# Laparoscopic Management of Perforated Peptic Ulcer: Multicenter Experience

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**Abstract**

**Background:** Perforated peptic ulcer (PPU) is a common surgical emergency. Exploratory laparotomy and repair with the omental patch are routine surgical intervention till now. In developing counties, laparoscopic repair is still not considered the gold standard in this emergency condition.

**Objectives:** This study was conducted to evaluate laparoscopic management of PPU in terms of peri-operative outcomes.

**Patients and methods:** This prospective observational study included 151 patients who presented with PPU in three tertiary hospitals from February 2018 to February 2023. Patients were divided into two groups: group (L) included 75 patients who received laparoscopic management, and group (O) included 76 patients who received open management. Demographic and peri-operative data were collected tabulated and analysed.

**Results:** No statistically significant difference between the studied groups regarding demographic and clinical data. The laparoscopic management group had statistically significant longer operative time (95±10.6 *vs.* 60±14.6 min.), lower doses of narcotic injections (1.564±0.432 *vs.* 5 ± 0.175), lower mean pain Visual Analogue Scale (VAS) (3±1 *vs.* 7±1), shorter time to resume oral feeding (2.1 ±.52 *vs.*3.4 ±.576 days), lower incidence of postoperative ileus, lower incidence of chest infection and wound infection, shorter hospital stay (5±1.54 *vs.* 8±1.6 days), shorter time to return to daily normal activities (12±2.9 *vs.* 24±3.4 days), and better satisfaction about cosmetic results. No statistically significant difference between the studied groups regarding postoperative leakage of the repair and incidence of intra-abdominal septic complications.

**Conclusion:** Laparoscopic management of PPU has statistically significant better postoperative outcomes. It could be adopted as a standard technique in cases with small perforation, Boey's score ≤ 1, and Mannheim Peritonitis Index ≤ 20.

**Keywords:** Laparoscopic repair; Open repair; Peptic ulcer; Perforation.

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## Introduction

PPU is a common surgical emergency, accounting for 3.4-5% of all surgical emergency procedures (**Bertleff et al., 2009**). Upper midline laparotomy and simple closure with an omental reinforcement is still the routine procedure of PPU (**Lunevicius and Morkevicius, 2005-1; Lunevicius and Morkevicius, 2005-2**). Since the late 1980s, laparoscopy has gained increasing popularity in elective surgery. But with the improvement of laparoscopic technology and experience, Laparoscopy has gained wide acceptance by surgeons for many emergencies (**Ates et al., 2007**).

Laparoscopy was first reported for the management of PPU in 1990 (**Nathanson et al., 1990**). It became an attractive alternative due to the benefits of minimal access and magnification, such as exploration of the peritoneal cavity, finding and closure of the perforation, and peritoneal lavage (**Katkhouda et al., 1990**). Laparoscopic repair confers many benefits including reduced postoperative pain, fewer pulmonary complications, shorter hospital stays, and earlier returns to normal daily activities, but it has some drawbacks such as longer operative time, higher incidence of reoperations due to leakage at the repair site, and a higher incidence of intra-abdominal collections secondary to inadequate lavage (**Lo et al., 2011**). In a recent meta-analysis of 4 randomized trials, on 289 patients, the results did not support the higher effectiveness of the laparoscopic approach and were not conclusive regarding operative time and leakage rate (**Antoniou et al., 2013**). Accurate selection of patients with PPU for laparoscopic intervention has a major impact on the outcomes (**Bertleff et al., 2009**). Boey's score and Mannheim Peritonitis Index (MPI) could be used to select candidates for laparoscopy with a better prognosis (**Lau, 2004; Bamrah et al., 2020**). Boey's score is based on three criteria: shock on admission, American Society of Anaesthesiologists (ASA III–V), and delayed presentation (duration of symptoms >24 h). The patient is given one point for each positive criterion (**Lee et al., 2001**). Laparoscopic repair is reported to be safe with Boey's scores ≤ 1. Boey's scores 2 and 3 are associated with high morbidity and mortality rate (**Lau, 2004**). Mannheim peritonitis index (MPI) was developed by **Wacha et al. (1987)** based on the retrospective analysis of 8 prognostic factors in 1253 patients with secondary peritonitis (Table1). Patients with MPI ≤ 20 have the least morbidity and mortality rates, down to zero% in some studies (**Bamrah et al., 2020; Wacha et al., 1987**).

