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Laparoscopic Approach Criteria in Perforated Gastro-Duodenal Ulcers with Diffuse Peritonitis

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Abstract: This article presents a comparative analysis of laparoscopic versus open surgery in patients with perforated gastric and duodenal ulcers complicated by diffuse peritonitis. Based on data from 114 patients (59 laparoscopic, 55 open), criteria for selecting surgical approach were identified, including hemodynamic stability, time from perforation, severity of peritonitis, and ulcer size. The study found that, when applied according to defined criteria, laparoscopic repair significantly reduced postoperative complications, accelerated recovery, and achieved comparable mortality rates. The results support the feasibility and safety of laparoscopic intervention in stable patients even in the presence of diffuse peritonitis.

Keywords: Laparoscopy, perforated ulcer, peritonitis, surgical treatment.

Perforated peptic ulcer (PPU) is a life-threatening complication of peptic ulcer disease, often leading to generalized (diffuse) peritonitis. Despite advances in medical therapy for ulcer disease, PPU remains a frequent surgical emergency. The incidence of ulcer perforation in peptic ulcer patients is about 5%, and it accounts for the majority of ulcer-related mortality. Mortality rates for perforated gastric or duodenal ulcers range from 1.3% to as high as 20%, even with prompt treatment. Such high mortality is largely due to diffuse peritonitis leading to sepsis and multi-organ failure if not rapidly controlled.

The development of diffuse peritonitis from a perforated ulcer signifies that gastric or duodenal contents have leaked into the abdominal cavity, causing widespread infection and inflammation. This condition necessitates emergency surgical intervention to close the perforation and thoroughly lavage the peritoneal cavity. Traditionally, the standard of care has been an open laparotomy with surgical repair (typically an omental patch closure) of the perforation and peritoneal lavage. This open approach is effective but associated with significant postoperative pain, longer recovery, and risk of wound-related complications, especially in a setting of diffuse peritonitis and often in patients with comorbidities.

In recent decades, laparoscopic surgery has been introduced for the management of perforated peptic ulcers. Laparoscopic repair offers the well-known benefits of minimally invasive surgery: reduced surgical trauma, less postoperative pain, and faster recovery. Multiple clinical trials have demonstrated that laparoscopic repair of PPU can achieve shorter hospital stays and quicker return to normal activity. Importantly, meta-analyses indicate that laparoscopic repair yields similar overall morbidity and mortality outcomes compared to open surgery, with the notable advantage of significantly lower surgical site infection rates. Thus, there is a strong rationale to prefer a laparoscopic approach when feasible, to reduce postoperative complications and improve patient comfort.

However, the role of laparoscopy in the presence of diffuse peritonitis has been debated. Severe peritonitis can make laparoscopic visualization and manipulation challenging, and there are concerns about managing extensive contamination laparoscopically. Surgeons must consider patient stability and the extent of infection when choosing the surgical method. Current guidelines suggest that a laparoscopic approach is appropriate for hemodynamically stable patients with perforated ulcers, provided the surgical team has adequate laparoscopic expertise. In unstable patients or those with severe sepsis, an open procedure is recommended as laparoscopy may be unsafe. Therefore, determining clear criteria for selecting laparoscopic intervention in cases of perforated gastric and duodenal ulcers with diffuse peritonitis is highly relevant. Optimizing the surgical approach based on patient condition and disease severity could improve outcomes by balancing the benefits of minimally invasive surgery against the need for effective source control in severe intra-abdominal infections.

Purpose of the Study. The purpose of this study is to improve the outcomes of surgical treatment in patients with perforated gastric and duodenal ulcers complicated by diffuse peritonitis. We aim to identify objective criteria for choosing laparoscopic interventions in such emergency cases. By comparing the clinical results of laparoscopic versus open surgical management, we seek to determine if tailored use of laparoscopy can reduce complications and mortality while maintaining effective treatment of diffuse peritonitis. Ultimately, the study is directed at developing recommendations that can guide surgeons in selecting the optimal surgical approach (laparoscopic or open) for each patient to achieve the best possible outcome.

