A comparative study of laparoscopic versus laparotomy repair of perforated peptic ulcer: A prospective study

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Background
Laparoscopic surgery is still gaining popularity in conditions associated with peritonitis, such as a perforated peptic ulcer.
Aim of the work
This study aimed to compare laparoscopic and laparotomy repair of perforated peptic ulcers regarding intraoperative parameters, postoperative pain, time of the start of oral feeding, postoperative complication, hospital stay, resuming normal activity, and outcomes.
Patients and methods
This is a prospective study of 50 patients (males and females), of any age with perforated peptic ulcer. Those patients will be divided by the random serial number method into two groups: the ***laparoscopic group*** and the ***open (laparotomy) group.*** In a period from 15th April 2022 to 15th February 2023 data related to patients were recorded and subjected to analysis.
Results
All patients were divided into two groups: ***Laparoscopic group*** with 25 patients (23 of them underwent successful laparoscopic repair and two patients were converted to open) and the ***open (laparotomy) group*** with 25 patients underwent laparotomy repair (of which 23 patients were living, and two patients died on the third and tenth postoperative days). There were no significant differences in baseline characteristics between both groups in terms of age, gender, special habits, preoperative risk factors, comorbidities, laboratory, and radiological findings; also both groups showed insignificant differences regarding the American Society of Anesthesiologists (ASA) scores (P=0.83), total Boey's score (P=0.77), shock on admission (P= 1.00), and the duration of symptoms $>$ 24 hours (P= 0.77). Operative time was significantly increased in the laparoscopic versus open group (P=0.0001). While, first-day pain score (VAS), opioid requirements, time of starting oral feeding, length of hospital stay, and return to normal activity were highly significantly decreased in laparoscopic repair compared with open repair (P= $<$0.0001 for each). Total postoperative complications showed insignificant difference between the studied groups (P=0.16), but they were more prevalent between the open group (14 patients, 56%) versus the laparoscopic group (9 patients, 36%). Good cosmetic results of wounds were more prevalent in the laparoscopic group [20 patients (80.00%)] than the open group [13 patients (56.52%)], but insignificant, P=0.17.
Conclusion
Laparoscopic repair had an upper hand over open repair regarding less intraoperative blood loss, less postoperative pain, requiring less postoperative analgesia, early starting of oral feeding, less postoperative complications, shorter hospital stay, early return to normal activity, and good cosmetic results of wounds.

Keywords:
laparoscopic repair, laparotomy repair, outcomes, perforated peptic ulcer

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Introduction

Since the late 1980s, laparoscopy has become increasingly popular. In the beginning, laparoscopy was mainly used for elective surgery, as the effect of the pneumoperitoneum on the acute abdomen with peritonitis was not clear. However, the benefits of laparoscopy with regard to the acute abdomen as a diagnostic tool have been established and since then its therapeutic possibilities also seem to be advantageous [1]. The perforation occurs in 2–14% of peptic ulcer patients, and it remains the second most common cause of visceral perforation that requires urgent surgery [2]. It is reported that peptic ulcer disease may have short-term morbidity in up to 50% of patients and mortality in up to 30% respectively, threatening seriously the

health and life of human beings. Therefore, it is of long-standing interest to explore the effective treatments for peptic ulcer disease in modern surgery [3]. Perforated peptic ulcer disease (PPU) is an important indication for emergency surgery, complicating 2%–10% of peptic ulcer disease [4]. A perforated peptic ulcer is a condition in which a laparoscopic repair is an attractive option. Not only is it possible to identify the site and pathology of the perforation, but the procedure also allows closure of the perforation and peritoneal lavage, just like in open repair but without a large upper abdominal incision [5]. Laparoscopic repair confers benefits including reduced postoperative pain, less pulmonary infection, shorter hospital stay, and earlier return to normal activities [6]. The drawbacks of this surgery are the prolonged operating time, higher incidence of reoperations owing to leakage at the repair site, and a higher incidence of intra-abdominal collection secondary to inadequate lavage, and also not all patients are suitable for laparoscopic repair; it is, therefore, important to preselect patients who are good candidates for laparoscopic surgery [7]. The Boey's scoring system is based on three criteria: (a) shock at admission, (b) American Society of Anesthesiologists (ASA III–V), and (c) delayed presentation (duration of symptoms >24 h). The patient is given one point for each positive criterion, with possible scores of 0–3. Patients with scores of 0, 1, 2, and 3 were noted to have mortality rates of 0, 10, 45.5, and 100%, respectively [8]. Laparoscopic repair is reported to be safe with Boey's scores 0 and 1; Boey's scores 2 and 3 are associated with high morbidity and mortality rate, independent of the type of surgery [9].

The aim of the work

This presentation aimed to compare laparoscopic and open (laparotomy) repair of perforated peptic ulcers regarding intraoperative parameters, postoperative pain, time of the start of oral feeding, postoperative complications, hospital stay, resuming normal activity, cosmetic results of wounds, and outcomes.

Patients and methods

The study design

This is a prospective study that was conducted at the emergency department of general surgery in Sohag University Hospital for comparing between laparoscopic and open (laparotomy) repair of perforated peptic ulcers in a period from 15th April 2022 to 15th February 2023.

Ethics approval and consent to participate

Written informed consent was taken from all participating patients or their legal guardians. Ethical approval was obtained from the medical research ethics committee under IRB Registration number: Soh-Med-22-4-31.

Study population

This is a prospective study of 50 patients (males and females) of any age with a perforated peptic ulcer, who will be admitted to the Emergency Department of General Surgery in Sohag University Hospital. The patients will be divided by the random serial number method into two groups: The laparoscopic group that included 25 patients and the open (laparotomy) group including 25 patients. All patients underwent urgent operation during a period from 15th April 2022 to 15th February 2023. Data related to patients including sociodemographic details, preoperative data, intraoperative findings, postoperative parameters, and outcomes were collected by authors, recorded, and subjected to analysis. All operations will be performed under general anesthesia.

Inclusion criteria

The inclusion criteria included the following:

(1) Patients who agreed to participate in the study (by taking informed consent).
(2) Patients with perforated peptic ulcer based on clinical assessment, investigations, and confirmed by exploration.
(3) Either male or female of any age.

Exclusion criteria

(1) Patients with a surgical diagnosis other than a perforated peptic ulcer.
(2) Patients with gastric outlet obstruction.
(3) Bleeding ulcer.
(4) Previous abdominal exploration that results in upper abdominal scare, e.g. midline, paramedian, transverse epigastric incisions, etc.
(5) Patients who absconded or left the study or died during the period of study.
(6) Patients with cardiac and chest conditions (excluded from laparoscopic).

Conversion criteria

Conversion criteria included:

(1) Difficult identification of the perforation.
(2) Cardiovascular instability.
(3) Iatrogenic injuries that could not be managed laparoscopically.

The preoperative data include:
All patients will be assessed through the patient's history, preoperative risk factors, comorbidities, clinical examination, the American Society of Anesthesiologists (ASA) score [10], radiological evaluation (plain chest radiograph, abdominal ultrasound, abdominal C-T, and gastrograffin meal) and laboratory investigations (complete blood picture, liver function tests, kidney function tests, serum amylase and lipase, blood sugar, serum sodium, calcium, and potassium) for routine preoperative evaluation. Also, all patients will be evaluated regarding ***Boey's score*** (preoperative predictive factors), which is based on three criteria: (a) shock at admission, (b) American Society of Anesthesiologists (ASA III–V), and (c) delayed presentation (duration of symptoms >24 h); the patient is given one point for each positive criterion, with possible scores of 0–3.

Preoperative resuscitation: Should be administered before surgery.

(1) Fluids and electrolyte correction.
(2) Intravenous antibiotic therapy.
(3) Proton-pump inhibitor injection.

Surgical technique for laparoscopy procedure

Patient's position

The patient is placed in the supine position with the legs straight and spread out. The patient's position is changed to the Trendelenburg position during peritoneal lavage and to the anti-Trendelenburg position during suture.

Team position

The surgeon stands between the patient's legs and the assistant to the patient's left side. This position is changed during peritoneal lavage with the surgeon to the left of the patient and the assistant between the patient's legs.

Equipment's position

The instrument table is placed at the patient's legs. The laparoscopic unit is placed on the patient's left side toward the shoulder.

Trocar site

An optical trocar of 10–12 mm is introduced in the perimbilical region. One operating trocar of 5 mm is placed in the inferior aspect of the right upper quadrant on the mid-clavicular line for a traumatic grasper. A trocar of 5 mm is placed on the left side at the transpyloric level on the mid-clavicular line for the needle holder. A fourth trocar of 5 or 10 mm is placed in the epigastric region and accommodates one or several means of liver and viscera retraction.