## Patients and Methods

A prospective and retrospective cohort study on 151 patients diagnosed with PPU and admitted to general surgery departments, in three tertiary hospitals, between February 2018, to February 2023. Approval of the local ethical and Clinical committee was obtained (SVU-MED-SUR011-4-22-10-466), and the study was registered in ClinicalTrials.gov (ID: NCT05699616).

All patients presented with PPU with Boey's score ≤ 1, and MPI ≤ 20 were included in the study (**Table 1**)(**Bamrah et al., 2020**). Patients were selected randomly for open or laparoscopic repair according to the patient preference and availability of laparoscopic surgery

expertise in emergency setting. All patients were managed by simple closure of perforation with pedicled omental patch either open repair group (O) or laparoscopic repair group (L).

**Table 1. Mannheim Peritonitis Index**

| Risk Factor | | Weightage, if any |
|---|---|---|
| **Age >50 years** | | 5 |
| **Female Gender** | | 5 |
| **Organ Failure*** | | 7 |
| **Malignancy** | | 4 |
| **Preoperative duration of peritonitis >24 hours** | | 4 |
| **Origin of sepsis not colonic** | | 4 |
| **Diffuse generalised peritonitis** | | 6 |
| **Exudates** | **Clear** | 0 |
| | **Cloudy, Purulent** | 6 |
| | **Faecal** | 12 |

*Definitions of organ failure:
-Kidney: creatinine >177 µmol/L, urea >167 µmol/L, oliguria <20 ml/h.
-Lung: pO2 <50 mmHg, pCO2 >50 mmHg.
-Shock: hypodynamic or hyperdynamic.
-Intestinal obstruction: Paralysis >24 h or complete mechanical ileus.

Patients with confounding factors that affect the outcomes are excluded (i.e., previous abdominal surgery, perforation associated with other pathology that needs excisional surgery or treated by other procedures, hypalbuminaemia, and severe co-morbidity).

Diagnosis of PPU and evaluation of the general condition of the patients were obtained through a detailed history, full general and abdominal examination, laboratory, and radiological investigations. Laboratory investigations included CBC, RBS, Urea, Creatinine, Liver function tests, coagulation profile, $Na^+$, $K^+$, serology, and serum amylase. Radiological investigations included abdominal ultrasonography, plain erect abdominal X-Ray, and CT abdomen as required.

Along with the evaluation and investigation process, immediate resuscitative measures were started and continued. All patients received intravenous fluids, Proton Pump Inhibitors (PPI), antibiotics (third-generation cephalosporin and metronidazole), and analgesics.

***Surgical techniques***

All procedures were performed under general anaesthesia, in a supine position, and the patient was secured on the table by a belt. The standardized technique described by **(Siow, Mahendran, 2014)**. was used for the repair of the perforation and peritoneal lavage. Four ports were used in laparoscopic repair, and the upper midline incision was used in the open repair.

Closure of the perforation was done over a pedicled omentum, with 2 or 3 interrupted 2/0 polyglactin intracorporeal ties in laparoscopic cases or hand sewn in open cases, followed by 360-degree focused sequential lavage of all abdominal recesses. Irrigation was done till effluent looks clear; aspiration was done till the field looks dry. A single soft silicon drain was left in the Morrison pouch and kept under positive pressure (**Supplementary figures 1-7**).

**Postoperative care:** Patients received intravenous fluids, a broad-spectrum antibiotic, PPI, analgesic, and thromboprophylaxis started 6 hours after surgery. Pain severity on the 1st postoperative day was determined according to the visual analogue score (VAS). NGT was removed, and patients started the Liquid diet once bowel sounds were audible, usually by the third day, a solid diet was introduced on the fifth postoperative day. Patients were discharged home when they tolerated oral diet, had open bowel, a normal white blood cell count, and no fever. Patients were discharged on antibiotics for 5 days, PPI, and Helicobacter pylori eradication therapy (in positive patients) for 6 weeks.

Follow-up of patients in the outpatient clinic at 1st,3rd, and 6th week, then after 2 months. Upper endoscopy was scheduled for H-pylori positive patients after six weeks to assess ulcer healing and eradication of H. pylori.

**Statistical analysis**

Demographic and clinical data, as well as peri-operative outcomes, were collected, tabulated, and analysed by SPSS version 26 (Statistical Package for Social Sciences, PSS Inc., Chicago, Illinois, USA). A comparison between the studied groups was done regarding operative time, analgesics requirements, time to start a normal diet, hospital stay duration, time to return to work, and post-operative complications. Student t-test was used for numerical variables and Pearson's Chi-square test for nominal variables Categorical variables were expressed in frequency distributions, numerical variables were expressed in mean ± SD. *p*-value < .05 was considered as significant.

