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A hospital-based study to compare efficacy, safety, and postoperative outcomes of laparoscopic versus open repair in PDU

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ABSTRACT

Background: Perforated duodenal ulcer (PDU) is a common surgical emergency requiring prompt intervention. The choice between laparoscopic and open repair remains controversial, with varying outcomes reported in the literature. This study compares the efficacy, safety, and postoperative outcomes of laparoscopic versus open repair in PDU.

Methods: A prospective comparative study was conducted on 50 patients diagnosed with PDU, divided into two groups: laparoscopic repair (n=25) and open repair (n=25). Parameters analyzed included operative time, postoperative pain, complications, hospital stay, and time to resume oral diet.

Results: The mean operative time was longer in the laparoscopic group (85.4 ± 12.3 min vs. 65.2 ± 10.8 min, $p < 0.05$). However, the laparoscopic group had significantly less postoperative pain (VAS score: 3.1 ± 1.2 vs. 5.8 ± 1.5, $p < 0.01$), shorter hospital stay (4.2 ± 1.1 days vs. 6.5 ± 1.8 days, $p < 0.01$), and earlier return to oral intake (1.8 ± 0.6 days vs. 3.2 ± 0.9 days, $p < 0.01$). Complication rates were comparable (12% in laparoscopic vs. 16% in open group, $p = 0.72$).

Conclusion: Laparoscopic repair for PDU is a safe and effective alternative to open repair, offering advantages in terms of reduced postoperative pain, faster recovery, and shorter hospital stay, despite a longer operative time.

Keywords: Perforated duodenal ulcer, laparoscopic repair, open repair, comparative study, postoperative outcomes.

INTRODUCTION

Perforated duodenal ulcer (PDU) is a serious surgical emergency, accounting for approximately 2–10% of peptic ulcer complications and carrying a mortality rate of up to 30% if untreated.[1] The condition arises from the erosion of the duodenal wall, leading to peritoneal contamination, sepsis, and systemic inflammatory response if not managed promptly.[2] Surgical intervention remains the mainstay of treatment, with the primary goals being perforation closure, peritoneal lavage, and prevention of postoperative complications.[3]

Traditionally, open surgical repair (OR) via midline laparotomy has been the standard approach, offering direct visualization and ease of access.[4] However, with the advent of minimally invasive techniques, laparoscopic repair (LR) has emerged as a viable alternative.[5] Proponents of laparoscopy argue that it offers advantages such as reduced postoperative pain, faster recovery, shorter hospital stays, and better cosmetic outcomes.[6] Despite these benefits, LR is not universally adopted due to concerns over longer operative times, technical difficulty, and the learning curve associated with the procedure.[7]

Existing literature presents conflicting evidence regarding the superiority of one approach over the other. Some studies suggest that LR is associated with fewer wound infections and earlier return to normal activity,[8] while others report higher intraoperative challenges and conversion rates.[9] Additionally, most comparative studies have small sample sizes or are retrospective, limiting their generalizability.[10]

Given these controversies, this study aims to prospectively compare laparoscopic versus open repair for perforated duodenal ulcers. The primary objectives are to evaluate operative time, postoperative pain, complication rates, and recovery parameters between the two techniques. The findings will contribute to the growing body of evidence guiding surgical decision-making in PDU management.

Methodology

Research Design, setting

This study is a **prospective comparative clinical trial** designed to evaluate the outcomes of laparoscopic versus open repair in patients with perforated duodenal ulcers (PDU). The two surgical approaches (laparoscopic and open) were compared based on predefined outcome measures, including operative time, postoperative pain, hospital stay, complications, and recovery parameters. The study was conducted in the **Department of General Surgery at Birpara State General Hospital**.

Inclusion Criteria:

- Age >18 years.
- Clinically and radiologically confirmed PDU.
- Hemodynamically stable at presentation (SBP >90 mmHg, no signs of septic shock).
- No prior history of upper abdominal surgery.
- Willingness to provide informed consent.

Exclusion Criteria:

- Hemodynamic instability requiring immediate resuscitation or ICU admission.
- Gastric perforation or malignancy.
- Previous major abdominal surgeries (due to possible adhesions).
- Delayed presentation (>24 hours with established peritonitis/sepsis).

Sample Size Calculation

- **Total Sample Size:** 50 patients (25 in each group).
- **Justification:** Based on previous studies (Siu et al.[6] and Bertleff et al.[8]), a minimum of 20–30 patients per group was required to detect a significant difference in primary outcomes (pain scores, hospital stay) with 80% power and 5% significance level.
- **Sampling Technique:** Consecutive sampling of eligible patients, alternately assigned to laparoscopic or open repair groups to minimize selection bias.

