Therapeutic Laparoscopy from the Start Vs Diagnostic Laparoscopy First for Acute Abdomen: Would Outcomes Differ?

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ABSTRACT

Objective: *The outcomes of laparoscopic procedures in patients with acute abdomen vary widely. The aim of our study is to evaluate the diagnostic accuracy and therapeutic efficacy of laparoscopy in patients with acute abdomen, as well as to compare the short-term outcomes of laparoscopy between patients who undergo therapeutic laparoscopy from the start and those who undergo diagnostic laparoscopy first.* ***Methods:*** *One hundred and sixty-five patients who underwent laparoscopy for acute abdomen were prospectively studied. Patients were divided into two groups[A:patients who underwent therapeutic laparoscopy from the start; B:patients who underwent diagnostic laparoscopy first]. Patients were followed up for 6 months and a comparison between the study groups was carried out.* ***Results:*** *The diagnostic accuracy and therapeutic efficacy of laparoscopy were 97.3% and 75%, respectively. Group A included 90 patients(54.5%), whereas group B included 75 patients(45.5%). Conversion rate was lower in group A[n=13(14.4%)] compared to group B[n=35(46.7%)];P=0.001. Morbidity rate was relatively lower in group A[n=5 (5.5%)] compared to group B[n=9 (12%)];P=0.139. Postoperative hospital stay was shorter in group A[1-8 days(mean±SD=1.92±1.47)] compared to group B[1-21 days (mean±SD= 4.15±3.37)]; P=0.001. The overall mortality rate was 0.6%.* ***Conclusion:*** *Laparoscopy in acute abdomen is a relatively safe approach that has a high diagnostic accuracy and a good therapeutic efficacy. Therapeutic laparoscopy from the start appears to be associated with higher therapeutic efficacy, lower conversion rate, relatively lower morbidity rate and shorter hospital stays, compared to diagnostic laparoscopy first.*

Keywords: *Therapeutic laparoscopy; Diagnostic laparoscopy; Acute abdomen; Accuracy; Efficacy; Outcomes.*

INTRODUCTION

Acute abdomen is a common presentation at the surgical department that can present a diagnostic dilemma[1]. Clinical examination often fails to yield a diagnosis, particularly when symptoms and signs are compounded by obesity. Blood investigations, in many cases, may just indicate the presence of an inflammatory process. Also, radiological investigations may sometimes yield false-negative results[2]. In the 1990s, laparoscopy has gradually evolved as a key to solving the diagnostic dilemma of an unspecific acute abdomen and a less-invasive alternative to laparotomy in many cases[3,4]. Furthermore, favorable experiences have been reported with the use of laparoscopy as a therapeutic tool in patients with *acute abdomen*[4-7].

Because of the broad range of underlying disorders and clinical presentations that can be encountered in patients with *acute abdomen*, the types of laparoscopic procedures vary widely in those patients[8,9]. In some patients, *a definite* clinical *diagnosis* is reached preoperatively and thus, *therapeutic laparoscopy* is carried out *from the start*. However, in another group of patients, *no definite diagnosis* can be reached preoperatively and thus, *diagnostic laparoscopy* is required *first*. This may be followed by either therapeutic laparosopy, conversion to open surgery or termination of the procedure. Because of this wide variation in the types of procedures performed, and the varying degrees of surgeons' experiences in emergency laparoscopy, the outcomes of laparoscopy in patients with *acute abdomen* also vary widely. Hence, we carried out a prospective, non-randomized, observational study over a 12-month period in order to evaluate the diagnostic accuracy, therapeutic efficacy and potential benefits of laparoscopy in patients with *acute abdomen*, as well as to compare the short-term outcomes of laparoscopy between patients

who undergo *therapeutic laparoscopy from the start* and those who undergo *diagnostic laparoscopy first*.

PATIENTS AND METHODS

One hundred and sixty-five patients who underwent diagnostic and/or therapeutic laparoscopy for a*cute abdomen* at the Emergency Department(ED), Kasr Al-Aini Hospital, Cairo University between August 2015 and January 2016 were enrolled into the study. After explaining the operative procedure, its intent(diagnostic and/or therapeutic), and its possible risks/complications –including risk of conversion to open surgery-, informed consent was obtained from all patients before surgery. The study protocol was approved by the institutional ethical committee and conformed to the provisions of the Helsinki Declaration(as revised in Seoul, Korea, 2008).

