Outcomes of laparoscopic modified Cellan-Jones repair versus open repair for perforated peptic ulcer at a community hospital

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Abstract

Introduction Minimally invasive or open Graham Patch repair remains the gold standard approach for management of perforated peptic ulcers (PPU). Herein, we report outcomes of laparoscopic technique and compare it with open approach at a community hospital.

Methods Retrospective observational study conducted comparing laparoscopic modified Cellan-Jones repair (mCJR) versus the standard open repair of PPU. Patients aged 18–90 years during 2016–2021 were offered either a minimally invasive or open approach depending on surgeon laparoscopic capability, and were compared in terms of demographics, co-morbidities, intra-operative details, and short-term outcomes.

Results A total of 49 patients were included (46.9% males, mean age 52.9 years, mean BMI 25.0, ASA $\geq$ III 75.5%, 75.5% smokers, 26.5% current NSAIDs use, and 71.4% alcohol drinkers). Duodenum was the most common perforation site (57.1%), and majority of ulcers were 1–2 cm (72.9%). Laparoscopic approach was performed in 16 consecutive patients (32.7%) by a single surgeon, with no conversions. Preoperative characteristics were similar for both groups. Compared to open approach, laparoscopic group were taken to operation immediately (< 4 h) (87.5% vs. 15.2%, $p < 0.001$), had lower estimated blood loss (11.8 ml vs. 73.8 ml, $p = 0.063$), and longer operative time (117.1 min vs. 85.6 min, $p = 0.010$). Postoperatively, nasogastric tube was removed earlier in laparoscopic group (POD1-2, 87.5% vs. 24.2%, $p = 0.001$), with earlier resumption of diet (POD1-2, 62.6% vs. 9.1%, $p = 0.002$), less narcotic usage (< 3 days, 58.3% vs. 6.1%, $p < 0.001$), earlier return of bowel function (POD1-2, 43.8% vs. 9.1%, $p = 0.003$) and shorter length of stay (LOS) (3.7 days vs. 16.1 days, $p < 0.001$). Both in-house mortality and morbidity rates were lower in the laparoscopic group, but not statistically significant [(0% vs. 6.1%, $p = 0.347$) and (12.5% vs. 39.4%, $p = 0.500$), respectively].

Conclusion Laparoscopic mCJR is a feasible method for repair of PPU, and it is associated with shorter LOS, and less narcotics usage in comparison to the open repair approach.
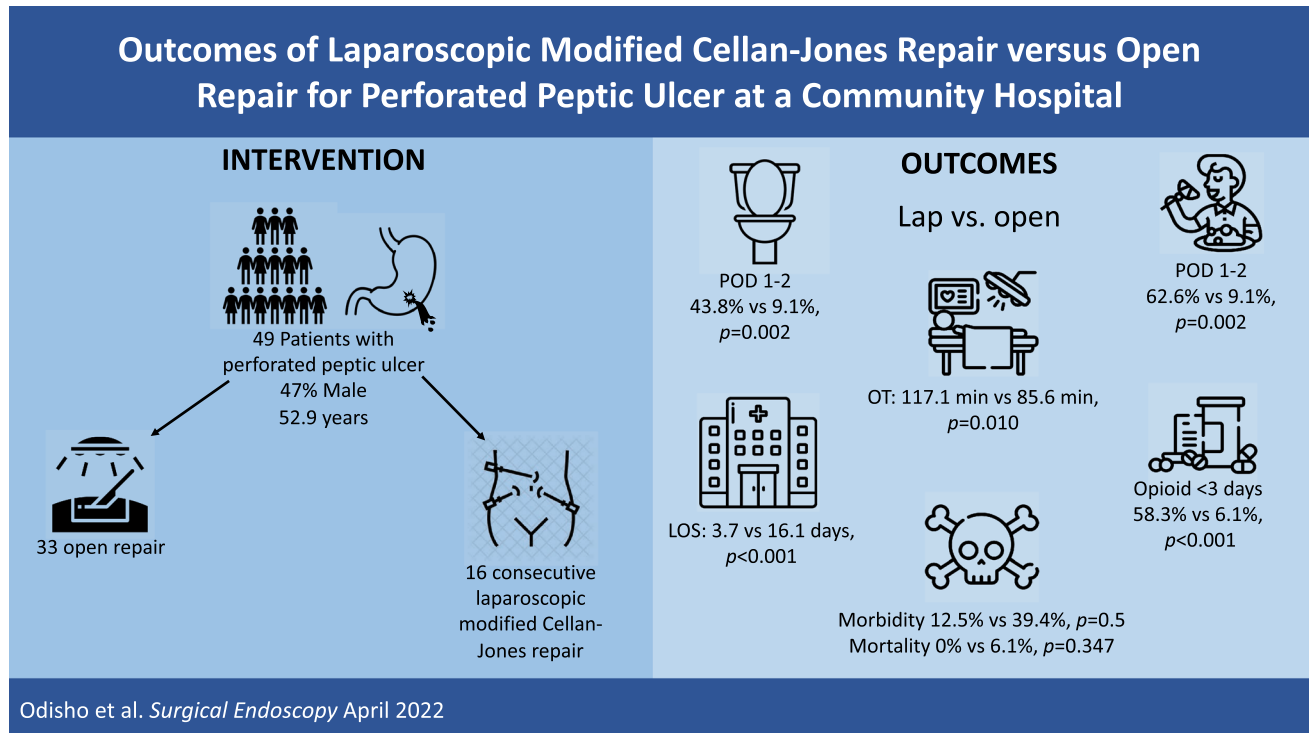
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Graphical abstract

