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Evaluation of outcomes of duodenal ulcer perforation closure using single-port laparoscopic surgery

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Abstract

Objective: *To investigate the clinical and paraclinical characteristics of patients with perforated duodenal ulcers and to evaluate the outcomes of single-port laparoscopic closure of the perforation.* ***Subject and method:*** *A cross-sectional descriptive study combined with a prospective interventional longitudinal follow-up was conducted on 87 patients with perforated duodenal ulcers who underwent single-port laparoscopic closure from January 2021 to January 2024.* ***Result:*** *Among the 87 patients, the mean age was 52.3 ± 10.7 years, with males accounting for 60.9%, primarily in the 41-60 age group (51.7%). A history of peptic ulcer disease was the most common comorbidity (36.8%). In 79.3% of cases, symptoms began abruptly within 12 hours, with abdominal pain (97.7%) and peritoneal signs (92.0%) as the predominant features. Most patients were classified as Boey score 0 (80.5%). The perforation was located on the anterior duodenal bulb in 63.2% of cases, with a size of 5-10 mm in 66.7%. Diagnosis was mainly based on upright abdominal X-rays (74.7%) and CT scans (67.8%). Closure was performed using an X-stitch in 63.2% of patients, with drain placement in 97.7%. The mean operative time was 74.5 minutes. The complication rate was low (4.5%), and no mortality was reported.* ***Conclusion:*** *Duodenal ulcer perforation predominantly affects middle-aged men and typically presents with classic clinical symptoms and a short onset time. Simple suture closure combined with drainage via single-port laparoscopy yields favorable surgical outcomes.*

Keywords: *Perforated ulcer, single-port laparoscopy, duodenal ulcer.*

I. Background

Duodenal ulcer is a common gastrointestinal disease globally, with a prevalence rate of approximately 2.1% among adults [1]. Among its complications, bleeding and perforation are the most common. Statistics show that the incidence of duodenal ulcer perforation ranges from 3.77 to 10 cases per 100,000 people annually [2]. Despite advancements in surgery and resuscitation, the mortality rate from this complication remains concerning, ranging from 2.8% to 9.1% [3]. Single-port laparoscopic surgery (SPLS) represents a significant step in the trend toward minimally invasive surgery, offering aesthetic advantages due to concealed scars at the umbilicus and potentially faster recovery. While there is ongoing debate regarding postoperative pain reduction, this technique has been applied across various fields such as gastrointestinal surgery, urology, and gynecology. In Vietnam, although conventional laparoscopic surgery is widespread, no comprehensive studies have assessed the effectiveness of single-port laparoscopy in treating duodenal ulcer perforation. Therefore, we conducted the study titled "Evaluation of Outcomes of Duodenal

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Ulcer Perforation Closure Using Single-Port Laparoscopic Surgery" with the objectives of: (1) Investigating the clinical and paraclinical characteristics of patients with duodenal ulcer perforation, and (2) Evaluating the outcomes of single-port laparoscopic closure of perforated duodenal ulcers.

2. Subject and method

Study population

The study included 87 patients with duodenal ulcer perforation treated using single-port laparoscopic closure from January 2021 to January 2024.

Inclusion Criteria

Diagnosed with duodenal ulcer perforation based on history, clinical presentation, paraclinical tests, and confirmed intraoperatively with indication for single-port laparoscopic closure.

ASA score ≤ 3.

No complications such as pyloric stenosis or gastrointestinal bleeding.

Male or female patients aged ≥ 16 years.

No restrictions on time from symptom onset to hospital admission.

Consent to participate in the study.

Exclusion Criteria

Gastric ulcer perforation.

Duodenal ulcer perforation with: severe comorbidities (ASA > 3), excessive abdominal distension making laparoscopy unfeasible, concurrent bleeding or pyloric stenosis, or history of multiple abdominal surgeries.

Patients who refused participation.

Study Design:

A cross-sectional descriptive study combined with a prospective interventional longitudinal follow-up.

Sample size:

Fomular:

$$N = ((Z_{1-\alpha/2})^2 \times p(1 - p)) / d^2$$

Where:

N: Minimum sample size for the study

Z: Z-score corresponding to a 95% confidence level ($\alpha = 0.05$), Z = 1.96.

p: Proportion of patients successfully treated with single-port laparoscopic duodenal ulcer perforation repair, based on Ho Huu Thien [4], p=0.973.

d: Relative precision, selected as d=0.05. → Substituting values yields a minimum required sample size of 41.

