Value of laparoscopic exploration of penetrating abdominal trauma

Ahmed A. Al Aziz

Lecturer of General Surgery Faculty of Medicine, Cairo University, Egypt

Correspondence to Ahmed A. Al Aziz, MD, Lecturer of General and Laparoscopic Surgery, Cairo University, Egypt. Tel: 01001907892; e-mail: zizoo_81@hotmail.com

Received 5 November 2017
Accepted 6 December 2017

The Egyptian Journal of Surgery
2018, 37:166–171

Objective
The aim was to evaluate the role of laparoscopy in the management of patients with penetrating abdominal trauma.
Patients and methods
This prospective study included 60 hemodynamically stable patients with penetrating abdominal trauma presenting to the Casualty Department. The patients were subjected to routine investigations including routine laboratory and radiological investigations and were randomly divided into two groups: local wound exploration (LWE) group (n=30) and laparoscopy group (n=30). In the LWE group, the patients were subjected to LWE under local anesthesia followed by laparotomy if the wound penetrated the deep fascia. In the laparoscopy group, the patients were subjected to diagnostic laparoscopy and managed laparoscopically or converted to laparotomy according to the circumstances. Otherwise, the patient was discharged within 24 h.
Results
In the LWE group, six (20%) patients were discharged as having intact peritoneum; one of them was back 2 days later, had exploratory laparotomy and a small bowel injury was repaired. A total of 24 (80%) patients with perforated peritoneum proceeded to laparotomy; 17 (56.7%) of them had negative laparotomy. In the laparoscopy group 18 (60.0%) patients showed negative laparoscopy, four (13.3%) patients were managed laparoscopically, and eight (26.7%) were converted to laparotomy.
Thus, 33 laparotomies were performed; the rate of complications was 39.4% with significant difference between negative and therapeutic cases (P=0.619). The operative time and hospital stay were significantly longer in cases of laparotomy compared with laparoscopy ($P<0.001$).
Conclusion
Routine laparotomy has a negative rate of 57%. Laparoscopy did not miss intra-abdominal injuries, was therapeutically effective in 12%, and was negative in 60% of cases.

Keywords:
abdominal trauma, laparoscopic exploration, penetrating

Egyptian J Surgery 37:166–171

1110-1121

Introduction

In the emergency department, the management of a patient with penetrating abdominal trauma (PAT) is always considered a diagnostic and therapeutic challenge. There is almost a consensus that immediate laparotomy (LAP) is mandatory for cases presenting with peritonitis, hemodynamic instability, or evisceration [1].

However, how to evaluate a stable patient without peritonitis is still a matter of debate for many reasons. In modern practice, the surgeon must balance the risks and the benefits of variable diagnostic and therapeutic procedures within the context of patient safety [2]. Mandatory laparotomy was considered the standard of care for the evaluation and treatment of abdominal trauma for decades, but it results in negative laparotomy rates in 12–40% of cases [3,4]. Despite decreasing the risk of missed injury to near zero, exploratory laparotomy has been associated with a complication rate of 15–50% and prolonged hospital stay [3].

Negative laparotomy cannot be accepted as an inevitable consequence of a sole management policy in today's environment. Therefore, laparotomy should be reserved for those patients who will get clear benefits. Noninvasive procedures such as computed tomography (CT) and abdominal sonography can deliver critical information with lower risk and little discomfort for the patient. Nevertheless, these methods may miss a serious intra-abdominal injury with subsequent increased

 DOI: 10.4103/ejs.ejs_118_17

morbidity, mortality, and cost [5]. Diagnostic peritoneal lavage (DPL) is another option that can accurately detect intraperitoneal hemorrhage or a ruptured hollow viscus [6].

In the last decade, laparoscopy attained a wider role in the evaluation and treatment of patients with abdominal trauma [2]. Laparoscopy has been utilized for both blunt and penetrating injuries, but it has gained more prevalent acceptance for the management of patients with penetrating abdominal injuries [7]. Several studies have reported good results of laparoscopic procedures in abdominal trauma in terms of high sensitivity and specificity for the diagnosis of intra-abdominal injuries, low rate of missed injuries, and few complications [8–11]. The laparoscopic approach avoided nontherapeutic laparotomies in ~60% of patients with abdominal stab wounds (SW) [8,11].