First step

The veress needle or an open technique will be used to enter the abdomen. Intra-abdominal pressure between 8 and 12 mmHg is usually sufficient to realize enough room to work properly. The abdomen is explored to identify the perforation and to assess the magnitude of peritonitis. Once the liver is retracted, the exposed area is carefully checked and the perforation is usually clearly identified as a small hole on the anterior aspect of the first part of the duodenum, juxtapyloric, pyloric, or gastric.

Second step

The next step is cleaning the abdomen. The whole abdomen must be irrigated and aspirated with a warm saline solution. About 4–6 liter of warm saline is necessary to clean the abdomen.

Third step

For direct closure of the perforation by interrupted PDS or 2/0 Vicryl sutures, usually three stitches are placed in a transversal manner over the perforation. Methods used for closure were simple closure with an omental patch (modified Graham's repair), simple closure, or Graham's omental patch. A wide bite of 0.5–1 cm from the perforation edge is required to avoid cutting through the friable ulcer edges. The knot is tied using intracorporeal knotting. Once the perforation is closed, a small fragment of the greater omentum can be fixed over the suture line. When it is difficult to approximate the edges of the ulcer, as in cases with chronic callous ulcers and large perforation, direct closure of perforation should be avoided and closure of the perforation with an omental patch only must be used to avoid cutting the duodenal or gastric wall.

Finally

Routine drainage of the peritoneal cavity is performed, and the abdomen must be examined for any possible bowel injury or hemorrhage.

Surgical technique for the open procedure

The patient was placed in the supine position and general anesthesia was administered. An exploratory upper midline incision was made. After formal exploration and identification of perforation, we used either the modified Graham's repair, simple repair, or Graham's omental patch. In the modified Graham's repair three interrupted sutures were used and a piece of omentum was laid over these sutures,

which were then tied just sufficiently tight to hold the omental graft in situ. Peritoneal toileting is conducted with warm saline until it becomes clear, then drains are inserted, and closure of the abdomen is done.

Postoperative care

Nothing by mouth, giving intravenous fluids, broad-spectrum antibiotics, proton-pump inhibitor, opioid analgesics, and prophylactic heparin given to prevent deep vein thrombosis. After the return of intestinal movement usually by the third or fourth day, removal of Ryle and gradually starting oral fluid along with adding triple therapy for Helicobacter pylori.

Follow-up

Patients with a history of chronic ulcers continued the use of NSAIDs, and infection with H. pylori was more likely to have persistent symptoms, signs, and complications of peptic ulcer. Therefore, the postoperative follow-up of patients with perforated peptic ulcer includes the following: a combination of antibacterial and antisecretory therapy to eradicate H. pylori should be administered to all patients. After 6 weeks postoperatively: Endoscopy was done for confirmation of ulcer healing. Eradication of H. pylori was confirmed. Also, intake of NSAIDs is stopped in all patients.

The time of operation

For laparoscopic repair: is calculated from the first port site insertion till the last port site closure.

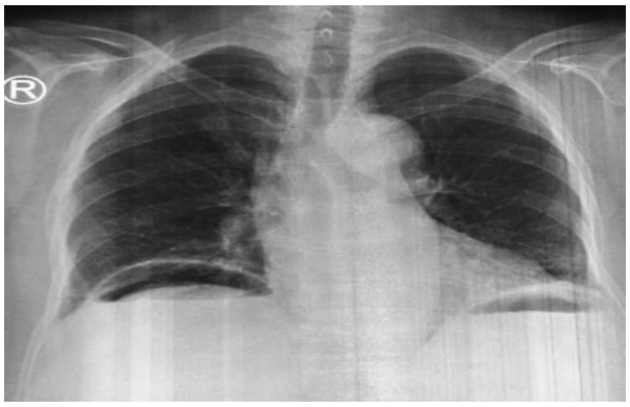
For open (laparotomy) repair: calculated from the start of the laparotomy incision till the last stitch in the closure of the laparotomy incision.

Fig. 1: Peptic ulcer perforation (pain chest radiograph: shows free air under the dome of both diaphragms due to air leak Figs. 2–11.

Intraoperative findings

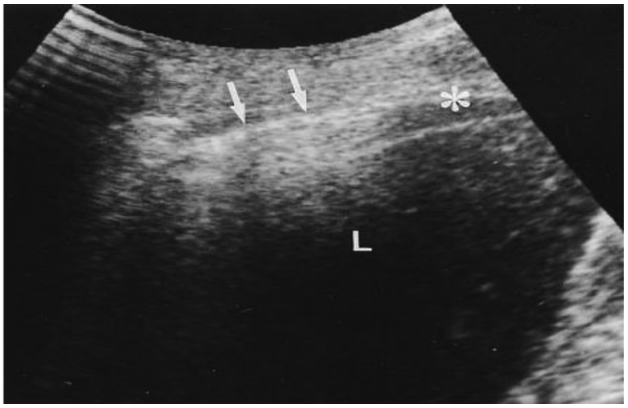
Location of the perforation [Juxtapyloric, duodenal, gastric (in addition to treatment biopsy was taken from all perforated gastric ulcers for histopathological study) and pyloric], ***perforation size*** (mm), ***conversion to open repair*** [Causes for conversion are difficult access, large ulcers, preoperative diagnostic uncertainty, iatrogenic injury not treated laparoscopically], ***type of repair*** [modified Graham's repair (simple closure plus omental patch), simple closure, Graham's omental patch], ***operative time*** (min.) and ***intraoperative complications,*** e.g. hemorrhage and iatrogenic injury to intra-abdominal structures.

Figure 1



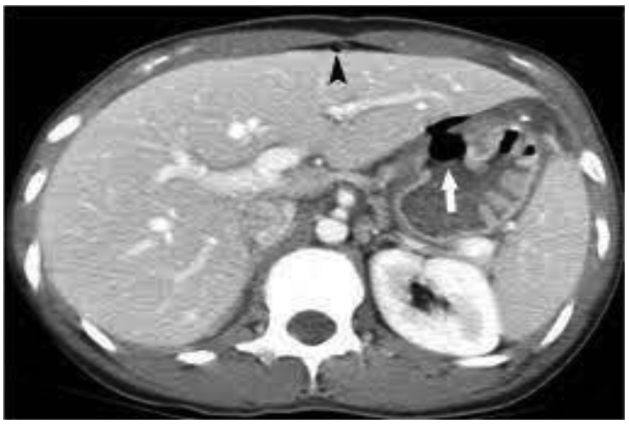
Peptic ulcer perforation (plain chest radiograph: shows free air under the dome of. both diaphragms due to air leak).

Figure 2



Perforated peptic ulcer. Ultrasound demonstrates free intraperitoneal fluid (*) and air (arrows) between the lateral abdominal wall and the liver (L).

Figure 3

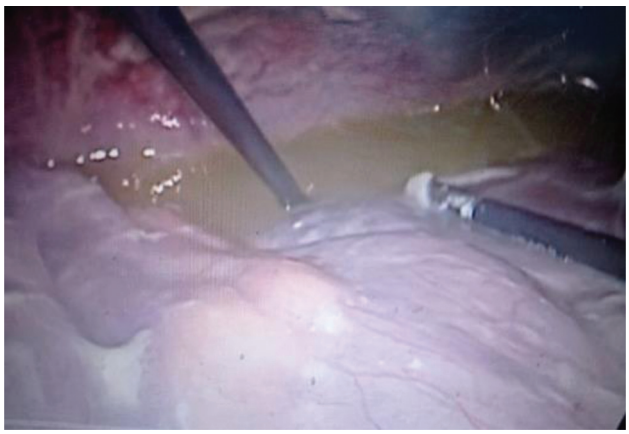


CT abdomen chowing focal defect in the lesser curvature of the gastric body is caused by a deep ulcer (arrow) associated with the surrounding mural thickening. Note the small air bubble (arrowhead) on the anterior peritoneal surface of the liver.

Figure 4

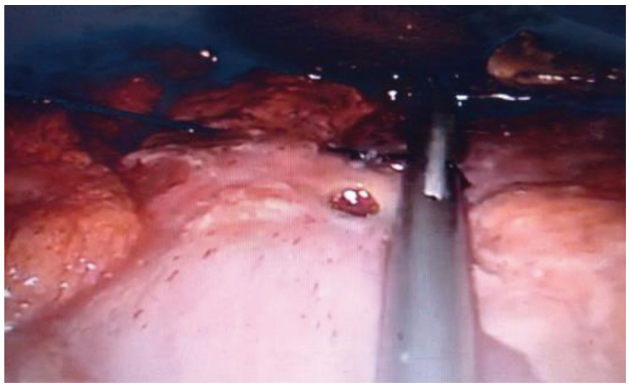
CT findings are suggestive of a perforated ulcer from the first part of the duodenum with active air and blood leak.