Materials and Methods. This study was conducted as a retrospective analysis of 114 patients who underwent emergency surgery for perforated gastric or duodenal ulcers complicated by diffuse peritonitis. All patients were treated at our surgical department between 2015 and 2024. The diagnosis of perforation was confirmed by clinical examination (acute abdomen with signs of peritonitis) and imaging (free air under the diaphragm on X-ray or CT evidence of perforation), followed by operative findings of a perforated ulcer with generalized peritoneal contamination.

Patients were divided into two groups for comparative analysis. The comparison group consisted of 55 patients who underwent conventional open surgery (laparotomy) for ulcer closure, while the primary group consisted of 59 patients who received laparoscopic surgical intervention. The assignment to open or laparoscopic treatment was not randomized; rather, it was based on the clinical judgment of the attending surgical team and the evolution of our institutional practice. Early in the study period, open laparotomy was more frequently performed. As laparoscopic expertise and equipment became more available, minimally invasive repair was attempted in an increasing number of cases, provided the patient's condition allowed.

All 114 patients had diffuse peritonitis at the time of surgery, defined as the presence of purulent or gastrointestinal fluid throughout the abdominal cavity (beyond the upper abdomen into the paracolic gutters and pelvis). Preoperative resuscitation was performed in all cases, including fluid therapy, broad-spectrum antibiotics, and nasogastric decompression. The decision criteria for attempting a laparoscopic repair included hemodynamic stability (blood pressure maintained without requiring high-dose vasopressors) and absence of contraindications such as refractory shock or inability to tolerate pneumoperitoneum. Patients with signs of septic shock on admission or with comorbid conditions severely affecting cardiopulmonary function were managed with immediate open surgery for expediency and safety.

The open surgical technique involved a midline laparotomy incision, identification of the perforation (most often located on the anterior duodenal bulb or stomach), and closure of the ulcer perforation with interrupted absorbable sutures reinforced with an omental patch (Graham patch). Extensive peritoneal lavage with warm saline (typically 6–10 liters) was then carried out until the return fluid was clear. Abdominal drains were placed in the subhepatic space and pelvis in most cases to allow postoperative drainage of any residual contamination.

In the laparoscopic group, surgery was performed using a standard 3- or 4-port technique under general anesthesia. After establishing pneumoperitoneum (typically to an intra-abdominal pressure of ~12–14 mmHg) and inserting trocars, a thorough exploration of the abdominal cavity was done. The perforation site was identified – in our cohort, the majority were duodenal ulcers, encountered on the anterior first portion of the duodenum, with a smaller number of gastric ulcer perforations on the anterior antrum. Laparoscopic repair of the perforation was accomplished with one or two interrupted sutures using 2-0 or 3-0 absorbable material, tied intracorporeally. An omental patch was then secured over the perforation by mobilizing a tongue of omentum and tucking it into the suture line (similar to the open technique). A large-volume saline irrigation of the peritoneal cavity was performed laparoscopically using suction irrigation, ensuring all quadrants (subphrenic spaces, paracolic gutters, pelvic cavity) were cleansed of contaminating fluid. Finally, one or two closed-suction drains were placed laparoscopically near the repair site and in the pelvis before desufflation and trocar removal.

Data collected for analysis included patient demographics (age, sex), ulcer characteristics (location and size of perforation), duration of symptoms before surgery, and physiological status on admission. We also calculated severity scores such as the Boey score and Mannheim Peritonitis Index (MPI) for each patient to stratify risk. Operative details (surgery duration, need for conversion from laparoscopy to open, etc.) were recorded. Postoperative outcomes were compared between the two groups, including the incidence of complications (classified by Clavien-Dindo grade) and specific complications such as surgical site infection (wound infection), intra-abdominal abscess, sepsis, and pulmonary complications. Postoperative mortality was defined as any death occurring during the index hospitalization or within 30 days of surgery. Length of hospital stay (days from surgery to discharge) was noted for all survivors.

Statistical analysis was performed using SPSS 25.0 software. Continuous variables (such as operative time and hospital stay) were compared between groups using Student's t-test or Mann-Whitney U test as appropriate (after testing for normal distribution). Categorical variables (such as complication rates and mortality) were compared using Chi-square test or Fisher's exact test. A p-value < 0.05 was considered statistically significant. The results were interpreted to determine whether the laparoscopic approach was associated with different outcomes compared to open surgery, and to identify any preoperative or intraoperative factors that should be considered contraindications for laparoscopy.

