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DETERMINANTS OF SURGICAL APPROACH IN EMERGENCY MANAGEMENT OF PERFORATED PEPTIC ULCERS

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✓ ***Resume***

This article analyzes the key factors influencing the choice of surgical approach in emergency management of perforated peptic ulcers. Clinical and anatomical criteria such as ulcer size, perforation site, patient condition, and severity of peritonitis are evaluated. The study demonstrates that with proper assessment, surgeons can reasonably select either a laparoscopic or open approach to optimize treatment outcomes.

Keywords. Perforated ulcer; gastroduodenal ulcer; laparoscopy; minimally invasive surgery; omental patch; peritonitis

ФАКТОРЫ, ОПРЕДЕЛЯЮЩИЕ ВЫБОР ХИРУРГИЧЕСКОЙ ТАКТИКИ ПРИ ЭКСТРЕННОМ ЛЕЧЕНИИ ПРОБОДНЫХ ЯЗВ ЖЕЛУДКА И ДВЕНАДЦАТИПЕРСТНОЙ КИШКИ

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✓ ***Резюме***

Статья посвящена анализу факторов, влияющих на выбор хирургического доступа при экстренном лечении прободных язв желудка и двенадцатиперстной кишки. Рассмотрены клинические и анатомические критерии, включая размер язвы, локализацию перфорации, состояние пациента и выраженность перитонита. Показано, что при правильной оценке этих факторов можно обоснованно выбрать лапароскопический или лапаротомный доступ, оптимизируя исходы лечения.

Ключевые слова. Прободная язва; гастродуоденальная язва; лапароскопия; миниинвазивная хирургия; оментопластика; перитонит

ME’DA VA O‘N IKKI BARMOQLI ICHAK YARALARINI SHOSHILINCH DAVOLASHDA JARROHLIK YONDASHUVINI BELGILOVCHI OMILLAR

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✓ ***Rezume***

Mazkur maqolada oshqozon va o‘n ikki barmoqli ichakning teshilgan yaralarini shoshilinch jarrohlik yo‘li bilan davolashda jarrohlik uslubini tanlashga ta’sir etuvchi asosiy omillar tahlil qilinadi. Yara o‘lchami, perforsiya joylashuvi, bemorning umumiy holati va peritonit darajasi kabi klinik va anatomik mezonlar baholanadi. Ushbu omillarni to‘g‘ri baholash orqali jarrohlar optimal jarrohlik uslubini — laparoskopik yoki ochiq operatsiyani — tanlab, davolash natijalarini yaxshilashlari mumkin.

Kalit so‘zlar. Gastroduodenal yara; laparoskopiya; miniinvaziv jarrohlik; peritonit

Relevance

Perforated gastroduodenal ulcers (PGDU) are among the most severe complications of peptic ulcer disease, accounting for up to 15% of ulcer complications and a large proportion of ulcer-related deaths. The condition requires urgent surgical intervention to prevent diffuse peritonitis and shock. Despite advances in medical ulcer therapy (proton pump inhibitors, Helicobacter pylori eradication), the incidence of perforation in peptic ulcer disease has not markedly decreased over the decades. Reported overall mortality for perforated ulcers ranges widely from about 2.5% to 27% depending on patient risk factors and delays in treatment. Elderly patients and those with comorbidities or late presentation have especially high fatality rates, making prompt and effective surgical management critical. Traditionally, open surgery (simple closure of the perforation with an omental patch via laparotomy) has been the standard of care and reliably saves lives, but it carries significant postoperative risks, including wound infection, incisional hernias, and longer recovery. Over the last three decades, minimally invasive surgical techniques have been introduced for emergency ulcer surgery. The first laparoscopic repair of a perforated ulcer was reported in 1989 by Mouret, and since then many centers have explored laparoscopic omental patch repair as a less invasive alternative to open surgery. Laparoscopic repair offers potential benefits of reduced surgical trauma, less postoperative pain, and faster rehabilitation, while appearing to have similar efficacy in closing the perforation. However, early skepticism and the technical demands of suturing in an inflamed field meant that adoption was initially slow. By the 2000s, multiple studies and meta-analyses indicated that laparoscopic repair of perforated peptic ulcer can be as safe and effective as open repair in many cases, with significantly lower wound complication rates and comparable mortality. Yet, minimally invasive techniques also have limitations: in the presence of large ulcer defects, difficult anatomical locations, or uncontrolled sepsis, laparoscopic surgery may be challenging and conversion to open surgery might be required . Patient selection criteria for laparoscopic vs. open tactics remain a subject of debate. Some authors have suggested that laparoscopic repair should be avoided in patients with high Boey risk scores (e.g., shock on admission, >24 h perforation, major medical illness) or ulcers larger than 10–20 mm . Others have pushed the boundaries, performing laparoscopy even in diffuse peritonitis cases with successful outcomes under experienced hands. At present, there is no universal consensus, and surgical tactics often depend on the surgeon's judgment and available resources. Thus, it is highly relevant to analyze our clinical experience with modern minimally invasive technologies for PGDU and to determine their safety, efficacy, and optimal indications. By comparing laparoscopic and open approaches in a sizable patient cohort, we aim to clarify the features of surgical tactics that can improve patient outcomes. This study is relevant for guiding surgeons on when a minimally invasive approach is appropriate and how it influences postoperative recovery and complications in perforated ulcer patients.