**Results**

The current study included 151 patients. Data were collected from completed files in the study period that included of 126 retrospective and 25 prospective cases. Of 25 patients in the prospective cohort, there were 10 patients were managed by laparoscopic approach and 15 patients by open surgical repair. And of whom 126 patients which retrospectively evaluated, 65 were managed by laparoscopy and 61 by open repair. A total of 75 patients underwent laparoscopic surgery (Group L), and 76 patients underwent open surgery (Group O).No statistically significant difference between the studied groups regarding demographic and clinical data (*p* value > .05) (**Table 2**).

**Table 2. Demographic and clinical data of the studied groups**

| Variables | Group (L) (n = 75) | Group (O) (n= 76) | p value |
|---|---|---|---|
| **Age (mean ± SD)** | 39 ± 9.8 | 40 ± 9.4 | .57 |
| **Gender (Male: Female)** | 63:12 | 62:14 | .428 |
| **History of NSAIDs** | 26 | 24 | .79 |

| | | | |
|---|---|---|---|
| **intake** | | | |
| **History of peptic ulcer** | 21 | 20 | .81 |
| **H. pylori infection** | 70 | 71 | .88 |
| **Duration of symptom in hours (Means±SD)** | 14 ±.65 | 16±2.5 | .57 |

The laparoscopic management group had a statistically significant longer operative time (95±10.6 *vs.* 60±14.6 min.), lower doses of narcotic injections (1.564±0.432 *vs.* 5 ± 0.175), lower mean of pain VAS (3±1 *vs.* 7±1), shorter time to resume enteral feeding (2.1 ±.52 *vs.*3.4 ±.576 days), lower incidence of postoperative ileus, lower incidence of chest infection and wound infection, shorter hospital stay (5±1.54 *vs.* 8±1.6 days), shorter time o to return to normal daily activities (12±2.9 *vs.* 24±3.4 days), and better satisfaction about cosmetic results. No statistically significant difference between the studied groups regarding post-operative leakage of the repair and incidence of the intra-abdominal abscess (**Table 3**).

**Table 3. Peri-operative outcomes of the studied groups**

| Variables | | Group (L) (n = 75) | Group (O) (n= 76) | p value |
|---|---|---|---|---|
| **Operative time in min. (Mean ±SD)** | | 95±10.6 | 65±14.6 | .0003 |
| **Pain score in first day (VAS mean ± SD)** | | 3±1 | 7 ±1 | .0001 |
| **Doses of analgesics required post-operatively (Mean ±SD)** | | 8±2.4 | 19±5.4 | .00015 |
| **Doses of narcotic injections (Mean ±SD)** | | 1.564 ±0.432 | 5 ± 0.175 | .00158 |
| **Time to resume oral feeding** | | 2.1 ±.52 | 3.4 ±.576 | .00370 |
| **Hospital stay in days** | | 5±1.54 | 8±1.6 | .00428 |
| **Time to return to normal activity in days** | | 12±2.9 | 24±3.4 | .0012 |
| **Conversion %** | | 4 5.3 % | ---- | ----- |
| **Prolonged ileus** | | 1 | 12 | .0002 |
| **Leak of the repair** | | 3 | 2 | .53 |
| **Wound infection** | | 2 | 12 | .0003 |
| **Wound burst** | | - | 3 | - |
| **Chest infection** | | 2 | 15 | .0002 |
| **Intra-abdominal abscess** | | 3 | 2 | .78 |
| **Cosmetic results** | **Good** | 66 | 9 | .0001 |
| | **Accepted** | 9 | 22 | |
| | **Not accepted** | 0 | 45 | |

Two patients (2.6%) developed wound infection in the laparoscopic group in comparison with 12 patients (15.7%) in the open group (p value .0002). The incidence of chest infection and pneumonia increased in the open group than in the laparoscopic group 15 patients versus 2 patients (*p* value .0002). Intra-abdominal abscess was encountered in 3 patients in the laparoscopic group versus 2 patients in the open group and this was not statistically significant.