Outcomes of Laparoscopic Modified Cellan-Jones Repair versus Open Repair for Perforated Peptic Ulcer at a Community Hospital

INTERVENTION

49 Patients with perforated peptic ulcer
47% Male
52.9 years

33 open repair

16 consecutive laparoscopic modified Cellan-Jones repair

OUTCOMES
Lap vs. open

POD 1-2
43.8% vs 9.1%,
p=0.002

POD 1-2
62.6% vs 9.1%,
p=0.002

OT: 117.1 min vs 85.6 min,
p=0.010

LOS: 3.7 vs 16.1 days,
p<0.001

Opioid <3 days
58.3% vs 6.1%,
p<0.001

Morbidity 12.5% vs 39.4%, *p*=0.5
Mortality 0% vs 6.1%, *p*=0.347

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Keywords Perforated peptic ulcer · Peritonitis · Laparoscopic repair · Open repair · Omental patch · Modified Cellan-Jones

With the advent of proton pump inhibitors and *Helicobacter pylori* (*H. pylori*) eradication therapy, surgical intervention for peptic ulcer disease (PUD) is limited to perforated ulcers in the emergent setting. Perforation is an acute life-threatening complication of PUD and occurs in nearly 20% of cases of duodenal ulcer patients [1]. The etiology of PUD is multifactorial, with *H. pylori* infection and nonsteroidal anti-inflammatory drugs (NSAIDs) being identified as the two main causes of peptic ulcer, among other contributing factors (alcohol use, smoking, cocaine use, chronic stress, and older age) [2–4].

Perforation is a common complication of PUD, with an average 2–14% of peptic ulcers resulting in perforation [3], most commonly occurring in females over the age of 60 and NSAID, alcohol or tobacco users. While bleeding is the most frequent complication of PUD, perforation carries a higher rate of surgical intervention and is the most lethal complication, associated with a 30-days mortality risk ranging from 3–40%, with advanced age, higher American Society of Anesthesiologists (ASA) classification, elevated body mass index (BMI), and perforation diameter being nonmodifiable risk factors associated with increased mortality [5–8]. The only modifiable risk factor associated with mortality is time to operation, whereby a delay of more than three hours is associated with a doubling of mortality risk [1].

The operative management for PPU involves control of intraperitoneal contamination, and closure and/or buttress of the perforation. The choice of surgical technique, laparoscopy versus laparotomy, varies depending on the patient's preoperative clinical status, surgeon expertise/preference, and location of defect, with the goal of short operative time. It has been widely reported that open abdominal surgery increases postoperative pain and is associated with higher morbidity (ventral incisional hernia rate, surgical site infection, postoperative respiratory compromise, delayed recovery times, and dehiscence) when compared to laparoscopic surgery [9, 10]. Some studies have shown laparoscopy to lessen these postoperative variables and is associated with fewer complications (i.e., surgical site infection, length of stay (LOS), better cosmetic outcomes) than open repair [1, 9, 11]. Despite these favorable outcomes, laparoscopic repair is less commonly used, owing to longer operative times in less experienced centers, higher incidence of reoperations owning to leakage at the repair site, and higher incidence of intraabdominal fluid collections secondary to inadequate lavage and the requirement of extensive surgical skill [12]. Additionally, others point to laparotomy as the better

treatment, especially for repairing ulcers larger than 9 mm [13, 14]. Aside from deciding between laparotomy versus laparoscopy, there are also several described approaches of repair, including primary repair, Graham's Patch repair, and the modified Graham's patch repair [15]. These techniques and their advantages and disadvantages have been described at length in previous studies [16].

