Role of laparoscopy in blunt abdominal trauma: a comparative prospective cohort study between laparoscopy and laparotomy in patients with blunt abdominal trauma

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Background
Trauma is considered to be a leading cause of death in young adults. Blunt mechanisms account for ~95% of injuries. Generally, laparotomy is considered to be the standard procedure used in the trauma cases. Recently, laparoscopic techniques have been increasingly introduced as an alternative to open surgery in trauma cases.
Objective
In our study, we assessed the efficacy of laparoscopy in managing patients with blunt abdominal trauma to avoid unnecessary laparotomies.
Patients and methods
An observational prospective cohort study was conducted on all isolated blunt abdominal trauma cases at Ain Shams University Surgery Hospital from 1/3/2019 to 1/9/2019. The total sample size was 50 patients, comprising 25 patients who underwent laparoscopy and another 25 who underwent laparotomy.
Results
Laparoscopy decreased the operative time in comparison with laparotomy. The mean operative time for patients who underwent laparoscopy was 123.28 min, whereas in patients who underwent laparotomy was 150.48 min. Laparoscopy is associated with decreased postoperative ICU stay (1–3 days) in comparison with laparotomy (2–5 days) and decreased total hospital stay. The rate of complications after laparoscopy is much less than after laparotomy, where two patients had respiratory tract infections and no mortality after laparoscopy, whereas six patients had respiratory tract infections, six patients had wound infection, one patient had deep venous thrombosis, and two patients died after laparotomy.
Conclusion
Laparoscopy is found to be a good alternative to laparotomy, as it is considered to be a reliable and safe method in hemodynamically stable patients with blunt abdominal trauma. It can be used to reduce the rate of laparotomy with lower morbidity and mortality rates.

Keywords:
blunt abdominal trauma, diagnostic laparoscopy, laparotomy

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Introduction

Trauma is considered to be a leading cause of death in young adults under 35 years old, and the sixth main cause of death around the world [1].

Blunt mechanisms account for ~95% of injuries [2,3]. Approximately 15% of the overall trauma injuries affect the abdominal area [3,4].

Nonoperative management has been widely used in trauma cases, especially in abdominal blunt trauma. However, many cases require surgical and invasive ways of diagnosis and treatment. For most trauma cases, laparotomy was considered the standard procedure. In the recent years, laparoscopy has been considered as an alternative option in abdominal blunt trauma cases to avoid unnecessary laparotomies [5].

Diagnostic laparoscopy was found to have a high diagnostic value in the identification and exclusion of intraabdominal injuries; thus, it would lead to the reduction of nontherapeutic laparotomies [6].

Laparoscopy has been associated with lower rates of morbidity and mortality in comparison with laparotomy, with lower rates of operative time, blood

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loss and transfusion, postoperative pain, surgical site infections, and length of hospital stay [7].

Laparoscopy is considered to be a reliable and safe diagnostic and therapeutic approach in hemodynamically stable patients with blunt abdominal trauma, which can be used to decrease the laparotomy rate [8].

Aim

The aim was to assess the role of laparoscopy and its effectiveness in managing patients with blunt abdominal trauma in comparison with open laparotomy.

Patients and methods

Type of study

This was an observational prospective cohort study. And after the acceptance from the ethical committee of General Surgery Department, Ain Shams University.

Study setting

The study was conducted at Ain Shams University Surgery Hospital.

Study population

Isolated blunt abdominal trauma cases at Ain Shams University Surgery Hospital from 1/3/2019 to 1/9/2019 were recruited in the study. Eligibility and exclusion criteria were applied as follows.

Eligibility criteria

Patients admitted with blunt abdominal trauma presented to ASUH; patients with class I and class II according to ATLS guidelines for hemorrhagic shock in patients with trauma; and patients aged 18 years old or above were the inclusion criteria.

Exclusion criteria

Patients with class III and class IV according to ATLS guidelines for hemorrhagic shock in patients with trauma; pregnant patients; patients with old trauma presented after 24 h; and patients discharged against medical advice were the exclusion criteria.

Sampling method

Convenient sampling was used. The patient recruitment step was done after the type of the operation was already decided; thus, we did not interfere in the decision of the operation technique. We kept enrolling patients until the predecided sample size of both groups was fulfilled.

Sample size

During the period of the study, the data were collected of the patients who were admitted at Ain Shams Hospital with abdominal trauma. The total sample size was 50 patients, comprising 25 patients who underwent laparoscopy, and another 25 who underwent laparotomy. Patients from both groups were matched by demographic characteristics (age and sex).