Prolonged post-operative ileus was encountered more in the open group than in the laparoscopic group, 12 patients *versus* one patient due to less manipulation of the intestine by laparoscopic technique (*p* value .0002). Prolonged postoperative ileus is considered when the patient has two or more of the following five criteria: Nausea or vomiting, intolerance to an oral diet, absence of passage of flatus, abdominal distension, radiologic confirmation that present on or after the $4^{th}$ postoperative day (**Vather et al., 2013**) . Patients with ileus were managed conservatively by bowel rest, intravenous (IV) fluid therapy, and nasogastric decompression. Recovery was considered when patients could tolerate an oral diet and pass flatus and stool.

Post-operative leakage occurred in 5 patients in $4^{th}$-$7^{th}$ post-operative days, and were diagnosed by charcoal test, GIT water-soluble contrast follow through, and confirmed by using CT abdomen with oral and intravenous contrast. Three of them were in the laparoscopic group versus 2 patients in the open group and this was not statistically significant. All patients were managed conservatively by following-up the drain, nasogastric decompression, nothing per month, antisecretory drugs, and antibiotics.

## Discussion

PPU is a common surgical emergency that has many management options ranging from conservative management up to exploratory laparotomy. Conservative management is performed in patients with a sealed perforation confirmed by a gastrografin study. Primary endoscopic stenting with self-expandable metallic stents is another non-operative option. Another approach is laparoscopic repair either by intra-corporeal suturing and knotting or suture-less techniques such as gelatin sponge plug, fibrin glue sealing, and endoscopic clipping. Conservative management, stenting, and suture-less techniques are not widely accepted till now. The main management practical options are open repair or laparoscopic omentoplasty.

Laparoscopic repair of PPUs has advantages of minimal access surgery including better visualization and magnification of the peritoneal cavity, allowing repair of the perforation and peritoneal lavage through small 3 or 4 stab incisions, with subsequent less postoperative pain, early ambulation, less postoperative complications, and early return to work **(Lee et al., 2001; Bertleff et al., 2009).**

Laparoscopy has begun to be used for emergency surgical interventions for PPU frequently and effectively, but it is still not yet considered the golden standard approach, due to a significant long learning curve time, longer operative times, as well as lack of clear significant benefits regarding perioperative mortality and morbidity

(**Antoniou et al., 2013; Srivastava et al., 2018**).

In our study, there were no statistical differences between the two groups regarding demographic data (age and sex), and risk factors for perforation (NSAIDs, history of peptic ulcer, and H. pylori), and this is similar to many studies regarding data collected by **Bertleff and Lange (2010)** from 29 studies on 2784 patients.

In our study, the mean operative time was 95±10.6 min. and 65±14.6 min. in the laparoscopic and open groups, respectively. The difference was statistically significant ($p < .05$). This agrees with the findings shown by **Bertleff et al.( 2009)** and **Nicolau et al. (2008)**.

Also, data collected by **Lau (2004)** from 13 publications comprising 658 patients showed a significantly longer operative time for laparoscopic repair. In Meta-analysis, **So et al. (1996);** found that the median operative time in laparoscopic and open patients was 80 and 65 min, respectively.

The conversion rate in our study was very low (5.3%). The conversion was decided in 3 cases after failing to identify the site of perforation after 15 minutes trials, In the other case, conversion was decided due to hemodynamic instability after peritoneal insufflation, that not corrected even after lowering the insufflation rate and the pneumoperitoneum pressure.

Data collected by **Lau (2004)** from 13 publications comprising 658 patients found that the rates of conversion from laparoscopic to open repair ranged from 0 to 29.1% and the overall success rate of laparoscopic repair was 84.7%. The rate of conversion by **Siu et al. (2004)** was 14.2%. The reasons for the conversion included difficulty identifying the site of ulcer perforation, bleeding, large perforation, technical problems, cardiovascular instability, ileal perforation, injury to the stomach, adhesion, and hemodynamic instability.

In the present study, analgesic requirements were 8±2.4 doses in the laparoscopic group, vs. 19±5.4 doses in Group (O). This difference was statistically significant ($p < .05$). Similar study by **Golash et al. (2008)** revealed that laparoscopic repair of peptic ulcer perforation consumed fewer analgesic doses in the postoperative period. A meta-analysis by **Lau (2004),** on 10 trials, exposed there was a statistically significant reduction in the dosage requirements of opiate analgesia in the laparoscopic group in eight of the studies.

In our study, the time to resume oral feeding was 2.1 ±.52 *vs.*3.4 ±.576 days. In laparoscopic and open repair groups respectively, it is statistically significant ($p$ *value* $< .0037$). This might be attributed to less postoperative ileus in the laparoscopic group. A similar study by **Katkhouda et al. (1999);** showed a significantly earlier resumption of the oral diet after laparoscopic repair. However, a study by **Siu et al. (2004);** exhibited comparable results.