All the study patients presented to the ED with *acute abdomen* which was defined as any acute abdominal pain, of <1 week duration, that might require urgent or immediate intervention, including emergency surgery. All patients underwent preoperative evaluation in the form of history-taking, thorough physical examination, laboratory investigations[complete blood count, random blood sugar, liver and kidney functions tests, serum electrolytes, coagulation profile] and radiological investigations[one or more of the following; plain X-ray chest(erect), plain X-ray abdomen(erect/supine), pelvi-abdominal ultrasonography, computed tomography(CT) scan of the abdomen and pelvis]. Serum amylase was done in patients with upper abdominal pain, generalized abdominal pain or suspected biliary pathology. Urinalysis was done in patients with dysuria or hematuria, whereas pregnancy test was done in all females of *child-bearing* age.

Guided by the history, clinical examination and investigations, a decision was made by the ED surgical team to proceed for diagnostic and/or therapeutic laparoscopy. Contraindications to laparoscopy included hemodynamic instability, uncontrolled coagulopathy, multiple previous laparotomies, abdominal distension with massive intestinal dilatation, and patient's refusal of laparoscopy. In all cases, access to the peritoneal cavity was achieved by the open method*"Hasson technique"*. This was accomplished by making a small skin incision in the infra- or supra-umbilical region, dissecting down to the rectus fascia, identifying the peritoneum, then grasping it with Allis clamps and opening it with scissors. After access port placement, a detailed inspection of the peritoneal cavity was performed. Depending on the site of suspected pathology, all relevant organs/viscera were examined for signs of inflammation(e.g.swelling, erythema, exudates, inflammatory adhesions, phlegmon). If an obvious pathology that requires surgical management (e.g.resection, repair or drainage) was identified, a therapeutic procedure (laparoscopic or open) was carried out in the same setting, as appropriate. Additional ports(5mm or 10mm) were placed under direct vision to further explore any areas of interest or to perform a therapeutic procedure. The number and site of the ports, as well as the position of the surgeon, assistants and nurse varied according to the planned procedure. Before the procedure was terminated, a meticulous examination was undertaken to ensure adequate hemostasis, as well as correct instrument and gauze counts. Ports were removed under direct vision to ensure there was no bleeding. The abdominal cavity was decompressed by expelling the pneumoperitoneum to reduce postoperative abdominal/shoulder pain. All port sites >5mm were closed with absorbable sutures. The skin was closed with continuous or interrupted subcuticular sutures.

Intravenous fluids, antibiotics and analgesics were prescribed postoperatively, as necessary, according to the performed procedure and the patient's needs. Drains were removed once the daily output was serous and <30cc. Patients were instructed to come for follow up at 2 weeks, 1 month and 6 months after surgery.

The study patients were divided into two groups (A,B). Group A included patients "*with a definite preoperative diagnosis"* who underwent *therapeutic laparoscopy from the start*, whereas group B included patients *"without a definite preoperative diagnosis"* who underwent *diagnostic laparoscopy first*. The latter group included patients who presented with generalized or localized peritonitis of an unknown source (e.g. perforated duodenum without pneumoperitoneum) or with subacute intestinal obstruction without a definite cause. Group A was further subdivided into 2 subgroups (A1,A2);

[A1:patients who underwent therapeutic laparoscopy and did not require conversion to open surgery; A2:patients who required conversion to open surgery]. Group B was also subdivided into 2 subgroups (B1,B2); [B1:patients who underwent either a diagnostic or a combined diagnostic-therapeutic laparoscopic procedure and did not require conversion to open surgery; B2:patients who required conversion to open surgery].

The diagnostic accuracy, therapeutic efficacy and potential benefits of laparoscopy in patients with acute abdomen were evaluated. The study groups were then compared in terms of rates of conversion to open surgery, reasons behind conversion, morbidity [intra-operative complications and short-term postoperative complications(in the first 6 months)], incidence of missed pathology, postoperative hospital stay, mortality and overall outcome.

