Research Square

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Can Risk Scoring Systems Guide the Selection of Laparoscopic Repair in Emergency Perforated Peptic Ulcer? A Retrospective Cohort Study

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Abstract

Background:

Perforated peptic ulcer (PPU) carries substantial morbidity and mortality and remains a true surgical emergency. Laparoscopic repair is now used more often, but whether it outperforms open surgery is debated, partly because patients selected for laparoscopy differ from those taken to open surgery. Whether clinical risk scores or inflammatory markers can guide this choice is also unclear. We examined whether three clinical scores (Boey, PULP, ASA) and inflammatory and nutritional indices (NLR, SII, PNI) could identify patients who benefit more from laparoscopic than open repair of PPU.

Methods:

We retrospectively reviewed 525 patients operated on for PPU at a tertiary referral center (2015–2025), grouped as laparoscopic (LG, n = 189) or open (OG, n = 336) repair. The primary endpoint was major postoperative complications (Clavien-Dindo ≥ III); secondary endpoints were 30-day mortality, ICU admission, and length of hospital stay. Logistic regression models with interaction terms tested whether the scores and markers modified the effect of surgical approach, and subgroup analyses were performed to generate hypotheses.

Results:

Laparoscopic patients were younger (39.3 vs. 49.8 years, $p < 0.001$), a difference that itself suggests selection bias. They had fewer major complications (6.3% vs. 22.3%, $p < 0.001$), lower 30-day mortality (2.6% vs. 14.6%, $p < 0.001$), fewer ICU admissions (15.3% vs. 37.5%, $p < 0.001$), and a shorter stay. This advantage was not independently significant after adjusting for age, sex, and severity scores (adjusted OR 0.94, 95% CI 0.37–2.40, $p = 0.891$), consistent with confounding by indication. None of the scores or markers showed a significant interaction with surgical approach (all $p > 0.05$). Subgroup analyses suggested a larger laparoscopic benefit in low-risk patients (Boey 0–1, PULP < 8, PNI ≥ 45, perforation ≤ 10 mm), though no significant interaction supported this.

Conclusions:

Unadjusted analyses favor laparoscopic repair, but this apparent benefit is primarily attributable to patient selection rather than the procedure itself. Although the prognostic scores and biomarkers evaluated show strong predictive validity, they do not guide the choice of surgical approach. More sophisticated, patient-specific decision-support tools remain an unmet need in the management of perforated peptic ulcer.

Background

Peptic ulcer disease has become less common as proton pump inhibitors and Helicobacter pylori eradication have entered routine use, but the same decline has not been seen for its severe complications, perforation among them. A perforated peptic ulcer (PPU) is still a surgical emergency that can be fatal, with reported mortality of roughly 10% to 40%, and it remains one of the more demanding problems in emergency general surgery. Older age, coexisting illness, late diagnosis, and septic shock at presentation are the factors most often linked to a poor outcome [1, 2].

Treatment of PPU rests on surgery. Open repair was long the default, but minimally invasive methods have steadily won acceptance since Philippe Mouret first described laparoscopic repair in 1990 [3]. A laparoscopic repair may bring less postoperative pain, fewer wound infections, and a shorter admission. Whether it actually does better on the outcomes that matter most, mortality and severe complications, has not been settled [4, 5].

Randomized trials and meta-analyses point in a consistent direction: laparoscopy can speed early recovery, but overall morbidity and mortality end up much the same for the two approaches [4]. Large database studies add an important caveat, namely that laparoscopy's apparent benefit is shaped by selection bias, since the younger and more stable patients are the ones usually offered a minimally invasive operation [6]. That bias makes head-to-head comparisons hard to read and argues for sharper criteria in choosing who gets which procedure.

Working out who stands to gain most from laparoscopy is therefore an open and clinically important problem. Several scoring tools speak to disease severity and prognosis in PPU, among them the Boey score [7] and the Peptic Ulcer Perforation (PULP) score [8], while the American Society of Anesthesiologists (ASA) grade is commonly used to gauge a patient's overall physiological state [9]. More recent candidates are inflammatory and immunonutritional measures, including the neutrophil-to-lymphocyte ratio (NLR), the systemic immune-inflammatory index (SII) [10], and the prognostic nutritional index (PNI) [11].