Results and Discussion. A total of 114 patients were included, with 59 patients in the laparoscopic group and 55 in the open surgery group. The two groups were similar in baseline characteristics. The mean age was 45 years (range 20–80 years) in the laparoscopic group and 47 years (range 18–82) in the open group. Men predominated in both groups (approximately 80% of patients), which is consistent with the known male bias in PPU incidence. The majority of ulcers were duodenal perforations (~70%), with the remainder gastric perforations, and this distribution was comparable between groups. The mean duration from symptom onset (perforation) to surgery was about 10 hours in both groups, as most patients presented within the same day of perforation. There were no significant differences in preoperative severity scores between the groups; for instance, the proportion of patients with a Boey score ≥ 2 was similar. Notably, the few patients who were in frank septic shock on presentation were all operated on with open surgery, as reflected by slightly higher initial lactate levels and heart rates in the open group (though these differences were not statistically significant given the small numbers).

Out of 59 patients intended for laparoscopic repair, the procedure could be completed successfully via laparoscopy in 54 cases (91.5%). Five patients (8.5%) in the laparoscopic group required conversion to an open procedure. The reasons for conversion were: diffuse dense adhesions and fibrin deposits obscuring visibility in 2 cases, difficulty in locating or suturing a large ulcer perforation in 2 cases, and intraoperative hemodynamic instability in 1 case. These scenarios align with known absolute contraindications to laparoscopy, such as inability to adequately visualize or control the source of contamination. The conversion rate observed

underscores that while laparoscopy is feasible in most diffuse peritonitis cases, the surgical team must be prepared to convert to an open approach if needed, in order to ensure patient safety. In line with best practices, we adopted a low threshold for conversion – any indication of uncontrolled infection or doubt in the laparoscopic repair prompted an immediate switch to open surgery.

The mean operative time was slightly longer in the laparoscopic group, averaging 80 ± 15 minutes, compared to 65 ± 10 minutes in the open group ($p < 0.01$). The increased duration for laparoscopy is expected due to the time required for establishing pneumoperitoneum and intracorporeal suturing. However, with growing surgeon experience, the time difference became less pronounced for later cases. Our operative times are within the range reported in other series of laparoscopic PPU repair. Despite a modestly longer surgery, this did not negatively impact outcomes in the laparoscopic group, as patients remained stable under anesthesia.

The overall postoperative complication rate was significantly lower in the laparoscopic group compared to the open surgery group. In the open group, 18 of 55 patients (32.7%) experienced one or more postoperative complications, whereas in the laparoscopic group 10 of 59 patients (16.9%) had complications ($p = 0.04$). This represents roughly a 50% reduction in the risk of complications with the laparoscopic approach. Table 1 summarizes the key clinical outcomes and complications in both groups.

Table 1. Comparison of outcomes between open surgery (comparison group) and laparoscopic surgery (primary group) in patients with perforated peptic ulcers and diffuse peritonitis

Outcome	Open Surgery (n = 55)	Laparoscopic Surgery (n = 59)	*p*-value
Operative time (minutes)	65 ± 10	80 ± 15	0.001
Conversion to open	–	5/59 (8.5%)	–
Overall complications	18/55 (32.7%)	10/59 (16.9%)	0.04
• Wound infection	12 (21.8%)	2 (3.4%)	0.005
• Intra-abdominal abscess	3 (5.5%)	2 (3.4%)	0.67
• Anastomotic leak (re-perforation)	2 (3.6%)	1 (1.7%)	0.60
• Pulmonary complications (pneumonia)	5 (9.1%)	2 (3.4%)	0.27
Postoperative mortality	2/55 (3.6%)	1/59 (1.7%)	0.56
Length of hospital stay (days)	9.5 ± 3.0	6.8 ± 2.1	0.002

As shown in Table 1, the laparoscopic approach dramatically reduced the incidence of wound infections (3.4% vs 21.8% in open surgery; $p = 0.005$). This is a major benefit of avoiding a large abdominal incision and is consistent with existing literature, where laparoscopic repair yielded significantly fewer surgical site infections. There was no statistically significant difference in intra-abdominal abscess formation between the two groups (approximately 5% in both, p = NS). Three patients in the open group developed intra-abdominal abscesses requiring percutaneous drainage, while two patients in the laparoscopic group developed localized abscesses that were successfully treated with antibiotics and ultrasound-guided aspiration. The rate of suture leakage or re-perforation was low in both groups (one case in the laparoscopic group vs two cases in the open group, $p = 0.60$). These few cases of leak all occurred in patients who had large ulcer sizes (>10 mm) and presented late; they required re-operation (repeat laparotomy) and ultimately recovered after appropriate treatment.