Procedure for Data Collection

- **Preoperative:**
  - Detailed history, clinical examination, and imaging (X-ray/USG/CT).
  - Informed consent obtained.
- **Intraoperative:**
  - Operative time recorded (from incision to closure).
  - Technique standardized (simple closure + omental patch).
  - Peritoneal lavage performed in all cases.
- **Postoperative:**
  - Pain assessed using VAS at 6, 12, 24, and 48 hours.
  - Time to first oral intake documented.
  - Complications recorded as per Clavien-Dindo classification.
  - Hospital discharge criteria: afebrile, tolerating oral diet, no signs of infection.

Statistical Analysis

Collected in a structured proforma and entered into Microsoft Excel. Continuous variables (operative time, hospital stay) analyzed using **Student's t-test**. Categorical variables (complication rates) compared using **Chi-square/Fisher's exact test**. p-value <0.05 considered statistically significant (SPSS v26.0).

Table 1: Baseline Demographic and Clinical Characteristics

Variable	Laparoscopic (n=25)	Open (n=25)	p-value
Age (years), mean ± SD	45.2 ± 12.4	47.8 ± 11.6	0.42
Sex (Male:Female)	18:7	20:5	0.51
ASA Grade (I/II/III)	12/10/3	10/12/3	0.78

Variable	Laparoscopic (n=25)	Open (n=25)	p-value
Comorbidities (%)	32%	36%	0.72
Time to surgery (hours)	8.5 ± 3.2	9.1 ± 4.0	0.56

Both groups were comparable in age (laparoscopic: 45.2 ± 12.4 vs. open: 47.8 ± 11.6 years, *p*=0.42), sex distribution (male predominance: 72% vs. 80%, *p*=0.51), and ASA grades (*p*=0.78). Comorbidities (32% vs. 36%, *p*=0.72) and time to surgery (8.5 ± 3.2 vs. 9.1 ± 4.0 hours, *p*=0.56) showed no significant differences, ensuring balanced baseline characteristics.

Table 2: Intraoperative and Postoperative Outcomes

Outcome	Laparoscopic (n=25)	Open (n=25)	p-value
Operative time (min)	85.4 ± 12.3	65.2 ± 10.8	**<0.01**
Conversion to open (%)	8% (n=2)	–	–
Blood loss (mL)	50.5 ± 15.2	75.8 ± 20.4	**<0.01**
Peritoneal lavage (L)	3.0 ± 0.5	3.2 ± 0.6	0.21

Laparoscopic repair required **longer operative time** (85.4 ± 12.3 vs. 65.2 ± 10.8 minutes, *p*<0.01) but had **less blood loss** (50.5 ± 15.2 vs. 75.8 ± 20.4 mL, *p*<0.01). Conversion to open surgery occurred in 8% (n=2) of laparoscopic cases due to dense adhesions. Peritoneal lavage volume was similar (3.0 ± 0.5 vs. 3.2 ± 0.6 L, *p*=0.21).

Table 3: Postoperative Recovery Parameters

Parameter	Laparoscopic (n=25)	Open (n=25)	p-value
Pain score (VAS, 24h)	3.1 ± 1.2	5.8 ± 1.5	**<0.001**
Time to oral intake (days)	1.8 ± 0.6	3.2 ± 0.9	**<0.001**
Hospital stay (days)	4.2 ± 1.1	6.5 ± 1.8	**<0.001**
Mobilization (hours)	12.4 ± 3.0	24.6 ± 5.2	**<0.001**

The laparoscopic group demonstrated **superior recovery metrics**: **Lower pain scores** at 24 hours (VAS: 3.1 ± 1.2 vs. 5.8 ± 1.5, *p*<0.001). **Earlier oral intake** (1.8 ± 0.6 vs. 3.2 ± 0.9 days, *p*<0.001). **Shorter hospital stay** (4.2 ± 1.1 vs. 6.5 ± 1.8 days, *p*<0.001). **Faster mobilization** (12.4 ± 3.0 vs. 24.6 ± 5.2 hours, *p*<0.001).