Values in our study were expressed as means and standard deviations (mean±SD) or as numbers(%). Mean values of different variables in both groups were compared using the unpaired *t* test, whereas categorical variables were compared using the Chi square test. A *P* value<0.05 was considered statistically significant whereas a *P* value<0.01 was considered statistically highly significant. Data was analyzed using SPSS for Windows version 19.

RESULTS

The study patients ranged in age from 11 to 75 years (mean ± SD = 29.24 ± 12.32) with a male: female ratio of 48:117 (29.1%:70.9%). Group A included 90 patients (54.5%) *"with a definite preoperative diagnosis"* who underwent *therapeutic laparoscopy from the start*, whereas group B included 75 patients (45.5%) *"without a definite preoperative diagnosis"* who underwent *diagnostic laparoscopy first* **(Table 1)**.

Table 1: Clinical features of the study patients (n= 165).

Variable	Group A (n=90)	Group B (n=75)	*P* value
Patients factors			
Age (years)	28.07 ± 12.44	30.65 ± 12.11	0.180
Gender (M:F)	26 : 64 (28.9% : 71.1%)	22 : 53 (29.3% : 70.7%)	0.950
Diagnosis			
Preoperative diagnosis	Acute appendicitis [n=62(68.9%)] Acute cholecystitis [n=24(26.7%)] Perforated duodenal ulcer [(n=4(4.4%)].	Generalized peritonitis [n=30(40%)] Localized peritonitis [n=41(54.7%)] Subacute intestinal obstruction [n=4(5.3%)]	0.001**
Laparoscopic diagnosis	Acute appendicitis [n=62(68.9%)] Acute cholecystitis (uncomplicated) [n=23(25.6%)] Gall bladder empyema [n=1(1.1%)] Perforated duodenal ulcer [n=4(4.4%)].	Acute appendicitis [n=25(33.3%)] Perforated appendix [n=12(16%)] Perforated duodenal ulcer [n=4(5.3%)] Tubo-ovarian pathology (ovarian cyst rupture or torsion, ovarian endometriosis, tubo-ovarian abscess) [n=9(12%)] Pelvic abscess "post-appendectomy (n=2), post-caesarean section delivery (n=3)" [n=5(6.7%)] Acute Pancreatitis [n=4(5.3%)] Mesenteric vascular occlusion [n=3(4%)] Adhesive intestinal obstruction [n=3(4%)] Intra-abdominal / pelvic adhesions and / or fluid collections [n=3(4%)] Appendicitis and other pathology (ovarian cyst) [n=1(1.3%)] Perforated viscus (small bowel) [n=1(1.3%)] Transverse colon mass [n=1(1.3%)] Hemorrhagic ascites [n=1(1.3%)] Negative laparoscopy [n=1(1.3%)]	0.001**

Variable	Group A (n=90)	Group B (n=75)	*P* value
Laparoscopic procedures performed *(whether completed laparoscopically or converted)*	Lap. appendectomy [n=62(68.9%)] Lap. cholecystectomy [n=24(26.7%)] Lap. duodenal ulcer repair [n=4(4.4%)]	Diagnostic laparoscopy [n=75(100%)] Lap. appendectomy [n=37(49.3%)] Lap. duodenal ulcer repair [n=4(5.3%)] Lap. adhesiolysis and / or drainage of pelvic abscess or other fluid collections [n=15(20%] Lap. ileal repair [n=1(1.3%)] Lap. appendectomy and ovarian cystectomy [n=1(1.3%)]	0.001**
Therapeutic efficacy of laparoscopy	77/90 (85.6%)	34/58 (58.6%)	0.001**
Morbidity ***Intra-operative complications*** Bowel injury Bleeding from a liver injury Anesthesia-related (hypoxia/hypercapnia)	5(5.5%) A1 : A2 = 1(1.3%) : 4(30.8%) 2(2.2%) 1(1.1%) 1(1.1%) ---	9(12%) B1 : B2 = 2(5%) : 7(20%) 2(2.7%) --- --- 2(2.7%)	0.139
Early Post-operative complications Pyrexia Wound infection Ileus Leakage of duodenal contents	3(3.3%) 1(1.1%) 1(1.1%) 1(1.1%) ---	7(9.3%) 2(2.7%) 3(4%) 1(1.3%) 1(1.3%)	
Conversion rates	13(14.4%)	35(46.7)	0.001**
Postoperative hospital stay (days)	1.92 ± 1.47	4.15 ± 3.37	0.001**
Incidence of missed pathology	0%	0%	--
Mortality rate	0%	1 (1.3%)	0.272

