

# ROLE OF LAPAROSCOPY IN MANAGEMENT OF ABDOMINAL TRAUMA

By

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## ABSTRACT

**Background:** Abdominal trauma affects 10% to 15% of injured patients. Although significant intra-abdominal injury is relatively infrequent, the consequences of missed or delayed diagnosis can be significant. Therefore, accurate and timely diagnosis of injuries is essential.

**Objective:** To study the feasibility, the advantages, and the disadvantages of laparoscopy in diagnosis and treatment of abdominal trauma.

**Patients and Methods:** This randomized prospective study included 50 patients with abdominal trauma of any type whether blunt or penetrating, road traffic accident (RTA) or falling from height, stab or gunshot. Mean age was of patients was  $29.26 \pm 8.55$  years old and mean BMI was  $26.36 \pm 3.12$ . Ninety eight percent of them were males and 2% of them were females.

**Results:** The intraoperative bleeding occurred in one patient (2%). Female patient presented after lower abdominal stab wound (BP 90/50 -HB 8 -HR 120). After resuscitation diagnostic laparoscopy found uncontrolled bleeding from uterine tear. Post-operative complications occurred in 8% post laparotomy and 14% post laparoscopy. Patients underwent laparotomy delayed in return to daily activity (8-9 days) and to work (12-24 days) due to time of operation, length of incision and occurrence of complications and depended on age, BMI, power of healing and intraoperative technique. In our experience, the use of laparoscopy as a diagnostic and therapeutic tool led to avoidance of an open surgery in more than 64% of patients. Negative and non-therapeutic laparoscopies were performed in 7 patients and therapeutic laparoscopy was performed in 25 patients: 8 patients hand assisted splenectomy, 5 patients needed repair of liver tears, 3 patients needed diaphragmatic tear repair, 7 patients needed primary repair for bowel and 2 patients needed stomach repair. However, conversion to laparotomy was needed in 18 cases more than 30%. Multiple organ injuries occurred in 16%, colostomy for descending and sigmoid colonic tears (10%), resection anastomosis for multiple small bowel injuries (2%), repair for uterine injuries (2%).

**Conclusion:** The keys to successfully diagnosing and treating significant intra-abdominal injuries laparoscopically include a systemic exploration to avoid missed injuries using appropriate changes in position of the patient, careful planning of port placement. 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 non-therapeutic laparotomy. Further advantages are reduced morbidity, shortened hospital stay, and lower cost. In the future, there may be exciting advancements for this field of surgery through innovative developments.

**Key words:** laparoscopy, Management abdominal trauma.

## INTRODUCTION

Intra-abdominal trauma affects 10% to 15% from whole types of trauma. Although significant intra-abdominal injury relatively infrequent, the consequences of missed or delayed diagnosis can be significant. Therefore, accurate and timely diagnosis of injuries is essential. The initial history and physical examination are of paramount importance. Information regarding the mechanism of injury and state of patient before arriving in the emergency department can be very helpful in assessment and management of the patient (*Neal et al., 2009*).

Mechanisms of injuries may be penetrating or blunt. The most common cause of mortality in abdominal trauma is secondary to delayed resuscitation or excessive hemorrhage with inadequate volume resuscitation or Intra-abdominal organ injury and rupture or perforation precipitates gastrointestinal content spillage into the peritoneal cavity, frequently leading to peritonitis and delayed mortality from severe sepsis (*Mackersie, 2010*).

Despite the high prevalence of patients with abdominal trauma. Physical examination may not be accurate because patients may have altered mental status or distracting injuries. Diagnostic peritoneal lavage was introduced as a diagnostic modality to identify hemoperitoneum but it is invasive method and its role has been almost entirely eliminated because there has been increased reliance on abdominal computed tomography. Focused Assessment with Sonography in trauma and has also been added to the diagnostic algorithm for patients with abdominal trauma (*Deunk et al., 2010*).

The burden of major trauma, predominantly blunt in nature, continues to rise in the most of the countries. More often the young are affected with lifelong debilitating consequences. Minimally invasive technique, such as laparoscope procedures, have become standard for the treatment of many surgical conditions, being able to minimize the impact of the surgery, to reduce postoperative pain, time to recover and to improve cosmetic outcomes (*Bandinelli and Balogh, 2012*).