In terms of systemic complications, the incidence of postoperative pneumonia was lower in the laparoscopic group (3.4% vs 9.1%), though this difference was not significant given the sample size. The trend toward fewer pulmonary complications can be attributed to less pain and earlier mobilization in the minimally invasive group, which encourages better breathing and coughing

efforts postoperatively. Importantly, the postoperative mortality did not differ significantly between groups. Two patients (3.6%) in the open surgery group died, compared to one patient (1.7%) in the laparoscopic group (p = 0.56). All three of these patients had severe diffuse peritonitis with late presentation and significant comorbidities. The causes of death were multi-organ failure due to sepsis in the context of high physiological risk (all had MPI scores above 30 and Boey score of 3). Our mortality outcomes are in line with global reports, which show PPU mortality in the range of a few percent up to 20% depending on patient risk factors. In our series, the use of laparoscopy in appropriately selected patients did not increase mortality risk; on the contrary, the lone death in the laparoscopic group occurred in a patient who was borderline for laparoscopic management (and was converted to open). Thus, with proper patient selection, laparoscopy appears as safe as open surgery in terms of survival.

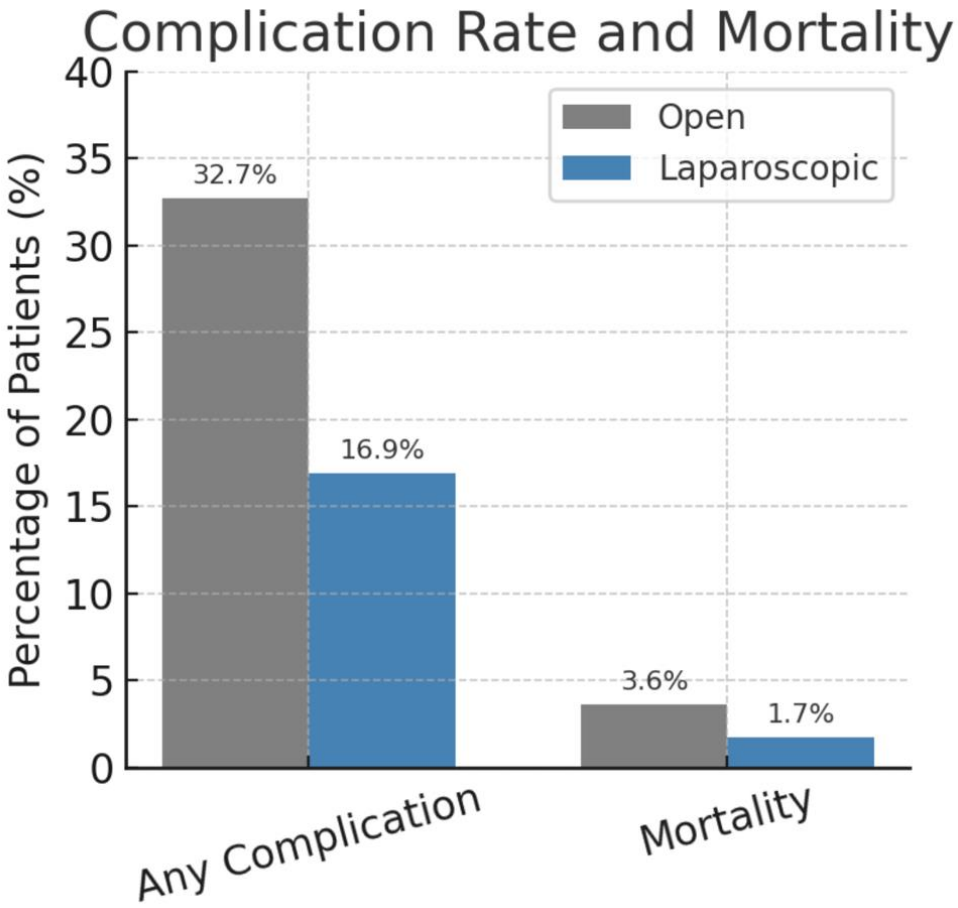

Figure 1. Overall postoperative complication rate and mortality in the open vs laparoscopic groups (percentage of patients). The laparoscopic group had roughly half the incidence of any postoperative complication compared to the open group, while mortality was low and not significantly different between groups. This demonstrates a clear reduction in overall morbidity with the laparoscopic approach

