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Laparoscopy for abdominal trauma, is it safe and beneficial? If so, what are surgical pitfalls? And when to proceed?

Bassem Mohamed Sieda

ABSTRACT

Aim: Mandatory urgent explorative laparotomy as a role and standard procedure for managing blunt versus abdominal penetrating wounds carry a significant percentage of negative laparotomies in the absence of visceral injuries. Debate remains regarding the optimum role of laparoscopy in the setting of trauma although it can offer advantages over traditional exploratory laparotomy. Laparoscopy can be a screening, diagnostic or therapeutic tool in trauma. Laparoscopy is a unique diagnostic procedure inspecting the peritoneum for signs of perforation and excluding significant intra-abdominal injuries. Methods: A prospective study included 118 patients with abdominal trauma in haemodynamically stable patients, done in 2 institutes. 70 patients with blunt trauma and 48 patients with penetrating trauma. Patients were assigned into two groups, group A underwent laparoscopic exploration of the abdomen (61 Patients) and group B undergo exploratory laparotomy (57 patients). Results: 118 patients with abdominal trauma in hemodynamically stable patients, 70 patients with blunt trauma and 48 patients with penetrating trauma. There was a significant difference between both groups regarding postoperative complication, in laparotomy group 10 patients developed postoperative complications, four with postoperative ileus, one with pneumonia and other five with wound infections in laparoscopy group and only one patient developed postoperative ileus and this was statistically different between both groups, Significant P-value 0.009 and Odd ratio 6.277 and (95CI %) (1.311 – 30.043. Hospital stay was less in laparoscopy group (P-value<0.001). Negative or non-therapeutic laparotomy accounts for 15 patients (41.7%) from 36 patients with no intervention done. Conclusion: Not all patients with abdominal trauma are the candidate for laparoscopy. It is particularly diagnostic and therapeutic and avoids negative laparotomies.

Keywords: Abdominal trauma, Laparoscopy for trauma, Pitfalls of laparoscopy for trauma

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INTRODUCTION

Exploratory laparotomy was and still a traditional mainstay of management in patients with penetrating abdominal trauma (PAT). Negative laparotomy is associated with up to 5% mortality and 20% morbidity rates [1]. Small bowel injury is present in only about half of PAT patients, so laparotomy is not always necessary. A reliable and consistent tool for identification of those patients with a visceral injury who require a laparotomy

is needed. Diagnostic laparoscopy (DL) may provide such a tool [2].

The risk of delayed intervention for visceral injuries in initially asymptomatic patients and the need to decrease hospitalization costs by an earlier discharge of patients with insignificant injuries have justified the search for a less invasive and more reliable method of evaluation, There are different diagnostic methods available, including local wound exploration (LWE), diagnostic peritoneal lavage (DPL), abdominal sonography, and computed tomography (CT), it is difficult to determine the presence and severity of intra-abdominal injuries caused by penetrating abdominal stab wounds [3].

Prompt identification of intraabdominal injury after blunt injuries still poses a significant clinical challenge, particularly in patients with diaphragmatic, mesenteric, and/or small bowel injury. The presence of free fluid in the abdomen without evidence of any organ injury also must be clarified. An exploratory laparotomy will often be needed in this setting; however, if performed routinely for every suspected diaphragmatic and/or small bowel injury, up to 45% of exploratory laparotomies will be non-therapeutic [4].

MATERIALS AND METHODS

This study was carried out in two institutions, the Emergency Unit of General Surgery department in Zagazig University Hospitals and Saudi German Hospitals Riyad, KSA, between March 2017 and August 2018, the study included 118 patients with abdominal injuries in haemodynamically stable patients.

All patients were managed with the advanced trauma life support guidelines and all of them were considered stable after initial resuscitation and primary survey.

Patients were classified into two groups, group A, 61 patients underwent laparoscopic exploration of the abdomen and group B, 57 patients underwent exploratory laparotomy.

The study was done according to the ethical standards of our Zagazig University hospitals institution, approved by ethics committee and review board, informed consent taken from patients themselves in haemodynamically stable patients and unstable patients that excluded from the study, informed consent obtained from first degree relatives

Diagnostic laparoscopy is highly safe and beneficial for stable trauma patient weather penetrating or blunt as and although several noninvasive diagnostic methods are available and may provide high-quality information for evaluation of trauma patients, missed injuries still constitute a high percentage associated with high mortality and morbidity and there is still a degree of diagnostic uncertainty. This uncertainty in the diagnostic process was, and is, an important justification for exploratory laparotomies undertaken to avoid missed injuries. A considerable number of these laparotomies are unnecessary or nontherapeutic and have the corresponding morbidity.

Not all patients are a candidate for laparoscopy so When to proceed for laparoscopically, and what is the study design?