Here, we describe our method of repair, which we have termed the modified Cellan-Jones repair (mCJR). In contrast to the modified Graham's Patch repair in which the defect is primarily repaired and the same sutures are used to patch the omentum to the repair, in the mCJR, the defect is repaired primarily, and new sutures are used to patch the repair with omentum. In this manner, the previously quoted complications associated with the modified Graham's patch repair, including increased leakage rate, as a result of the poor seal obtained when suture knots interposed between visceral serosa and the omental patch and the lessened apposition of omentum, are mitigated.

Thus, the goal of this study is twofold. The primary outcome is to compare short-term outcomes of laparoscopy and laparotomy techniques in PPU repair at our institution. The secondary outcome of the study is to compare 30-days morbidity and mortality between the two approaches and patient in-hospital progression.

Methods

Patient selection

This was a retrospective observational study of laparoscopic and open repair of PPU in patients aged 18–90 years old with a clinical and radiological diagnosis of PPU during 2016–2021 at a community teaching hospital. The study protocol was approved by the hospital ethics committee and informed consent was obtained from all patients, with no refusals. Characterization of laparoscopic and open repair was achieved in terms of patients' demographics, co-morbidities, intra-operative details, postoperative recovery, and short-term outcomes. A total of 16 laparoscopic cases were identified during this period and performed by a single surgeon. All patients included in the data analysis were consecutive, with no exceptions made to exclude eligible patients meeting inclusion criteria our inclusion criteria for laparoscopic repair included adult patients between the ages of 18 and 90 who underwent laparoscopic repair for PPU and qualified for laparoscopic repair, *i.e.,* were hemodynamically stable and could tolerate pneumoperitoneum. Preoperatively, all patients received a nasogastric tube (NGT) for gastric decompression, a urinary catheter, broad-spectrum antibiotics, parenteral analgesics, intravenous proton pump inhibitor (PPI), and were adequately resuscitated for at least four hours prior to surgery.

Operative technique

Open repair group

The patient was placed in a supine position. An exploratory upper midline incision was made. After formal exploration and identification of perforation, the PPU was repaired either by the Graham's repair or the modified Graham's repair. The Graham's patch repair describes the placement of through-and-through sutures at the site of perforation that are tied over a free graft of omentum. In the modified Graham's Patch repair, the sutures are tied after the defect is primarily repaired, and a piece of omentum is then placed over these knots and the same sutures are then tied over the omental graft. This is followed by peritoneal toilet with warm saline until the effluent becomes clear, followed by insertion of drains, and closure of the abdomen.

Laparoscopic repair group modified Cellan-Jones repair (mCJR)

For the laparoscopic group, patients are positioned in the French position in slight reverse Trendelenburg tilt position. Two 5 mm trocars are placed, one in the supraumbilical area and one in the right mid-clavicular line. A third 12 mm trocar is placed in the left mid-clavicular line. Liver retraction is achieved with either a Nathanson liver retractor in the subxiphoid region or via a 5 mm trocar in right anterior axillary line. The surgeon stands between the patient's legs in order to facilitate ease of anatomic manipulation and laparoscopic knot tying, and the camera operator stands at the patient's side. In order to minimize spillage of gastric, biliary and pancreatic contents, the spilled enteric contents are diligently evacuated via suction of all four quadrants and the perforation site is closed before peritoneal irrigation. Perforation size is measured using either suction tip (5 mm) or by the jaw length of the Maryland dissector (20 mm).