Figure 5



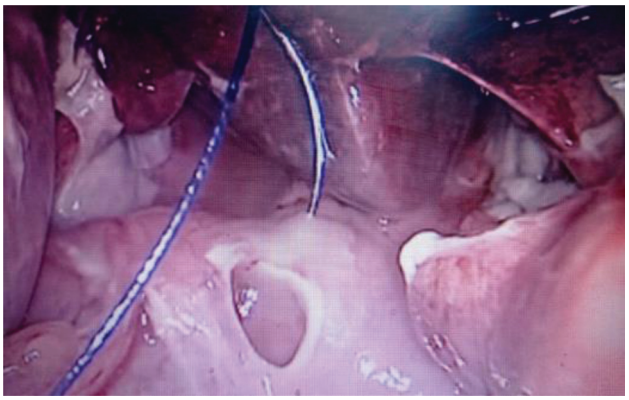
Laparoscopic suction of intraperitoneal collection due to perforated peptic ulcer.

Figure 6



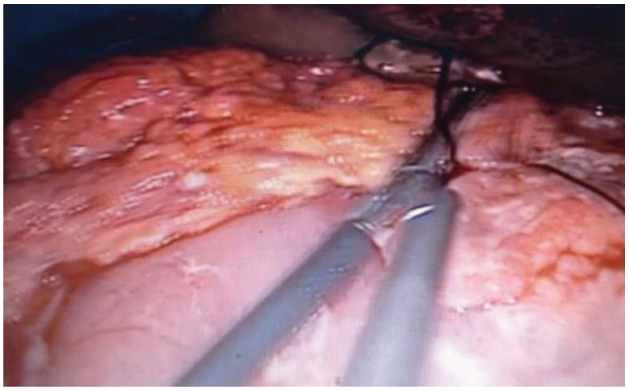
Perforated gastric ulcer.

Figure 7



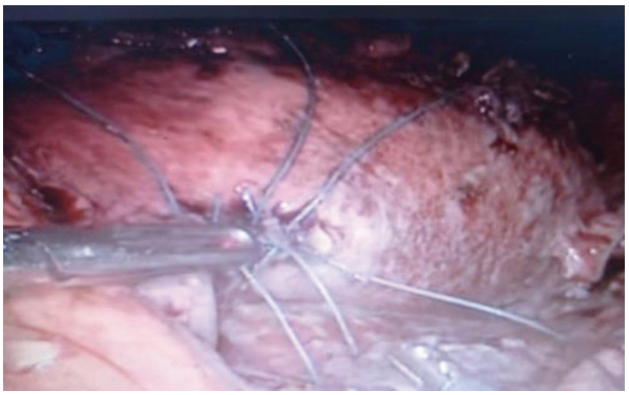
Laparoscopic repair (suturing) of perforated duodenal ulcer.

Figure 8



Laparoscopic repair of perforated gastric ulcer by Graham's omental patch.

Figure 9

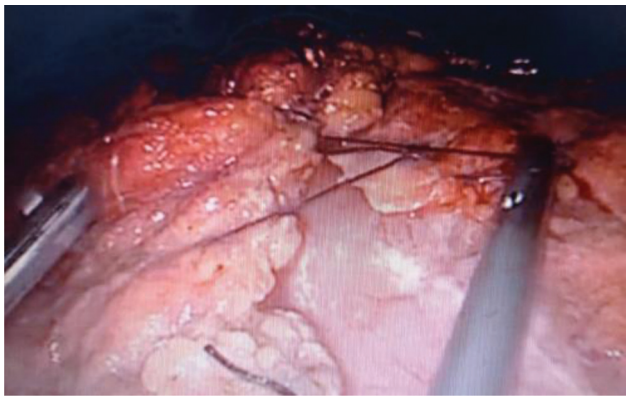


Laparoscopic repair of perforated gastric ulcer by simple closure.

Postoperative parameter

Postoperative complication (wound infection, port site infection, wound dehiscence, leakage, intestinal obstruction, fecal fistula, intra-abdominal sepsis, intra-abdominal hemorrhage, pneumonia, pulmonary thromboembolism, end-stage renal failure, postoperative ileus, gastric emptying difficulty, deep vein thrombosis, and reexploration), ***Length of hospital***

Figure 10



Laparoscopic repair of perforated gastric ulcer by simple closure plus omental patch (modified Graham's repair).

Figure 11

Open (laparotomy) repair of perforated duodenal ulcer.

stay (in days), ***Surgical Outcome*** :- ***a- Overall morbidity*** (major pathologic symptoms that might threaten the life of patients) according to the Clavien-Dindo classification [11], such as wound dehiscence, intra-abdominal hemorrhage, intra-abdominal sepsis, bowel obstruction, fecal fistula, deep vein thrombosis, and pulmonary thromboembolism were recorded. ***b- Mortality*** (operative death was defined as death occurring while the patient is in the hospital following surgery).

All these data were recorded and evaluated between the two groups.

Statistical analysis

Data were analyzed using STATA version 14.2 (Stata Statistical Software: Release 14.2 College Station, TX: StataCorp LP.). Quantitative data were represented as mean, standard deviation, median, and range. Data were analyzed using Student's *t*-test to compare the means of the two groups. When the data was not normally distributed Mann–Whitney test was used. Qualitative data were presented as numbers and percentages and compared using either Chi square test or Fisher's exact test. Graphs were produced using Excel or STATA program. *P* value was considered significant if it was less than 0.05.

Results

This study was carried out on 50 patients (males and females), of any age who had perforated peptic ulcer. All patients were divided into two groups: ***Laparoscopic group*** with 25 patients (23 of them underwent successful laparoscopic repair and two patients were converted to open) and ***open (laparotomy) group*** with 25 patients underwent laparotomy repair (of which 23 patients survived and two patients died). There were insignificant differences regarding age, gender, special habits, and the risk factors for perforation of peptic ulcer between the two studied groups, as shown in Table 1 and Figs. 12 and 13.

Previous abdominal surgery[*]: that led to lower abdominal scars, e.g: McBurney's incision, Pfannenstiel's incision, .etc. (Most operations were cesarean section and appendicectomy).

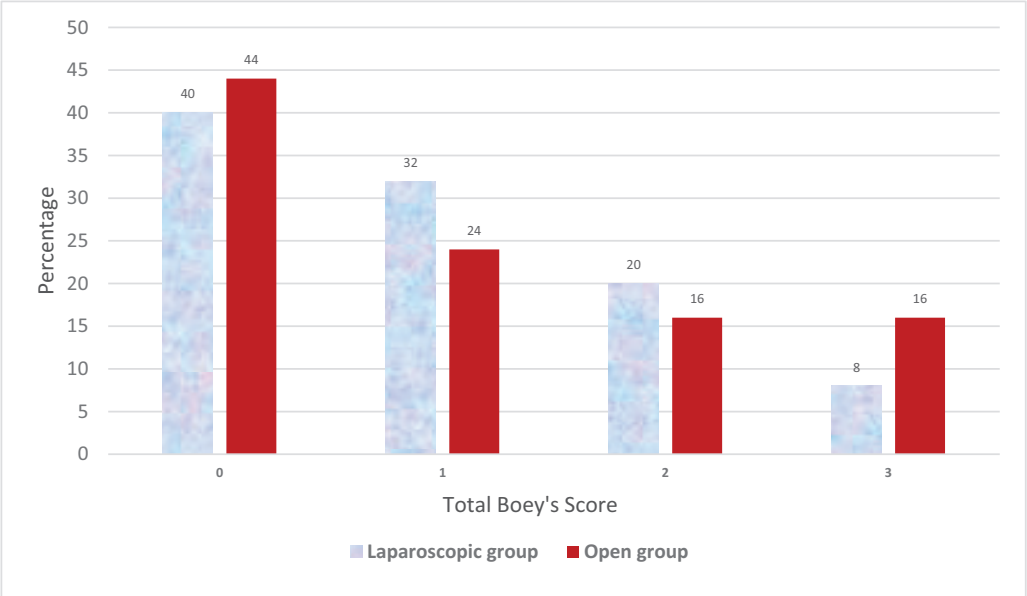
Shock on presentation (systolic blood pressure < 90 mmHg on admission), ASA grades, Boey's score, symptoms, and abdominal clinical examination were statistically insignificant between the studied groups, as shown in Table 2 and Fig. 14.