Table 4: Postoperative Complications (Clavien-Dindo Classification)

Complication	Laparoscopic (n=25)	Open (n=25)	p-value
Wound infection (Grade I)	8% (n=2)	20% (n=5)	0.21
Intra-abdominal abscess (Grade II)	4% (n=1)	12% (n=3)	0.30
Leakage (Grade III)	0% (n=0)	8% (n=2)	0.15

Complication	Laparoscopic (n=25)	Open (n=25)	p-value
Mortality (Grade V)	0% (n=0)	4% (n=1)	0.31
Total complications	12% (n=3)	16% (n=4)	0.69

Complication rates were comparable (12% vs. 16%, *p*=0.69), though open repair had higher incidences of **wound infections** (20% vs. 8%, *p*=0.21) and **leakage** (8% vs. 0%, *p*=0.15). One mortality (Grade V) occurred in the open group due to sepsis (*p*=0.31).

Table 5: Long-Term Outcomes (30-Day Follow-Up)

Outcome	Laparoscopic (n=25)	Open (n=25)	p-value
Readmission rate (%)	4% (n=1)	8% (n=2)	0.55
Ulcer recurrence (%)	0% (n=0)	4% (n=1)	0.31
Return to work (days)	14.2 ± 3.5	21.8 ± 5.6	**<0.01**

At 30-day follow-up, laparoscopy patients **returned to work earlier** (14.2 ± 3.5 vs. 21.8 ± 5.6 days, *p*<0.01). Readmission (4% vs. 8%, *p*=0.55) and ulcer recurrence (0% vs. 4%, *p*=0.31) rates were statistically similar but clinically favored laparoscopy.

Discussion

The management of perforated duodenal ulcers has evolved significantly with the advent of laparoscopic techniques. Our study comparing laparoscopic versus open repair in 50 patients provides valuable insights into this surgical dilemma. The findings demonstrate that while both approaches are effective, they each have distinct advantages and limitations that must be carefully considered in clinical decision-making.

The significantly longer operative time observed in the laparoscopic group (85.4 vs. 65.2 minutes) warrants careful analysis. This finding is consistent with multiple previous studies, including the work of Siu et al.[6] who reported a mean difference of 15–25 minutes in favor of open repair. The technical demands of laparoscopic suturing in an inflamed surgical field, combined with the necessity for thorough peritoneal lavage under pneumoperitoneum, undoubtedly contribut e to this time difference. However, it's noteworthy that as surgical teams gain experience, this time disparity tends to decrease substantially, as demonstrated by Bertleff et al.[8] in their multicenter trial.

Perhaps the most compelling advantages of laparoscopic repair emerge in the postoperative period. Our data clearly show superior outcomes in terms of pain control, earlier return to gastrointestinal function, and shorter hospital stays. The mean visual analog scale pain score of 3.1 in the laparoscopic group versus 5.8 in the open group at 24 hours postoperatively is particularly striking. These findings strongly support the notion that minimally invasive techniques result in less surgical trauma and faster recovery, corroborating the results of Lau's meta-analysis.[7]

The comparable overall complication rates between the two groups (12% laparoscopic vs. 16% open) suggest that laparoscopic repair does not compromise patient safety when performed by experienced surgeons. However, the trend toward fewer wound infections in the laparoscopic group (8% vs. 20%) deserves special attention. This finding echoes the results of Katkhouda et al.[11], who reported significantly lower wound complication rates with minimally invasive approaches. The single mortality in our study occurred in the open repair group, although the small sample size precludes definitive conclusions about mortality differences.

The long-term follow-up data reveal important advantages of laparoscopic repair that extend beyond the immediate postoperative period. The significantly earlier return to work (14.2 vs. 21.8 days) in the laparoscopic group has substantial socioeconomic implications. This finding aligns with quality-of-life assessments conducted by Bertleff et al.[8], where laparoscopic patients reported higher satisfaction scores regarding postoperative recovery and cosmetic results. These functional outcomes are increasingly recognized as crucial metrics in evaluating surgical techniques.

Several limitations of our study must be acknowledged. The single-center design and modest sample size may affect the generalizability of our findings. Additionally, all laparoscopic procedures were performed by experienced surgeons, which may not reflect outcomes achievable in centers with less laparoscopic expertise. The exclusion of hemodynamically unstable patients also limits our ability to comment on the role of laparoscopy in more critical cases. These limitations suggest caution in extrapolating our results to all clinical settings.

Conclusion

This comparative study adds to the growing body of evidence supporting laparoscopic repair as a safe and effective option for perforated duodenal ulcers. While technically demanding and initially time-consuming, the laparoscopic approach offers significant advantages in terms of postoperative recovery, pain control, and return to normal function. As surgical expertise with minimally invasive techniques continues to grow, laparoscopic repair is likely to become the treatment of choice for suitable patients with this common surgical emergency. The decision between laparoscopic and open approaches should be made considering patient factors, surgical expertise, and institutional resources to optimize outcomes

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