The most common indications and inclusion for laparoscopic diagnosis and treatment are:

(1) Blunt trauma –when an intestinal injury is suspected with blunt abdominal trauma, the extent of an injury and/or of ongoing bleeding is usually unclear. Laparoscopy can provide a secure diagnosis and a therapeutic issue.

(2) Blunt Trauma-Suspected Diaphragmatic or solid organ injury weather intraperitoneal (Splenic) or retroperitoneal (pancreatic), Lesions to the pancreas tend to be surreptitious and escape detection with ultrasound and CT studies. When revealed by laparoscopy,

They can be debrided and drained.

(3) Blunt or penetrating trauma with Injury to the mesentery, laparoscopy can visualize the site and type of injury and help assess intestinal vitality, so that appropriate surgical measures can be taken.

(4) Penetrating trauma – stable patients with Penetrating abdominal injury or equivocal injury (cutaneo-apponeurotic penetration but not sure of peritoneal penetration) .

(5) Unclear abdomen after blunt trauma. The term "unclear abdomen" evokes a great discrepancy between radiologist and surgeon and indicates a discrepancy between the findings of imaging studies and clinical examination. In spite of conservative treatment, the patient's diffuse and unspecific symptoms do not improve. Laparoscopy can quickly clarify such situations and may also provide a therapeutic option.

(6) A free fluid of unknown source, some trauma patients have as fluid diagnosed as a free fluid in the peritoneal cavity, but the source of bleeding cannot be determined. In these patients, nonoperative treatment is usually a risky option. The source is mostly a mesenteric laceration which will often be missed with CT scanning and detected laparoscopically.

Exclusion criteria: Haemodynamically unstable patients, Gunshots wounds, penetrating injuries in the back or flank and pregnant women.

Providing that patients are haemodynamically stable, the used cardinal signs were pulse (not more than 90/min) and systolic blood pressure not less than 90 mmHg), Haematocrit value not less than 30%. Normal respiratory rate ranging from 12:20 breaths per minute. Lactate and base deficit also is a guiding tool. No contraindications for laparoscopy like previous abdominal surgery, significant associated extra-abdominal injuries, patient refusal, and

tension pneumothorax. Lastly no clinical signs of diffuse peritonitis (Fever, tachycardia, diffuse abdominal pain and tenderness) and lastly no positive data by imaging CT. No associated hollow viscus injury or pneumoperitoneum and no splenic contrast.

Initially, all patients were subjected to proper history taking including age, sex, mode and time of trauma, concurrent injury, time of last meal and associated medical illness. Then thorough general and local examination was conducted.

All patients were evaluated upon arrival in the emergency department. If patients didn't have an indication for urgent laparotomy (hypotension, intestinal evisceration, and diffuse peritonitis, external bleeding), patients were subjected to the following:

(1) Chest X-ray: to detect air under the diaphragm. It was the first modality of investigation for diagnosing diaphragmatic insult.
(2) Focused Abdominal Sonography (FAST) it was applied in all patients to evaluate for the presence of free fluid.
(3) Computed Tomography (CT): One of the most important roles of CT was to detect spleen and liver grading system and diaphragmatic injury, but it is difficult for CT to detect neither solid organ injury nor perforated viscus.
(4) LWE (Local Wound Exploration): In patients with penetrating trauma with negative Focused Abdominal Sonography (FAST) were subjected to LWE in emergency room under local anaesthesia except for patients with omental evisceration which were considered sure sign of peritoneal penetration. Patients with intact fascia were discharged from the emergency department after a closure of the skin and follow up in the outpatient clinic. Patients with peritoneal penetration or equivocal penetration were subjected to laparoscopy or laparotomy randomly.

Operative technique

In group A, under general anaesthesia with endotracheal intubation. In penetrating trauma patients, stab sites were secured by means of suturing or clipping.

A forward-viewing laparoscope (30o) was inserted at the umbilicus and first inspect peritoneum at the site of the stab for penetrating trauma if it was intact and no intraperitoneal abnormal fluid closure of the wound was performed without any further exploration of the abdomen and patient was discharged after recovery from anaesthesia.

If peritoneal penetration were detected, Visceral, solid organ injury or abnormal free fluid, a two additional 5 and 10 mm trocars were placed laterally to the right and left rectus sheath but positions of additional ports were different according to the site of the stab.

For Blunt trauma patient, quick assessement and thorough exploration to be done as well as conventional surgery (Figures 1–2), shows blood collected, where (Figure 3) shows haematoma of the transverse colon.

In the event of active bleeding, hemostasis was performed with diathermy, clips, surgiseal, endoloop-type ligation and intra-corporeal suture-ligation.