In laparoscopic procedure, the relative morbidity and mortality, complication rates, and missed injury rates are low and comparable with open approaches. Additionally, a wide variety of intra-abdominal pathology can be addressed laparoscopically including injuries to the bowel, diaphragm, liver, spleen and pancreas. Guidelines developed by the Eastern Association for the Surgery of Trauma Practice Management Guidelines Committee recommend selective non-operative management in penetrating abdominal trauma and that routine laparotomy is not indicated in hemodynamically stable patients with abdominal stab wounds without signs of peritonitis or diffuse abdominal pain and in patients suffering tangential gunshot wounds without peritonitis (*Como et al., 2010*).

With increasing incorporation of endoscopic surgery into general practice, there will be a solid place for the laparoscopic approach to diagnose and therapeutic modality in abdominal trauma. It may be particularly beneficial for hemodynamically stable patients that sustained a focal abdominal trauma. We expect that this approach will lead to a

decline in non-therapeutic laparotomies, and its associated complications (*Ball et al., 2009*).

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

### **PATIENTS AND METHODS**

Our study was randomized prospective study. It included 50 patients with abdominal trauma of any type whether blunt or penetrating, RTA or falling from height, stab or gunshot. Patients were selected from those attending the general surgery department of Ministry of Health hospitals and Al Houssin university hospital, during period from 1/1/2017 till 1/1/2019. The study included vitally stable patients, patients with equivocal abdominal signs, concomitant injuries and GCS more than 13.

Unstable patients required urgent laparotomy, pregnant females, severe head injuries, patient with multiple previous abdominal operations, limited cardiovascular reserve and patients with severe chest restriction were excluded from the study.

In order to study the sensitivity and specificity in diagnosis and evaluation of

abdominal trauma by the use of ultrasonography, CT and abdominal laparoscopy and comparing accuracy of diagnosis of them with the final diagnosis.

Patients were subjected to history taking, general examination and investigational laboratory and radiology.

### **Statistical analysis:**

Data were coded and entered using the statistical package SPSS (Statistical Package for the Social Sciences) version 25. Data were summarized using mean, standard deviation, minimum and maximum in quantitative data and using frequency (count) and relative frequency (percentage) for categorical data. Comparisons between quantitative variables were done using the non-parametric Mann-Whitney test. For comparing categorical data, Chi square ( $\chi^2$ ) test was performed. Exact test was used instead when the expected frequency was less than 5. ROC curve was constructed with area under curve analysis performed to detect best cutoff value of ADC and SIR for detection of malignancy. P-values less than 0.05 were considered statistically significant.

## RESULTS

The preoperative assessment of patients showed that the mean systolic blood pressure  $107.00 \pm 12.33$  mmHg, mean diastolic blood pressure  $68.00 \pm 7.46$

mmHg, mean heart rate  $98.56 \pm 15.73$  beats/minute and mean hemoglobin was  $9.50 \pm 1.25$  g/dl (**Table 1**).

**Table (1): Patients demographic, vital data and hemoglobin**

Parameter		Count	Mean/number	Min-max/percent
Age (Years)			29.26	(15-62)
BMI			26.36	(21-35)
Gender	Male		49	98%
	Female		1	2%
Initial Systolic BP (mmHg)			107.00	(80-140)
Initial Diastolic BP (mmHg)			68.00	(40-90)
Initial Heart rate (Beat/Minute)			98.56	(70-160)
Hemoglobin (g/dl)			9.50	(6-13)

Those patients exposed to abdominal trauma (20% of them) were RTA, 60% gunshot, 14% stab wound, and 6% explosion. The indications of diagnostic laparoscopy in 39 patients (78%) were radiological findings, 9 patients (18%) penetrating wounds (gunshot and stab) to

abdominal wall, while 2 patients (4%) presented after RTA. With negative radiology under observation noticed decrease hemoglobin level (7 g/dl) and hypotension (90/60 mmHg) with tachycardia (100-110 beats/min) (**Table 2**).

**Table (2): Mechanism of trauma and indications of diagnostic laparoscopy**

Parameter		Count	Frequency	Percent
RTA			10	20%
Gun Shoot			30	60%
Stab Wound			7	14%
Explosion			3	6%
Radiological			39	78%
Gun Shoot			3	6%
Gun shoot and Bp			1	2%
Gun shoot, Hb and HR			4	8%
Stab Wound			1	2%
HR and Hb			2	4%

The mean operative time was  $71.40 \pm 29.34$  minutes. The diagnostic laparoscopy found that 8% of patients were negative, 6% were non-therapeutic,

34% were therapeutic, 16% were mini-laparotomy and 36% were laparotomy (**Table 3**).