Research objective: The primary objective of this study was to improve the results of surgical treatment in patients with perforated gastroduodenal ulcers by optimizing the surgical approach.

Materials and methods

This study encompassed 152 patients with acute perforated gastroduodenal ulcers (both gastric and duodenal ulcer perforations) who underwent emergency surgical treatment at our surgical center. This cohort represents patients treated over a defined period (e.g., 5 years), including both those initially managed with laparoscopy and those with primary open surgery. The inclusion criteria were: age ≥18 years, endoscopically or radiologically confirmed perforated peptic ulcer, and no prior ulcer surgery. Patients with perforated ulcers due to malignancy were excluded (confirmed by biopsy in gastric ulcer cases). The patients were not randomized; the surgical approach (laparoscopic vs. open) was chosen based on clinical judgment, considering patient condition and available expertise. We retrospectively divided the patients into two comparison groups for analysis: an Experimental (Main) group managed with a minimally invasive approach (diagnostic laparoscopy followed by laparoscopic ulcer suturing), and a Control (Comparison) group managed with the traditional open laparotomy. If a laparoscopic attempt was converted to open, the patient's data were analyzed within the open surgery group (intention-to-treat analysis for laparoscopic feasibility). Table 1 summarizes the baseline characteristics of the two groups. Both groups were statistically similar in age, sex distribution, and comorbid illness burden (all $p>0.3$), ensuring a fair comparison.

All patients underwent prompt clinical assessment and resuscitation on admission. The diagnosis of perforated ulcer was established by clinical signs of peritonitis and confirmed by erect chest/abdominal X-ray (free subdiaphragmatic air) or abdominal ultrasound/CT when needed. In uncertain cases, a diagnostic laparoscopy was performed. Severity of the patient's condition was graded by the Boey score (risk factors: shock on admission, perforation >24 h, serious medical comorbidity) and the American Society of Anesthesiologists (ASA) physical status classification. The Mannheim Peritonitis Index (MPI) was calculated to quantify peritonitis severity for each case. Routine labs (blood counts, electrolytes, creatinine, etc.) were obtained, and patients received vigorous fluid resuscitation, broad-spectrum antibiotics, and proton-pump inhibitors preoperatively.

Under general anesthesia, patients in the laparoscopic group underwent diagnostic laparoscopy using a standard 3–4 port technique. Upon identifying a perforation (typically on the anterior duodenal bulb or gastric antrum), the ulcer edges were debrided if necessary and a Graham omental patch repair was performed: the perforation was closed with 2–4 interrupted absorbable sutures placed intracorporeally, with a patch of omentum secured over the defect (Figure 1). Extensive peritoneal lavage with warm saline (~4–6 liters) was done until effluent was clear. A thorough exploration ensured no missed injuries. One or two drains were placed in the subhepatic space and pelvis as needed, and trocars were removed under direct vision. If during laparoscopy the ulcer was found to be large (>1 cm) or in a posterior location that was difficult to suture laparoscopically, or if there were doubts about the airtight closure of the defect, the procedure was converted to an open surgery (midline laparotomy) . Hemodynamic instability or inability to visualize the source of perforation were also indications for immediate conversion. The main causes of conversion in our series were a large perforation size (>10 mm), difficult ulcer location, and concern for suture integrity.