In the present study, the duration of hospital stay was 5±1.54 *vs.* 8±1.6 days in the laparoscopic *vs.* open repair group, respectively. This difference was statistically significant (*p-value* < .05). Also, **Mehendale et al. (2002);** conducted a study on 77 patients with duodenal ulcer

perforation and found that the median hospital stay was 4 days for laparoscopic and 9 days for open repair.

In this study, 68 (9.6%) patients in Group (L) and 50 patients (65.78%) in Group (O) had no postoperative complications. The study by **Ibrahim et al. (2017 )** showed comparable results for complications. Chest infection is the most common postoperative complication. In our study, 2 (2.6%) patients in Group (L) and 15 (19.7%) patients in group (O) presented with a chest infection. In the randomized trial by **Siu et al. (2004);** there was a significant reduction in chest infection after laparoscopic repair; the infection rate was zero % for the laparoscopic group, and 12% for Group (O). This might be attributed to less postoperative pain and early ambulation that allows deep breaths and effective expectoration.

Wound infection is the next most common complication after open management of PPU. In our study, the rates of wound infections were 2 (2.6%) in laparoscopic repair and 12 (15.7%) in Group (O) which is statistically significant (*p-value* < .05). Wound burst occurred in 3 (3.9%) patients in Group (O). In a study by **Siu et al. (2004);** there was a significant reduction in wound infection, and it occurred in 3% of the patients in the laparoscopic repair group, and in 12% of the patients who underwent open repair. In the current study, there was no significant difference between the two studied groups regarding the leak. The minimal leak occurred in 3 (4%) patients in Group (L) and was managed conservatively. In Group (O), the leak occurred in 2 (2.63%) patients, of whom one patient was reoperated and another patient was managed conservatively. These results agreed with the results of meta-analysis performed by **Lau (2004)**. Infection was the suggested cause of leakage, the rational of our management approach is that low output fistula can be managed conservatively by control of infection, good drainage of any collections, and GIT rest.

In this study, intra-peritoneal abscess occurred in 3 (4%) patients in the laparoscopic group; 2 (2.63%) of them were drained by insertion of the ultrasound-guided big tail drain, and the other patient was reoperated laparoscopically for a pelvic abscess. In the laparotomy group, abscess occurred in 2 (2.63%) patients, one was drained by Pig-tail drain, and the other patient was reoperated. There was no significant difference between the two groups regarding the incidence of intra-abdominal collection or abscess formation. These results agreed with the results of **Lau (2004)** meta-analysis.

In our study, the time needed to return to normal daily activities and work was shorter in the laparoscopic group than open group and it was statistically significant. Data collected by **Lau (2004)**, involving six studies showed that the time taken to return to normal activity by patients who underwent laparoscopic surgery was significantly earlier than the patients who underwent open repair, and this also agreed with similar studies conducted by **Katkhouda et al. (1999); Siu et al. (2004);** and **Mehendale et al. (2002).**

In a recent meta-analysis by **Quah et al. (2018);** on 7 randomized controlled trials, on 631 patients, results revealed that

laparoscopic repair for PPU has reduced morbidity, and shorter hospital stay. There are no significant differences in postoperative mortality, leakage, abscess formation, and re-operation rates. These results agree with the results of our study.

Laparoscopic suturing and peritoneal lavage are the two main steps that are suspected of longer operative time and subsequent septic complications. Recently, technological advances in laparoscopic instruments, theatre tables that allow free positioning and tilting, and high-volume irrigation systems much facilitated laparoscopic suturing and peritoneal lavage. Also, operative time is gradually decreased over time by the improvement of laparoscopic suturing skills and training **(Lagoo et al., 2002; Lunevicius and Morkevicius, 2005-1**).

Laparoscopic management of PPU provides better patient care. It improves patient well-being and satisfaction. It is also associated with decreased overall hospital costs and increased hospital bed turnover. It is also assumed to decrease late complication as incisional hernia, and adhesive intestinal obstruction. These benefits outweigh the drawbacks of longer operative time that will improve with expertise.

## Conclusion

Laparoscopic management of PPU has less postoperative pain, fewer postoperative complications, and shorter hospital stays. No statistically significant difference in post-operative leakage, intrabdominal septic complications, and reoperation rate. It could be adopted as a standard technique in cases with small perforation, Boey's score ≤ 1, and MPI ≤ 20.

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