Data are expressed as mean ± SD or number (%); **P < 0.01= highly significant; *Lap. = Laparoscopic.*

In group A (n=90), a preoperative *definite* diagnosis of acute appendicitis was made in 62 patients (68.9%), a *definite* diagnosis of acute cholecystitis was made in 24 patients (26.7%), whereas a *definite* diagnosis of perforated duodenal ulcer was made in 4 patients (4.4%). Definite diagnoses were reached preoperatively in all the 90 patients on the basis of typical findings on clinical examination, laboratory investigations and/or imaging. In all cases, *therapeutic laparoscopy* was carried out *from the start*. Therapeutic procedures [laparoscopic appendectomy (n=62), laparoscopic cholecystectomy (n=24) **(Fig.1)**, laparoscopic duodenal ulcer repair (n=4)] were successfully completed laparoscopically in 77 cases (85.6%) *"Subgroup A1"*, while 13 cases (14.4%) required conversion to open surgery *"Subgroup A2"* **(Table 2, Fig.2)**. Almost all conversions were due to technical failure in patients with severe acute inflammation of the appendix, gall bladder or duodenum with or without extensive adhesions and/or phlegmon formation.

Fig. (1): Diagnostic laparoscopy image showing acute cholecystitis with peri-cholecystic adhesions in one of our study patients.

Table 2: Different types of abdominal incisions used for conversion to open surgery in group A (n=13) and group B (n=35) patients.

Type of abdominal incision	Group A [n (%)]	Group B [n (%)]
Midline laparotomy	-	3 (4%)
Upper midline laparotomy	1 (1.1%)	3 (4%)
Lower midline laparotomy	-	14 (18.7%)
Grid-iron incision	5 (5.5%)	10 (13.3%)
Right subcostal (Kocher's) incision	7 (7.8%)	-
Low transverse (phannenstiel) incision	-	5 (6.7%)

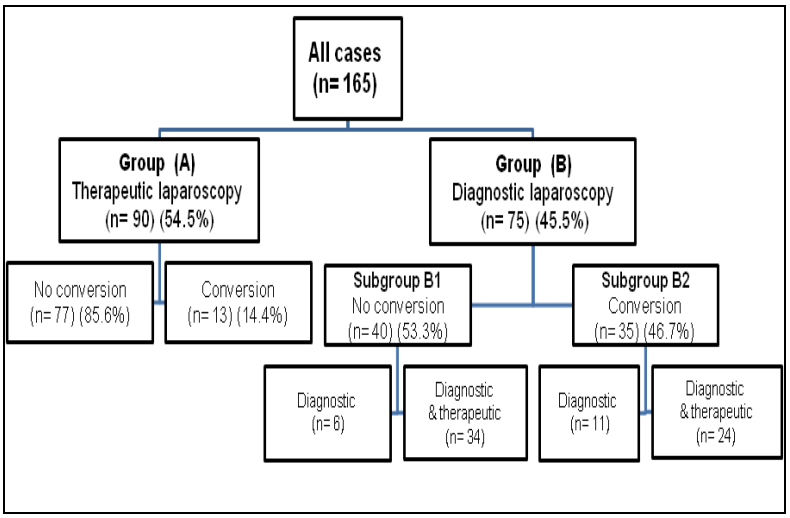


Fig. (2): Classification of our study patients (n=165) according to the procedures performed.