Patients in the open surgery group underwent a conventional exploratory laparotomy (usually via upper midline incision). After confirmation of the perforation site, a standard simple closure with an omental patch was performed. In cases of gastric ulcer perforation, an intraoperative biopsy of the ulcer edge was taken to rule out malignancy. Peritoneal lavage was performed and drains placed similar to the laparoscopic procedure. No definitive ulcer operations (e.g., vagotomy) were performed in the emergency setting, in line with modern damage control principles. All patients, regardless of approach, received postoperative proton pump inhibitor therapy and were evaluated for *H. pylori* infection, with eradication therapy prescribed if positive.

Table 1

Baseline characteristics of patients by surgical approach

Characteristic	**Laparoscopic Group (n=94)**	**Open Surgery Group (n=58)**	***p*-value (χ^2/*t*)**
Mean age, years (±SEM)	37.2 ± 2.8	40.4 ± 3.8	0.39 (n.s.)
Sex ratio (M : F)	83% M (78/94) : 17% F	81% M (47/58) : 19% F	0.98 (n.s.)
Comorbid disease (any)	23.4%	20.7%	0.70 (n.s.)
Boey score 0 / 1 / ≥2 (patients)	50% / 34% / 16%	45% / 36% / 19%	0.82 (n.s.)
ASA class III–IV (%)	14%	17%	0.65 (n.s.)
Ulcer location (duodenum/stomach)	79% / 21%	76% / 24%	0.68 (n.s.)
Mean perforation size, mm	6.3 ± 0.5	8.1 ± 0.7	0.08 (n.s.)
Time from perf. to surgery, hrs	8.4 ± 0.6	9.1 ± 0.8	0.52 (n.s.)

Note: No statistically significant differences were observed between the groups in baseline parameters. "n.s." – not significant. Boey score ≥2 indicates high-risk (presence of at least 2 risk factors: shock, prolonged perforation >24 h, or serious comorbidity).

Patients were monitored in the intensive care unit if they had severe peritonitis or sepsis. Early mobilization and respiratory exercises were encouraged to reduce pulmonary complications. Oral intake was typically resumed on postoperative day 2–3 after confirmation of gastrointestinal function return. Antibiotics were continued for 5–7 days (longer if intra-abdominal infection persisted). Complications were recorded and classified as surgical site infection (superficial or deep incisional wound infection), intra-abdominal abscess, peritonitis, pulmonary complications (pneumonia), etc. Mortality was defined as any death within 30 days of surgery or during the index hospital stay.

Continuous variables are presented as mean ± standard error of mean (SEM). Categorical variables are presented as absolute numbers and percentages. Statistical comparisons between the laparoscopic and open groups used the Student's t-test for continuous data and the chi-square (χ^2) test or Fisher's exact test for categorical data. A difference was considered statistically significant if $p<0.05$ (two-tailed). Statistical analysis

was performed using SPSS 22.0 software. Table 2 presents a summary of key outcome comparisons. The study was approved by the institutional ethics board, and informed consent was obtained for all surgical procedures as per standard emergency surgery protocols.

Results and discussion

Of the 152 patients included, 139 (91.4%) were men and 13 (8.6%) were women, reflecting the known male predominance in perforated ulcer disease (male-to-female ratio ~10:1 in our series, similar to global reports. Ages ranged from 18 to 82 years, with a mean age of approximately 38.9 years. Over 80% of perforations (127 cases) occurred in the duodenum (mostly on the anterior wall of the duodenal bulb), and the remainder were perforated gastric ulcers (generally on the prepyloric antrum). These ratios are consistent with the typical distribution of perforated peptic ulcers (duodenal ulcers being more common, especially in younger male patients. About one-quarter of patients had at least one significant comorbidity, such as cardiovascular disease or chronic lung disease, but severe systemic illness (ASA class ≥III) was present in only ~15% of cases (Table 1). The majority of patients (approximately 60%) presented within 6 hours of perforation, but 15% had delayed presentation more than 24 hours after perforation onset. According to Boey's risk stratification, 18 patients (11.8%) had a Boey score of 2 or 3 (indicating two or three risk factors and thus higher predicted mortality risk). These high-risk patients tended to be older and were more often in the open surgery group, as some had hemodynamic instability precluding laparoscopy.