To repair the perforated ulcer, the edges are approximated by intracorporeal knotting using 2–0 suture in interrupted fashion, and the suture ties are cut. The primary repair is then tested for air leak by submerging the repair under saline and insufflating the NGT with 2 L O_2. Once it is confirmed that no leak is present, Tisseel® is placed over the closed perforation for additional reinforcement of the repair. The repair is then reinforced by either omentum or falciform ligament depending on site of perforation by placing three new sutures across the repaired perforation, and tying them over the omental or falciform patch over the repaired perforation. After repair of the perforation site, the abdominal cavity is thoroughly irrigated with normal saline solution until the

fluid becomes clear, suctioned and 15 Fr Jackson Pratt drains are placed in the pelvis to drain any remaining fluid used for irrigation. Total operative time is measured from time of skin incision to dressing placement. In the postoperative period, all patients are continued on intravenous fluids, broad-spectrum antibiotics, PPI and analgesics. The NGT is removed once bilious output is noted. Patients are started on a full liquid diet with NGT removal. For the laparoscopic group, flatus and bowel function are not required for discharge. Drains are removed prior to discharge from hospital and patients are discharged home with a close follow-up system, whereby they receive a call within 24 h and are seen in clinic within 72 h of discharge.

Statistical analysis

Demographics, co-morbidities, operative details, postoperative complications, and 30-day mortality were collected. Descriptive analysis using mean ± standard deviation (SD), and cross-tabulation were used to compare frequencies. Data analysis was performed using the Chi-square test for categorical variables, Student's t-test for continuous variables with parametric distribution, and the Mann–Whitney test for continuous variables with non-parametric distribution. $P \leq 0.05$ was considered statistically significant. All analyses were performed using SPSS (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.). This study was granted full approval by the institutional review board of Wayne State University, Detroit, Michigan.

Results

During the study period, 33 patients underwent laparotomy and 16 patients underwent laparoscopy for peritonitis and were found to have perforated peptic ulcer (Table 1). The gender (male) and mean age (fifth decade) were comparable between the two groups. In the laparoscopic group, 69% of patients had duodenal perforations located in the anterior wall of first part of duodenum and 52% had duodenal perforations in the open group. The dimensions of perforation were assessed intra-operatively. The majority of perforations were of size between 1 and 2 cm, in both groups. There was one giant ulcer in the laparoscopic group (> 2 cm) and five in the open group. The perforations in the laparotomy

Table 1 Preoperative patient characteristics, co-morbidities and laboratory values

n (%)	All ($n=49$)	Laparoscopic ($n=16$)	Open ($n=33$)	p value
Gender (male)	23 (46.9%)	7 (43.8%)	16 (48.5%)	0.755
Age (year ± SD)	52.9 ± 15.4	54.0 ± 12.1	51.8 ± 16.6	0.596
BMI (kg/m^2 ± SD)	25.0 ± 6.1	23.9 ± 5.7	25.6 ± 6.4	0.371
ASA ≥ III	37 (75.5%)	10 (62.5%)	27 (81.8%)	0.140
Previous history of PUD	22 (44.9%)	5 (31.3%)	17 (51.5%)	0.181
Antiacid use	17 (34.7%)	3 (18.8%)	14 (42.4%)	0.103
History of *H. pylori*	2 (4.1%)	1 (6.3%)	1 (3.0%)	0.593
Smoking	37 (75.5%)	13 (81.3%)	24 (72.7%)	0.515
Alcohol intake	35 (71.4%)	11 (78.6%)	24 (72.7%)	0.319
NSAIDs use	13 (26.5%)	6 (37.5%)	7 (21.2%)	0.226
Cocaine abuse	7 (14.3%)	3 (18.8%)	4 (12.1%)	0.534
No co-morbidities	12 (24.5%)	3 (18.8%)	9 (27.3%)	0.241
Previous abdominal surgery	24 (49.0%)	7 (43.8%)	17 (51.5%)	0.610
Tachycardia	20 (40.8%)	3 (18.8%)	17 (51.5%)	0.029
Hypotension	6 (12.2%)	0 (0%)	6 (18.2%)	0.069
Duration of symptoms				0.701
≤ 12 h	21 (42.9%)	8 (50.0%)	13 (39.4%)	
12–24 h	12 (24.5%)	4 (25.0%)	8 (24.2%)	
> 24 h	16 (34.0%)	4 (25.0%)	12 (36.4%)	
Perioperative CT scan	39 (79.6%)	12 (75.0%)	27 (81.9%)	0.016
Hemoglobin (mg/dL ± SD)	13.3 ± 3.2	12.4 ± 3.0	13.8 ± 3.3	0.125
WBC (10^9 cells/L ± SD)	11.5 ± 4.6	13.2 ± 4.9	10.6 ± 4.3	0.089
Lactic acid (29) (mg/dL ± SD)	6.9 ± 18.1	2.7 ± 1.1	9.0 ± 22.2	0.237
Albumin (31) (g/dL ± SD)	3.7 ± 0.8	4.0 ± 0.4	3.5 ± 0.9	0.046

