retroperitoneal hematomas, and two with small mesenteric hematoma. No further interventions were performed in the above-mentioned 13 patients.

Laparoscopic intervention was performed in three patients; one presented with liver laceration under conservative management. The patient's condition deteriorated after 1 week. He presented with acute abdomen, fever, tachycardia, anemia, and leukocytosis.

Figure 1



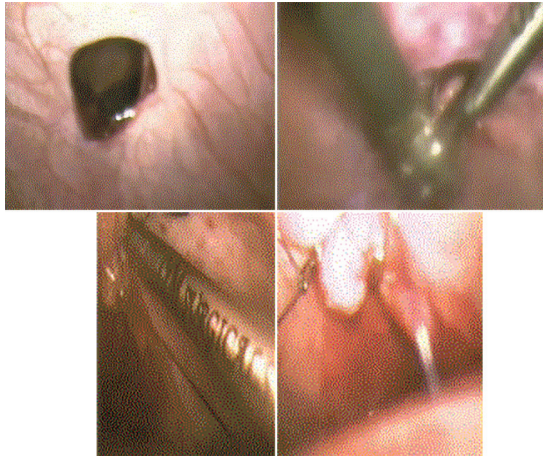
Trocar site.

Figure 2



Liver penetration.

Figure 3



Diaphragmatic tear.

Figure 4



Stomach penetration.

Figure 5



Splenic laceration and laparoscopic splenectomy [1].

Table 1 Patients' characteristics according to the mechanisms of injury

Patient characteristics	Mechanisms of injury	
	Blunt trauma	Penetrating trauma
Number	21	44
Age (years)	25–45	18–30
Male	16	36
Female	5	8
Negative laparoscopy	4	14
Nontherapeutic laparoscopy	9	11
Therapeutic laparoscopy	3	12
Conversion to exploration	5	7
Length of hospital stay	6 ± 4.8	2 ± 2.5
Morbidity	3	1
Mortality	0	0

During laparoscopy we found a big cavity at the right lobe at the site of laceration filled with necrotic materials and hematomas, the necrotic tissue inside was removed, coagulation of the bleeding points, clip ligation of suspected biliary small ducts or bleeding vessels and irrigation and drainage of the cavity then putting a drain inside it.

The other two patients presented with splenic laceration and subcapsular hematoma that was diagnosed with CT, and were under conservative treatment until their condition deteriorated. Diagnostic laparoscopy was performed, which indicated internal hemorrhage because of rupture of subcapsular hematoma; laparoscopic splenectomy was performed using a Harmonic scalpel.

In the other five patients, a laparotomy was performed following injury identification on diagnostic laparoscopy. These patients were under conservative management until their condition deteriorated. Two patients presented with large splenic lacerations that required urgent open splenectomy. Three patients underwent bowel repair or resection because of bowel perforation.

Complications in patients undergoing laparoscopy without conversion to laparotomy were minor and limited to postoperative chest infection in one patient; there were no intraoperative complications during laparoscopy. In patients who required a laparotomy, minor complications were encountered in the form of paralytic ileus in one patient and wound infection in another. The average length of hospital stay was 6 ± 4.8 days for all BT patients.

Penetrating trauma

Forty-four patients underwent a laparoscopic evaluation in the setting of PT (Table 2). Diagnostic laparoscopy ruled out an intraperitoneal injury (negative laparoscopy) in 14 patients, including four patients with no peritoneal penetration.

Table 2 Laparoscopic evaluation and management of patients with penetrating trauma

Findings at laparoscopy	Numbers	Finding at laparotomy	Surgical procedure
No injury	14		Diagnostic laparoscopy
Liver laceration	9		Nontherapeutic laparoscopy ($n = 6$) Therapeutic laparoscopic ($n = 3$)
Stomach	6		Laparoscopic repair
Retroperitoneal hematoma	3		Nontherapeutic laparoscopy
mesenteric hematoma	2		Nontherapeutic laparoscopy
Diaphragmatic injury	3		Laparoscopic repair
Bowel injury	5	3 colonic perforation 2 small bowel perforation	Open repair Open repair
Hemoperitoneum	2	Mesenteric artery injury	Open suture ligation

Nontherapeutic laparoscopy was performed in 11 patients: six presented with minor liver lacerations, two with mesenteric hematoma, and three with retroperitoneal hematoma related to the descending colon with no significant colonic injury.

Therapeutic laparoscopy was performed in 12 patients: three liver lacerations needed biosurgical materials (gel foam), three diaphragmatic injuries needed repair, and six stomach perforation required repair. Seven patients had injuries identified at laparoscopy that necessitated conversion to open exploration (Table 2).

No complications were encountered in patients undergoing laparoscopy without conversion to open exploration. Among patients who required a laparotomy, a minor complication was encountered in the form of wound infection in one patient. The average length of hospital stay was 2 ± 2.5 days for all PT patients.

Laparoscopy in BT and PT was negative in 19 and 31.8%, respectively, and was nontherapeutic in 42.8 and 25%, respectively. Also, 15 patients were managed with laparoscopy (three cases with BT and 12 cases with PT). Overall, because of the use of laparoscopy, laparotomy was avoided in (53/65) 81.5% of the patients in this study.