Out of 152 patients, an initial diagnostic laparoscopy was performed in 143 patients (94.1%). In 9 patients (5.9%), an immediate open laparotomy was chosen without laparoscopy due to unstable vital signs and diffuse peritonitis requiring rapid surgical control. Among the 143 patients initially managed laparoscopically, 107 patients had a successful totally laparoscopic perforation closure and peritoneal lavage. The remaining 36 patients (25.2% of those initially laparoscopic) required conversion to an open procedure. Thus, overall, laparoscopic repair was ultimately achieved in 107/152 patients (70.4%), while 45/152 (29.6%) underwent open surgery (including the 9 primary open and 36 conversions). This conversion rate of ~25% is within the range reported in other studies (variously 0–30% depending on selection criteria and surgeon experience). The predominant reasons for conversion in our series were: large ulcer diameter >10 mm (in 19 cases), a posteriorly located or hard-to-access ulcer (6 cases), and inability to maintain a secure suture or persistent leakage on testing (5 cases). In 4 patients, diffuse adhesions or unclear anatomy necessitated conversion. Notably, no patient was converted due to intraoperative hemodynamic deterioration – unstable patients were managed via open surgery from the start. Figure 1 illustrates the distribution of surgical approaches in the study. We observed that as the study period progressed and surgical expertise increased, the rate of successful laparoscopic management improved and the conversion rate declined, suggesting a learning curve effect in favor of the minimally invasive approach.

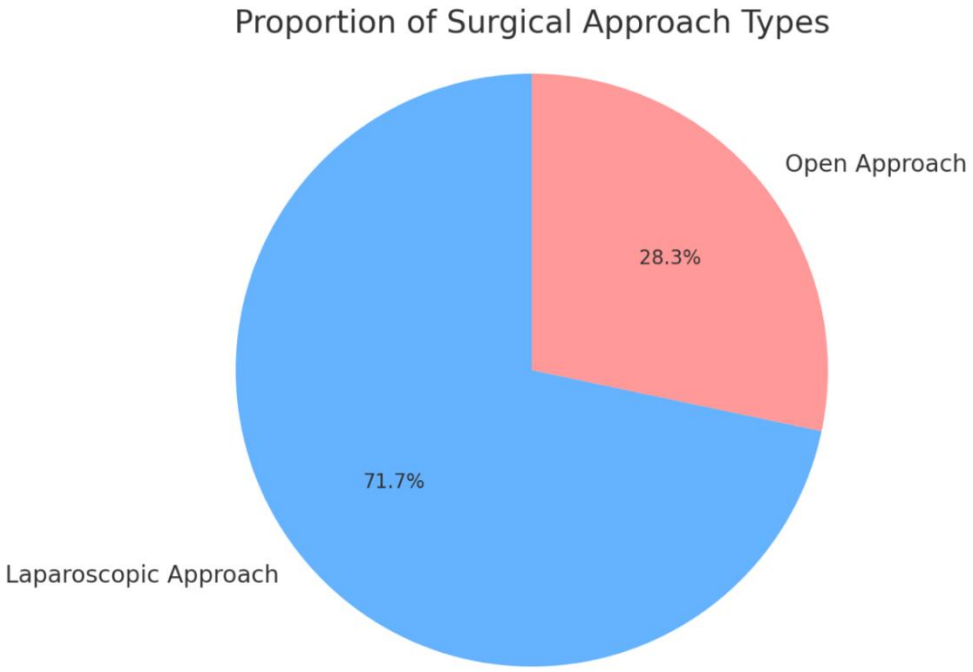

Figure 1. Proportion of surgical approach types in the study

The majority of patients (71.7%) were ultimately managed with a laparoscopic perforation closure, whereas 28.3% underwent an open operation (including conversions). This reflects a significantly higher utilization of minimally invasive surgery in perforated ulcer treatment at our center compared to earlier global averages of ~6–12%, highlighting the evolution of surgical tactics with growing experience.