SD standard deviation, *BMI* body mass index, *NSAID* nonsteroidal anti-inflammatory drugs, *CT* computed tomography, *WBC* white blood count

group were repaired either by Graham's Patch (45.5%) or modified Graham's repair (27.3%). The perforations in the laparoscopic approach were all repaired using the mCJR.

Once admitted to the hospital, the majority of patients in the laparoscopic group (87%) were taken up for surgery within 4 h after initial resuscitation, while 81.8% of patients in the open group were operated on within 24 h of admission (Table 2).

While the postoperative complication rate was minimal in the laparoscopic group with only one case of urinary retention and one case of ileus, patients in the open group had multiple complications. The most frequent complication noted in the open group was pneumonia (18%). There were no deaths in the laparoscopic group and two cases of mortality in the open group (Table 2).

Discussion

The literature demonstrates that minimally invasive surgery provides significant benefit over open operation with decreased hospital length of stay, time to return of bowel function, and postoperative pain, among other variables. These outcomes directly lead to decreased cost and increased patient satisfaction. The study by Davenport and colleagues [17] demonstrated that within the United States American College of Surgeons National Surgical Quality Improvement Project (ACS NSQIP) population, the proportion of laparoscopic PPU repairs has nearly tripled from 4.5% in 2010 to 11.4% in 2016 ($p < 0.001$), indicating that more surgeons are utilizing the laparoscopic approach to repair PPUs. This can be attributed to generally decreased morbidity associated with laparoscopic surgery and increased study data pertaining to safety and efficacy of the technique, with improved postoperative outcomes including reduced surgical site infections, postoperative complications, and hospital length of stay [1, 11, 12, 17, 18]. Additionally, in a large meta-analysis of five randomized controlled trials examining laparoscopic versus open repair of PPU, Tan and colleagues [19] demonstrated that laparoscopic outcomes were comparable to open surgery with regard to re-operation and mortality, while laparoscopic repair was associated with significant reduction in surgical site infection, faster time to diet and less postoperative pain. Our study affirms these associations, demonstrating a statistically significant reduction in hospital length of stay, earlier return to routine activities, and reduced rate of postoperative complications. These findings are important in that reduction in these unfavorable postoperative outcomes translate to optimized patient outcomes in terms of morbidity and mortality as well as have potential for cost savings.

It is important to recognize that the study subjects in the open versus laparoscopic groups were demographically comparable, and there was no statistically significant difference between the two groups, including with regard to ASA scores or BMI, two factors that would suggest sicker patients with multiple co-morbidities. When comparing the size of perforation, size was comparable between the two groups, with the majority of perforations being 1–2 cm in size. The majority of these perforations in the open group were repaired using either the Graham's Patch repair and the modified Graham's Patch repair, whereas the modified Cellan-Jones repair (mCJR) was performed in all laparoscopically repaired patients. Blood loss was greater in the open group, which was statistically significant.

Although multiple studies have demonstrated the benefits of repairing PPUs laparoscopically, in our study, it was associated with longer operative duration (Laparoscopic 117.1 ± 35.6 min, open 85.6 ± 41.8 min, $p = 0.01$), which is comparable to other studies [17, 20]. This may be explained by the fact that there is improved exposure and more efficient mobilization in open repair. Furthermore, intraperitoneal lavage under laparoscopy is more time consuming, and this factor may contribute to the prolonged duration. Additionally, the slower learning curve of the laparoscopic approach may be another contributing factor, especially in a teaching hospital whereby residents are involved. This finding is in conjunction with other studies comparing open and laparoscopic approaches, which demonstrate longer operating times in laparoscopic groups in comparison to open repair [1, 21]. Interestingly, Bhingare and colleagues [22] noted that the position of the surgeon also impacted operative time, whereby repair of perforation with the surgeon in between the legs of the patient, with patient in Lloyd Davis position with reverse Trendelenburg tilt, was easier and more convenient for the surgeon, and took less than one and half hour for completion of procedure.