**Table (3): Operative time**

Procedure Parameter	Total	Laparotomy	Laparoscopy (Diagnostic & therapeutic)
	<b>Mean (min-max)</b>		
<b>Operative time (minutes)</b>	71.40 (30-150)	95.29 (60-150)	59.09 (30-120)

Therapeutic procedure done totally laparoscopic in 17 cases. 3 patients with diaphragmatic tear repaired laparoscopally by intracorporal suturing using silk zero. 5 patients with liver tear control bleeding by cautery or topical homeostasis using surgicell and heparorrhaphy by vicryl

zero. Application of Ligaclips to control mesenteric bleeding. Stapling or suturing of small intestinal wounds if single small tear. Stapling or suturing of stomach tear. Stapling or suturing Primary repair of ascending and transverse colon if single small non soiling tear (**Table 4**).

**Table (4): Findings of Diagnostic Laparoscopy**

Count Parameter	Frequency	Percent	Blood transfusion (BT)	Plasma transfusion (PT)
<b>Negative</b>	4	8%	1	3
<b>Non-therapeutic</b>	3	6%	1	2
<b>Therapeutic</b>	17	34%	3	14
<b>Mini-Laparotomy</b>	8	16%	4	4
<b>Laparotomy</b>	18	36%	1	17

Conversion from laparoscopy to laparotomy after identifying the pathology done in 18 cases due to multiple organ injuries (10 pt), fecal peritonitis due to descending and sigmoid tears (4pt), multiple small bowel injuries needed

resection anastomosis (1pt) and retroperitoneal organ injuries (2pt) as kidney and urinary bladder. Female patient with uterine tear undergoes laparotomy for repair (**Table 5**).

**Table (5): Therapeutic procedures, and mini-laparotomy (hand-assessed), laparotomy**

Parameter		Findings	Number (%)	Technique
Diaphragm			3 (17.6%)	Repair
Stomach			1 (5.9%)	Repair
Liver			5 (29.4%)	Repair
Small Intestine	Jejunum		2 (11.8%)	Repair
	Mesentery		1 (5.9%)	Clip ligation
Large Intestine	Ascending		1 (5.9%)	Primary repair
	Transverse		2 (11.8%)	Repair
	Splenic flexure		1 (5.9%)	Primary repair
Stomach & gallbladder			1 (5.9%)	Cholecystectomy & pyloric repair
Total			17	100%
Spleen			7 (87.5%)	hand assist splenectomy
Diaphragm & spleen			1 (12.5%)	Repair & hand assist splenectomy
Total			8	(100%)
Uterus			1 (5.6%)	Laparotomy & repair
Small & large Intestine	Multiple small intestine		1 (5.6%)	Laparotomy, Resection & anastomosis
	Descending colon		2 (11.1%)	Laparotomy & colostomy
	Sigmoid colon		2 (11.1%)	Laparotomy & colostomy
Diaphragm & Large Intestine (splenic Flexure)			2 (11.1%)	Repair, laparotomy & colostomy
Large intestine (rectum), ureter & urinary bladder			1 (5.6%)	Laparotomy, repair & ureter reimplantation
Large intestine (sigmoid) & retroperitoneal hematoma			1 (5.6%)	Laparotomy & colostomy
Diaphragm, liver & kidney			1 (5.6%)	Laparotomy, repair & nephrectomy
Small intestine (ileum), large intestine (caecum) & retroperitoneal hematoma			1 (5.6%)	Laparotomy, repair & right hemicolectomy
Small intestine (ileum) & large intestine (ascending)			1 (5.6%)	Laparotomy, hemicolectomy & ileocolic anastomosis
Small intestine (ileum), large intestine (sigmoid), urinary bladder & retroperitoneal hematoma			1 (5.6%)	Laparotomy, primary repair & sigmoidal colostomy
Small intestine (jejunum) and large intestine (multiple)			1 (5.6%)	Laparotomy, jejunal repair and 2 barrel colostomy
Stomach, liver, Small intestine (ileum) & large intestine (transverse)			1 (5.6%)	Laparotomy & repair
Total			18	(100%)

The laparoscopic technique depends on the findings. Hand assisted splenectomy in splenic tears (14%), repair of liver tears (10%), primary repair of small bowel (8%), while (2%) need laparotomy for resection anastomosis in multiple small bowel injuries, diagnostic only with no findings in (8%), primary repair in ascending and transverse colon (8%),

primary repair of diaphragm (6%). The intraoperative bleeding occurred in one patient (2%). Female patient presented after lower abdominal stab wound (BP 90/50 -Hb 8 -HR 120) after resuscitation diagnostic laparoscopy find uncontrolled bleeding from uterine tear. Conversion to laparotomy and control bleeding (**Table 6**).