Patients who underwent laparoscopic surgery demonstrated faster postoperative recovery. Resumption of oral feeding and return of bowel function occurred about a day earlier on average in the laparoscopic group than in the open group (mean time to first oral intake ~2 days vs ~3 days, respectively). This correlates with the lower incidence of postoperative ileus observed with the minimally invasive approach. The length of hospital stay was significantly shorter for the laparoscopic group, with a mean of 6.8 days compared to 9.5 days for the open group (p = 0.002).

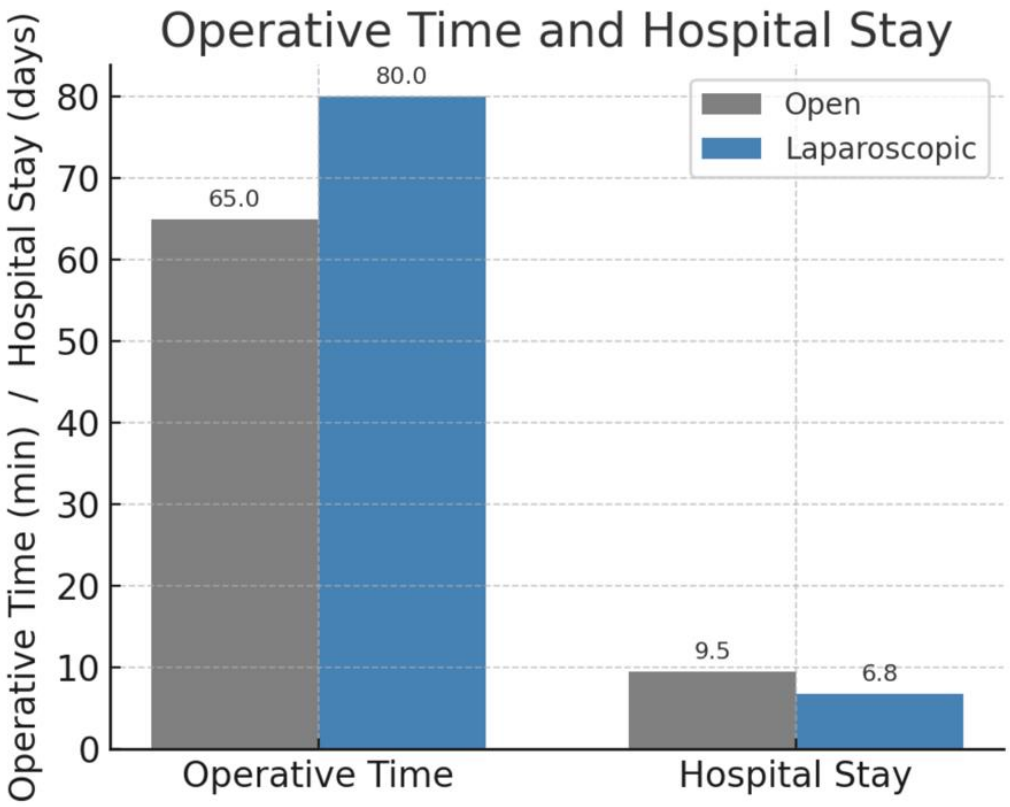

Figure 2. Mean operative time and postoperative hospital stay for open vs laparoscopic surgery groups. The laparoscopic repair had a slightly longer operative time on average, but resulted in a markedly shorter hospital stay, indicating faster recovery. These differences highlight the improved postoperative course with the minimally invasive approach

The shorter hospitalization associated with laparoscopy is an important finding, as it suggests reduced healthcare utilization and a faster convalescence. Patients in the laparoscopic group were typically ready for discharge earlier, once they had stable vital signs, tolerated oral intake, and had no uncontrolled pain or infection. This earlier discharge is directly related to their smoother postoperative course. Additionally, the requirement for postoperative analgesics was lower in the laparoscopic group (we observed less use of opioid analgesics beyond 48 hours post-op), reflecting reduced pain – a benefit noted in prior studies. Early mobilization and rehabilitation were more easily achieved after laparoscopy, contributing to improved outcomes and patient satisfaction.