Intra-operative complications were reported in 2 patients(2.2%) in group A[bowel injury(ileal perforation) during laparoscopic appendectomy(n=1) that necessitated open conversion and primary repair through a grid-iron incision, bleeding from a liver injury during laparoscopic cholecystectomy(n=1) that was controlled by electrocautery]. Post-operative complications were reported in 3 patients(3.3%), all of whom had required conversion to open surgery[pyrexia(n=1), wound infection(n=1), prolonged ileus(n=1)]. The overall morbidity rate in group A was 5.5% [1.3%(1 out of 77 cases) in subgroup A1 compared to 30.8%(4 out of 13 cases) in subgroup A2] and the postoperative hospital stay ranged from 1-8

days(mean±SD=1.92±1.47). The longest hospital stay(8 days) was reported in a patient with gall bladder empyema in whom conversion to open cholecystectomy was undertaken. No cases of missed pathology were reported in group A and the mortality rate was 0%.

In group B(n=75), a preoperative diagnosis of generalized peritonitis was made in 30 patients(40%), a diagnosis of localized peritonitis was made in 41 patients(54.7%), whereas a diagnosis of subacute intestinal obstruction was made in 4 patients(5.3%). In all cases, the exact underlying etiology could not be identified preoperatively and thus, *diagnostic laparoscopy* was carried out *first*. Group B was further subdivided into 2 subgroups(B1 and B2) **(Fig.2)**. Subgroup B1 included 40 patients(53.3%) who did not require conversion to open surgery. In this subgroup, *only a diagnostic laparoscopic procedure* was carried out in 6 patients(8%), without needing to perform any therapeutic procedure[acute pancreatitis(n=4) **(Fig.3)**, ovarian endometriosis(n=1), negative laparoscopy(n=1)], whereas *a combined diagnostic-therapeutic laparoscopic procedure* was successfully carried out in 34 patients(45.3%) [laparoscopic appendectomy(n=23), laparoscopic duodenal ulcer repair(n=1), laparoscopic appendectomy and ovarian cystectomy(n=1), laparoscopic adhesiolysis and/or drainage of pelvic abscess or other fluid collections(n=9)]. On the other hand, subgroup B2 included 35 patients(46.7%) who required conversion to open surgery. The reasons behind conversion included failure to establish a definite diagnosis (n=2), failed attempt of therapeutic laparoscopy(n=23) **(Fig.4)**, intra-operative hypoxia/hypercapnia (n=2) and laparoscopic diagnosis of a disease that is best managed by open surgery(i.e.nature of the disease) (n=8) **(Fig. 5, 6, 7)**. Different types of abdominal incisions were used for open conversion in subgroup B2 **(Table 2)**.

Fig. (3): Diagnostic laparoscopy image showing omental saponification due to acute pancreatitis in one of our study patients.

Fig. (4): Image showing an ileal perforation in a patient with post-appendectomy subacute intestinal obstruction. The ileum was delivered through the old appendectomy scar and primarily repaired.

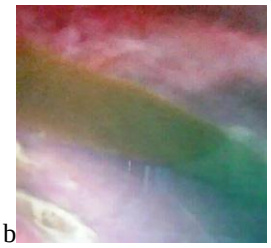
a  b 

Fig. (5): Diagnostic laparoscopy images showing a perforated duodenal ulcer in one of our study patients (***A:*** Image showing the perforation; ***B:*** Image showing a peri-hepatic bilious collection).

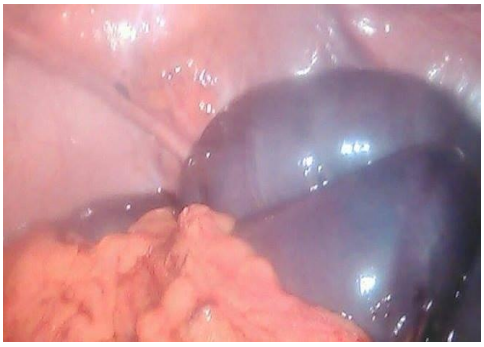


Fig. (6): Diagnostic laparoscopy image showing mesenteric vascular occlusion with an ileal segment gangrene (30 cm from the ileocecal valve) in one of our study patients.