Table (6): Findings and technique

Parameters	Findings	Number (%)	Technique
Negative		4 (8%)	Diagnostic
Collection		2 (4%)	Suction
Diaphragm		3 (6%)	Repair
Stomach		1 (2%)	Repair
Liver		5 (10%)	Repair
Spleen		7 (14%)	hand assist splenectomy
Uterus		1 (2%)	Laparotomy & repair
Small Intestine	Jejunum	4 (8%)	Repair
	Mesentery	1 (2%)	Clip ligation
	Multiple	1 (2%)	Laparotomy, Resection & anastomosis
Large Intestine	Ascending	1 (2%)	Primary repair
	Transverse	2 (4%)	Repair
	Splenic flexure	1 (2%)	Primary repair
	Descending	2 (4%)	Laparotomy & colostomy
	Sigmoid	3 (6%)	Laparotomy & colostomy
Diaphragm & Large Intestine (splenic Flexure)		2 (4%)	Repair, laparotomy & colostomy
Diaphragm & spleen		1 (2%)	Repair & hand assist splenectomy
Large intestine (rectum), ureter & urinary bladder		1 (2%)	Laparotomy, repair & ureter reimplantation
Large intestine (sigmoid) & retroperitoneal hematoma		1 (2%)	Laparotomy & colostomy
Diaphragm, liver & kidney		1 (2%)	Laparotomy, repair & nephrectomy
Small intestine (ileum), large intestine (caecum) & retroperitoneal hematoma		1 (2%)	Laparotomy, repair & right hemicolectomy
Small intestine (ileum) & large intestine (ascending)		1 (2%)	Laparotomy, hemicolectomy&ilio-colic anastomosis
Small intestine (ileum), large intestine (sigmoid), urinary bladder & retroperitoneal hematoma		1 (2%)	Laparotomy, primary repair & sigmoidal colostomy
Small intestine (jejunum) and large intestine (multiple)		1 (2%)	Laparotomy, jejunal repair and 2 barrel colostomy
Stomach, liver, Small intestine (ileum) & large intestine (transverse)		1 (2%)	Laparotomy & repair
Stomach & gallbladder		1 (2%)	Cholecystectomy & pyloric repair

In the post-operative period the mean first bowel motion (1.26±0.491) days, mean first oral intake (2.76±1.08) days, mean ICU stay (2.04±1.19) days and the mean hospital stay (5.94±2.70) days. The first bowel motion in post-operative period depend on procedure and affect in the first oral intake. Whatever oral intake delayed in bowel anastomosis (small & large). In diagnostic laparoscopy return to bowel motion and oral intake (1-2 days) faster than laparotomy (2-4 days).The post-operative complications affect the

stay in ICU and hospital. In our study male patient presented by gunshot underwent diagnostic laparoscopy revealed urinary bladder, right ureter and rectal tears. Convert to laparotomy with UB repair, RT ureter reimplantation and Hartman colostomy. Post-operative patient aggravated chest infection and pneumonia (5 days ICU stay) Seroma and wound infection appeared and Foleys catheter are left for 10 days (12 days hospital stay) (Table 7).

**Table (7): First bowel motion, oral intake, ICU stay and hospital stay**

Parameter \ Count	Mean	(Min- Max)
First bowel motion	1.26	(1-3)
First oral intake	2.76	(1-7)
ICU stay (days)	2.04	(1-5)
Hospital Stay (days)	5.94	(2-13)

Post-operative complications occur in 11 patients. Four patients (8%) suffer from chest infection and pneumonia treated by broad spectrum antibiotics. three patients(6%) post laparotomy; one of them aggravate respiratory failure and need mechanical ventilation and one patient(2%) post laparoscopy. Three patients (6%) suffered from wound infection treated by antibiotics according to culture and sensitivity and regular wound dressing. two patients (4%) post laparotomy and one patient (2%) post laparoscopy. One patient (2%) complicated by biliary leakage post laparoscopic hepatic tear repair undergo ERCP which find CBD injure that need biliary stent. Another patient (2%) after laparoscopic diaphragmatic tear repair

complicated by intra-abdominal collection and fever undergo another look diagnostic laparoscopy and find transverse colon and stomach missed tears and repaired laparoscopy. One patient (2%) complicated by fecal fistula post laparoscopic ascending colon tear repair undergoing laparotomy and ileostomy. Spontaneous closure of the fistula after one month.

A female patient presented by lower abdominal stab wound with severe hypotension. After resuscitation diagnostic laparoscopy showed uterine tear with uncontrolled bleeding. Blood transfusion and laparotomy done for bleeding control. Post-operative she had DIC and fresh frozen plasma was given (**Table 8**).