The aim of this study was to evaluate the role of laparoscopy in the management of hemodynamically stable patients with PAT compared with exploratory laparotomy.

Patients and methods

This comparative prospective study was conducted in Kasr Al-Ainy Hospital from April 2013 to August 2013. All the patients gave informed written consent and complied with the management and follow up regimen. It included 60 patients with PAT [SW and gunshot wounds (GSW)] presenting to the Casualty Department. The patients were eligible if they were hemodynamically stable, defined as systolic blood pressure more than or equal to 100 mmHg, diastolic blood pressure more than or equal to 60 mmHg, heart rate less than 110 bpm, and minimal requirements for crystalloid resuscitation (<2 l). Patients with GSW who were thought by physical examination to likely have tangential passage of the missile through the abdominal wall without peritoneal penetration were included.

Exclusion criteria included those who were hemodynamically unstable, patients with peritonitis or evisceration, and those in whom laparoscopy was contraindicated.

Patients were subjected to routine investigations including routine laboratory and radiological investigations such as abdominopelvic ultrasonography, CT scan, and plain erect abdominal radiographic, each case according to its requirement to reach diagnosis. Data collected included the mechanism of injury, anatomical site of penetration, injuries found and their management, operative time, postoperative complications, and hospital stay.

The patients were randomly divided into two groups: local wound exploration (LWE) group (n=30) and laparoscopy group (n=30). In the LWE group, the patients were subjected to LWE under local anesthesia to assess the extent of penetration. If the wound penetrated the deep fascia, formal laparotomy, and management was done. If not, the wound was sutured and the patient discharged. In the laparoscopy group, the patients were subjected to diagnostic laparoscopy (DL). If it proved to be penetrating, the management will be conducted either laparoscopically or the operation was converted to laparotomy according to the circumstances. Otherwise, the patient was discharged within 24 h.

Negative laparotomy was defined as the absence of intra-abdominal injury. Nontherapeutic laparotomy was defined as finding an organ injury that did not require intervention, e.g. nonbleeding minimal liver or spleen injuries. Therapeutic laparotomy was defined as an organ injury that required surgical correction. Therapeutic laparoscopy was defined as an organ injury that was surgically repaired through laparoscopy.

Statistical methods

Statistical analysis was done using IBM SPSS statistics version 22 (IBM Corp., Armonk, New York, USA). Numerical data were expressed as mean and SD and range. Qualitative data were expressed as frequency and percentage. χ^2-test (Fisher's exact test) was used to examine the relation between qualitative variables. For quantitative data, comparison between two groups was done using independent sample t-test or Mann–Whitney test. A P value of less than 0.05 was considered significant.

Results

Table 1 shows the age and sex distribution of the two groups. GSW were observed in few patients of the two groups.

Results of evaluation of local wound exploration group

During primary LWE, the peritoneum of six (20%) patients was judged to be intact and the primary suture was done and then the patients were discharged. One of these six patients was back 2 days later with signs of peritonitis and went through an exploratory laparotomy where a small bowel

injury was found and repaired. The remaining 24 (80%) patients with perforated peritoneum proceeded to laparotomy. Seven out of 24 (23.3%) had positive laparotomy findings and were managed accordingly. In 17 (56.7%) patients, laparotomy yielded negative findings. The results and management of the LWE group in relation to the mechanism of injury are shown in Table 2. One of the two positive GSW cases had liver lacerations associated with mesenteric and small bowel injury. The other patient had spleen lacerations associated with omental and left colon injury. The five injuries in SW patients are shown in Table 2.

Table 1 Age and sex distribution and mechanism of injury of the two studied groups

	LWE group (*n*=30)	Laparoscopy group (*n*=30)	*P* value
Age (years)	28.8±9.1	27.2±6.8	0.444
13–19	3 (10.0)	0 (0.0)	0.125
20–30	12 (40.0)	15 (50.0)	
31–40	8 (26.7)	12 (40.0)	
41–50	7 (23.3)	3 (10.)	
Sex (male/female)	28/2	29/1	1.000
Mechanism of injury			
Gunshot	3 (10.0)	6 (20.0)	0.472
Stab wound	27 (90.0)	24 (80.0)	

LWE, local wound exploration.