Based on the findings of our comparative analysis and supported by existing evidence, we can outline practical criteria for selecting patients with perforated peptic ulcer and diffuse peritonitis for laparoscopic intervention. First and foremost, hemodynamic stability is required – patients presenting with septic shock (profound hypotension requiring vasopressors) are poor candidates for laparoscopy and should undergo immediate laparotomy. In our series, all patients who were unstable (systolic BP < 90 mmHg despite resuscitation) were managed with open surgery, given the need for rapid source control without the initial time loss of establishing laparoscopy.

The severity of peritonitis plays a role in decision-making. We found that patients with extremely high Mannheim Peritonitis Index (MPI) scores (>30) or a Peritonitis Severity Score (PSS) >10 had worse outcomes with any surgical approach, and particularly these factors predicted the need for conversion if laparoscopy was attempted. This concurs with other research indicating that an MPI ≥ 30 or PSS > 10 marks very severe peritonitis where primary open surgery is often the safest option. Thus, an MPI in the high range can be used as a criterion favoring an open approach. Conversely, patients with moderate severity (e.g., MPI in the teens or low 20s) can usually be treated laparoscopically with good results.

Another important criterion is the time elapsed since perforation. Generally, if the perforation is identified and operated on within about 12 hours, laparoscopic management is usually feasible. All of our laparoscopic cases had symptom duration under 24 hours. In contrast, prolonged perforation (e.g., >24–36 hours) leads to extensive inflammation, friable tissues, and sometimes walled-off abscesses, which complicate laparoscopic repair. Some authors have recommended using 24 hours as a rough cutoff, beyond which the likelihood of needing conversion rises and outcomes worsen. In our practice, we exercise caution if the history suggests a long delay; such patients are evaluated on a case-by-case basis, considering factors like response to resuscitation and imaging findings.

Imaging and intraoperative findings also guide the surgical approach. Absolute contraindications to laparoscopy in diffuse peritonitis include the presence of dense fibrin deposits and adhesions that cannot be cleared laparoscopically, large loculated abscesses or purulent collections that require manual break-up, and very large perforation size. For instance, a perforation larger than 10 mm in diameter is technically challenging to suture laparoscopically and has a higher risk of leak. We excluded such cases from attempted laparoscopy in our series, or if encountered, we converted to open (two of our conversions were due to a large ulcer size). Similarly, if a patient had a history of extensive upper abdominal surgery (where dense adhesions were anticipated), we found laparoscopy to be impractical – three patients with prior upper abdominal operations were managed with laparotomy from the start. These considerations match established contraindications: dense adhesions, inability to visualize the perforation or a very large ulcer, and inaccessible perforation location (e.g., a posterior wall ulcer) are all strong reasons to choose an open operation.

Our analysis underscores that when the above criteria are met, laparoscopic intervention is the preferable approach for perforated peptic ulcer with diffuse peritonitis. We observed superior outcomes in terms of reduced wound complications and faster recovery, without any compromise in the thoroughness of peritoneal cleansing or in patient safety. This aligns with a growing body of evidence that laparoscopic repair of PPU is both safe and effective in experienced hands. A recent comparative study concluded that laparoscopic surgery should be considered the first-choice approach for patients with perforated peptic ulcer, given its association with fewer complications and shorter hospital stay. Our study reinforces that conclusion in the specific context of diffuse peritonitis, a scenario that has historically made some surgeons hesitant to use laparoscopy.

It is worth noting that while overall morbidity was lower with laparoscopy, the most critical outcomes (such as mortality and need for reoperation due to leak) were equivalent between laparoscopic and open groups. This indicates that, as long as proper surgical technique is applied, minimally invasive surgery does not worsen the fundamental prognosis of the disease. In fact, because we carefully selected patients for laparoscopy, we effectively avoided subjecting the highest-risk patients to potential laparoscopic pitfalls. One can argue that this selection bias is precisely what a criteria-based approach entails – identifying which patients are likely to benefit from laparoscopy and which are not. Through such selection, we ensure that laparoscopy is used in cases where it can be advantageous, and that it is avoided (or promptly converted) in cases where it would likely fail or cause delay.