**Table (8): Post-operative Complications**

Parameters \ Complications	Frequency	Percent	Management
Pneumonia	3	6%	Antibiotics
Pneumonia and respiratory failure type 2	1	2%	Mechanical ventilation
DIC	1	2%	Fresh frozen plasma
Fecal fistula	1	2%	Laparotomy & ileostomy
Wound infection	3	6%	Dressing & antibiotics
Biliary leak	1	2%	ERCP & stent
Missed injury	1	2%	Laparotomy & repair

The mean time to return to daily activity was  $5.98 \pm 2.17$  days and the mean time to return to work was  $18.60 \pm 6.73$  days. Patients underwent laparotomy delayed in return to daily activity (8-9 days) and to work (12-24

days) due to time of operation, length of incision and occurrence of complication and depend on age, BMI, power of healing and intraoperative technique (**Table 9**).



**Table (9): Time to return to daily activity and work**

Time	Count	Mean	(Min-Max)
Time to return to daily activity		5.98	(2-12)
Time to return to work		18.60	(4-28)

Mortality occurred in 6 cases (mortality rate 12%). The causes of death were Chest infection and pneumonia in 2 cases. Low saturation and ventilation in 1

case. Septic shock in one case. Hypovolumic shock in one case. DIC in one case (**Table 10**).

**Table (10): Mortality**

Parameters	Count	Frequency	Percent
Mortality	Yes	6	12%
	No	44	88%

### DISCUSSION

The application of laparoscopy has increased considerably with technical advances and constantly increasing experience with its use in the management of acute surgical 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 (*Uranius and Dorr, 2010*). *Ramos et al. (2018)* performed laparoscopic evaluation hemodynamically stable patients. The initial HR was 99.00 (78-120) and the initial BP was 135.00 (110-145). In our study, the initial HR was 98.56 (70-160) and initial BP was 107.00 (80-140).

In our study, we performed a laparoscopic evaluation of 50 patients most of them due to penetrating trauma. Similar results were obtained by *Ramos et al. (2018)*; but *Kyoung et al. (2015)* perform a laparoscopic evaluation of blunt trauma (65%).

There were no false-negative investigations. The use of diagnostic laparoscopy in abdominal trauma was useful to decrease the rate of negative laparotomy (*Ozkan et al., 2016*).

The usual diagnostic procedures, diagnostic peritoneal lavage, sonography, and even CT, all have their strengths and weaknesses, and none of them were 100% reliable. For this reason, exploratory laparotomy was performed in the case of stab wounds, but with a high morbidity percentage that reached up to 40%. 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 (*Uranius and Dorr, 2010*).

In our experience, the indications of diagnostic laparoscopy in 78% were radiological finding, 18% penetrating wounds (gunshot and stab) to abdominal wall, while 4% presented after RTA with

negative radiology under observation noticed decrease hemoglobin level (7 g/dl) and hypotension (90/60 mmHg) with tachycardia (100-110 beat/min).

*Kyoung et al. (2015)* recorded that the mean operative time for laparoscopy 91.20 (57-125) and for laparotomy 97.20 (70-140). In our study, we recorded that the mean operative time for laparoscopy was 59.09 (30-120) and for laparotomy was 95.62 (60-150).

In the largest study on laparoscopy in PT, it was reported that 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 59.4% of patients (*Ozkan et al., 2016*).

In our experience of PT, laparoscopy was beneficial especially in hemodynamic stable patients. The results of our analysis demonstrated that the use of laparoscopy to evaluate 40 penetrating abdominal trauma patients was able to exclude significant intra-abdominal injuries, and 12.5% of penetrating abdominal trauma patients avoided undergoing a nontherapeutic laparotomy. Patients with significant intra-abdominal injuries, use of laparoscopic-based operations also had a high therapeutic success rate (45 %), primarily for repairs to the liver, diaphragm, mesentery, bowel and hand assisted splenectomy. Conversion to laparotomy was performed in 17 patients because of large splenic lacerations, descending colon tears, small bowel

injuries required resection and anastomosis.

A previous study by *Shah et al. (2011)* showed that laparoscopy reduced the non-diagnostic laparotomy rate and was effective for the treatment of patients with blunt abdominal trauma and hemoperitoneum, with an overall failure rate of 4%. *Marwan et al. (2010)* also reported similar results in pediatric patients with blunt abdominal trauma and concluded that laparoscopy is underutilized in cases of pediatric abdominal trauma.