Stomach injuries were repaired successfully with Vicryle 3/0 rounded needle 22 mm in interrupted one layer with the omental patch. Control of liver haemorrhage may present a daunting clinical scenario. Small tears, Grade I and II need nothing to do (Figures 4–6), which controlled by pressure, surgiseal, wherein large bleeding wounds, a pressure packing technique was effective in temporary control bleeding until the case converted to open technique. A diaphragmatic tear was repaired by proline 1/0 rounded needle, 22mm, (Figures 7–8). Small splenic tears were repaired, where the large tears cases were converted to open technique. Small bowel tears (Figure 9) or resection anastomosis for ileal perforation (Figure 10), was repaired by one to two interrupted sutures. Single layer by Vicryle or PDS 3/0 rounded needle. 22 mm (Figure 11) where colonic tears cases converted to open technique.

Drains were inserted in all cases after laparoscopic evaluation and removed after 24 hours if no abnormal discharge comes through it.

Conversion to laparotomy was decided if complete abdominal examination can't be performed adequately or injury can't be repaired by laparoscopy

In group B patients were subjected to exploratory laparotomy through midline incision with systematic exploration of solid organ, intestine and diaphragm and repair of injuries accordingly.

Patients in whom no injuries detected were followed up in the ward for 24 hours and discharged according to their clinical recovery. Assurance of hemostasis and absence of missed injuries in patients were confirmed by normal postoperative recovery.

Data Collection, parameter measured and Follow-up: Data collection was performed by the attending resident and our surgeon team, and each patient was evaluated by the main surgeon for 2 weeks in outpatient clinic after discharge by thorough clinical

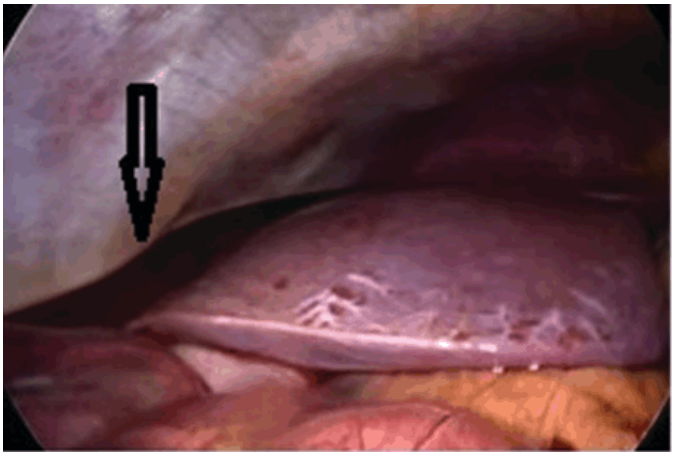

Figure 1: RT Subphrenic blood collection.


Figure 2: RT Paracolic blood collection.


Figure 3: Transverse colon haematoma.

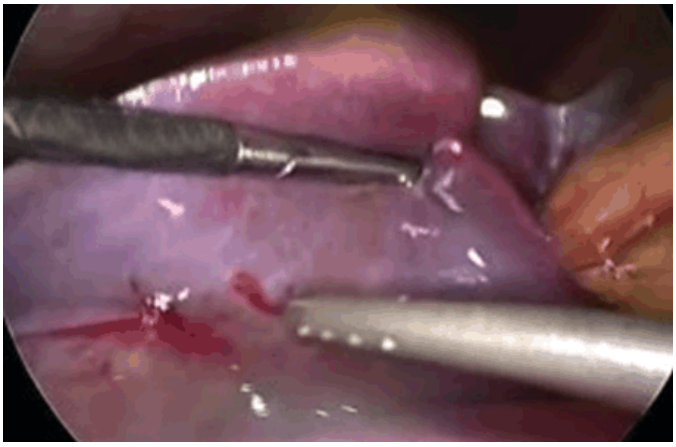
Figure 4: Liver laceration.

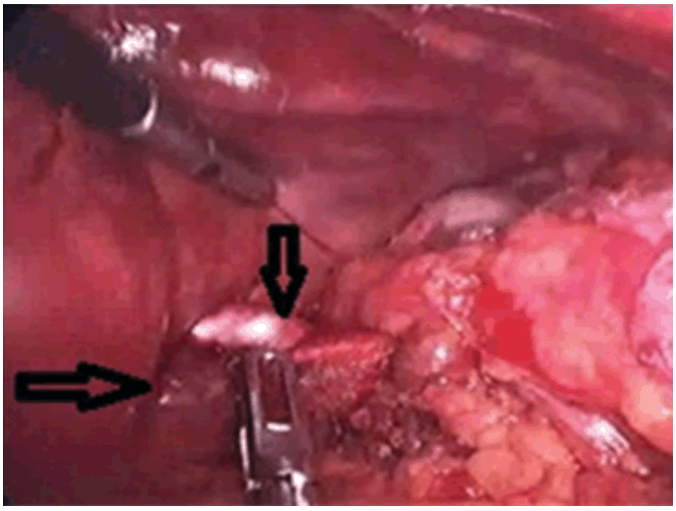
Figure 5: Haemostasis with surgiseal.