Fig. (7): Image showing a 2-month fetus found upon opening the sac of an anterior uterine wall ectopic pregnancy in one of our study patients.

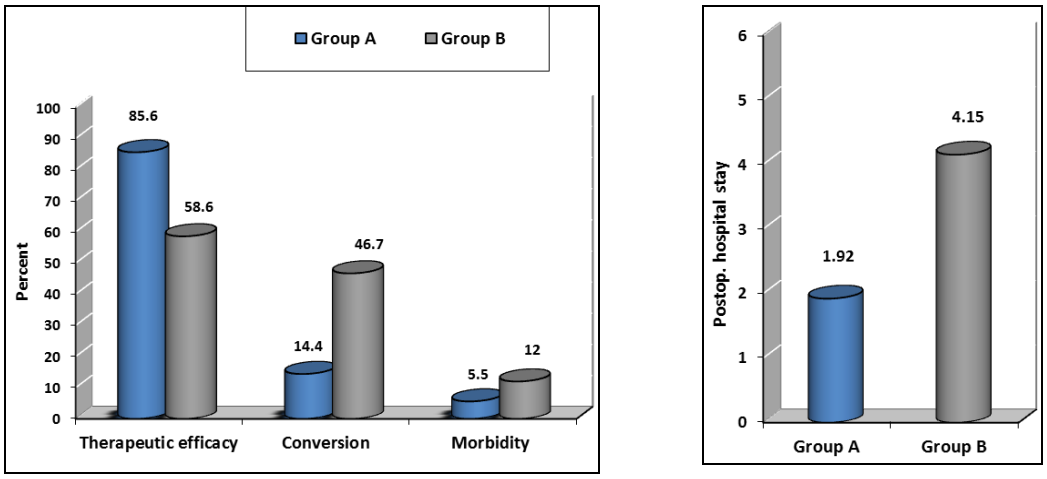


Fig. (8): Chart showing the therapeutic efficacy, conversion and morbidity rates, as well as the postoperative hospital stay in our study groups (A and B) *"Postop.= Postoperative".*

Intra-operative complications were reported in 2 patients(2.7%) in group B[intra-operative hypoxia/hypercapnia due to pneumoperitoneum (n=2)]. In both cases, despite reduction of insufflation pressures, the oxygen saturation(SaO2%) remained low and a decision was taken to convert to open surgery. Postoperative complications were reported in 7 patients(9.3%), five of whom had required conversion to open surgery[leakage of duodenal contents(n=1), pyrexia(n=2), wound infection(n=3), prolonged ileus(n=1)]. Duodenal leakage was noted in one patient on postoperative day(POD)2 following laparoscopic duodenal ulcer repair using an omental flap. This necessitated an exploratory midline laparotomy which revealed leakage of duodenal contents from the site of the repaired ulcer. Another flap was used for ulcer repair, then peritoneal lavage and drainage was carried out. The overall morbidity rate in group B was 12% [5%(2 out of 40 cases) in subgroup B1 compared to 20% (7 out of 35 cases) in subgroup B2] and the postoperative hospital stay ranged from 1 to 21 days (mean±SD=4.15±3.37). The longest hospital stay(21 days) was reported in a 25-year old female patient with mesenteric vascular occlusion and large bowel ischemia in whom diagnostic laparoscopy revealed a gangrenous sigmoid colon. This necessitated conversion to open surgery(through a lower midline laparotomy). Sigmoid colectomy and Hartmann's procedure

was carried out and the patient was transferred to the intensive care unit. On POD12, the stoma became gangrenous and a relaparotomy was undertaken. This revealed extensive colonic gangrene. Total colectomy and ileostomy was performed, but the patient died 10 days later of severe sepsis and organ dysfunction. This was the only mortality reported in group B(i.e.the mortality rate was 1.3%). No cases of missed pathology were reported in this group.