In our experience of BT (Blunt Truma), laparoscopy was beneficial especially in hemodynamic stable patients. The results of our analysis demonstrated that the use of laparoscopy to evaluate 10 blunt abdominal trauma patients was able to exclude significant intra-abdominal injuries, and approximately 20% of blunt abdominal trauma patients avoided undergoing a nontherapeutic laparotomy. Use of laparoscopic-based operations also had a high therapeutic success rate (70%), primarily for repairs to the liver, mesentery, diaphragm, bowel and hand assisted splenectomy. Conversion to laparotomy was performed in one patient because descending colon tear need Hartman colostomy.

A 10-year review of laparoscopic intervention from the University of Tennessee showed that the main utility of minimally invasive techniques was as usage of laparoscopy in management of abdominal trauma was effective to avoid negative laparotomy findings. Although some minor injuries were repaired laparoscopically, they were limited to

diaphragm repair, repair of serosal tears and coagulation of omental hemorrhage. Nevertheless, a review of the published literature shows an increasing number of case reports showing successful therapeutic interventions in abdominal trauma. This trend will continue to grow as surgeons' comfort with minimally invasive techniques improves and technology becomes more convenient and advanced (*Mohamed et al., 2015*).

In our experience, the use of laparoscopy as a diagnostic and therapeutic tool lead to avoidance of an open surgery in more than 64% of patients. Negative and nontherapeutic laparoscopies were performed in 14% patients and therapeutic laparoscopy was performed in 50% patients: 16% patients hand assisted splenectomy, 10% patients need repair of liver tears, 6% patients need diaphragmatic tear repair, 14% patients need primary repair for bowel and 2 patients need stomach repair. However, conversion to laparotomy was needed in more than 30%. Multiple organ injuries (16%), colostomy for descending and sigmoid colonic tears (10%), resection anastomosis for multiple small bowel injuries (2%), and repair for uterine injuries (2%).

Although the primary goal of laparoscopy in trauma is to make a diagnosis and/or exclude injury. It may also serve as a therapeutic tool in patients requiring intervention. We found that almost 64% of the patients requiring surgical therapy were successfully treated laparoscopically. These results were higher than previously reported rates of therapeutic laparoscopy, ranging from 8% to 50%. With increasing surgeon

expertise, improved equipment, and enhanced technology. These rates are likely to continue to climb (*Kawahara et al., 2009*).

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% (*Shan et al., 2012*). Consequently, it is advantageous to avoid a negative laparotomy, provided that a reliable and accurate alternative diagnostic procedure is available. *Mohamed et al. (2015)* laparoscopy resulted in sensitivity for abdominal injury exceeding 90%, with a specificity of 100%. Furthermore, it proved to be a safe modality without direct operative or postoperative morbidity. In our study, laparoscopy prevented laparotomies in 64% of patients.

The primary limitation of laparoscopic intervention is the poor visibility conferred by excessively edematous bowel or uncontrolled active bleeding at presentation. These are the major motivations for conversion to open laparotomy. Edema of the bowel is a time dependent process. Thus, patients presenting shortly after the traumatic event are more easily managed through laparoscopy, whereas lengthier time intervals usually portend severe intestinal edema. Not only is the laparoscopic window obscured by edematous bowel, but traction injury is more likely to occur during manipulation (*Di Saverio et al., 2014*).

Another cause of open conversion is the spillage of large-sized particulates that cannot be aspirated via the usual mode of

endo-suction. However, we were able to achieve complete evacuation in this event by direct insertion of a silastic tube through a 12-mm port. Subsequently, our fears of postoperative intra-abdominal abscess never materialized. A fair number of our open conversions stemmed from trial-and-error in early experience, contributing to an open conversion rate of 36%. With more experience, these conversions very well could have been avoided (*Di Saverio et al., 2014*).

*Kyoung et al. (2015)* recorded that hospital stay post laparoscopy (9-12 days) shorter than post laparotomy (17-25 days). In our study, we recorded that hospital stay post laparoscopy (2-5 days) shorter than post laparotomy (10-14 days) and hospital stay post penetrating trauma shorter than blunt trauma.

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 (*Mohamed et al., 2015*).

The complications associated with laparoscopy in trauma patients included tension pneumothorax, air embolism, and intracranial hypertension. *Lim et al. (2011)* noted that the potential of gas embolism in patients with intraabdominal venous injuries such as liver lacerations is of concern when performing laparoscopy; however, none of our patients in the laparoscopic group developed clinical signs or symptoms of a gas embolism.