Our conversion rate of ~8% is acceptable and comparable to other reports (conversion rates of 5–15% have been documented in the literature for laparoscopic PPU repair). Conversion should not be viewed as a failure but rather as a necessary safety net; we concur with other authors that it should be employed at the slightest hint of difficulty that cannot be resolved laparoscopically. By adhering to this principle, none of our laparoscopic patients suffered serious consequences from an attempted minimally invasive approach.

Another point of discussion is the learning curve and surgeon experience. All laparoscopic procedures in this study were performed by surgeons with significant experience in emergency laparoscopy. This likely contributed to the favorable outcomes. If surgical teams are not as

familiar with laparoscopic suturing or management of severe contamination, the open approach might yield better results. Therefore, our criteria assume the availability of surgical skill and equipment for laparoscopy. In centers where these are present, laparoscopy can be broadly applied to perforated ulcer cases. Where they are lacking, the priority is patient safety – an open operation is prudent if a surgeon is uncomfortable with laparoscopic repair in a given situation.

Our findings are consistent with the WSES (World Society of Emergency Surgery) guidelines, which state that a laparoscopic approach is reasonable for stable patients with perforated peptic ulcer, whereas open surgery is recommended for patients who are hemodynamically unstable or have other factors that make laparoscopy high risk. The comparative advantage of laparoscopy in stable cases is supported by multiple randomized trials and meta-analyses as discussed earlier, particularly highlighting reduced wound infections and pain. We add to this body of evidence by demonstrating these advantages specifically in the subset of diffuse peritonitis cases.

Finally, we acknowledge certain limitations in our study. The retrospective design and non-randomized group assignment mean there is inherent selection bias – surgeons likely chose laparoscopy for the less severe cases initially, which could partly explain the better outcomes. We attempted to mitigate this by analyzing risk scores and ensuring groups were comparable in objective measures, but some bias may remain. However, this reflects real-world practice, where clinical judgment is used to select the surgical approach. Additionally, our sample size, while modest, is sufficient to show significant differences in key outcomes; yet, a larger prospective trial would be ideal to further validate these criteria.

Conclusions

1. Based on the comparative analysis of open versus laparoscopic surgical treatment for perforated gastric and duodenal ulcers complicated by diffuse peritonitis, we conclude that a laparoscopic approach, when applied under appropriate selection criteria, offers significant advantages in patient outcomes. Laparoscopic repair resulted in a lower postoperative complication rate – particularly a marked reduction in wound infections – and facilitated faster recovery with shorter hospital stays as compared to the conventional open surgery approach. These benefits were achieved without an increase in mortality or any compromise in the management of peritonitis.
2. Crucially, successful implementation of laparoscopy in this setting depends on careful patient selection and adherence to defined criteria. Patients who are hemodynamically unstable or present with very advanced peritoneal infection (e.g., MPI score ≥ 30, prolonged delay > 24 hours, diffuse fibrin deposits or abscesses) should undergo open surgery for rapid control of sepsis. On the other hand, hemodynamically stable patients, even with diffuse peritonitis, can be considered for laparoscopic repair provided no absolute contraindications are present. Absolute contraindications to laparoscopy include findings such as extensive fibrinous adhesions, multiple interloop abscesses or purulent pockets that cannot be adequately cleaned laparoscopically, and giant ulcer perforations that are difficult to close via minimally invasive means. In such situations, primary open repair is warranted. If laparoscopic surgery is initiated and unexpected adverse factors are encountered, the surgical team should convert to an open procedure without hesitation to ensure patient safety.
3. Our study demonstrates that with these guidelines in mind, over half of perforated ulcer cases with diffuse peritonitis could be managed laparoscopically, leading to improved overall outcomes. The experience and skill of the surgical team are important enabling factors – adequate training in emergency laparoscopy is recommended to widen the eligibility for this approach. In summary, laparoscopic intervention should be the treatment of choice in perforated gastric and duodenal ulcers with diffuse peritonitis for appropriate candidates. By applying clear selection criteria, surgeons can maximize the minimally invasive benefits while minimizing risks, thereby improving the quality of care and prognosis for patients suffering this severe complication of peptic ulcer disease.

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