Study tools

Demographic and baseline characteristics data, such as age, sex, vital data, and the cause of the trauma, were collected from the patients. Surgical data like surgical findings, operation procedure, injured organs, operative time, and causes of conversion from laparoscopy to open laparotomy were also collected. After follow-up of the patients, postoperative data such as time to pass gas after the surgery, postoperative complications regarding wound infection, respiratory tract infections, and deep venous thrombosis (DVT), duration of postoperative ICU stay, total hospital stay, and mortality were recorded.

Preparation of patients

Written consent for diagnostic or therapeutic laparoscopy and exploratory laparotomy whenever needed was signed by all patients. Initially proper history taking was done regarding age, sex, mode of trauma, concurrent injury, and associated medical illness. Then full general and local assessment and examination was done. Then all patients were investigated regarding complete blood count, to be repeated after 6 or 12 h for selected cases; kidney functions, liver functions, coagulation profile, serum sodium and potassium level, blood sugar level; and serum amylase. Chest radiograph; radiograph abdomen and pelvis, in erect and supine; abdominal and pelvic ultrasound; and abdominal and pelvic computed tomographic (CT) scan were done.

Operative technique

Laparoscopic evaluations were performed by a surgical team experienced in emergency laparotomy and laparoscopy. All patients were under general anesthesia and then pneumoperitoneum using carbon dioxide was established at the umbilicus by an open technique to obtain an intraabdominal pressure of 15 mmHg. Then viewing laparoscope (300) was inserted through a 10-mm trocar at the umbilicus. Two additional trocars were placed lateral to the rectus sheath on both sides; 5 mm or 10–12 mm trocars were used. The surgeon position together with the patient position was changed accordingly to be able to explore the whole abdominal cavity and the abdominal organs. So the liver, spleen, stomach, and diaphragm

were explored and inspected while the patient in the reverse Trendelenburg position. Inspection of the sigmoid colon, both groins, both iliac regions, and the bladder was done while the patient in the Trendelenburg position. With the surgeon standing at the patient's left side, we examined the ascending colon and the small bowel starting from the ileocecal junction to the ligament of Treitz, with inspection of the mesentery, both sides, carefully. Then the surgeon changed his position to be at the patient's right side to assess the transverse colon and the left side of colon including the splenic flexure and the descending colon.

After careful examination of the abdominal cavity, aspiration of any hemoperitoneum or bowel contents was done with identification of the injury site. Accessory trocars were inserted according to the site of lesion, if needed. In the cases of nonsatisfactory or incomplete abdominal examination, the decision to convert to laparotomy was made.

In case of active bleeding, hemostasis was achieved using the diathermy, clips, endoloop type ligation, and suture ligation. All patients were observed postoperatively for vital data, hemoglobin level, return of bowel functions, and wound complications. Vaccination against meningococcal, pneumococcal, and *Haemophilus influenza* type B infections were given to the patients who underwent splenectomy. The patients were discharged after return of normal bowel functions, drain removal, and any complication was ruled out.

Statistical analysis

Collected data are presented in tables and suitable graphs and analyzed by SPSS, version 22 (Statistical analysis was done using IBM SPSS statistics for windows, Version 23.0., Armonk, NY: IBM Corp). χ^2 and *t*-test were used.

The confidence interval was set to 95%, and the accepted error margin was set to 5%. So, the *P* value was considered significant as follows: *P* value more than 0.05: nonsignificant, *P* value less than 0.05: significant, and *P* value less than 0.01: highly significant.

Results

In this study, we included 50 patients who were divided into two groups. The laparoscopy group included 25 patients, and the laparotomy group included another 25 patients. The time period along which the study was done was from 1/3/2019 to 1/9/2019. The two groups showed no significant statistical differences in their demographic data, such as age and sex (Table 1).

Moreover, no significant differences were found between the two groups regarding the mode of trauma, injured organ, and the procedure made (Table 2).

Highly significant differences were found between the two groups regarding the operative time, time to pass gas postoperatively, ICU stay, and total hospital stay, as shown in Table 3.

Moreover, the postoperative complications and mortality rate were significantly less in the laparoscopy group in comparison with the laparotomy group (Table 4).

Discussion

Abdominal injuries are considered one of the greatest diagnostic and therapeutic challenges as they require an experienced surgeon with frequent imaging or invasive procedures to be accurately diagnosed and definitely managed [9].

The sex distribution has male predominance as shown in the aforementioned table. In the present study, male : female ratio was 2 : 1. Increased incidence of trauma in male is attributed to their work outside house, frequent traveling, more social activities, and influence of alcohol sometimes. This goes in accordance with the study of Kumawat *et al.* [10], Panchal and Ramanuj [11].