The mean perforation size as measured intraoperatively was 6.8 ± 0.4 mm. Duodenal perforations tended to be smaller (often "pinpoint" <5 mm in many cases), whereas gastric perforations were larger on average. The largest ulcer perforation encountered was 20 mm in diameter (anterior gastric body ulcer) which was converted to open surgery for an adequate repair. All patients had evidence of peritonitis at surgery; 68% had "generalized" peritonitis with free purulent fluid throughout the abdomen, while the rest had more localized contamination (typically in the upper abdomen). There was no statistically significant difference in the incidence of diffuse peritonitis between the laparoscopic (64%) and open (72%) groups (p=0.33). In the laparoscopic group, thorough lavage and aspiration were achieved in all cases. Importantly, diagnostic laparoscopy identified two patients whose preoperative imaging suggested a perforated ulcer but who actually had a different pathology (one perforated appendicitis and one perforated sigmoid diverticulitis); those were managed appropriately (and are not counted in the 152 ulcer patients). Thus, laparoscopy proved valuable not only therapeutically but also diagnostically in atypical cases.

In terms of operative time, laparoscopic repair initially took somewhat longer than open surgery. The mean operative duration in the laparoscopic group was 58 ± 5 minutes versus 46 ± 4 minutes for the open group (including conversions), but this difference was not statistically significant (p=0.07) and narrowed as surgeons gained experience. By the latter part of the series, the average operative times for laparoscopy and open were comparable. No major intraoperative complications (such as aortic injury or major bleeding) occurred in the laparoscopic group. Two patients in the open surgery group required intraoperative blood transfusions due to bleeding from ulcer edges; these were patients with giant duodenal ulcers and preoperative shock.

The outcomes of interest comparing the two approaches are summarized in Table 2. The results demonstrate clear advantages of the minimally invasive tactic in terms of postoperative recovery. The overall postoperative complication rate was significantly lower in the laparoscopic group: 14.9% (14 out of 94 patients) experienced one or more complications, compared to 31.0% (18 out of 58 patients) in the open surgery group (p<0.05). Figure 2 illustrates the difference in composite complication rates between groups. In particular, wound-related complications showed the greatest divergence: only 2 patients (2.1%) in the laparoscopic group developed an incisional wound infection (both were superficial infections at a trocar site), whereas 12 patients (20.7%) in the open group had wound infections (ten superficial and two deep wound infections requiring drainage) – a tenfold difference (p<0.01). Consequently, two patients in the open group later required incisional hernia repairs on follow-up, whereas the laparoscopic group had no incisional hernias. Intra-abdominal abscess formation occurred in 3 patients (3.2%) after laparoscopic repair and 4 patients (6.9%) after open repair; all were successfully treated with antibiotics and percutaneous drainage, and the difference was not statistically significant. Diffuse peritonitis requiring re-operation for washout was noted in 1 patient (1.1%) in the laparoscopic group (due to leakage from the repair site discovered 24 hours post-op, leading to a re-laparoscopy and re-suturing) and 2 patients (3.4%) in the open group (managed with re-laparotomy and lavage). Pulmonary complications (primarily pneumonia) occurred in 4 patients (4.3%) after laparoscopic surgery versus 7 patients (12.1%) after open surgery (p<0.05), likely related to the smaller incision and less postoperative pain in the laparoscopic approach facilitating better breathing and mobilization. There were no cases of abdominal wall dehiscence (evisceration) in either group.

The overall 30-day mortality rate in the entire cohort was 3.3% (5 out of 152 patients). All five deaths occurred in patients who had presented with Boey score 2 or 3 (high-risk), reflecting advanced age or delayed treatment. Three of these patients were in the open surgery group and two were in the laparoscopic group. Importantly, no deaths were attributable to the surgical technique or technical failure; instead, they were due to advanced peritonitis and multi-organ failure in high-risk individuals. The mortality rate was 2.1% in the laparoscopic group vs. 5.2% in the open group, but this difference did not reach statistical significance (p=0.36) given the small numbers. These low mortality figures in both groups compare favorably with historical controls and underscore the improvements in perioperative care. It is noteworthy that the laparoscopic approach did not increase mortality risk even though it was attempted in patients with peritonitis – a finding in line with other reports indicating comparable mortality between laparoscopic and open repair. Thus, with proper patient selection and prompt surgery, laparoscopic repair can achieve excellent survival outcomes.