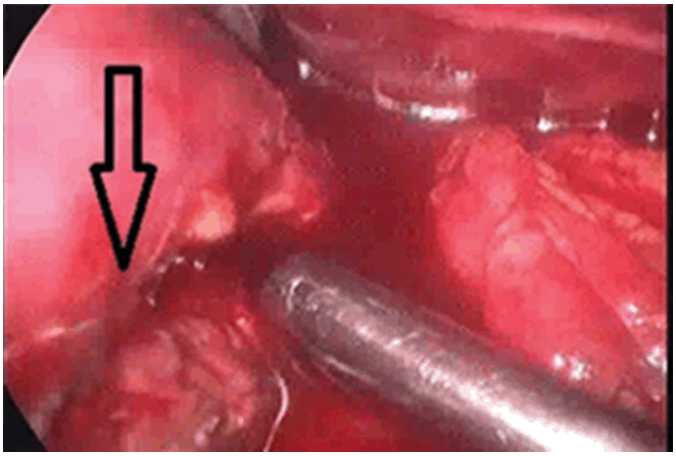
Figure 6: Deep liver tear.

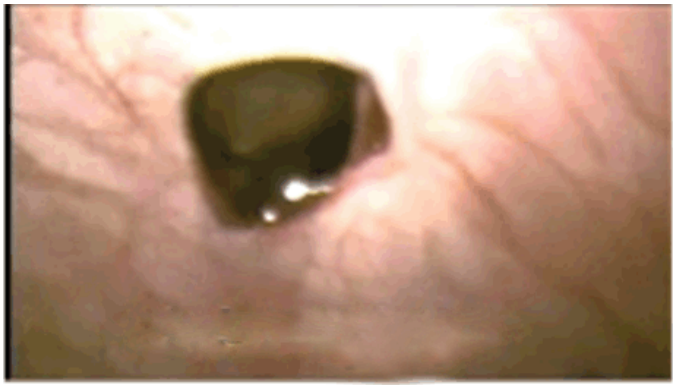
Figure 7: Tear of diaphragm.

examination and abdominal ultrasound to detect any complications or missed injuries.

Postoperative assessment included operative technique, operative time, length of hospital stay and complications.

Statistical analysis

Continuous variables were expressed as the mean ± SD and median (range) and the categorical variables were expressed as a number (percentage). Continuous variables were checked for normality by using Shapiro-Wilk test. Mann-Whitney U was used to compare two groups of none normally distributed data. Percent of categorical variables were compared using Chi-square test or Fisher's exact test when was appropriate. Odds Ratio (95%CI) was calculated by univariate logistic regression model with considering complications as outcome and group as independent predictor for that

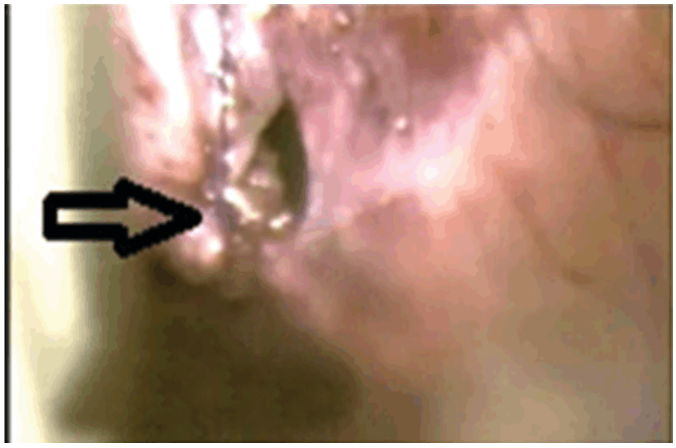

Figure 8: Repair of diaphragmatic tear.

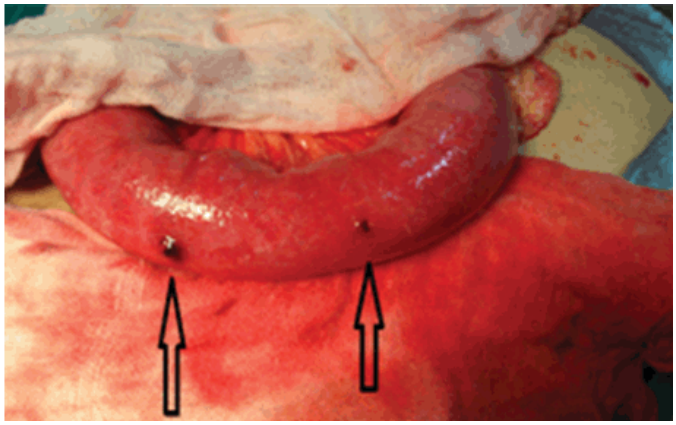

Figure 9: Small injury of bowel.