With regard to the postoperative course, this study demonstrated rapid postoperative improvement following laparoscopic repair with early return to routine activities, including lesser duration of nasogastric tube, earlier oral feeding, and lesser analgesic requirements with shorter hospital stay in comparison to the open repair, which were all statistically significant. This is comparable to previous studies [20, 22–27]. With regard to resumption of diet, oral feeding was started earlier in laparoscopic patients and was well tolerated, whereby more than half of the patients (62.6%) had diet initiation after postoperative day 1–2, in comparison to 54.5% of patients in the open group initiating diet on postoperative day 3–5. This can be explained by less postoperative ileus in the laparoscopic group. In line with other studies, the length of hospital stay after laparoscopic repair was shorter than open repair [27–29]. It is also noteworthy to mention that the LOS in our laparoscopic group is significantly decreased (3.7 ± 1.6 days) in comparison to other studies characterizing laparoscopic repair for PPU,

Table 2 Operative and postoperative details and outcomes

n(%)	All (n = 49)	Laparoscopic (n = 16)	Open (n = 33)	p value
Time to operating room				< 0.001
Immediately	19 (38.8%)	14 (87.5%)	5 (15.2%)	
Within 24 h	29 (59.2%)	2 (12.5%)	27 (81.8%)	
Delayed	1 (2.0%)	0 (0%)	1 (3.0%)	
Site of perforation (gastric)	21 (42.9%)	5 (31.3%)	16 (48.5%)	0.362
Size of perforation				0.615
< 1 cm	7 (14.6%)	2 (12.5%)	5 (15.6%)	
1–2 cm	35 (72.9%)	13 (81.3%)	22 (68.8%)	
> 2 cm	6 (12.6%)	1 (6.3%)	5 (15.7%)	
Type of repair				< 0.001
Modified Graham's patch	9 (18.4%)	0 (0%)	9 (27.3%)	
Graham's patch	15 (30.6%)	0 (0%)	15 (45.5%)	
Primary repair	2 (4.1%)	0 (0%)	2 (6.1%)	
mCJR	23 (46.9%)	14 (100.0%)	7 (21.2%)	
Omental patch	40 (81.6%)	12 (75.0%)	28 (84.8%)	0.391
JP drain	30 (61.2%)	9 (56.3%)	21 (63.6%)	0.619
EBL (mL ± SD)	51.9 ± 152.3	11.8 ± 2.9	73.8 ± 185.5	0.063
Operative time (min ± SD)	96.3 ± 41.9	117.1 ± 35.6	85.6 ± 41.8	0.010
Nasogastric tube				< 0.001
No NGT	1 (2.0%)	0 (0%)	1 (3.0%)	
1–2 days	22 (44.9%)	14 (87.5%)	8 (24.2%)	
3–5 days	18 (36.7%)	2 (12.5%)	16 (48.5%)	
> 5 days	8 (16.3%)	0 (0%)	8 (24.2%)	
Oral feeding resumption				0.002
POD1-2	13 (26.5%)	10 (62.6%)	3 (9.1%)	
POD3-5	23 (40.7%)	5 (31.3%)	18 (54.5%)	
> POD5	13 (32.8%)	1 (6.1%)	12 (28.3%)	
Opioid use				< 0.001
< 3 days	11 (22.4%)	9 (58.3%)	2 (6.1%)	
3–5 days	17 (34.7%)	6 (37.5%)	11 (33.3%)	
> 5 days	21 (42.9%)	1 (6.3%)	20 (60.6%)	
Return of bowel function				0.002
1–2 days	10 (20.4%)	7 (43.8%)	3 (9.1%)	
3–5 days	26 (53.1%)	9 (58.3%)	17 (51.5%)	
> 5 days	13 (26.5%)	0 (0%)	13 (39.4%)	
Empiric *H. pylori* treatment	22 (44.9%)	13 (81.3%)	9 (27.3%)	< 0.001
Morbidity rate (≥ 1 complication)	16 (32.7%)	2 (12.5%)	14 (39.4%)	0.500
In house mortality	2 (4.1%)	0 (0%)	2 (6.1%)	0.347
LOS (day ± SD)	12.2 ± 14.4	3.7 ± 1.6	16.1 ± 16.3	< 0.001
Discharge location				0.035
Home	36 (73.5%)	16 (100%)	20 (60.6%)	
Inpatient rehabilitations	7 (14.3%)	0 (0%)	7 (21.2%)	
Nursing home	2 (4.1%)	0 (0%)	2 (6.1%)	