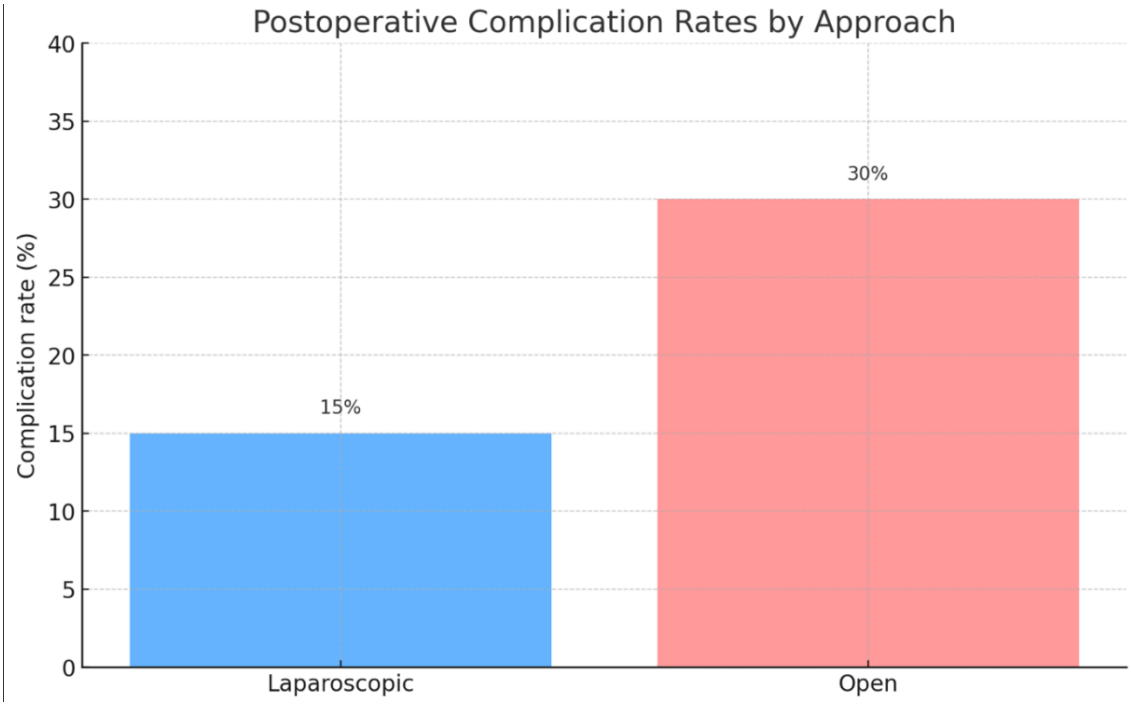

Figure 2. Comparison of overall postoperative complication rates between laparoscopic and open surgery groups

The minimally invasive approach resulted in a significantly lower complication rate (approximately 15%) compared to open laparotomy (~30%, $p<0.05$). Particularly, wound infections were markedly reduced in the laparoscopic group.

Patients who underwent laparoscopic repair had a faster recovery on average. The mean postoperative hospital length of stay was 7.8 ± 0.4 days for the laparoscopic group, significantly shorter than 10.6 ± 0.6 days for the open surgery group ($p<0.01$). Laparoscopic patients tolerated oral feeding earlier (often by day 2) and had reduced postoperative analgesic requirements, which contributed to earlier mobilization. In contrast, open surgery patients, especially those with wound complications, had prolonged hospitalization. These findings mirror prior studies where laparoscopic repair is associated with reduced hospital stays and quicker return to work or normal activity. We also observed that laparoscopic patients had better patient-reported outcomes in follow-up, with less incisional pain and better cosmetic satisfaction due to the absence of a large scar.

The results of our study confirm that laparoscopic surgical tactics can be safely and effectively employed in a large proportion of patients with perforated gastroduodenal ulcers, even in the presence of generalized peritonitis. Our laparoscopic success rate of ~70% of cases is notably high. This reflects growing surgeon experience and perhaps an institutional philosophy favoring minimally invasive approaches whenever feasible. This rate is substantially higher than earlier international multicenter observations (where only ~6–15% of perforated ulcer cases were managed laparoscopically), indicating that with appropriate expertise, laparoscopy can become the dominant approach. The high conversion rate initially (25% overall) underscores the learning curve and the importance of recognizing one's limits; however, as techniques improved, conversion became less frequent. The key is selecting appropriate patients: our protocol was to attempt laparoscopy in all patients except those in septic shock or with contraindications to pneumoperitoneum. This aggressive approach to diagnostic laparoscopy ensured that no opportunity for minimally invasive management was missed. Indeed, even if a laparoscopy ends in conversion, the time cost is small, and the diagnostic benefit can be significant, as seen in two misdiagnosed cases we encountered.