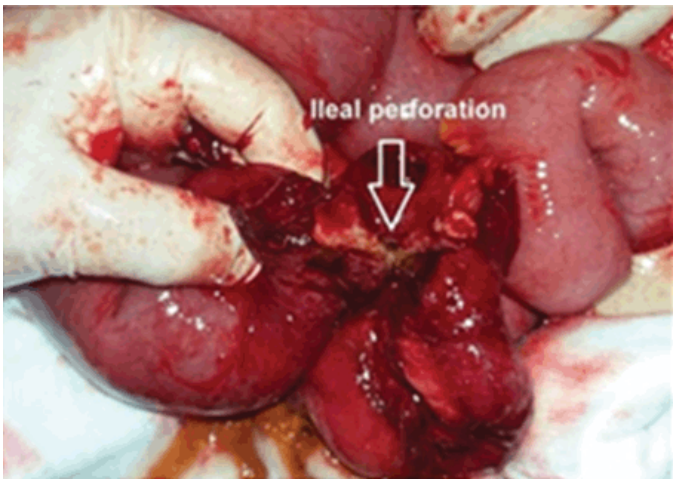

Figure 10: Neglected ileal perforation.

outcome. All tests were two sided. P-value < 0.05 was considered statistically significant. All data were analyzed using Statistical Package for Social Science for windows version 20.0 (SPSS Inc., Chicago, IL, USA) & MedCalc for windows version 13 (MedCalc Software bvba, Ostend, Belgium).

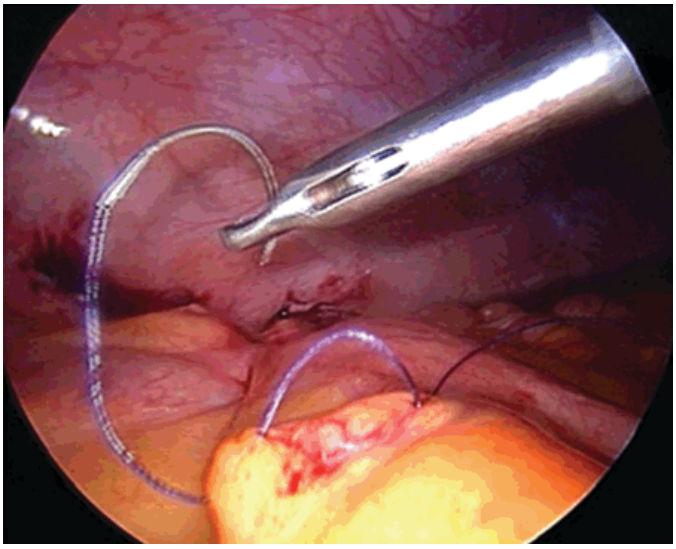

Figure 11: Small bowel repair.

RESULTS

Males were the predominant sex and median age was, 33 (17–47) in group A and 36 (19 – 51) in group B. there is no statistical difference between both groups regarding demographic data, as in laparoscopy group, age ranged from 17-47 years old and open group ranged from 19 to 51 years old (Table 1).

The prediction and guide for intervention detected in patients as follow: Total numbers of patients were 118, 70 patients with blunt trauma and 48 patients with penetrating trauma.74 with positive FAST, 40 patient with blunt trauma and 34 with penetration (Table 2) from which 20 with positive LWE, 4 with Omental evisceration, 8 with equivocal penetration, 2 with intestinal evisceration. From 74 had positive FAST findings. Of which 35 had injuries that didn't need intervention and 26 patients need intervention.

Of 118 patients with abdominal trauma who underwent sonography, 44 had negative FAST findings of which 30 has blunt trauma and 14 penetrating (6 with positive LWE, 2 with omental evisceration, 6 with equivocal penetration). From 44 with negative FAST, 19 patients had no intraabdominal injuries. And 11 patients had injuries that didn't need intervention with 14 had injuries need repair (diaphragm, stomach and small intestinal injuries) (Table 3).

Regarding abdominal injuries and non-therapeutic intervention**:** In group A, eleven (11) patients had no signs of peritonism and no peritoneal penetration and Twenty-one (21) patients in group B, all of which escaped intervention, 17 patients had peritonism or peritoneal penetration with diagnostic laparoscopy revealed no intra abdominal injuries in group A and 5 patients in group B with non therapeutic laparotomy .14 patients had intraabdominal injuries that need no treatment (9 liver tears, 3 splenic haematoma & 2 mesenteric tears) in

group A and in group B, another 10 patients underwent non-therapeutic laparotomy had intraabdominal injuries that need no treatment(8 liver tears & 2 mesenteric tears). 19 patients had injuries that need treatment repaired by laparoscopy in Group A (Stomach, Small bowel, and diaphragm), and 21 patients had injuries that need treatment in group B (Liver,splenic,small bowel and diaphragmatic). So nontherapeutic laparoscopy rate was 50.8 % in laparoscopy group and 26.3 % in laparotomy group.