Results of evaluation of the laparoscopy group

A total of 18 (60.0%) patients showed negative laparoscopic exploration and were discharged within 24 h. Four (13.3%) patients were managed laparoscopically according to their findings (Table 3). Eight (26.7%) patients were converted to laparotomy and managed accordingly. Two of these eight patients needed laparotomy as a result of laparoscopic complications.

Technical laparoscopic complications

(1) The first complication occurred in a patient with an SW. While running the small bowel, an enterotomy was made with a grasper. Laparotomy was required for small bowel repair, and the patient had no other injuries.
(2) The second patient sustained a right-sided thoracoabdominal GSW and had a chest tube placed preoperatively. During CO_2 insufflation for laparoscopy, the patient became acutely hypotensive and the systemic oxygen saturation dropped. A diagnosis of tension pneumothorax was made and a second chest tube was inserted with immediate relief of tension and normalization of blood pressure and oxygenation; the initial chest tube had occluded by angulation.

Table 2 Results of evaluation of local wound exploration group (*n*=30)

	Gunshot wound (*n*=3) [*n* (%)]	Stab wound (*n*=27) [*n* (%)]	Total (*n*=30) [*n* (%)]
Negative LWE	1 (33.3)	5 (16.7)	6 (20.0)
Positive laparotomy	**2 (66.7)**	**5 (73.3)**	**7 (23.3)**
Liver lacerations	1 (33.3)	1 (3.7)	2 (6.7)
Spleen lacerations	1 (33.3)		1 (3.3)
Gastric lacerations		1 (3.7)	1 (3.3)
Omental injury	1 (33.3)[a]	2 (7.4)[a]	2 (6.7)[a]
Mesenteric injury	1 (33.3)[a]	2 (7.4)[a]	3 (10.0)[a]
Diaphragmatic injury	2 (66.7)[a]	1 (3.7)	3 (10.0)[a]
Small bowel injury	1 (33.3)[a]	2 (7.4)	3 (10.0)
Colonic injury	1 (33.3)[a]	1 (3.7)[a]	2 (6.7)[a]

[a]Associated injuries.

Table 3 Results of evaluation of the laparoscopy group (*n*=30)

	Gunshot wound (*n*=6) [*n* (%)]	Stab wound (*n*=24) [*n* (%)]	Total (*n*=30) [*n* (%)]
Negative laparoscopy	2 (33.3)	16 (66.7)	18 (60.0)
Positive laparoscopy	4 (66.7)	8 (33.3)	12 (40.0)
Liver lacerations	2 (33.3)	1 (4.2)	3 (10.0)
Spleen lacerations		1 (4.2)	1 (3.3)
Gastric lacerations	1 (16.7)[a]	1 (4.2)	2 (6.7)
Omental injury		1 (12.5)	1 (3.3)
Mesenteric injury		1 (4.2)[a]	1 (3.3)[a]
Diaphragmatic injury	2 (33.3)		2 (6.7)
Small bowel injury	1 (16.7)[a]	2 (8.3)	3 (10.0)
Colonic injury		1 (4.2)	1 (3.3)

[a]Associated injuries.

Laparotomy was performed with repair of a 1–2 cm diaphragm laceration and cauterization of a superficial liver injury.

Classification of wounds according to the site of entrance

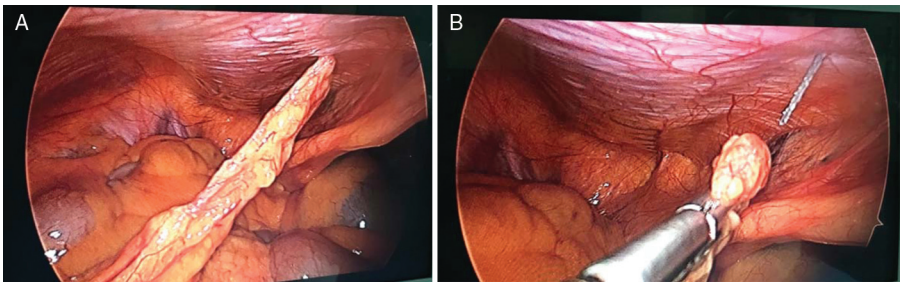
(1) Thoracoabdominal: four patients out of the 60 (6.7%) presented with thoracoabdominal penetrating wounds. One patient with GSW had a diaphragmatic tear repaired laparoscopically. Another patient was subjected to laparotomy due to the excessive bleeding that was coming out through the SW and had negative findings. The muscular bleeding was controlled and a chest tube was inserted due to hemothorax.
(2) Anterior abdominal wall: 55 (91.6%) patients presented with penetrating wounds in the anterior abdominal wall: 48 SW and seven GSW. Five patients with negative wound exploration were discharged.
(3) Lateral abdominal wall: a case of lateral abdominal wall SW was discharged at the same day after being subjected to LWE which was negative. Figures 1 and 2 show the fate of the 60 patients in the two groups in relation to the wound site.