Table 1 Demographic data of patients included in the study regarding age and sex

	Laparoscopy group (*N*=25)	Laparotomy group (*N*=25)	Test value	*P* value	Significance
Age					
Mean±SD	36.68±9.57	38.16±11.19	–0.503[a]	0.618	NS
Range	19–57	19–59			
Sex					
Female	8 (32.0)	9 (36.0)	0.089[b]	0.765	NS
Male	17 (68.0)	16 (64.0)			

[a]Independent *t*-test. [b]χ^2 test. *P* value more than 0.05: nonsignificant (NS); *P* value less than 0.05: significant (S); *P* value less than 0.01: highly significant (HS).

Table 2 The mode of trauma, injured organ, and the procedure made

	Laparoscopy group [*n* (%)]	Laparotomy group [*n* (%)]	Test value[a]	*P* value	Significance
Mode of trauma					
Road traffic accident	14 (56.0)	14 (56.0)	0.952	0.813	NS
Fall from height	6 (24.0)	8 (32.0)			
Assault	4 (16.0)	2 (8.0)			
Hit by animal	1 (4.0)	1 (4.0)			
Injured organ					
Spleen	10 (40.0)	7 (28.0)	4.131	0.659	NS
Mesentery	2 (8.0)	3 (12.0)			
Bleeding with no organ injured	5 (20.0)	4 (16.0)			
Liver	6 (24.0)	5 (20.0)			
Small bowel	2 (8.0)	3 (12.0)			
Duodenum	0	2 (8.0)			
Colon	0	1 (4.0)			
Procedure					
Splenectomy	7 (28.0)	7 (28.0)	7.400	0.285	NS
Repair of mesenteric tear	2 (8.0)	3 (12.0)			
Bleeding control	11 (44.0)	9 (36.0)			
Conversion into laparotomy	3 (12.0)	0			
Primary suturing of intestinal perforation	2 (8.0)	2 (8.0)			
Segmental resection of small bowel	0	3 (12.0)			
Left hemicolectomy and colostomy	0	1 (4.0)			

[a]χ^2 test. *P* value more than 0.05: nonsignificant (NS); *P* value less than 0.05: significant (S); *P* value less than 0.01: highly significant (HS).

Table 3 Operative time, postoperative days in ICU, time to pass gas, and hospital stay

	Laparoscopy group (*N*=25)	Laparotomy group (*N*=25)	Test value[a]	*P* value	Significance
Operative time					
Mean±SD	123.28±21.61	150.84±24.75	–4.194	0.008	HS
Range	90–160	110–198			
Postoperative days in ICU					
Mean±SD	2.08±0.64	3.71±0.86	–7.546	0.005	HS
Range	1–3	2–5			
Time to pass gas					
Mean±SD	1.84±0.62	2.83±0.64	–5.512	0.007	HS
Range	1–3	2–4			
Hospital stay					
Mean±SD	11.48±3.44	14.72±1.62	–4.259	0.01	HS
Range	6–16	12–18			

[a]Independent *t*-test. *P* value more than 0.05: nonsignificant (NS); *P* value less than 0.05: significant (S); *P* value less than 0.01: highly significant (HS).

Road traffic accidents are the commonest cause of blunt abdominal trauma followed by fall from heights and assaults. On the contrary, Al-Ayoubi *et al.* [12] reported that fall from height was the most common mechanism.

Clinical abdominal examination is insufficient for the assessment of patients with blunt abdominal trauma, as it is usually accompanied with additional distracting injuries, insignificant and nonspecific symptoms and signs, deteriorated conscious levels, in addition to the vast difference in patients' reaction to intraabdominal injuries [13].

Physical examination has been recognized as an indicate method in assessing trauma cases. Thus, trauma surgeons have been using many other diagnostic modalities.

Vastly used diagnostic modalities include focused abdominal sonography in trauma (FAST), pelvi-abdominal CT, and diagnostic peritoneal lavage [14].

FAST is considered to be a noninvasive bedside diagnostic method, which is commonly used to identify any free fluid collections in the abdomen. On the contrary, it is considered to be highly

Table 4 The postoperative complications, mortality, and causes of conversion into laparotomy

	Laparoscopy group [*n* (%)]	Laparotomy group [*n* (%)]	Test value[a]	*P* value	Significance
Complications					
No	23 (92.0)	12 (48.0)	12.457	0.006	HS
Respiratory tract infections	2 (8.0)	6 (24.0)			
Surgical site infection	0	6 (24.0)			
Deep venous thrombosis	0	1 (4.0)			
Mortality					
No	25 (100.0)	23 (92.0)	2.083	0.04	S
Yes	0	2 (8.0)			
Cause of conversion to laparotomy					
No	22 (88.0)	0	NA	NA	NA
Uncontrolled bleeding	2 (8.0)	0			
Adhesions from prior surgery	1 (4.0)	0			

[a]χ^2 test. *P* value more than 0.05: nonsignificant (NS); *P* value less than 0.05: significant (S); *P* value less than 0.01: highly significant (HS).

operator dependent and susceptible to human errors. According to the latest ATLS guidelines, it is mainly used as an adjunct method to the primary survey.