Overall comorbidity, 19 patients of the laparoscopic group suffered from one or more comorbidities, while 18 patients of the open group suffered from one or more comorbidities, so there was insignificant difference regarding comorbidity between the studied groups, *P*=0.75. White blood corpuscle (WBC) count, hemoglobin (Hb), and serum albumin showed insignificant difference between the studied groups, *P*=0.73, 0.51, 0.24, respectively. As regards radiological findings, plain chest radiograph (air under the diaphragm), and abdominal sonar [intraperitoneal fluid (IPF) collection + air] showed a success rate of 100% in the diagnosis of perforated peptic ulcer in this research, while abdominal C-T was done in five patients of the laparoscopic group and in four patients of the open group to confirm or exclude other diseases, e.g, intra-abdominal masses, liver cirrhosis,etc., and showed insignificant difference r, *P*=1.00. No patient needs a gastrografin meal for the diagnosis of perforated peptic ulcer, as shown in Table 3.

Table 1 Comparison between laparoscopic and open repair group as regards sociodemographic data and risk factors for perforation of peptic ulcer

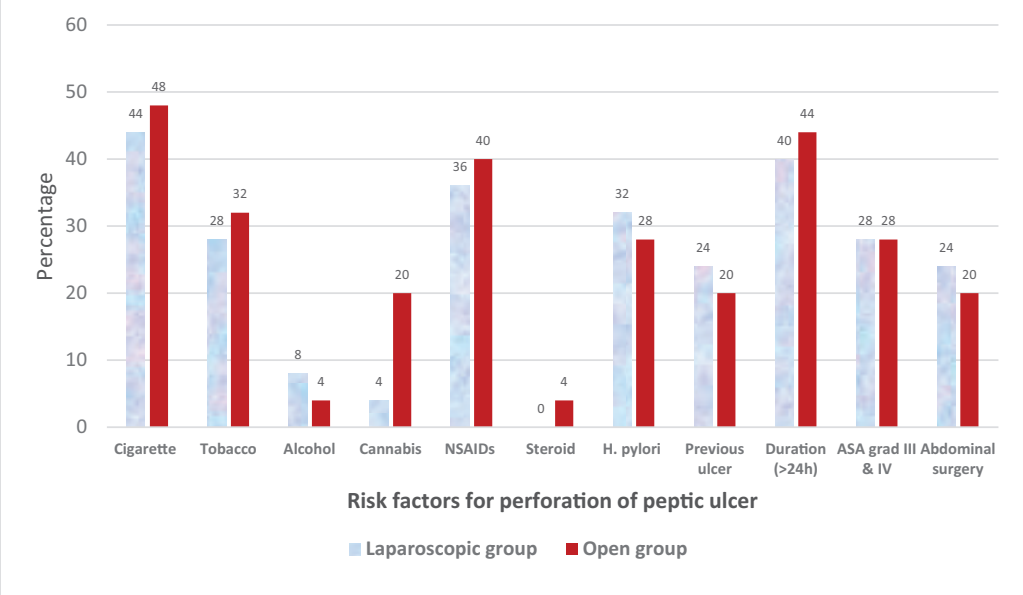
Variables	Laparoscopic group *N*=25	Open group *N*=25	*P* value
Age/year			
Mean±SD	46.64±12.47	47.80±12.79	0.87
Median (range)	47 (25:70)	53 (23:70)	
Gender			
Female	5 (20.00%)	4 (16.00%)	0.71
Male	20 (80.00%)	21 (84.00%)	
Special habits			
Cigarette	11 (44.00%)	12 (48.00%)	0.78
Tobacco	7 (28.00%)	8 (32.00%)	0.76
Alcohol	2 (8.00%)	1 (4.00%)	1.00
Cannabis	4 (16.00%)	5 (20.00%)	1.00
Cocaine	0	0	
Preoperative risk factors for the perforation of peptic ulcer			
Consumption of cigarette	11 (44.00%)	12 (48.00%)	0.78
Consumption of tobacco	7 (28.00%)	8 (32.00%)	0.76
Consumption of alcohol	2 (8.00%)	1 (4.00%)	1.00
Consumption of cannabis	4 (16.00%)	5 (20.00%)	1.00
Consumption of cocaine	0	0	
NSAIDs use	9 (36.00%)	10 (40.00%)	0.77
Steroid use	0	1 (4.00%)	1.00
H. pylori infection	8 (32.00%)	7 (28.00%)	0.76
History of previous ulcers	6 (24.00%)	5 (20.00%)	0.73
Duration of symptoms (>24 h)	10 (40.00%)	11 (44.00%)	0.77
ASA grade III & IV	7 (28.00%)	7 (28.00%)	1.00
Total Boey's Score			
0	10 (40.00%)	11 (44.00%)	0.77
1	8 (32.00%)	6 (24.00%)	
2	5 (20.00%)	4 (16.00%)	
3	2 (8.00%)	4 (16.00%)	
Previous abdominal surgery*	6 (24.00%)	5 (20.00%)	0.73

Figure 12



Preoperative total Boey's score.

Figure 13



Preoperative risk factors for the perforation of peptic ulcer in the studied groups.

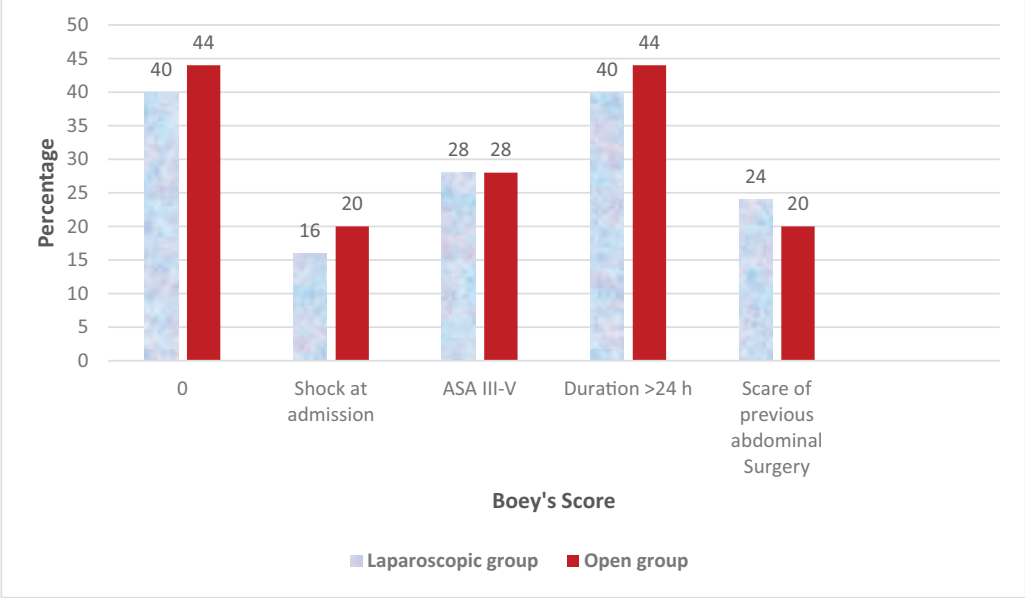
Table 2 Comparison between laparoscopic and open repair group as regards clinical data on admission

Variables	Laparoscopic group *N*=25	Open group *N*=25	*P* value
Shock on presentation (systolic blood pressure < 90 mmHg on admission)	4 (16.00%)	5 (20.00%)	1.00
ASA grades			
I	10 (40.00%)	8 (32.00%)	0.83
II	8 (32.00%)	10 (40.00%)	
III	6 (24.00%)	5 (20.00%)	
IV	1 (4.00%)	2 (8.00%)	
Boey's score			
0	10 (40.00%)	11 (44.00%)	0.77
Shock at admission	4 (16.00%)	5 (20.00%)	1.00
ASA III-V	7 (28.00%)	7 (28.00%)	1.00
Duration of symptoms >24 h	10 (40.00%)	11 (44.00%)	0.77
Symptoms			
Sudden epigastric pain	16 (64.00%)	15 (60.00%)	0.77
Generalized severe abdominal pain	14 (56.00%)	16 (64.00%)	0.56
Nausea	8 (32.00%)	9 (36.00%)	0.77
Vomiting	11 (44.00%)	12 (48.00%)	0.78
Fever	14 (56.00%)	15 (60.00%)	0.77
Abdominal discomfort	9 (36.00%)	11 (44.00%)	0.56
Abdominal clinical examination			
Rigidity	14 (56.00%)	16 (64.00%)	0.56
Generalized tenderness	15 (60.00%)	17 (68.00%)	0.56
Rebound tenderness	16 (64.00%)	18 (72.00%)	0.54
Muscle guarding	3 (12.00%)	2 (8.00%)	1.00
Abdominal distension	8 (32.00%)	10 (40.00%)	0.56
Scars of previous operations	6 (24.00%)	5 (20.00%)	0.73

The operative time (min) was significantly increased in the laparoscopic group versus the open group, *P*=0.0001. While the location of the perforation, perforation size, type of repair, and intraoperative complications were statistically insignificant between the two studied groups (*P*=0.93, 092, 0.80, and 1.00, respectively) as shown in Table 4 and Fig. 15.