Collectively, 33 laparotomies were performed; three for thoracoabdominal wounds and 30 for anterior abdominal wall wounds. Out of these 33 laparotomies, 17 (51.5%) were negative. All of these 17 cases had routine laparotomy. Table 4 shows complications of the laparotomies. The rate of complications was 39.4%. There was no significant difference between negative and therapeutic cases regarding the rate of complications (P=0.619). Operative time and hospital stay were significantly longer in cases of laparotomy compared with laparoscopy (P<0.001) (Table 5).

Discussion

The results of this study demonstrated that management of stable patients with PAT with routine laparotomy yielded negative findings in 56.7%. LWE before laparotomy missed a case with perforated peritoneum among six patients who were discharged based on having intact peritoneum. On the other hand, laparoscopic exploration was negative in

Figure 1



Fate of the 30 patients in the local wound exploration group in relation to the wound site. LWE, local wound exploration.

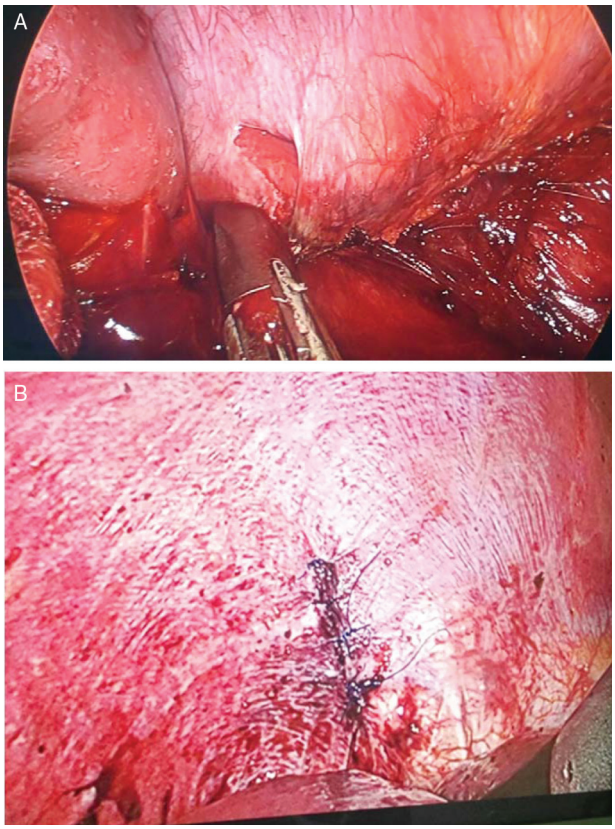
Table 4 Postoperative complications in cases of laparotomy (*n*=33)

	Negative laparotomy (*n*=17) [*n* (%)]	Therapeutic laparotomy (*n*=16) [*n* (%)]	Total (*n*=33) [*n* (%)]
Wound infection	3 (17.6)	2 (12.5)	5 (15.2)
Wound dehiscence	0 (0.0)	1 (6.2)	1 (3.0)
Pneumonia/chest infection	2 (11.8)	2 (12.5)	4 (12.1)
Ileus	1 (5.9)	2 (12.5)	3 (9.1)
All complications	6 (35.3)	7 (43.8)	13 (39.4)

Table 5 Operative time and hospital stay in cases of laparoscopy and laparotomy

	Laparoscopy		Laparotomy	
	Negative (*n*=18)	Therapeutic (*n*=4)	Negative (*n*=17)	Therapeutic (*n*=16)
Operative time (min)				
Mean	27.3±2.5	77.5±18.6	65.3±32.4	
Range	20–30	40–120	20–180	
Hospital stay (days)				
Mean	1.4±0.7	2.1±0.8	5.1±1.3	6.2±3.2
Range	1–2	1–4	2–7	2–15

Figure 2



Fate of the 30 patients in the laparoscopy group in relation to the wound site.