Sampling method: A convenient sampling method was used. All patients diagnosed with duodenal ulcer perforation and indicated for single-port laparoscopic repair from January 2021 to January 2024, who met the inclusion and exclusion criteria, were enrolled. A total of 87 patients were included in the study.

Data collection and processing method

Study variables:

Demographic and clinical indicators: age, gender, medical history, clinical signs and symptoms, time from perforation to surgery, key paraclinical indicators (biochemical and hematological tests, X-ray, ultrasound, CT scan).

Surgical outcomes: intraoperative findings, operative time, time to first flatus, time to restore gastrointestinal function, postoperative analgesic use, abdominal condition, suture method (simple suture, interrupted, or X-stitch), drain placement, postoperative course, and complications.

Data processing:

Data were analyzed using SPSS version 22.0. Quantitative variables were presented as mean ± standard deviation. Qualitative variables were presented as percentages. T-tests were used to assess differences between two means, with $p<0.05$ considered statistically significant.

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3. Result

Table 1. General Characteristics of the Study Population

Characteristic		Nhóm bệnh (n = 87)	
		Number	**Percentage (%)**
Mean age ± SD		52,3 ± 10,7	
Age group	≤ 40 years	15	17,2
	41 - 60 years	45	51,7
	> 60 years	27	31,0
Gender (male)		53	60,9
Medical history	Peptic ulcer disease	32	36.8
	Chronic hepatitis	12	13.8
	Previous duodenal ulcer perforation repair (via laparoscopy)	3	3.4
	Other previous abdominal surgeries	2	2.3
	Other comorbid conditions	18	20.7

Comments: Table 1 shows that the study group had a mean age of 52.3 ± 10.7 years, with the majority falling within the 41-60 age range (51.7%). The proportion of male patients was high (60.9%). Regarding medical history, peptic ulcer disease was the most common comorbidity (36.8%), followed by other conditions (20.7%) and chronic hepatitis (13.8%). Cases with a history of previous duodenal ulcer perforation repair (3.4%) and other prior abdominal surgeries (2.3%) were recorded at low rates.

Table 2. Clinical and Paraclinical Characteristics

Percentage		Number (n)	Percentage (%)
Clinical Presentation			
Onset	Sudden and severe	82	94,3
	Gradual	5	5,7
Time from onset to hospital admission	< 12	< 12 hours	69
	12-24	12-24 hours	14
	> 24	>24 hours	4
	Meantime (hours)	8,2 ± 4,1 (1-28)	
Typical symptoms	Abdominal pain	85	97,7
	Peritoneal irritation	80	92,0
	Shock	12	13,8
Boey score	Boey 0	70	80,5
	Boey 1	17	19,5
	Boey 2-3	0	0

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Percentage		Number (n)	Percentage (%)
Paraclinical findings			
Subdiaphragmatic (X-ray)	Yes	65	74,7
CT scan (positive findings)	Yes	59	67,8
Ultrasonography	Pneumoperitoneum	47	54,0

Comments: The results show that the majority of patients (94.3%) experienced a sudden and severe onset of symptoms, with 79.3% admitted to the hospital within 12 hours of onset. Common clinical signs included abdominal pain (97.7%) and peritoneal irritation (92.0%), while the incidence of shock was lower (13.8%). Regarding the Boey score, 80.5% of patients were classified as Boey 0, with no cases in Boey 2-3. Paraclinical findings revealed that subdiaphragmatic free air on X-ray was positive in 74.7% of cases, CT scans were positive in 67.8%, and free intraperitoneal air was detected by ultrasound in 54.0% of patients.

Table 3. Intraoperative Characteristics

Characteristic		Number (n)	Percentage (%)
Perforation site	Anterior duodenal bulb	55	63.2
	Posterior duodenal bulb	30	34.5
	Lesser curvature	2	2.3
Perforation size	<5mm	22	25,3
	5-10mm	58	66,7
	>10mm	7	8,0
Peritoneal status	Localized peritonitis	48	55.2
	Generalized peritonitis	39	44.8
Ulcer characteristics	Soft ulcer base	76	87.4
	Fibrotic ulcer base	11	12.6

Comments: The study results show that the perforation was predominantly located on the anterior duodenal bulb (63.2%), with a common perforation size of 5-10mm (66.7%). Most cases presented with localized peritonitis (55.2%) and a soft ulcer base (87.4%).