Of the 25 patients in the laparoscopic repair group, two were converted to open repair (8%). The first one was

Figure 14



Comparison between laparoscopic and open repair group as regards Boey's Score on admission and scars of previous abdominal surgery.

Table 3 Comparison between laparoscopic and open repair group as regards Comorbidities, laboratory, and radiological findings

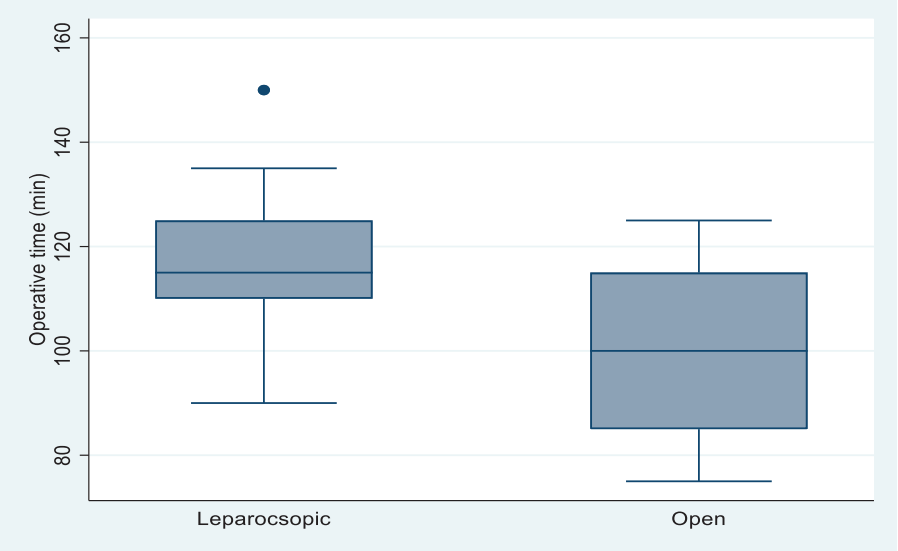
Variables	Laparoscopic group *N*=25	Open group *N*=25	*P* value
None	6 (24.00%)	7 (28.00%)	0.75
Hypertension	11 (44.00%)	9 (36.00%)	0.56
D.M	7 (28.00%)	6 (24.00%)	0.75
COPD	4 (16.00%)	4 (16.00%)	1.00
BMI>30 kg/m	5 (20.00%)	4 (16.00%)	1.00
IHD	6 (24.00%)	7 (28.00%)	0.75
CVA	0	2 (8.00%)	0.49
ESRF	0	0	
Liver cirrhosis	0	3 (12.00%)	0.24
Hepatitis B	2 (8.00%)	2 (8.00%)	1.00
Hepatitis C	5 (20.00%)	4 (16.00%)	1.00
Osteoarticular Pathology	9 (36.00%)	10 (40.00%)	0.77
Autoimmune Diseases	0	1 (4.00%)	1.00
Oncology	0	0	
Any comorbidity	19 (76.00%)	18 (72.00%)	0.75
Laboratory and radiological findings			
WBC (1000ul)			
Mean±SD	14.76±2.76	15.01±2.35	0.73
Median (range)	14 (10.8:23)	14.6 (11:18.5)	
Hb (g/dl)			
Mean±SD	13.33±1.07	13.60±1.81	0.51
Median (range)	13.4 (11.5:15.1)	13.9 (11.1:16.3)	
Serum albumin (g/L)			
Mean±SD	3.82±0.25	3.7±0.44	0.24
Median (range)	3.8 (3.5:4.3)	3.6 (2.6:4.5)	
Plain chest radiograph (air under the diaphragm)	25 (100%)	25 (100%)	
Abdominal Sonar (IPF collection + air)	25 (100%)	25 (100%)	
Abdominal C-T(IPF collection + air)	5 (20.00%)	4 (16.00%)	1.00

Table 4 Comparison between laparoscopic and open repair groups as regards intraoperative findings

Variables	Laparoscopic group *N*=25	Open group *N*=25	*P* value
Location of perforation			
Gastric*	4 (16.00%)	3 (12.00%)	
Juxtapyloric	12 (48.00%)	11 (44.00%)	0.93
Duodenal	7 (28.00%)	9 (36.00%)	
Pyloric	2 (8.00%)	2 (8.00%)	
Perforation size (mm)			
Mean±SD	8.8±2.61	8.96±4.16	0.92
Median (range)	9 (4:15)	8 (4:16)	
Type of repair			
Simple closure	3 (12.00%)	2 (8.00%)	0.80
Graham's omental patch	4 (16.00%)	3 (12.00%)	
Modified Graham's repair	18 (72.00%)	20 (80.00%)	
Operative time (min)			
Mean±SD	117.4±13.0	100±16.45	0.0001
Median (range)	115 (90:150)	100 (75:125)	
Intraoperative complication			
Iatrogenic injury	2 (8.00%)	2 (8.00%)	1.00
Hemorrhage	1 (4.00%)	2 (8.00%)	1.00

Gastric*: All biopsies taken were negative for malignancy.

Figure 15



Comparison between laparoscopic and open repair groups as regards operative time (min).

converted to open due to difficult access as a result of gross adhesions due to severe peritonitis; the second was also due to difficult access due to adhesions and bleeding from injury of gastric vessels during adhesiolysis, as shown in Table 5 and Fig. 16.

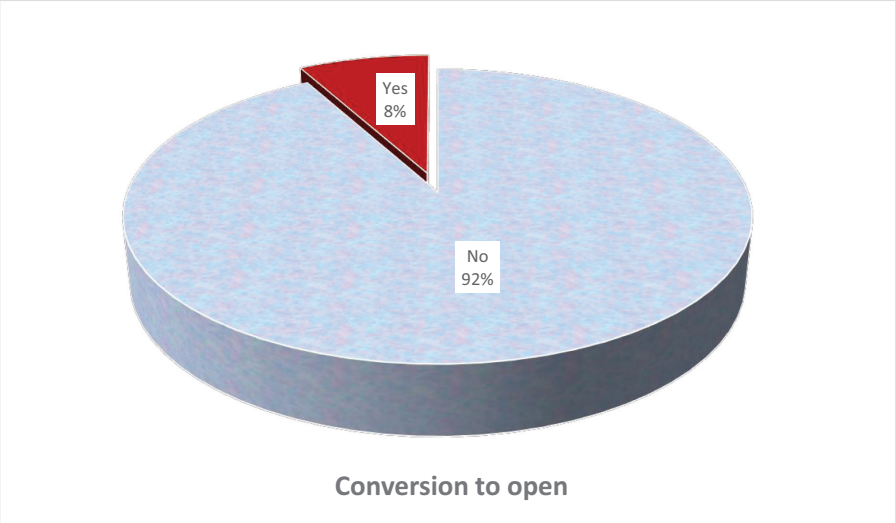
Total postoperative complications showed insignificant difference between the studied groups (*P*=0.16), but they were more prevalent among the open group (14 patients, 56%) versus the laparoscopic group (9 patients, 36%). Specific complications such as the Clavien- Dindo Classification (II, III, and IV), pneumonia, postoperative ileus, wound infection/port site infection, wound dehiscence, fecal fistula, intra-abdominal hemorrhage, pulmonary thromboembolism (PTE), gastrointestinal bleeding, and end stage renal failure (ESRF) were higher among open group patients but not statistically significant (*P*=0.71, 0.19, 0.16, 0.16, 0.31, 1.0, 1.0, 0.49, 1.0, and 0.49, respectively). But Clavien-Dindo Classication (I), intra-abdominal collection, and deep venous thrombosis (DVT) were higher among the laparoscopic group patients but not statistically significant (*P*=0.71, 1.0 and 1.0, respectively). Of

Table 5 Rate of conversion to open and its causes

Variables	Number (%)
Conversion to open	2 (8.00%)
Causes of conversion (*n*=2)	
Difficult access	2 (100%)
Large ulcer	0
Preoperative diagnostic uncertainty	0
Cardiovascular instability	0
Iatrogenic injury cannot be managed by laparoscopy	1 (50.00%)

the 25 patients of the open repair group, two (8%) of them underwent reoperation, one due to high output fecal fistula, intra-abdominal collection, and wound dehiscence, and the second case was due to massive postoperative hemorrhage. Of the 25 patients of the laparoscopic repair group one (4%) of them underwent reoperation due to postoperative high-output fecal fistula and intra-abdominal collection. Death occurs in two (8%) cases of the open repair group, one died on the tenth postoperative day due to severe pneumonia and pulmonary thromboembolism (PTE); the second

Figure 16



Rate of conversion.