From 6 patients with diaphragmatic injury: Two patients in whom stomach was seen herniating into the chest were diagnosed on basis of chest X-ray. One patient had doubtful X-ray findings in which we had the suspicion of diaphragm injury which was diagnosed with help of CT. One patient who had multiple rib fractures with grade 3 splenic injury was diagnosed due to continuous drainage of over 1 L in 2 days in the chest tube. The rest of the cases were diagnosed with computerized tomography scan which was done due to clinical suspicion along with significant findings on X-ray.

Conversion to laparotomy occurred in 9 cases (14.7%), 2 cases with bleeding liver tear, 3 cases with splenic injury that need splenectomy (2 of which had stomach & splenic injuries), Commonest cause of conversion was continuous intraabdominal bleeding that could not be controlled rapidly, one with retroperitoneal haematoma due to inadequate examination by laparoscope, one case had sigmoid and intraperitoneal bladder injury and 2 cases with small intestinal circumferential injuries.

There were two cases with missed injury both detected by the intestinal content in an abdominal drain in the next day and managed by exploration in the same hospital stay; it was a small tear in the small intestine.

There was significant difference between both groups regarding the hospital stay, postoperative analgesia with advantage for laparoscopy, Mean ± SD hospital stay was 1.80 ± 1.31 days in group A and 3.36 ± 2.58 days in group B with significant P-value <0.001 (Table 4).

The incidence of postoperative complications had much more decreased in completely laparoscopic cases and statistically different between the both groups with significant P_value 0.009 and Odd ratio 6.277 and (95CI %) (1.311 – 30.043), in laparotomy group 10 patients developed complications, 4 patients with postoperative ileus, one with pneumonia, and other 5 with wound infections. In laparoscopy group, one patient developed postoperative ileus and one patient developed tension pneumothorax in a patient with a diaphragmatic injury. (Table 5).

DISCUSSION

Identification of patients at high risk of clinical or imaging deterioration is of utmost importance for

Table 1: Demographic data of the studied patients

Demographic data	All patients (n = 118)	Group A (n = 61)	Group B (n = 57)	p-value
Age (years)				
Mean ± SD	33.47 ± 8.14	32.93 ± 7.88	34.05 ± 8.44	0.459•
Median (Range)	34 (17 – 51)	33 (17 – 47)	36 (19 – 51)	
Sex				
Male	75 (63.6%)	41 (67.2%)	34 (59.6%)	0.394§
Female	43 (36.4%)	20 (32.8%)	23 (40.4%)	

n =Total number of patients; Quantitative data were expressed as the mean ± SD & median (range); Qualitative data were expressed as a number (percentage); • Mann Whitney U test; § Chi-square test; p< 0.05 is significant.

Table 2: Preoperative FAST findings of the studied patients

Preoperative FAST findings	All patients (n = 118)	Group A (n = 61)	Group B (n = 57)	p-value§
FAST				
Negative	40 (33.9%)	26 (42.6%)	14 (24.6%)	0.038
Positive	78 (66.1%)	35 (57.4%)	43 (75.4%)	
Type of trauma				
Blunt	70 (59.3%)	40 (65.6%)	30 (52.6%)	0.153
Penetrating	48 (40.7%)	21 (34.4%)	27 (47.4%)	
LWE				
Not done	92 (78%)	43 (70.5%)	49 (86.0%)	0.043
Done	26 (22%)	18 (29.5%)	8 (14.0%)	

n =Total number of patients; Qualitative data were expressed as a number (percentage); § Chi-square test; p< 0.05 is significant.

Table 3: Comparison between laparotomy and Laparoscopy regarding results of abdominal injuries in patients subjected to this study

Abdominal injuries	All patients (n = 118)	Group A (n = 61)	Group B (n = 57)	p-value§
Organ injury				
Absent	32 (27.2%)	11 (18%)	21 (36.8%)	0.066
Present	86 (72.8%)	50 (82%)	36 (63.2%)	
Omental evisceration				
Absent	112 (94.9%)	57 (93.4%)	55 (96.5%)	0.680
Present	6 (5.1%)	4 (6.6%)	2 (3.5%)	
Equivocal penetration				
Absent	102 (86.4%)	48 (78.7%)	54 (94.7%)	0.011
Present	16 (13.6%)	13 (21.3%)	3 (5.3%)	
Intestinal evisceration				
Absent	116 (98.3%)	60 (98.4%)	56 (98.2%)	1.000
Present	2 (1.7%)	1 (1.6%)	1 (1.8%)	
Intervention				
Not done	77 (65.3%)	42 (68.9%)	35 (61.4%)	0.396
Done	41 (34.7%)	19 (31.1%)	22 (38.6%)	

n =Total number of patients; Qualitative data were expressed as a number (percentage); § Chi-square test; p< 0.05 is significant.