How well these tools predict death and complications is well documented; whether they can steer the choice between operations is not. Most prior work has simply pitted laparoscopic against open repair and stopped short of the question that matters more at the bedside, which is which patient belongs in which operation.

We set out to test whether the established scores (Boey, PULP, ASA), used alongside the inflammatory and nutritional indices (NLR, SII, PNI), can flag the patients more likely to benefit from laparoscopic repair of a perforated peptic ulcer. Rather than compare techniques once more, we wanted to put the choice of operation on a more individualized footing in the emergency setting.

Methods

Study Design and Patient Population

The study was a retrospective cohort review carried out in the Department of General Surgery at Prof. Dr. Cemil Taşçıoğlu City Hospital. We examined every patient operated on as an emergency for perforated peptic ulcer from January 1, 2015 through December 31, 2025.

The study was approved by the ethics committee of Prof. Dr. Cemil Taşçıoğlu City Hospital (Approval No: 91-23.02.2026).

Because of the retrospective design, the requirement for individual informed consent was waived by the ethics committee. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Adults (≥ 18 years) treated by laparoscopic or open repair of a perforated gastric or duodenal ulcer were eligible. We excluded malignant perforations, perforation accompanied by gastrointestinal bleeding, primary resections, perforations of non-peptic origin, and records with missing clinical data. Patients were identified using ICD-10 diagnosis codes for peptic ulcer perforation (K25.1, K26.1, K27.1); of 540 patients identified, 15 were excluded after review of pathology and operative reports (11 with malignant perforation confirmed on pathology and 4 with marginal ulcer perforation), leaving 525 patients for analysis (Fig. 1).

Sample size was estimated from a propensity-matched national cohort study reporting overall morbidity of 21.5% after laparoscopic and 39.0% after open repair of perforated peptic ulcer [12]. Based on this absolute difference, a two-sided power calculation ($\alpha = 0.05$) indicated that approximately 107 patients per group would be needed for 80% power and approximately 143 patients per group for 90% power; our final cohort (189 laparoscopic and 336 open repair patients) exceeded both thresholds. As the study was retrospective, all consecutive eligible patients treated during the 11-year study period were included rather than a pre-fixed target number.

Information came from the hospital's electronic records, operative notes, and a prospectively kept database, and every record was anonymized before analysis.

Data Collection and Outcomes

We recorded demographics, clinical findings, laboratory values, and operative details.

The primary outcome was a major postoperative complication, taken as any event of Clavien-Dindo grade III or above, that is, one calling for surgical, endoscopic, or radiological intervention, a life-threatening event needing intensive care, or death.

Secondary outcomes were 30-day mortality, the need for intensive care unit (ICU) admission, and length of stay.

Risk Assessment and Biomarkers

Preoperative risk was graded with the established clinical scores and with laboratory-derived markers.

The Boey score counted three items: shock before operation, a major comorbidity, and symptoms lasting more than 24 hours.

The PULP score was derived from a multivariable model that weighs age, comorbidity, ASA grade, serum creatinine, time since perforation, and preoperative shock.

The PNI combined serum albumin and the peripheral lymphocyte count as a measure of immunonutritional state.

Inflammatory markers were the NLR and the SII.

Surgical Strategy

Patients fell into two strategy groups: the laparoscopic group (LG), covering anyone in whom a laparoscopic repair was attempted whether or not it was later converted, and the open group (OG), covering those taken directly to open repair. Of the 189 patients in the laparoscopic group, 147 (77.8%) underwent a completed laparoscopic repair and 42 (22.2%) were converted to open surgery.

Converted cases stayed in the laparoscopic group for analysis, an intention-to-treat approach that mirrors how the decision plays out in practice.

Perioperative Management and Surgical Technique

Every patient received the same preoperative preparation: nasogastric decompression, urinary catheterization, fluid resuscitation, broad-spectrum antibiotics, and intravenous proton pump inhibitors.

For the laparoscopic operation the patient lay supine in the French position, legs apart and the table tilted about 30° head-up. We created the pneumoperitoneum by an open Hasson approach and held intra-abdominal pressure at 12 mmHg, working through three ports, a single 10-mm and two 5-mm.

Once the perforation was located, it was closed using the laparoscopic modified Graham patch technique: primary closure with atraumatic sutures buttressed by an omental patch. We washed out the abdomen with warm saline and left a drain in every case.