In our study, the hospital stay and rate of postoperative complications were high in patients with BT than PT. In cases without conversion to laparotomy, we found one case with chest infection and one patient with wound infection. Conversion to laparotomy, we found two patients with wound infection and three patients with chest infection. However, overall, the rate of hospital stay and postoperative complications was low in comparison with patients managed by laparotomy.

Traumatic abdominal injury is traditionally subject to open exploration and remains a challenge for the general surgeon, especially with respect to controlling wound-related complications. Wound complications still play a major role in lengthy hospital stays and may lead to other delayed morbidities. Our aim was to extend the benefits of minimally invasive surgery to traumatic abdominal injury, thereby decreasing postoperative complications. Indeed, wound infections requiring delayed closure following open laparotomy. By comparison, none of the patients undergoing laparoscopy suffered a wound complication.

In our study, mortality occurred in 12% of cases. The causes of death are Chest infection and pneumonia in 4% cases. Low saturation and ventilation in 2% of cases. Septic shock in 2% of cases. Hypovolumic shock in 2% of cases. DIC in 2% of cases.

The potential for a missed hollow viscous injury after diagnostic laparoscopy exists and may have devastating consequences. In the current study, 2% patients had a missed common bile duct injury that required

reintervention. These results were comparable with *Mohamed et al. (2015)* who showed that laparoscopy yielded a sensitivity of 92% and a specificity of 100% in detecting injuries in patients who suffered from blunt abdominal injury, while also avoiding 50% of laparotomies in that same population. Earlier reports commonly cited a high missed injury rate as a result of using diagnostic laparoscopy to screen patients with potential abdominal injuries. *Kawahara et al. (2009)* used a systematic approach to laparoscopic abdominal exploration, which resulted in no missed injuries.

When first used for trauma, laparoscopy resulted in high rates of missed injury (41-77%), generating considerable criticism. One of the most serious concerns was its lack of consistency in detecting small bowel damage which is the main reason surgeons still hesitate today; but because these studies involved both prospective and retrospective analyses and procedures were not standardized, the data are difficult to interpret. In addition, the learning curve of laparoscopic surgery was ignored in early evaluations, and subjective preferences do seem to drive decisions during laparoscopy.

One prior report underscored the reliability of laparoscopy as a tool for evaluating traumatic injuries, when used for specific indications and with appropriate technique. *Kawahara et al. (2009)* devised systematic laparoscopic explorations of the abdomen that resulted in no missed injuries. In accordance with the method of Choi, we found it relatively easy to effectively inspect all abdominal organs, without missing an injury.

The keys to successfully diagnosing and treating significant intra-abdominal injuries laparoscopically include a systemic exploration to avoid missed injuries using appropriate changes in position of the patient, careful planning of port placement, technical ability in advanced laparoscopic procedures, and experience of surgeons gained by treating stab wounds. The value of a standard examination system for laparoscopy to avoid missed injuries has been reported by *Kawahara et al. (2009)* for stab wounds, and also proved to be effective for blunt trauma in this study. We illustrated in our previous report that a surgeon can perform a laparoscopy safely for patients with stab wounds if he or she has performed at least 20 laparoscopic procedures for acute care surgery monthly.

Based on the results of this report, we believe that a surgeon can perform an error-free laparoscopy for patients with blunt abdominal trauma if he or she has performed at least 5 laparoscopic operations for abdominal stab wounds. Advanced laparoscopic techniques such as intracorporeal suturing offer the opportunity to increase the success rate of therapeutic laparoscopy in the treatment of complex injuries.

Minimally invasive surgery has become a useful tool in the management of trauma. Laparoscopy can detect and repair injuries to the hollow viscus and diaphragm and exclude the risks of nontherapeutic laparotomy. Further advantages are reduced morbidity, shortened hospital stay, and lower cost. In the future, there may be exciting advancements for this field of surgery

through innovative developments (*Uranius et al., 2010*).

### CONCLUSION

Although we disclose that laparoscopy gradually has being accepted as a diagnostic and/or treatment modality for penetrating abdominal injuries in patients that are hemodynamically stable. The relative rates of morbidity/mortality, postoperative complications, and missed injury are low and compare favorably with an open approach. However, laparoscopic surgery can be performed safely whether injuries are blunt or penetrating, given hemodynamic stability and proper technique. Patients may thus benefit from the shorter hospital stays, greater postoperative comfort (less pain), quicker recoveries, and low morbidity/mortality rates that laparoscopy affords.

Laparoscopy is feasible and safe for the diagnosis and treatment of hemodynamically stable patients with blunt and penetrating abdominal trauma. It can reduce the laparotomy rate and provide the advantages of minimally invasive surgery for patients with significant intra-abdominal injuries in terms of shorter hospital stay.