mCJR modified Cellan-Jones repair, *JP* Jackson Pratt, *EBL* estimated blood loss, *SD* standard deviation, *NGT* nasogastric tube, *POD* postoperative day

whereby mean duration of hospital stay ranged from 5 to 7 days [22, 30–32]. To our knowledge, this is the shortest length of stay for laparoscopically repaired PPU patients in literature. The significantly shorter hospital stay in the laparoscopic group can be attributed to early recovery, early oral feeding, early removal of NGT, and lower morbidity observed in our patients. Additionally, discharge of these patients was not dependent on return of bowel function.

Lastly, laparoscopically repaired patients underwent a close and diligent follow-up schedule post discharge, including receiving a call within 24 h and being seen in clinic within 72 h of discharge.

Postoperative complications in the laparoscopic group were minimal and benign in nature, including one case of urinary retention and one case of ileus. This is drastically in contrast to the open group, which experienced a wide variety of postoperative complications including three cases of intraabdominal abscesses and fluid collections, five cases of pneumonia and respiratory failure and two cases of death. Pneumonia was the most common postoperative morbidity in the open group. The significant rate of pneumonia (18% in open, 0% in laparoscopic), may be explained by the fact that performing an upper abdominal incision limits the respiratory effort of the patient due to increased postoperative pain, which then leads to atelectasis and other complications. This has also been commonly demonstrated by previous studies [29, 33, 34]. Despite comparable large perforation sizes in both groups, there were no cases of leakage, intraabdominal fluid collection, need for re-exploration or mortality in the laparoscopic group. The rate of leakage and re-operation have been as high as 8% in studies whereby other methods of repair were used [26]. In the present study, ulcer size did not correlate with mortality, ats the patients in the open group that succumbed to death had ulcer sizes less than 2 cm.

Furthermore, there were no conversions to open in our laparoscopic group, despite large perforation diameter, including sizes 2–3 cm, which demonstrates that the mCJR is advantageous even in relatively large sized perforations which may have difficulty placing sutures through friable edges. This is in contrast to the study by Alnaimy and colleagues [20], in which three of thirty-two laparoscopically repaired perforations using the modified Graham's Patch repair were converted to open.

This study has several limitations associated with it being a retrospective study. Additionally, the number of cases in the laparoscopic group is small in comparison to the open group, which may be attributed to the fact that a single minimally invasive trained surgeon performed all of the laparoscopic cases, while there was an inclination for the open approach among other acute care surgeons. Furthermore, different methods of repair were utilized (mCJR versus modified Graham's Patch versus Graham's repair) in the two groups, which make it difficult to ascertain the causality of the reported outcomes.

In conclusion, although open surgery is currently the more frequently utilized approach for repair of PPU, a strong argument can be made that for select patients (without preoperative septic shock), laparoscopy is a safe and effective approach as it may be a diagnostic and therapeutic alternative to open surgery. As evident in our 16 laparoscopically repaired consecutive patients, with appropriate resuscitation,

PPU patients are able to tolerate pneumoperitoneum and therefore reap the benefits of minimally invasive laparoscopic repair. Considering the benefits associated with the laparoscopic procedure, such as minimization of postoperative wound pain, early return to routine daily activities and early discharge, it may outweigh the consumable cost required in the performance of laparoscopic procedures. One of the significant findings in this study was the short LOS in the laparoscopic group, which becomes increasingly relevant and important in the recent COVID-19 pandemic era, which imparts a substantial strain on healthcare resources. A limiting factor to approaching PPU laparoscopically is largely surgeon expertise in laparoscopic knotting, which can be overcome with further dedicated training or via performing extracorporeal knotting, which requires less surgical experience and has a shorter learning curve than intracorporeal tying. Additionally, as demonstrated in our study, placing the patient in the French position with the operator between the patient's legs can further facilitate suturing, making it more expedient to repair the defect.

Paired with laparoscopic repair, this study also demonstrates the described mCJR may be advantageous for repairing PPU, even for relatively large perforations. Thus, while there is a definite role for open approach to perforated ulcer repair, surgeon skill and careful evaluation of perioperative characteristics and preoperative clinical status will allow for the safe use of laparoscopic approach with the associated patient benefits.

Declarations

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