In the open group the abdomen was entered through an upper midline or epigastric incision. Closure of the defect and the omental patch followed the same principles as in the laparoscopic operation; after thorough peritoneal lavage a drain was placed and the operation closed.

Statistical Analysis

Analyses were run in Python 3.12 using pandas, NumPy, SciPy, statsmodels, and scikit-learn, and we treated a two-sided p below 0.05 as significant.

The distribution of continuous variables was assessed with the Kolmogorov-Smirnov test. Continuous data appear as mean ± standard deviation when normally distributed or, where the distribution was skewed, as median with interquartile range, and were compared by Student's t-test or the Mann-Whitney U test accordingly. Categorical data appear as counts and percentages and were compared by the chi-square test.

To see whether any score or marker marked out patients with a different benefit from laparoscopic versus open repair, we built logistic regression models carrying the surgical strategy, the candidate predictor, and their interaction term. A significant interaction was read as evidence that the effect of the operation differed across levels of that predictor. These models were fitted using complete-case analysis; patients with missing values for a given predictor were excluded from that predictor's model, and no imputation was performed. The number of patients available and missing for each predictor is reported in Table 3.

Table 3
Interaction analysis between surgical approach and candidate risk scores/biomarkers.

Predictor	N available (missing)	Interaction p-value
Boey score	512 (13)	0.931
PULP score	514 (11)	0.762
ASA score	523 (2)	0.320
NLR	478 (47)	0.750
SII	478 (47)	0.844
PNI	458 (67)	0.755
Perforation size	501 (24)	0.129

Interaction p-values test whether the effect of surgical approach (laparoscopic vs open) on major complications differs across levels of each predictor, from logistic regression models with a surgical strategy × predictor interaction term. N available indicates patients with non-missing data for that predictor; the number in parentheses is the number missing (out of 525). ASA: American Society of Anesthesiologists; NLR: Neutrophil-to-Lymphocyte Ratio; PNI: Prognostic Nutritional Index; PULP: Peptic Ulcer Perforation score; SII: Systemic Immune-Inflammation Index.

We also ran exploratory subgroup analyses, splitting patients by clinically meaningful cut-offs (low versus high Boey, PULP, ASA grade, PNI, and perforation size) and comparing the two operations within each stratum; these were treated as hypothesis-generating only.

As sensitivity analyses, we repeated the primary outcome comparison after excluding the converted cases (per-protocol analysis) to test whether the intention-to-treat handling of conversions affected the

direction of the result, and we re-estimated the adjusted association between surgical approach and major complications under alternative covariate sets (age and sex alone; with ASA added; with Boey added; and with both added) to assess whether this association was robust to model specification.

Use of Artificial Intelligence

A large language model (Claude Sonnet 4.6, Anthropic) was used solely to assist with English-language writing and editing of the manuscript. It was not used to generate, analyze, or interpret study data, and it does not meet authorship criteria. All content was reviewed and edited by the authors, who take full responsibility for the accuracy and integrity of the work.

Results

The analysis covered 525 patients treated surgically for perforated peptic ulcer. Their mean age was 46.0 ± 19.2 years (median 43, IQR 30–58) and 84.0% were men. By strategy, 189 (36.0%) had a laparoscopic operation, conversions included, and 336 (64.0%) had a primary open repair. The laparoscopic patients were clearly younger (mean 39.3 ± 15.9 vs. 49.8 ± 19.9 years, $p < 0.001$) (Table 1) and more often male (88.9% vs. 81.2%, $p = 0.030$). The groups also differed at baseline on several other measures of preoperative severity: median Boey, PULP, and ASA scores, and CRP, albumin, creatinine, urea, and PNI values all differed significantly between groups (all $p < 0.001$, Table 1), lymphocyte count also differed significantly ($p = 0.003$, Table 1), while WBC, neutrophil count, platelet count, NLR, and SII did not differ significantly (Table 1). The groups thus differed at baseline, consistent with younger and probably lower-risk patients being steered toward laparoscopy.

Table 1
Overall demographics.