Table 4: Length of hospital stays in patients subjected to this study

	All patients (n = 118)	Group A (n = 61)	Group B (n = 57)	p-valueŸ
Length of hospital stays (days)				
Mean ± SD	2.56 ± 2.17	1.80 ± 1.31	3.36 ± 2.58	<0.001
Median (Range)	2 (1 – 11)	1 (1 – 6)	2 (2 – 11)	

n = Total number of patients; Quantitative data were expressed as the mean ± SD & median (range); Ÿ Mann Whitney U test; p< 0.05 is significant.

Table 5: Postoperative complication

Postoperative complication	All patients (n = 118)	Group A (n = 61)	Group B (n = 57)	Odd Ratio (OR) and (95CI %)	p-value§
Complications					
Absent	106 (89.8%)	59 (96.7%)	47 (82.5%)	6.277 Reference (1.311–30.043)	0.010
Present	12 (10.2%)	2 (3.3%)	10 (17.5%)		
Ileus					
Absent	113 (95.8%)	60 (98.4%)	53 (93%)	4.528 Reference (0.491–41.787)	0.196
Present	5 (4.2%)	1 (1.6%)	4 (7%)		
Tension pneumothorax					
Absent	117 (99.2%)	60 (98.4%)	57 (100%)	0.000 Reference is 0.000	1.000
Present	1 (0.8%)	1 (1.6%)	0 (0%)		
Wound infection					
Absent	113 (95.8%)	61 (100%)	52 (91.2%)	155334120.0 Reference is 0.000 -	0.024
Present	5 (4.2%)	0 (0%)	5 (8.8%)		

n = Total number of patients; Qualitative data were expressed as a number (percentage); OR: odds ratio; 95% CI: 95% Confidence interval; § Chi-square test; p< 0.05 is significant.

inclusion and/or exclusion in laparoscopic management of trauma. An application of laparoscopy has greatly expanded with increasing experience in trauma surgery.

The use of therapeutic laparoscopy remains controversial up till now, with the majority of the literature compromising case reports or series. Laparoscopic repair of perforating injuries to the diaphragm represents the most frequently described therapeutic application, but there are increasing reports of laparoscopic haemostasis of minor injuries to the liver or spleen [5], and therapeutic

use of laparoscopy to repair limited gastrointestinal injuries [6-7].

At centers with appropriate expertise in laparoscopic surgery, even therapeutic laparotomies could be avoided in the most stable patient [8]. Using laparoscopy on all stable trauma patients, non- therapeutic laparotomies can be avoided in 55–100% of cases [2, 6]. If appropriate expertise is available to conduct total laparoscopic managment, laparotomy can be avoided in 91.5% of cases [9].

Identification of stable trauma patient will not differ greatly from surgeon to surgeon, blood pressure especially the systolic one (SBP) is the most commonly used criterion to define a stable trauma patient, but the numbers differ significantly. SBP values below 90, 100, and 110 mmHg were used to indicate hemodynamic instability In A study by authors [10–11], the operating surgeon made a decision of instability of the patient based on haemodynamic, metabolic, and respiratory parameters. An SBP below 90 mmHg and a mean inspiratory pressure greater than 30 mmHg were the most common isolated values to define an unstable patient; such patients were offered laparotomy. More studies are needed to clarify the definition of instability for laparoscopy.

According to our management technique, all unstable patients were offered an open conventional approach which is in agreement with [12]. Since Clinical examination may not always be sufficient and the usual diagnostic procedures, , including LWE, (DPL), abdominal sonography, and computed tomography (CT) are not 100% reliable, exploratory laparotomy is often performed in the case of stab wounds, but the associated morbidity can reach up to 40% and so, one of the major benefits of laparoscopy in trauma is its ability to screen for the necessity of laparotomy. This can reduce unnecessary morbidity and mortality; reduce hospital costs and length of stay [13]. Author [14] documented that, Laparotomy carries a 0–5% mortality rate, a 20% morbidity rate, and a 6% long-term risk of adhesive bowel obstruction.

In trauma patient, peritoneal free fluid is an indirect sign of acute bleeding and injury to the viscera or solid organs, until proven otherwise and this is the main objective of FAST. In our study sensitivity of FAST in detecting intraabdominal injuries was nearly 59% where there is 46 patient found to have abdominal insult but no intervention has done & specificity 100% this is consistent with [15], who found sensitivity 47.6% and specificity 95.6%. Also he stated that, it should be kept in mind that FAST and US imaging, in general, have a very limited role in the diagnosis of abdominal trauma, in his study that 26–34 % of patients with abdominal trauma have organ lesions which are not associated with free fluid, and about 25 % of these patients require laparotomy. The sensitivity of FAST in the diagnosis of organ lesions is 44–95 % but specificity is high (84–100 %).