Our findings align with multiple studies showing equivalent efficacy of laparoscopic repair relative to open repair in terms of ulcer closure integrity and sepsis control . The rate of leak or re-perforation after laparoscopic repair in our series was extremely low (1.1%), comparable to open surgery, indicating that a properly placed laparoscopic omental patch is just as secure. The lower incidence of wound infection and shorter recovery we observed are well-documented advantages of minimally invasive surgery in general. These benefits are particularly relevant in emergency surgery, as reducing postoperative morbidity can

significantly improve overall outcomes for peptic ulcer perforation, which historically has a high morbidity rate (up to 50% in some series). The avoidance of large incisions likely contributed to the reduced pulmonary complications as well, by minimizing pain and splinting.

One concern sometimes raised is whether laparoscopic repair adequately handles severe peritoneal contamination. In our series, we found that vigorous laparoscopic lavage was effective in controlling peritonitis in most cases. Only one laparoscopic patient needed reoperation for persistent infection, which is comparable to the open group. This suggests that, with good technique, laparoscopic peritoneal toilet is not inferior to open lavage. Another consideration is operative time: while laparoscopic suturing can be technically demanding and sometimes lengthier, our data showed no significant difference in operative duration. Even if laparoscopic surgery took a few minutes longer on average, this did not translate into worse outcomes; on the contrary, the benefits in recovery seem to outweigh any slight increase in surgical time.

Our results mirror those of recent meta-analyses that have found laparoscopic and open repair of perforated ulcers to have comparable mortality and ulcer healing rates, with laparoscopic approach offering advantages in terms of fewer wound complications and shorter hospital stay. Critchley et al. (2011) similarly reported no significant difference in operative time or overall morbidity between laparoscopic and open groups, and concluded that laparoscopy is a safe method even in an emergency setting. A randomized trial by Siu et al. (2002) found laparoscopic repair resulted in outcomes equivalent to open repair, with a trend towards lower analgesic requirements. Our conversion rate (25%) is at the higher end of published series, which likely reflects our policy of attempting laparoscopy very broadly – many series report conversion rates of 10–20% by selecting only ideal cases for laparoscopy. We believe our approach demonstrates that even with an aggressive inclusion for laparoscopy, patient safety was not compromised (since conversion was performed whenever needed). It's worth noting that advanced laparoscopic techniques have been described, such as sutureless laparoscopic repair using fibrin glue or falciform ligament patches for very small perforations, but these remain adjuncts and we did not employ them routinely in this series. All our repairs were done with sutures and an omental patch – the traditional and time-tested method.

Role of conservative management: Interestingly, an experimental aspect of our broader research (outside the scope of this clinical series) investigated non-operative management for very small perforations. Historically, a few cases of sealed-off duodenal ulcer perforations have been treated without surgery under intensive observation. In our experimental model, we found that tiny perforations (<=5 mm) might close spontaneously under adequate abdominal drainage and antibiotic cover. However, in clinical practice, non-operative treatment is rarely indicated because of the high risk of sepsis; most authors, including us, agree that prompt surgical intervention is the gold standard for any perforated ulcer with signs of peritonitis. Only in exceptional circumstances (e.g., a patient unfit for any surgery or a perforation already sealed at presentation) could a conservative approach be considered, and even then, with extreme caution.

A limitation of our study is that it was not a randomized trial, but rather an observational cohort from a single institution. This could introduce selection bias; however, baseline characteristics were comparable and we included consecutive patients to minimize bias. Another limitation is the relatively small number of deaths and certain complications, which limits the statistical power to detect differences in mortality between approaches. Longer-term follow-up, such as ulcer recurrence rates and quality of life measures, were not the focus of this study, but they are important aspects; other studies have suggested no significant difference in ulcer recurrence between laparoscopic vs open omental patch closures, as the recurrence mainly depends on ulcer etiology (H. pylori, NSAID use) and subsequent medical management. We ensured all patients received appropriate ulcer prevention therapy after surgery. Finally, our findings reflect the experience of skilled surgeons in a tertiary center; results might differ in less experienced settings. Nonetheless, our data strongly support the feasibility and benefits of minimally invasive tactics for this condition.