Characteristic	LG	OG	P value
N	189	336	
Age, mean ± SD	39.33 ± 15.86	49.78 ± 19.91	< 0.001
Age, median (IQR)	37.00 (26.00–48.00)	48.00 (33.00-65.25)	< 0.001
Male, n (%)	168 (88.9%)	273 (81.2%)	0.030
Female, n (%)	21 (11.1%)	63 (18.8%)	0.030
Boey score, median (IQR)	0.00 (0.00–0.00)	0.00 (0.00–1.00)	< 0.001
PULP score, median (IQR)	1.00 (1.00-1.25)	1.00 (1.00–5.00)	< 0.001
ASA score, median (IQR)	3.00 (3.00–3.00)	3.00 (3.00–3.00)	< 0.001
WBC (x10³/μL), median (IQR)	13.05 (10.01–17.08)	12.32 (9.27–16.48)	0.151
Neutrophil count (x10³/μL), median (IQR)	10.28 (6.65–14.48)	9.68 (6.46–13.93)	0.319
Lymphocyte count (x10³/μL), median (IQR)	1.54 (0.82–2.62)	1.15 (0.68–2.13)	0.003
Platelet count (x10³/μL), median (IQR)	267.00 (217.00-320.00)	268.00 (217.00-327.50)	0.754
CRP (mg/L), median (IQR)	5.17 (1.67–24.32)	30.96 (3.54-176.19)	< 0.001
Albumin (g/dL), median (IQR)	4.20 (3.71–4.47)	3.88 (3.05–4.30)	< 0.001
Creatinine (mg/dL), median (IQR)	0.83 (0.75–0.97)	0.92 (0.76–1.31)	< 0.001
Urea (mg/dL), median (IQR)	30.50 (24.00–39.00)	39.00 (28.00–64.00)	< 0.001
NLR, median (IQR)	6.69 (2.69–16.17)	8.58 (3.97–16.01)	0.111
SII, median (IQR)	1677.47 (728.41-4195.15)	2167.00 (952.27-4439.53)	0.182
PNI, median (IQR)	48.50 (44.27–56.86)	45.12 (35.48–52.44)	< 0.001

LG: Laparoscopic Group; OG: Open Group; IQR: Interquartile Range; ASA: American Society of Anesthesiologists; PULP: Peptic Ulcer Perforation score; WBC: White Blood Cell count; CRP: C-Reactive Protein; NLR: Neutrophil-to-Lymphocyte Ratio; SII: Systemic Immune-Inflammation Index; PNI: Prognostic Nutritional Index.

Postoperative results were better after laparoscopy than after primary open repair. Major complications (Clavien-Dindo ≥ 3) occurred in 6.3% versus 22.3% ($p < 0.001$), 30-day mortality fell to 2.6% from 14.6% ($p < 0.001$), and ICU admission to 15.3% from 37.5% ($p < 0.001$). Once baseline confounders (age, sex, Boey, and ASA scores) were accounted for, the laparoscopic approach no longer showed an independent

association with fewer major complications (adjusted OR 0.94, 95% CI 0.37–2.40, p = 0.891), suggesting that the unadjusted advantage largely reflects confounding by indication rather than a true procedural effect.

Two sensitivity analyses supported these findings. First, in a per-protocol analysis excluding the 42 converted cases, completed laparoscopic repair showed an even larger unadjusted reduction in major complications compared with open repair (4.1% vs. 22.3%; OR 0.15, 95% CI 0.06–0.35, p < 0.001), consistent in direction with the intention-to-treat result. Second, the adjusted association between surgical approach and major complications was consistently attenuated across alternative covariate sets: with age and sex alone, the association remained significant (OR 0.42, 95% CI 0.21–0.84, p = 0.014); adding ASA weakened it to borderline significance (OR 0.44, 95% CI 0.18–1.05, p = 0.065); and adding Boey score, alone or together with ASA, removed the association entirely (OR 1.04, 95% CI 0.44–2.43, p = 0.933; and OR 0.94, 95% CI 0.37–2.40, p = 0.891, respectively). This pattern indicates that baseline severity, and the Boey score in particular, consistently accounted for the apparent surgical-approach effect, regardless of the exact model specification.

Hospital stay was shorter as well (mean 6.2 ± 9.5 vs. 9.1 ± 17.8 days, p < 0.001; median 4 [IQR 4–5] vs. 5 [IQR 4–7] days, p < 0.001) (Table 2).

Table 2
Postoperative outcomes by group.