Discussion

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 [2].

In the earliest work on laparoscopy in abdominal trauma, Gazzangia *et al.* (1976) [4] evaluated 37 patients; in 14 of these patients, laparotomy was avoided because of a negative diagnostic laparoscopy (DL).

There were no false-negative investigations. They concluded that the use of diagnostic laparoscopy in abdominal trauma was useful to decrease the rate of negative laparotomy [5].

In the largest study on laparoscopy in PT, Ivatury's group (Zantut *et al.*, 1997) [6] 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 [5].

Here, in our institute, because of the increase in the rate of PT, we have incorporated laparoscopy into our management algorithm for PT to detect missed injuries and prevent potential morbidity and mortality (Fig. 5).

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% [7]. 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 [2].

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% [8,9]. 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 [10]. In our study, laparoscopy prevented 53 laparotomies in 65 patients (Algorithm 1).

Chol and Lim (2003) [11] performed a laparoscopic evaluation of 78 hemodynamically stable patients who had already undergone CT showing significant injuries. Nearly two-thirds of the patients were BT victims. This group reported no missed injuries, no mortality, and an 83% success rate in their ability to provide definitive surgical treatments ranging from gastrorrhaphy to small bowel resection to pancreatectomy. Although these results are exciting, data from different institutions show higher complication rates and missed injury rates and a narrower range of therapeutic interventions [12,13].

In our experience of BT, laparoscopy was beneficial especially in hemodynamic stable patients; nearly two-thirds of our patients benefited from diagnostic laparoscopy in avoiding unnecessary laparotomy and postoperative morbidity. Therapeutic laparoscopy was used in one patient who presented with infected liver lacerations and two patients with splenic laceration. Conversion to laparotomy was performed in five patients because of large splenic lacerations in two patients and three patients with small bowel injuries required resection and anastomosis.

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 [14]. Nevertheless, a review of the published literature shows an increasing number of case reports showing successful therapeutic interventions in abdominal trauma [15]. This trend will continue to grow as surgeons' comfort with minimally invasive techniques improves and technology becomes more convenient and advanced.

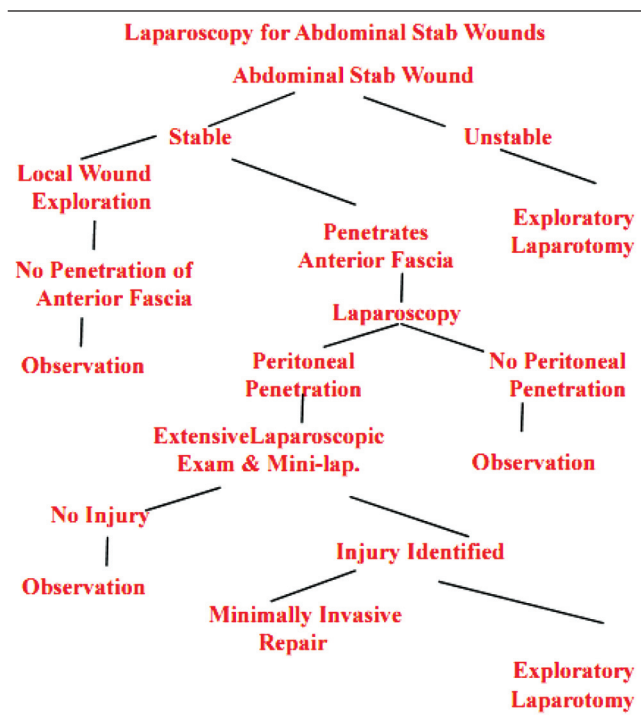
In our experience with PT, the use of laparoscopy as a diagnostic and therapeutic tool led to avoidance of an open surgery in more than 80% (37/44) of patients. Negative and nontherapeutic laparoscopies were performed in 25 patients and therapeutic laparoscopy was performed in 12 patients: six patients with gastrostomy at the anterior wall required laparoscopic closure, three patients with diaphragmatic penetration at the right copula of the diaphragm were managed by laparoscopic suturing, and 3 cases presented with bleeding liver laceration management laparoscopy by biotechnology coagulation materials as surge-cell. However, conversion to laparotomy was needed in seven cases (two cases with transverse colon perforation needed open repair with proximal colostomy and one with sigmoid perforation needed colostomy and Hartman, two cases with small bowel perforation needed open repair in one case and resection anastomosis in two cases, and two cases with hemoperitoneum because of mesenteric vessel injury required open ligation).

Potential risks when trauma patients undergo laparoscopy include air embolism, elevation of intracerebral pressure with head injuries, and tension pneumothorax when the diaphragm is injured. Small numbers of such complications were reported in the 1990s, and they now seem to be preventable if suitable measures are adopted [16].

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 and in patients with conversion to laparotomy, we found two patients with wound infection and one patient with paralytic ileus. 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.

Algorithm 1



Algorithm for the management of penetrating abdominal trauma [1].

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 [2].

Conclusion

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

Acknowledgements

Conflicts of interest

None declared.

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