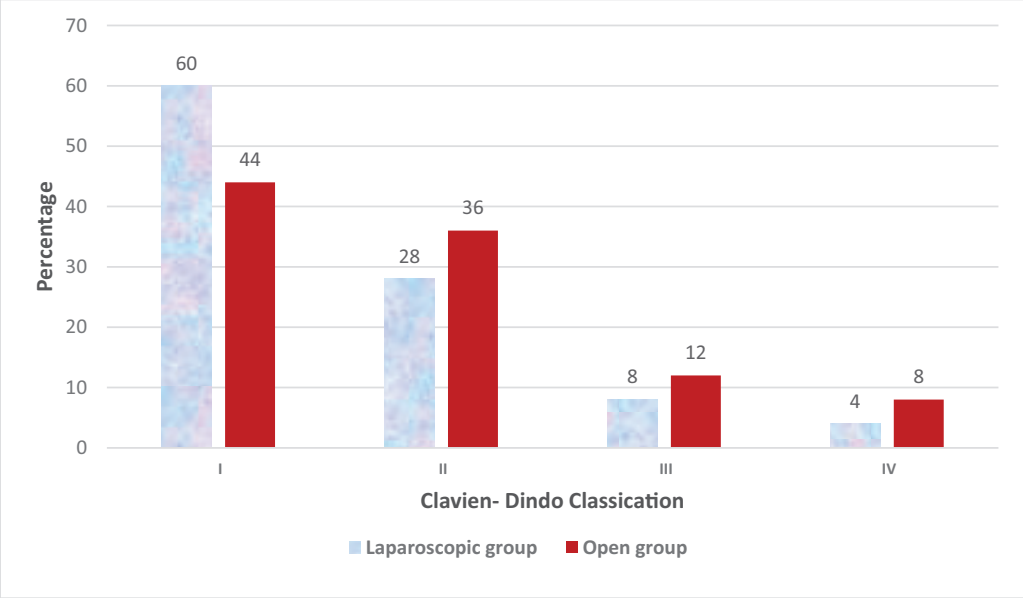
Table 6 Comparison between laparoscopic and open repair groups as regards postoperative complications

Variables	Laparoscopic group *N*=25	Open group *N*=25	*P* value
Clavien–Dindo Classication			
I	15 (60.00%)	11 (44.00%)	0.71
II	7 (28.00%)	9 (36.00%)	
III	2 (8.00%)	3 (12.00%)	
IV	1 (4.00%)	2 (8.0	
Wound dehiscence	0	1 (4.00%)	0.31
Fecal fistula	1 (4.00%)	2 (8.00%)	1.00
Intra-abdominal collection	2 (8.00%)	1 (4.00%)	1.00
Intra-abdominal hemorrhage	0	1 (4.00%)	1.00
Postoperative ileus	3 (12.00%)	7 (28.00%)	0.16
Gastric emptying difficulty	0	0	
Pneumonia	4 (16.00%)	8 (32.00%)	0.19
Pleural effusion	0	0	
Deep venous thrombosis (DVT)	1 (4.00%)	0	1.00
PTE	0	2 (8.00%)	0.49
Gastrointestinal bleeding	0	1 (4.00%)	1.00
Wound infection/port site inf.	3 (12.00%)	7 (28.00%)	0.16
ESRF	0	2 (8.00%)	0.49
Reoperation	1 (4.00%)	2 (8.00%)	0.55
Death	0	2 (8.00%)	0.49
Any postoperative complications	9 (36.00%)	14 (56.00%)	0.16

case died on the the third postoperative day due to massive postoperative gastrointestinal bleeding complicated by disseminated intravascular coagulopathy, as shown in Table 6 and Figs. 17 and 18.

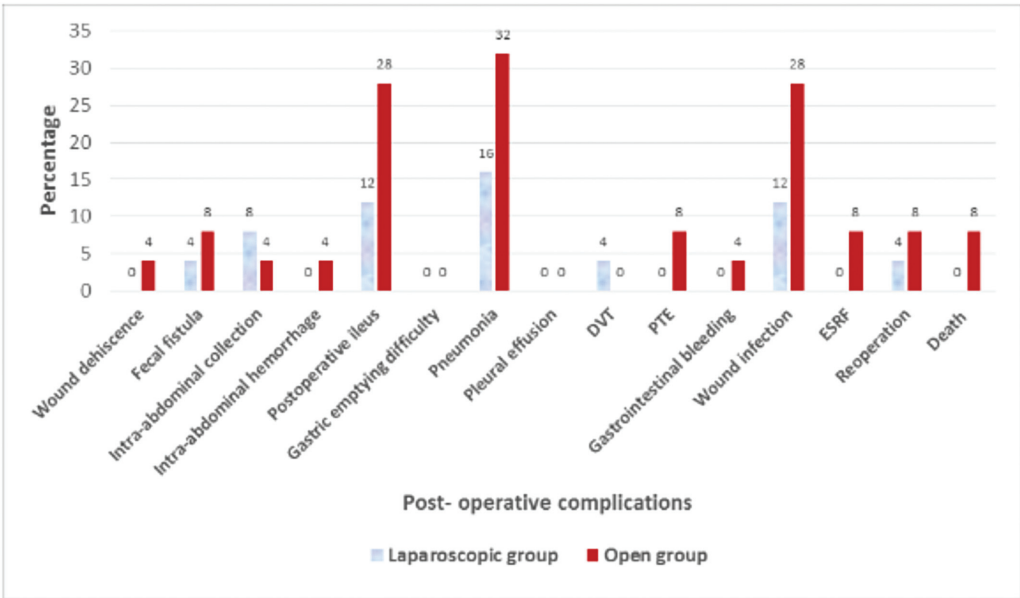
First-day pain score (VAS), opioid requirements in the first day, time of start of oral feeding, length of hospital stay, and return to normal activity were highly significantly decreased in the laparoscopic repair group compared with the open repair group (P= <0.0001 for each). While the length of ICU stay and cosmetic results of wounds showed insignificant differences between the studied groups (P= 0.18 & 0.17, respectively), but the good cosmetic results of wounds were more prevalent in the laparoscopic group [20 patients (80.00%)] than the open group [13 patients (56.52%)], as shown in Table 7 and Figs. 19 and 20.

Figure 17



Comparison between laparoscopic and open repair groups as regard postoperative Clavien–Dindo classication.

Figure 18



Comparison between laparoscopic and open repair groups as regards post operative complications.

Discussion

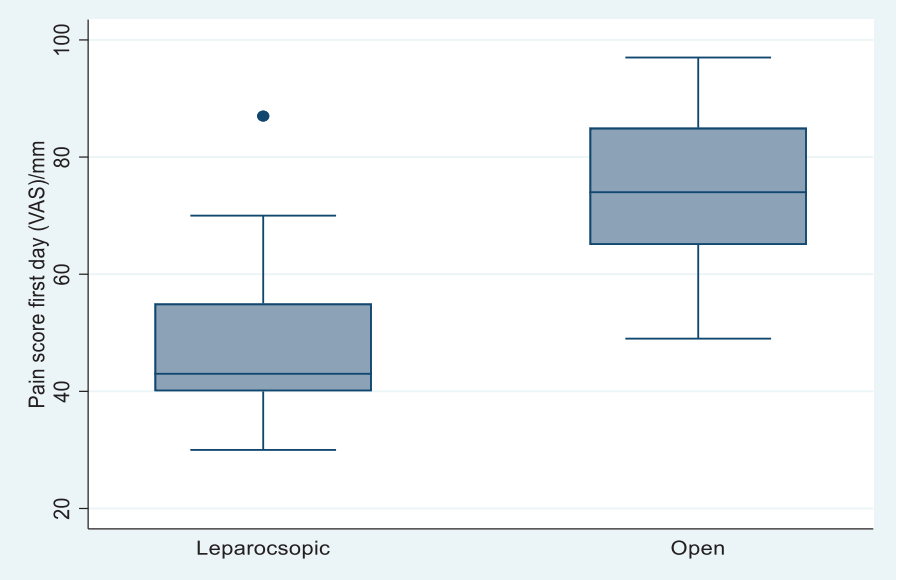
The distribution of sociodemographic data, preoperative risk factors for the perforation of peptic ulcer, clinical data on admission (systolic blood pressure, ASA grades, Boey's score, symptoms, and abdominal clinical examination), comorbidities, laboratory investigations [white blood cells, hemoglobin, and serum albumin] and radiological findings in the two intervention arms of this research were nearly similar and shows insignificant difference. This implies that the process of randomization was accurate and that any influence of these variables on the key outcomes of surgery was similarly distributed in the two studied groups.