DISCUSSION

"Ok, let's open and see!!". This is a statement that we commonly use in our surgical practice when we decide to *"do a laparotomy"*. In fact, making the decision of a laparotomy is a great challenge that faces every general surgeon at the ED when a case of acute abdomen comes to him/her. *Shall I open?!..but if it was a negative laparotomy, what would be the case then?..and what about the big midline scar and the pain postoperatively?..Was my decision wrong from the start?*. A lot of questions but no definite answers. So, why not *"Let's see and treat but without open!!"??*. Why not *"do a laparoscopy"??*.

Nowadays, laparoscopy plays a crucial role in the diagnostic and therapeutic algorithm for patients with abdominal emergencies[10]. The decision to perform diagnostic laparoscopy in patients with *acute abdomen* should be based on clinical judgment, weighing the sensitivities and specificities of other modalities(e.g.CT, ultrasonography) against the relative morbidity of laparoscopy[11]. In some cases, acute abdomen can be totally managed by therapeutic laparoscopy, as in the case of perforated appendicitis or perforated duodenal ulcer. In other cases, laparoscopy can help to choose the right place for the incision, as in the case of perforated diverticulitis or gynecological problems. Laparoscopy can also help to avoid unnecessary laparotomies in certain conditions(e.g.negative diagnostic laparoscopy, extensive mesenteric ischemia with bowel necrosis)[12]. Furthermore, the diagnostic and therapeutic versatility afforded by the laparoscopic approach helps to avoid extensive preoperative studies and delays in operative intervention, minimizes morbidity and shortens postoperative hospitalization[10].

According to the European Association for Endoscopic Surgery(EAES)2006 Guidelines on the role of laparoscopy in *acute abdomen* and the 2011 Consensus, the effectiveness of laparoscopy was as follows; [in acute cholecystitis: moderate(2006)-strongest(2011); in perforated gastroduodenal ulcers: strongest (2006)- moderate (2011); in acute appendicitis: strongest (2006 and 2011)]. There was no reported effectiveness in mesenteric ischemia and doubtful effectiveness in incarcerated hernias, small bowel obstruction and acute diverticulitis[10,13].

In our study, 165 patients underwent laparoscopy for *acute abdomen*. Overall, laparoscopy was *diagnostic only* in 17 cases (10.3%) [6 cases in subgroup B1 and 11 cases in subgroup B2], *therapeutic only* in 90 cases (54.5%) [all cases in group A], and was *both diagnostic and therapeutic* in 58 cases(35.2%)[34 cases in subgroup B1 and 24 cases in subgroup B2] **(Fig.2)**. The overall diagnostic accuracy of laparoscopy was 97.3%(i.e.73/75 patients in group B who underwent *diagnostic laparoscopy first*). In all those 73 patients, an *"accurate definite"* diagnosis was successfully established by laparoscopy. However, in only 2 patients in group B, a definite diagnosis was only reached upon conversion to open surgery[ectopic pregnancy(n=1), ileal perforation(n=1)]. Meanwhile, the overall therapeutic efficacy of laparoscopy was 75%(i.e.111/148 patients who underwent therapeutic laparoscopy). We noticed, however, that the therapeutic efficacy of laparoscopy was significantly higher in group A patients who underwent *therapeutic laparoscopy from the start*[85.6%(77/90)] compared to group B patients who underwent *diagnostic laparoscopy first* followed by therapeutic laparoscopy[58.6%(34/58)]; *P*=0.001**(Fig.8)**. The diagnostic accuracy and therapeutic efficacy of laparoscopy in our study are consistent with those reported in previous studies. In one study, laparoscopy could establish a definite diagnosis in 93-100% of cases, and could accomplish a definitive treatment in 44-73% of cases[14]. In another study, laparoscopy was diagnostic in 100% of cases and could accomplish treatment in 94% of those cases[15].

The overall rate of conversion to open surgery in our study was 29.1%(i.e.48 cases). This was obviously higher than the literature rates. For example, in a retrospective review of 514 patients

who underwent laparoscopy for *acute abdomen*, the conversion rate was 2.2%[16]. In another series of 30 patients, the conversion rate was 6.7%%[3]. The conversion rate in our study was significantly lower in group A[n=13(14.4%)] compared to group B patients[n=35(46.7%)]; *P*=0.001**(Fig.8)**. Our high conversion rates, particularly in group B, have been largely attributed to the wide use of laparoscopy in patients with complicated pathologies, where 45.3% of group B patients (34 / 75) presented with generalized peritonitis (n=30) or subacute intestinal obstruction (n=4).