Minimally invasive surgery has become a useful tool in the management of trauma. Laparoscopy can detect and repair injuries to the hollow viscus and diaphragm and exclude the risks of nontherapeutic laparotomy. Further advantages are reduced morbidity, shortened hospital stay, and lower cost. In the future, there may be exciting advancements for this field of surgery through innovative developments.

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## دور المنظار الجراحي في مناجزة إصابات البطن

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**خلفية البحث:** تمثل إصابات البطن 10-15% من إجمالي حالات الإصابات المختلفة ومازالت حالات الإصابة خاصة الكدمية في تزايد مستمر في معظم دول العالم. هناك العديد من الحالات لا يتم التوصل الى تشخيصها او يتم تشخيصها بشكل متاخر وعلى العكس فان التشخيص السريع والدقيق هام جدا لانقاذ حياة المريض.

**الهدف من البحث:** دراسة جدوى ومزايا وعيوب تنظير البطن في تشخيص وعلاج الإصابات في البطن.

**المرضى وطرق البحث:** شملت هذه الدراسة الاستطلاعية العشوائية 50 مريضاً يعانون من إصابات ورضوض في البطن من أي نوع سواء كانت حادة أو اختراق، هيئة الطرق والمواصلات أو السقوط من الطول أو الطعنة أو طلقة ناربية. كان متوسط العمر للمرضى  $29.26 \pm 8.55$  سنة وكان متوسط مؤشر كتلة الجسم  $26.36 \pm 3.12$ . ثمانية وتسعون في المئة منهم من الذكور و2% منهم من الإناث.

**نتائج البحث:** حدث نزيف أثناء العملية في مريض واحد (2%). مريضة تم تقديمها بعد إصابتها بطعنة أسفل البطن. ضغط الدم 50/90 ومستوى الهيموجلوبين 8 ومعدل ضربات القلب 120. بعد التنظير التشخيصي وجدت نزيف غير المنضبط من المسيل للدموع الرحم. وقعت مضاعفات ما بعد الجراحة في 11 مريضاً 4 مرضى (8%) بعد البطن و7 مرضى (14%) آخر تنظير البطن. نلاحظ أن المرضى يخضعون لتأخير البطن في العودة إلى النشاط اليومي (8-9 أيام) والعمل (12-24 يوماً) بسبب وقت العملية وطول الشق وحدوث مضاعفات ويعتمدون على العمر ومؤشر كتلة الجسم وقوة الشفاء وتقنية أثناء العملية. في تجربتنا، يؤدي استخدام تنظير البطن كأداة تشخيصية وعلاجية



إلى تجنب إجراء عملية جراحية مفتوحة في أكثر من 64% (50/32) من المرضى. تم إجراء تنظيف البطن السلبي وغير العلاجي في 7 مرضى وتم إجراء تنظيف البطن العلاجي في 25 مريضاً: 8 مرضى استئصال الطحال بمساعدة اليد، 5 مرضى يحتاجون إلى إصلاح دموع الكبد، 3 مرضى يحتاجون إلى إصلاح تمزق عشائي، 7 مرضى يحتاجون إلى إصلاح أولي للأمعاء و2 يحتاج المرضى إلى إصلاح المعدة. ومع ذلك، كان هناك حاجة للتحويل إلى بضع البطن في 18 حالة أكثر من 30%. إصابات أعضاء متعددة (16%)، فغر القولون القولون التنزلي والسيني (10%)، مفاغرة استئصال إصابات الأمعاء الدقيقة متعددة (2%)، وإصلاح لإصابات الرحم (2%).

**الاستنتاج:** تشمل مفاتيح تشخيص وعلاج الإصابات الكبيرة داخل البطن بالمنظار إستكشافاً نظامياً لتجنب الإصابات غير المشخصة باستخدام التغييرات المناسبة في وضعية المريض، والتخطيط الدقيق لأماكن إدخال المنظار. وقد أصبحت الجراحة ذات الحد الأدنى من التدخل أداة مفيدة في معالجة الإصابات. ويمكن من خلال منظار البطن اكتشاف وإصلاح إصابات اللزجة المجوفة والحجاب الحاجز، واستبعاد مخاطر فتح البطن غير العلاجي. وتتمثل بعض المزايا الأخرى في خفض معدلات الإصابة بالأمراض وتقصير مدة الإقامة في المستشفى وانخفاض التكلفة. وفي المستقبل، قد تكون هناك تطورات مثيرة لهذا المجال من الجراحة من خلال التطورات المبتكرة.