With respect to the location of the perforation, ***Bhogal et al.*** reported that the first part of the duodenum is the

Table 7 Comparison between laparoscopic and open repair groups as regards postoperative parameters

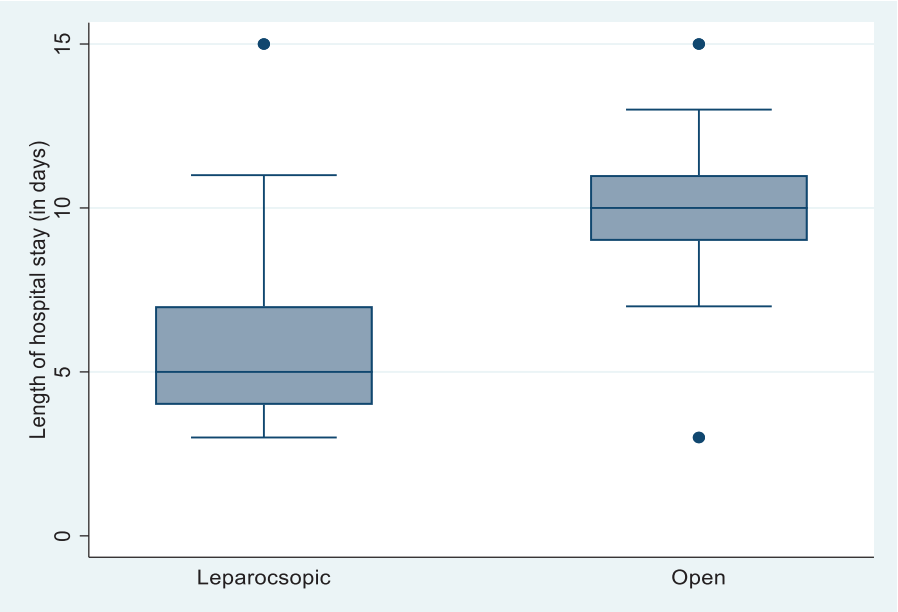
Variables	Laparoscopic group *N*=25	Open group *N*=25	*P* value
Pain score first day (VAS) /mm			
Mean±SD	46.72±13.22	73.24±12.95	<0.0001
Median (range)	43 (30:87)	74 (49:97)	
Time of start of oral feeding			
Mean±SD	2.84±1.14	4.83±0.87	<0.0001
Median (range)	2 (2:5)	5 (3:6)	
Length of hospital stay (in days)			
Mean±SD	6.08±2.86	9.8±2.33	<0.0001
Median (range)	5 (3:15)	10 (3:15)	
Length of ICU stay (in days)			
Mean±SD	0.88±1.87	1.88±2.77	0.18
Median (range)	0 (0:7)	0 (0:10)	
Return to normal activity (in day)			
Mean±SD	15.6±2.60	24.78±6.60	<0.0001
Median (range)	15 (12:22)	25 (15:40)	
Opioid requirements in the first day (in mg)			
Mean±SD	20.0±6.45	37.5±8.42	<0.0001
Median (range)	20 (10:30)	40 (20:50)	
Cosmetic results of wounds			
Good	20 (80.00%)	13 (56.52%)	0.17
Accepted	4 (16.00%)	6 (26.09%)	
Not accepted	1 (4.00%)	4 (17.39%)	

Figure 19



Comparison between laparoscopic and open repair groups as regards pain score first day (VAS) /mm.

Figure 20



Comparison between laparoscopic and open repair groups as regards length of hospital stay (in days).

commonest site [12]. Also in the ***Smith et al. study***, duodenal perforations followed by juxtapyloric perforations were the most common locations [13]. ***Lohsiriwat et al.*** found that the most common site of perforation was at the juxtapyloric region [14]. Also, ***Siow et al.*** observed the most common location for perforation was juxtapyloric (87 patients, 66.4%), followed by the duodenum (30 patients, 22.9%) and stomach (14 patients, 10.7%) [15]. This concurs with our presentation, in which juxtapyloric perforation was the most common site (23 patients, 46%), followed by duodenal perforation (16 patients, 32%), gastric perforation (7 patients, 14%), and lastly pyloric perforation (4 patients, 8%).

Regarding the perforation size, in the ***Lee et al.*** study, the perforation size showed insignificant difference between the studied groups, *P*=0.10, with a median range of 5.0 (0.8–15.0) and 5.0 (2.0–15.00) [16]. This agrees with our results in which there was insignificant difference between the two studied groups regarding the perforation size, *P*=0.92, with a median range of 9 mm (4-15) in the laparoscopic group versus 8 mm (4–16) in the open group.

As regards the type of repair, in the ***Vega et al.*** presentation, virtually all patients underwent simple closure of the ulcer, with or without associated omentoplasty; also there were insignificant differences between the two studied groups [17]. ***Smith et al.*** observed that the modified Graham's omental patch repair was the most common type of repair used, but there were insignificant differences between the two studied groups regarding the type of repair [13]. This agrees with our results; there were insignificant differences between the two studied groups regarding the type of repair (*P*= 0.80), and the commonest type of repair in both groups was the modified Graham's repair (simple closure plus omental patch), 38 patients (76%), followed by Graham's omental patch, 7 patients (14%), and then simple closure, 5 patients (10%).

Regarding operative time, ***Siow et al.*** found that there were no significant differences between the two groups regarding operating time (108.3 min vs.104.9 min, *P*=0.618) [15]. ***Smith et al.*** demonstrated that the PPU repair operations that started laparoscopically had a longer median operative time than open repairs by 28.5 min [13]. ***Zedan et al.***, found that there was a significant longer operation time in the laparoscopic group than the open group regarding the operating time, *P*=0.0001 [18]. ***Pereira et al.*** reported that the median operative time in the laparotomy group and in the laparoscopy group was 80 and 100 min, respectively (*P*=0.01) [19]. This concurs with our presentation; the operative time was significantly increased in the laparoscopic group in comparison to the open group, *P*=0.0001, with a median range in the laparotomy group and in the laparoscopy group it was 100 and 115 min, respectively.

With respect to the rate of conversion to open and its causes data collected by ***Lau's*** meta-analysis reported

that the rate of conversion to open repair ranged from 0 to 29.1%; the overall success rate of the laparoscopic repair was 84.7% [5]. The rate of conversion by ***Siu et al.*** was 14.2% [20], and by ***Lau et al.*** it was 23%. The reasons for conversion include difficulty in identifying the site of ulcer perforation, large perforation, technical problems, cardiovascular instability, ileal perforation, bleeding, gallbladder perforation, injury to the stomach, omental adhesion, and other unspecified factors [21]. In the ***Kim et al.*** presentation, the conversion to open surgery was performed in 19 (10.4%) patients in the laparoscopic surgery. The reasons for conversion to open were difficulty locating the perforated site, inflammatory adhesion, a large defect, and friable tissue [22]. ***Zedan et al.*** found that conversion to open surgery was required in four patients, representing 16%. Reasons for conversion were two patients suffering from severe purulent peritonitis making identification of perforation difficult and hazardous, and the third patient owing to the large size of perforation, which was more than 10 mm, and the fourth patient was due to hemodynamic instability [18]. In our presentation, two cases were converted to open repair (8%). The first one was due to difficult access caused by gross adhesions leading to difficulty in identifying the site of ulcer perforation, and the second case was also due to difficult access and bleeding from injury of gastric vessels during adhesiolysis.