60% of cases; and management was possible in 12% of cases. Technical complications of laparoscopic exploration were met in only two cases. Laparotomy was associated with a postoperative complication rate of 39.4%; the rate in negative laparotomy was 35.3%. Laparoscopy significantly decreased the operative time and hospital stay.

PAT continues to represent a challenge for emergency surgeons. Traditionally, exploratory LAP was the main management option. However, the high negative laparotomy rate and associated postoperative morbidity had driven the trend toward selective nonoperative management strategy [12]. Actually, recent reports have shown that 30–50% of all SW do not penetrate the peritoneum and 20–40% with peritoneal penetration do not involve significant injuries [13,14].

The available diagnostic methods including DPL, focused abdominal sonography for trauma, and CT are not satisfactory enough to determine the presence and severity of intra-abdominal injuries caused by penetrating wounds. Laparoscopy has been safely and effectively used for patients with PAT for diagnostic and therapeutic purposes [13,15].

In the current study, the use of laparoscopy was relatively safe, and was successful for the treatment of four patients with intra-abdominal injuries. It reduced unnecessary laparotomies from 57 to 0% with shortening of the operative time and hospital stay. Six (20%) patients of the laparoscopy group were converted to laparotomy for the management of major injuries with 100% sensitivity.

An evidence-based review has reported that DL in trauma patients spares 17–89% of nontherapeutic laparotomy [16]. In predicting the need for LAP, DL was reported to have sensitivity, specificity, and diagnostic accuracy ranging from 75 to 100%; the rate of missed injuries was less than 1% [17].

In asymptomatic patients with abdominal GSW, Sosa *et al.* [3] reported a drop in negative laparotomy rate from 12.4 to 4.7% when routine DL was started. In a retrospective cohort study, laparoscopy decreased the nontherapeutic laparotomy rate from 57.9 to 0%, shortened hospital stay and operative time [8].

A systematic review included one randomized, controlled trial and eight observational studies comparing the outcomes of laparoscopy with laparotomy in PAT. Laparoscopy was associated with a significantly lower risk of wound infection and pneumonia and a significantly shorter hospital stay and procedure time [18].

In addition to diagnostic capabilities, laparoscopy has a considerable therapeutic potential with certain cases depending on the experience of the surgeon in advanced laparoscopic techniques [9]. In the current study, four patients were managed laparoscopically; one of them had a gunshot injury involving the diaphragm which was repaired.In fact, optimal management of asymptomatic patients with penetrating abdominal wounds has yet to be determined. Many guidelines are now available [13,15,19]. Biffl and colleagues suggested an algorithm for nonoperative management of stable patients with anterior abdominal SW. In this algorithm, patients undergo LWE with subsequent discharge if penetration is excluded. Otherwise, in-hospital serial clinical assessments were done. Afterwards, operative management or further investigations were done according to the patients' status. According to this algorithm, serial clinical assessments resulted in avoidance of the added expense of CT, DPL, or laparoscopy [20]. However, other investigators prefer DL to LWE. This is based on the advantages of immediate laparoscopy including reduced morbidity, accuracy in detecting diaphragmatic and

intestinal injuries, reducing hospital stay, and increased cost effectiveness [21].

The results of the current study indicate a clear benefit of LWE under local anesthesia; it correctly identified 16.7% of patients who have intact peritoneum and consequently did not need further management. The main drawback is a missed case of small peritoneal tear that was wrongly discharged. Unnecessary laparotomy rate was rather high (57%). On the other hand, laparoscopy did not miss any case with intra-abdominal injury and was therapeutically effective in four patients. The rate of negative cases is still high (60%). Therefore, we recommend LWE as the first step in hemodynamically stable patients followed by serial clinical assessments for 24 h. If the patients' status is still doubtful, we can proceed to DL.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

References

1 Biffl WL, Leppaniemi A. Management guidelines for penetrating abdominal trauma. World J Surg 2015; 39:1373–1380.

2 Thompson MD, Chadwick Knight MD. Modern evaluation of abdominal trauma. Marshall J Med 2016; 2:37.

3 Sosa JL, Baker M, Puente I, Sims D, Sleeman D, Ginzburg E, *et al.* Negative laparotomy in abdominal gunshot wounds: potential impact of laparoscopy. J Trauma 1995; 38:194–197.