Heng et al [3] reported an accuracy of diagnostic laparoscopy was 100% in patients with penetrating trauma and these patients had a significantly shorter hospital stay (5.0 days versus 9.9 days; P_0.001) which is nearly consistent with us. For patients in the laparoscopic group with significant intra-abdominal injuries, therapeutic laparoscopy was successfully performed in 16 of 17 patients (94.1%), treating a total of 22 intraabdominal injuries

Yueli et al [16], in his studies, laparoscopy was used as a screening, diagnostic and therapeutic tool. A meta-analysis showed significant reductions in the incidence of postoperative complications, length of hospital stay, in this results a significant reduction in the length of ICU stay, time to postoperative exhaust, duration of pain, time to out of bed, and time to regular diet was demonstrated for patients underwent laparoscopy compared with open laparotomy, all of which might decrease the cost of hospitalization.

Penetrating trauma was in 48 patients (40.7%), rate of peritoneal penetration without organ injury after stab injuries was 22 patients (45.8%), and penetration with intra-abdominal injuries after stab was 54.2%. In contrary to us were [17] , stated that stab injuries only penetrate the abdominal cavity in approximately 70% of cases and if peritoneal penetration occurred, it does not always cause serious injury and there is an unnecessary laparotomy rate of 20–30%, This is difference with author (because we didn't included cases with intact fascia at LWE in our study), Differences in injury patterns, patient selection, and thresholds for treating injuries at laparotomy may explain some of this variation.

The results of our study demonstrated that the laparoscopy-based strategy reduced the nontherapeutic laparotomy rate and avoided laparotomies in 42 patients of trauma cases (68.9 %) where diagnostic laparoscopy done and revealed 11 patients need no intervention at all with 31 patients has minimal insult not in need for intervention. In consistent with us, author [18] found that 63% of patients who underwent laparoscopic evaluation in PAT avoided laparotomy.

Another study concerned with diagnostic laparoscopy for diaphragmatic injury, revealed that laparoscope diagnosed all cases of diaphragmatic injury with no missed cases; in consistent with [19-20] stated that laparoscopy had high sensitivity reaching 100% in detecting diaphragmatic laceration in thoraco-abdominal penetrating injuries.

We reported two cases (0.016%) of missed injuries. Uranus et al [21–22] reported missed injuries with screening laparoscopy were 0.4% (6 of 1,708 patients) and laparoscopy-related complications were 1.3% (22 of 1,672 patients) and Laparoscopy can prevent laparotomy in 63% of patients with a variety of injuries.

We had 9 (%) cases converted to laparotomy as injuries couldn't be repaired with laparoscopy. Most literature reported conversion rate was as 7–45%, Conversion rates at some institution increased from previously reported 7% to 11.7% for PAT and to 22.9% for BAT, The most common indications for conversion were patient instability, intraoperative bleeding, and inadequate

intraoperative visualization. Organ evisceration was reported as an indication for conversion in some studies [23–24], On the contrary, Matsevych et al [25], reported that laparoscopy is feasible and safe in patients with organ evisceration with no conversion to laparotomy [26]. Multiple hollow viscera injuries were reported as another reason for conversion, conversion to open surgery has been associated with an increased rate of small bowel obstruction [27].

With respect to outcomes, most authors report a decreased complication rate, shorter length of hospital stay, operative time and decreased costs when negative laparoscopy is compared with a negative or non-therapeutic laparotomy [28].

Obviously, a negative or non-therapeutic laparotomy may be detrimental to patients. It is connected with possible occurrence of complications, which according to different sources may affect from a few up to as many as 40% of those operated on.

The results of our study (17.6% of complications in laparotomy group and 0.16% in laparoscopy group) were consistent with those of other centers regarding the generally accepted laparoscopic advantages of decreased rates of negative laparotomy, shortened length of hospital stay, and quicker return to normal activity. We found overall that the laparotomy patients had higher morbidity. The laparotomy patients had more complications including pneumonia and more wound complications including dehiscence, infection, and abscess formation.

Data in this study supports the fact that laparoscopy is safe for penetrating as well as blunt abdominal injuries when used judiciously with proper patient selection.

CONCLUSION

Any trauma patient with negative focused abdominal sonography (FAST) but with unclear abdomen should be underwent laparoscopy to avoid missed injuries, Critical elements to a successful laparoscopy is appropriate patient selection. Also haemodynamically stable patient with blunt and penetrating trauma should have the chance of laparoscopy as a diagnostic tool and possible a therapeutic one. And thus will decrease the rate of negative and nontherapeutic laparotomies, thus lowering morbidity, early regain of bowel function, lower infection rate, decreasing length of hospitalization.

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Conflict of Interest
Authors declare no conflict of interest.

Data Availability
All relevant data are within the paper and its Supporting Information files.