Regarding postoperative complications, ***Lunevicius and Morkevicius*** observed that there was insignificant difference between laparoscopic and open groups, but the complications were more prevalent among the open group in comparison to the laparoscopic group (23% vs. 10%) [23]. In the ***Kim et al.*** presentation, the overall rate of 30-day postoperative complications, the primary study outcome, was slightly lower in the laparoscopic repair group than in the open repair group, but this difference was not statistically significant (24.6% vs. 31.7%, P=0.131) [22]. Also, ***Antoniou et al.***, reported that the incidence of major complications was 6% in the laparoscopic group and 11% in the open surgery group, P=0.225 [24]. In the ***Tan et al.*** study, the results showed that laparoscopic repair had a lower overall postoperative complication rate than open repair for perforated peptic ulcer, but the difference did not reach significance (P>0.05) [25]. This agrees with our results; there were insignificant differences between laparoscopic and open groups regarding total postoperative complications, P= 0.16, but they were more prevalent among the open group in comparison to the laparoscopic group (56% vs. 36%).

Also Tan et al. study showed through a subcategory analysis of postoperative complications, we further found that there were no significant differences in rates of repair site leakage, intra-abdominal abscess, postoperative ileus, pneumonia, and urinary tract infection between these two procedures. However, the laparoscopic repair had a lower surgical site infection rate than open surgery [25]. In our presentation, specific complications such as the Clavien–Dindo classication (II,III, and IV), pneumonia, postoperative ileus, wound infection/ port site infection, wound dehiscence, fecal fistula, intra-abdominal hemorrhage, pulmonary thromboembolism (PTE), gastrointestinal bleeding, and end-stage renal failure (ESRF) were higher in the open group but not statistically significant (P=0.71, P=0.19, P=0.16, P=0.16, P=0.31, P=1.0, P=1.0, P=0.49, P=1.0, and P=0.49, respectively). But Clavien-Dindo classication (I), intra-abdominal collection, and deep venous thrombosis (DVT) were higher in the laparoscopic group but not statistically significant (P=0.71, P=1.0, and P=1.0, respectively). Two (8%) cases of the open repair group underwent reoperation, one due to high output fecal fistula, intra-abdominal collection, and wound dehiscence and the second case was due to massive postoperative hemorrhage. Only one (4%) case in the laparoscopic group underwent reoperation due to postoperative high-output fecal fistula and intra-abdominal collection.

Ge et al. observed that the mortality was reported in four included studies; there was no significant heterogeneity among these studies [26]. Also ***Tan et al.*** showed that laparoscopic repair had similar mortality as the open repair for perforated peptic ulcer with no significant difference (P>0.05) [25]. This concurs with our results; death occurs only in two (8%) cases of the open repair group, which was statistically insignificant, P=0.49; one case died on the tenth postoperative day due to severe pneumonia and pulmonary thromboembolism (PTE), and the second case died on the third postoperative day due to massive postoperative gastrointestinal bleeding complicated by disseminated intravascular coagulopathy.

In the ***Tan et al.*** and other studies, reoperation showed no significant difference among these two studied groups, P>0.05 [25]. This agrees with our presentation in which there was insignificant difference regarding reoperation (P=0.55).

Postoperative pain was evaluated using the visual analog scale (VAS). ***Siow et al.*** observed that there were significantly lower pain scores in the laparoscopic

group compared with the open group, *P*=0.048 [15]. ***In the Kabbash et al***. study, the results showed that laparoscopic repair significantly had lower postoperative pain [27]. ***Tan et al***. showed that the laparoscopic repair had less postoperative pain than open repair of perforated peptic ulcer (*P*<0.05) [25]. In the ***Zedan et al***. presentation, pain score in first day by VAS was highly significantly decreased in laparoscopic versus open repair, *P*=0.0001 [18]. This agrees with our results; postoperative pain in the first day by VAS was highly significantly decreased in laparoscopic repair versus open repair, *P*=0.0001.

Regarding opioid requirements in the first day, ***Siow et al***. considered that the open group received more potent morphine infusion as compared with intermittent tramadol received by the laparoscopic group; this shows that the laparoscopic group had less postoperative pain [15]. ***Lau*** showed 10 trials that compared the amount of analgesic consumption by the laparoscopic and open repair groups. A significant reduction in the dosage of opiate analgesic required in the laparoscopic group was observed in eight of the studies [5]. In the ***Zhou et al***. study, the patients who underwent the laparoscopic procedure used fewer analgesics than the open procedure with significant difference (*P*< 0.001) [28]. ***Zedan et al***. observed that opioid requirement in the first day was highly significantly increased in open repair compared with laparoscopic repair, *P*= 0.0001 [18]. This concurs with our presentation in which opioid requirements in the first day showed a highly significant increase in the open repair compared with the laparoscopic repair, *P*= 0.0001.

With respect to time of starting oral feeding, ***Zhou et al***. reported the outcomes indicated that the patients who underwent laparoscopic repair resumed a normal diet earlier than the patients who underwent open repair and were statistically significant, *P*< 0.001 [28]. ***Pereira et al***. observed that the median time for the resumption of oral intake after surgery was 3 days in the laparoscopy group compared with 4 days in the laparotomy group, *p* 0.021 [19]. ***Zedan et al***. showed a significant decrease in laparoscopic versus open repair regarding the time of the start of oral feeding, *P*=0.002 [18]. In the ***Tan et al***. presentation, the results showed that the laparoscopic repair had a similar time to resume diet as the open repair for perforated peptic ulcer, which was insignificant, *P*>0.05 [25]. In our presentation, time of starting oral feeding was significantly increased in open repair versus laparoscopic repair, *P*=0.0001.

Regarding the length of hospital stay, in the ***Siow et al***. study, there was a mean decrease of 2.9 days, which was a statistically significant reduction favoring laparoscopic repair, *P*=0.008 [15]. ***Siu et al***. showed that the length of hospital stay was significantly decreased after laparoscopic repair versus open repair [20]. ***Zedan et al***. reported that hospital stay was significantly shorter in laparoscopic patients compared with open patients, *P*=0.022 [18]. ***Kim et al***. reported that the postoperative length of hospital stay was significantly increased in the open group versus the laparoscopic group (12.53 days vs. 10.03 days, *P*=0.003) [22]. ***Kabbash et al***. showed that thelaparoscopic repair significantly had lower postoperative hospital stay [27]. This agrees with our results in which there was a highly significant decrease in laparoscopic repair versus open repair regarding hospital stay, *P*= <0.0001.

With respecting to length of ICU stay, in ***Lee et al***. presentation, the length of ICU stay showed insignificant difference between the laparoscopic versus open groups, *P*=0.55 [16]. This concurs with our results, the laparoscopic group showed insignificant deference versus the open group regarding the length of ICU stay, *P*=0.18.

With respect to return to normal activity (in day), ***Siu et al***. found that patients returned to normal activities after laparoscopic repair within an average of 10±6.9 days, which was significantly earlier than the return of those who underwent open repair 26±15.1 days [20]. ***Zedan et al***. observed that patients who underwent laparoscopic repair had a shorter period to return to normal activity than those who underwent open repair, which was statistically highly significant, *P*= 0.0001 [18]. The collected data by ***Lau*** involved six studies that examined the time taken to resume normal activity by patients who underwent laparoscopic surgery that was significantly earlier than the patients who underwent open repair [5]. This agrees with the results of our study, in which return to normal activity was highly significantly decreased in laparoscopic repair in comparison to open repair, *P*= <0.0001.

Regarding the cosmetic results of wounds, ***Zedan et al***. observed that good cosmetic results were highly significantly increased among patients who underwent laparoscopic repair than those who underwent open repair, *P*=0.0001 [18]. In our presentation, the good cosmetic results of wounds were more prevalent in the laparoscopic group [20 patients (80.00%)] than the open group [13 patients (56.52%)], but not significant, *P*=0.17.

Conclusion

A perforated peptic ulcer is a common surgical emergency. Patients who suffer from perforated peptic ulcer disease usually require urgent surgery to close the defect and flush the peritoneal cavity. Laparoscopic correction of perforated peptic ulcer is safe and feasible for the experienced laparoscopic surgeon. Laparoscopic repair had the upper hand over open repair as regards less intraoperative blood loss, less postoperative pain, less requiring postoperative analgesia, early starting of oral feeding, less postoperative complications, shorter hospital stay, early return to normal activity, and had good cosmetic results of wounds.

Recommendation

It is recommended to increase the rate of repair of perforated peptic ulcers by laparoscopic surgery, as this will lead to a reduction in the time spent performing the laparoscopic repair.

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Conflicts of interest

There are no conflicts of interest.

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