4 Leppäniemi A, Salo J, Haapiainen R. Complications of negative laparotomy for truncal stab wounds. J Trauma 1995; 38:54–58.

5 Inaba K, Okoye OT, Rosenheck R, Melo N, Branco BC, Talving P, *et al.* Prospective evaluation of the role of computed tomography in the assessment of abdominal stab wounds. JAMA Surg 2013; 148:810–816.

6 Whitehouse JS, Weigelt JA. Diagnostic peritoneal lavage: a review of indications, technique, and interpretation. Scand J Trauma Resusc Emerg Med 2009; 17:13.

7 Miles EJ, Dunn E, Howard D, Mangram A. The role of laparoscopy in penetrating abdominal trauma. JSLS 2004; 8:304–309.

8 Lin H-F, Wu J-M, Tu C-C, Chen H-A, Shih H-C. Value of diagnostic and therapeutic laparoscopy for abdominal stab wounds. World J Surg 2010; 34:1653–1662.

9 O'Malley E, Boyle E, O'Callaghan A, Coffey JC, Walsh SR. Role of laparoscopy in penetrating abdominal trauma: a systematic review. World J Surg 2013; 37:113–122.

10 Villavicencio RT, Aucar JA. Analysis of laparoscopy in trauma. J Am Coll Surg 1999; 189:11–20.

11 Marwan A, Harmon CM, Georgeson KE, Smith GF, Muensterer OJ. Use of laparoscopy in the management of pediatric abdominal trauma. J Trauma 2010; 69:761–764.

12 Uranüs S, Dorr K. Laparoscopy in abdominal trauma. Eur J Trauma Emerg Surg Off Publ Eur Trauma Soc 2010; 36:19–24.

13 Sugrue M, Balogh Z, Lynch J, Bardsley J, Sisson G, Weigelt J. Guidelines for the management of haemodynamically stable patients with stab wounds to the anterior abdomen. ANZ J Surg 2007; 77:614–620.

14 Cothren CC, Moore EE, Warren FA, Kashuk JL, Biffl WL, Johnson JL. Local wound exploration remains a valuable triage tool for the evaluation of anterior abdominal stab wounds. Am J Surg 2009; 198:223–226.

15 Como JJ, Bokhari F, Chiu WC, Duane TM, Holevar MR, Tandoh MA, *et al.* Practice management guidelines for selective nonoperative management of penetrating abdominal trauma. J Trauma 2010; 68: 721–733.

16 Stefanidis D, Richardson WS, Chang L, Earle DB, Fanelli RD. The role of diagnostic laparoscopy for acute abdominal conditions: an evidence-based review. Surg Endosc 2009; 23:16–23.

17 Hori Y, SAGES Guidelines Committee. Diagnostic laparoscopy guidelines: this guideline was prepared by the SAGES Guidelines Committee and reviewed and approved by the Board of Governors of the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES), November 2007. Surg Endosc 2008; 22:1353–1383.

18 Hajibandeh S, Hajibandeh S, Gumber AO, Wong CS. Laparoscopy versus laparotomy for the management of penetrating abdominal trauma: a systematic review and meta-analysis. Int J Surg Lond Engl 2016; 34: 127–136.

19 Biffl WL, Kaups KL, Cothren CC, Brasel KJ, Dicker RA, Bullard MK, *et al.* Management of patients with anterior abdominal stab wounds: a Western Trauma Association Multicenter Trial. J Trauma 2009; 66:1294–1301.

20 Biffl WL, Kaups KL, Pham TN, Rowell SE, Jurkovich GJ, Burlew CC, *et al.* Validating the Western Trauma Association algorithm for managing patients with anterior abdominal stab wounds: a Western Trauma Association Multicenter Trial. J Trauma 2011; 71:1494–1502.

21 Uranues S, Popa DE, Diaconescu B, Schrittwieser R. Laparoscopy in penetrating abdominal trauma. World J Surg 2015; 39:1381–1388.