The overall morbidity rate in our study was 8.5%(i.e.14 cases). This is almost consistent with previous studies which reported various complications in patients undergoing laparoscopy for acute abdomen, with morbidity rates ranging from 0 to 24%[13,17]. The morbidity rate in our study was relatively lower in group A[n=5(5.5%)] compared to group B patients [n=9 (12%)];*P*=0.139. The postoperative hospital stay was significantly shorter in group A[1-8 days (mean±SD=1.92±1.47)] compared to group B patients[1-21 days (mean±SD =4.15±3.37)]; *P*=0.001. No cases of missed pathology were reported in either group. Meanwhile, the overall mortality rate in our study was 0.6%(i.e.1 patient). The only patient who died in the study was a female patient in group B who died of severe sepsis and organ dysfunction after undergoing two laparotomies for resection of gangrenous bowel. The mortality rate in our study coincides with the literature rates, which range from 0 to 5%[13,17]**.** In a recent case series of 50 patients who underwent laparoscopy for acute abdomen, the mortality rate was 0%[15]. According to the literature, the results of several experiences have demonstrated that emergency laparoscopy in patients with a*cute abdomen* is feasible, safe and beneficial enough to be a part of common surgical practice, as long as adequate training is obtained and satisfactory outcomes are observed[10]. The relatively low morbidity and low mortality rates in our study (8.5% and 0.6% respectively), which coincide with the literature rates[13,17], further support the relative safety of the laparoscopic approach in patients with *acute abdomen.*

Besides the aforementioned findings, our study has also highlighted some other benefits for the use of laparoscopy in patients with *acute abdomen*. First, laparoscopy has spared some patients[n=6(8% of group B patients)] the morbidity of unnecessary non-therapeutic midline laparotomies. In those 6 cases in subgroup B1, diagnostic laparoscopy was undertaken without needing to perform any therapeutic procedure. Second, laparoscopy has largely minimized the operative trauma in group B patients who required conversion to open surgery[(n=35)i.e.subgroup B2]. In those 35 patients, only 3 cases(4%) required a formal midline laparotomy. This indicates that, although laparoscopy might not accomplish definitive treatment in some patients with "*no definite preoperative diagnosis"*, it can still help to guide the operating surgeon to choose the proper *"targeted"* incision, which is usually smaller than the formal midline laparotomy incision. This, in fact, minimizes the operative trauma, spares patients the increased morbidity associated with formal midline laparotomies(e.g.significant wound pain, pulmonary complications), and improves overall patient satisfaction. On the other hand, our study still has some limitations. Of course, being an observational study that did not include patients who underwent *open surgery from the start* is the main drawback. Other limitations include lack of operative time recording, selection bias, as well as varying degrees of experience of decision-makers and operating surgeons.

Finally, we can conclude that, despite our study limitations and the high conversion rates reported, laparoscopy in *acute abdomen* is a relatively safe approach that has a high diagnostic accuracy, a good therapeutic efficacy and several potential benefits. *Therapeutic laparoscopy from the start* in patients with *a definite preoperative diagnosis* appears to be associated with higher therapeutic efficacy, lower rate of conversion to open surgery, relatively lower morbidity rate and shorter postoperative hospital stays, compared to *diagnostic laparoscopy first* in patients with *no definite preoperative diagnosis.* These findings suggest that better outcomes could be expected in patients with acute abdomen when laparoscopy is used as a therapeutic tool from the start*(after a preoperative diagnosis had been reached)* rather than when it is used as a diagnostic tool first*(if no definite preoperative diagnosis could be reached)*. This could be largely attributed to the more complicated pathologies that are commonly encountered in the latter group. However, randomized controlled trials that include, not only patients with acute abdomen who undergo

laparoscopy, but also those who undergo *open surgery from the start*, are still needed in order to further evaluate the pros and cons of various approaches.

Conflicts of Interest: Nothing to disclose.

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