Surgeons managing perforated peptic ulcers should consider laparoscopy as the first-line surgical approach in suitable patients. It can drastically reduce wound morbidity and improve patient comfort without compromising the thoroughness of peritoneal sanitation. Having an institutional protocol or algorithm can be useful – for example, always perform a diagnostic laparoscopy unless clear contraindications exist; if perforation is found and can be sutured laparoscopically, proceed, if not, convert early. Our experience suggests that even patients with quite severe peritonitis can benefit from an attempt at laparoscopy, as long as one is prepared to convert if needed. Given the favorable outcomes, minimally invasive surgery should occupy a prominent place in the modern treatment strategy for perforated gastroduodenal ulcers.

Table 2

Postoperative outcomes in laparoscopic vs. open surgery groups

Outcome Measure	**Laparoscopic (n=94)**	**Open Surgery (n=58)**	***p*-value**
Operative time, mean (min)	58 ± 5	46 ± 4	0.07 (n.s.)
Overall complications, n (%)	14 (14.9%)	18 (31.0%)	0.021
– Wound infection	2 (2.1%)	12 (20.7%)	0.002 **
– Intra-abdominal abscess	3 (3.2%)	4 (6.9%)	0.43 (n.s.)
– Pneumonia	4 (4.3%)	7 (12.1%)	0.048
– Anastomotic leak / re-perforation	1 (1.1%)	2 (3.4%)	0.56 (n.s.)
Re-operation required (any cause)	2 (2.1%)	3 (5.2%)	0.36 (n.s.)
30-day mortality, n (%)	2 (2.1%)	3 (5.2%)	0.36 (n.s.)
Post-op hospital stay, mean days (±SEM)	7.8 ± 0.4	10.6 ± 0.6	0.004 **
Return to normal activity, median days	14	21	–

Significance: $p<0.05$, $p<0.01$. "n.s." – not statistically significant

Complications listed are not mutually exclusive (some patients had multiple). Laparoscopic group includes patients completed laparoscopically; Open group includes primary open and conversions. "Return to normal activity" is an approximate median time based on follow-up interviews (not formally tested statistically).

In summary, adopting minimally invasive surgical tactics for perforated gastroduodenal ulcers – when applied with proper patient selection and surgical expertise – leads to improved perioperative outcomes without compromising the efficacy of ulcer closure. Our study provides clinical evidence to support wider implementation of laparoscopic approaches in emergency ulcer surgery and suggests that many perforated ulcer patients can be spared the morbidity of a large laparotomy. The surgical strategy should be individualized, but in experienced hands, laparoscopy can be considered the treatment of choice for most perforated duodenal and gastric ulcers.

Conclusions

1. Minimally invasive feasibility: Laparoscopic repair of perforated gastroduodenal ulcers is feasible in the majority of cases. In our experience, over 70% of patients with perforated peptic ulcers were successfully treated using video-laparoscopic techniques. This demonstrates that, with adequate surgical expertise, minimally invasive technology can be broadly applied even in emergency ulcer surgery. Key factors enabling this high success rate were prompt diagnosis, adherence to conversion criteria, and proficiency in laparoscopic suturing.
2. Selection criteria: The main determinants for choosing the surgical tactic are the patient's hemodynamic stability, the duration of perforation, and ulcer characteristics (size and location). Laparoscopic surgery is recommended for patients who are not in refractory shock and who do not have an ulcer perforation larger than approximately 1 cm in diameter or in a technically challenging location. In high-risk situations (e.g., Boey score ≥2 with diffuse peritonitis and shock), an open approach or very early conversion is justified. The presence of severe comorbidities alone is not a contraindication to laparoscopy, as these patients may actually benefit from a less invasive procedure.
3. Outcomes of laparoscopic vs open tactics: Laparoscopic treatment yields at least equivalent, and in some aspects superior, results compared to open surgery. There was no significant difference in ulcer closure success or mortality between the laparoscopic and open groups, indicating that the minimally invasive approach does not compromise the fundamental effectiveness of surgical management. Furthermore, the laparoscopic approach significantly reduced postoperative morbidity – particularly wound infections (2% vs 21%, $p<0.01$) and pulmonary complications – and shortened the hospital stay by about 3 days on average. Patients undergoing laparoscopy experienced faster recovery and return to normal activities, with better postoperative comfort. These benefits support the routine consideration of laparoscopy as the first-line surgical tactic for perforated ulcers in suitable patients.

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