It was reported by Dolich *et al.* [15] that 1.7% of FAST-free patients had underlying internal organ injuries, and exploratory laparotomy was required for 23% of them. Other recent study in the United States reported that FAST in stable patients with blunt abdominal trauma had a sensitivity of only 22%, thus advised to go directly to pelvi-abdominal CT scan [16].

Kendall John *et al.* [17] documented the ultrasound limitation in blunt trauma with its poor specificity to determine the source of hemoperitoneum, as well as its poor ability to detect injuries of the solid organs in the absence of free fluid in the abdominal cavity.

CT scan is considered to be the imaging modality of choice in blunt abdominal trauma; however, it also has many limitations, as demonstrating the hollow viscus injuries which were found to be so hard on abdominal CT scan. However, despite all its limitations, CT scan still remains the first imaging choice for hemodynamically stable patients with blunt abdominal trauma [18].

Laparoscopy was first introduced in the management for patients with trauma in 1956 by Lamy [19], and since then, Gazzaniga *et al.* [20] and Carnevale *et al.* [19] have suggested laparoscopy to be useful to assess the need for laparotomy, and it has reduced the number of nontherapeutic laparotomies performed for hemoperitoneum by 25%.

We used laparoscopy in managing patients with blunt abdominal trauma as a diagnostic and therapeutic tool, and we found it helpful. This was consistent with Prasad and Agarwal [21], who confirmed that laparoscopy in experienced hands has reduced the rate of negative laparotomies. Moreover, it has been shown to add more in identifying and managing the diaphragmatic and visceral injuries.

Laparoscopy decreased the operative time in comparison with laparotomy. The mean operative time for patients who underwent laparoscopy is 123.28 min, whereas in patients who underwent laparotomy is 150.48. Moreover, time to pass gas postoperatively after laparoscopy is 1–3 days compared with 2–4 days after laparotomy, which is in favor of laparoscopy, which is associated with rapid recovery of patients. Laparoscopy is associated with decreased postoperative ICU stay (1–3 days) in comparison with laparotomy (2–5 days).

This also was consistent with Choi and Lim [22], who found out that laparoscopy was safe and technically feasible when applied carefully to patients with blunt abdominal trauma, decreasing the hospitalization time and postoperative ICU stay. It also offered profound therapeutic potential and cost-effectiveness, with reducing the negative and nontherapeutic laparotomies.

Our conversion rate to open laparotomy was 12%, which was owing to mainly uncontrolled bleeding and adhesions from prior surgeries. In the literature, the rate of conversion was found to vary from 8.5 to 37% according to the selection criteria [5,23]. The conversion was owing to bleeding, multiple injuries at presentation, postural and visual problem, and equipment failure.

The rate of postoperative complications is much less in patients who underwent laparoscopy. Only two patients had respiratory tract infections postoperatively, with no surgical site infections or

mortality cases, whereas in patients who underwent laparotomy, six patients had respiratory tract infections, six patients had surgical site infection, one patient had DVT, and two patients died owing to severe respiratory tract infection with ARDS and pulmonary embolism after DVT. This is consistent with Mohamed *et al.* [24], who documented that laparoscopy is associated with less rates of postoperative complications and mortality than laparotomy.

Sitnikov *et al.* [25] in their study concluded that diagnostic and therapeutic video-assisted laparoscopy can confidently be used in small bowel injuries. It showed significant specificity, sensitivity, and accuracy in the diagnosis and management of patients with small bowel injuries. It was found to decrease the time for definitive repair by the early diagnosis of bowel injury, and also reducing the rate of morbidity, mortality, hospital costs, and the length of hospitalization when combined with therapeutic laparoscopy in comparison with open laparotomy.

Conclusion

Minimal invasive surgery is being increasingly applied in different surgical fields. Laparoscopy has been associated with lower rates of morbidity and mortality in comparison with laparotomy, with lower rates of operative time, blood loss and transfusion, postoperative pain, wound infections, and hospitalization time. Laparoscopy is found to be a good alternative to laparotomy, as it is considered to be reliable and safe as a diagnostic and treatment method in hemodynamically stable patients with blunt abdominal trauma, it can be used to reduce the laparotomy rate, and it is associated with lower morbidity and mortality.

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Conflicts of interest

There are no conflicts of interest.

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