Table 4. Postoperative outcomes

Characteristics		Number (n)	Percentage (%)
Hole sewing technique	X-stitch suture	55	63,2
	Simple suture	32	36,8
Peritoneal drainage	Yes	85	97,7
Time	Operative time (minutes)	75,2 ± 15,4	
	First flatus (hours)	36,5 ± 8,2 (24-72)	
	GI tract recovery (days)	3,2 ± 1,1 (2-8)	
	Postoperative analgesic use (days)	3,8 ± 0,9 (3-7)	
	Hospital stay (days)	8,1 ± 2,5 (5-16)	

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Comments: The table shows that most patients underwent X-stitch suture closure (63.2%) and nearly all had drain placement (97.7%). The average operative time was 74.5 minutes. Return of bowel function occurred after 36.5 hours, gastrointestinal transit was reestablished after 3.2 days, and the average hospital stay was 8.1 days.

Table 5. Postoperative complications

Complications	Number (n)	Percentage (%)
Wound infection	3	3,4
Trocar site infection	1	1,1
Suture leak	1	1,1
Abscess	0	0
Mortality	0	0

Comments: The results indicate a very low complication rate (wound infection 3.4%, trocar site infection and suture leak 1.1%), with no cases of abscess or mortality reported.

4. Discussion

Our study results show that the average patient age was 52.3 ± 10.7 years, with a markedly higher proportion of male patients (60.9%). This gender distribution aligns with previous studies, indicating that men are generally at higher risk for peptic ulcer disease [5]. The prevalence of comorbid conditions most commonly peptic ulcer disease (36.8%) also corresponds with systematic reviews suggesting that underlying diseases significantly affect surgical outcomes in cases of ulcer perforation [6], [7].

Clinically, the onset of symptoms in our study group was mostly characterized by sudden and severe abdominal pain in 97.7% of patients, reflecting the acute nature of the condition. This is consistent with existing literature, where delayed hospital presentation is associated with worse prognoses [8], [9]. The high rate of hospital admissions within 12 hours (79.3%) highlights the importance of timely intervention a key factor in reducing complications and mortality from perforated ulcers, especially as delayed surgery has been shown to be a negative prognostic indicator [7]. The association between preoperative shock, perforation duration, and postoperative complications is also in line with the Boey scoring system for surgical risk assessment [7], [8].

In terms of paraclinical findings, the presence of subdiaphragmatic free air on X-ray was found in a high proportion (74.7%), reinforcing the diagnostic value of imaging in detecting perforated peptic ulcers. This supports previous studies emphasizing the role of imaging in preoperative evaluation [10]. The most common site of perforation was the anterior duodenal bulb (63.2%), consistent with anatomical patterns typically seen in ulcer disease [6], [11]. Perforation sizes were mainly between 5-10mm, reflecting trends commonly observed in clinical settings.

Regarding surgical management, most patients underwent X-stitch suture closure (63.2%) and nearly all had intra-abdominal drainage (97.7%). According to Ho Huu Thien [4], 91% of patients were treated with X-stitch, while 9% received three separate sutures for larger perforations (> 10mm), with the largest perforation in that study being 15mm in diameter.

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Notably, the complication rates in our study were low wound infection at 3.4% and trocar site infection at 1.1% significantly lower than in previous reports (typically over 10%), suggesting advancements in preoperative preparation and surgical technique [12]. The average hospital stay of 8.1 days also reflects favorable treatment outcomes, compared to earlier studies reporting longer recovery durations [6].

5. Conclusion

The study demonstrates that patients with perforated duodenal ulcers predominantly present with acute onset, characterized by typical clinical features and effectively supported by diagnostic imaging. Single-port laparoscopic suture repair is a feasible, safe, and effective treatment method, offering rapid recovery, minimal complications, and no reported mortality. These results further affirm the role of minimally invasive surgery in the current management of perforated duodenal ulcers.

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