Outcome	LG	OG	P_value
Major complication (CD ≥ 3)	12 (6.3%)	75 (22.3%)	< 0.001
Mortality	5 (2.6%)	49 (14.6%)	< 0.001
ICU requirement	29 (15.3%)	126 (37.5%)	< 0.001
Length of stay, mean ± SD	6.24 ± 9.50	9.14 ± 17.82	< 0.001
Length of stay, median (IQR)	4.00 (4.00–5.00)	5.00 (4.00–7.00)	< 0.001
LG: Laparoscopic Group; OG: Open Group; ICU: Intensive Care Unit.			

We then used logistic regression with interaction terms to ask whether any score or marker singled out the patients who gained most from laparoscopy.

None of them, Boey (p = 0.931), PULP (p = 0.762), ASA (p = 0.320), NLR (p = 0.750), SII (p = 0.844), PNI (p = 0.755), or perforation size (p = 0.129), interacted significantly with the surgical strategy for major complications (Table 3). In other words, the relative benefit of laparoscopic over open repair held steady across levels of clinical risk and inflammatory burden. Data on NLR, SII, and PNI were available for 478, 478, and 458 patients respectively, and Boey, PULP, ASA, and perforation size for 512, 514, 523, and 501 patients respectively (Table 3); the remaining patients lacked one or more laboratory or clinical values required to calculate the corresponding score or marker.

Exploratory subgroup analyses looked at outcome differences inside clinically relevant risk strata.

In the lower-risk strata, Boey 0–1, PULP < 8, PNI ≥ 45, and perforation ≤ 10 mm, laparoscopy carried fewer major complications than open repair (p between 0.046 and < 0.001), and in some of these strata mortality was lower too.

Among the other higher-risk strata (Boey ≥ 2, PULP ≥ 8, or larger perforations) the gap between the two operations was smaller and mostly non-significant. Low PNI (< 45) was an exception: even in this higher-risk group, laparoscopy was associated with significantly fewer major complications (p = 0.016) and lower 30-day mortality (p = 0.018). Because the primary interaction tests were negative, these subgroup signals should be read cautiously, as hypotheses rather than conclusions (Table 4).

Table 4
Subgroup analysis (exploratory).

Subgroup	Outcome	LG events/n (%)	OG events/n (%)	P value
Boey High (2–3)	Major complication	3/3 (100.0%)	45/49 (91.8%)	1.000
Boey Low (0–1)	Major complication	9/186 (4.8%)	30/287 (10.5%)	0.046
Boey High (2–3)	30-day mortality	3/3 (100.0%)	40/49 (81.6%)	0.976
Boey Low (0–1)	30-day mortality	2/186 (1.1%)	9/287 (3.1%)	0.254
PULP High (≥ 8)	Major complication	4/5 (80.0%)	43/50 (86.0%)	1.000
PULP Low (< 8)	Major complication	8/184 (4.3%)	32/286 (11.2%)	0.015
PULP High (≥ 8)	30-day mortality	3/5 (60.0%)	34/50 (68.0%)	1.000
PULP Low (< 8)	30-day mortality	2/184 (1.1%)	15/286 (5.2%)	0.035
ASA High (≥ 3)	Major complication	12/186 (6.5%)	74/333 (22.2%)	< 0.001
ASA Low (1–2)	Major complication	0/3 (0.0%)	1/3 (33.3%)	1.000
ASA High (≥ 3)	30-day mortality	5/186 (2.7%)	49/333 (14.7%)	< 0.001
ASA Low (1–2)	30-day mortality	0/3 (0.0%)	0/3 (0.0%)	NA
PNI	Major complication	5/145 (3.4%)	22/192 (11.5%)	0.013

LG: Laparoscopic Group; OG: Open Group; ASA: American Society of Anesthesiologists; PNI: Prognostic Nutritional Index; PULP: Peptic Ulcer Perforation score. Subgroup comparisons are exploratory and hypothesis-generating; the corresponding interaction tests are reported in Table 3.

Subgroup	Outcome	LG events/n (%)	OG events/n (%)	P value
High (≥ 45)				
PNI	Major complication	7/44 (15.9%)	53/144 (36.8%)	0.016
Low (< 45)				
PNI	30-day mortality	1/145 (0.7%)	9/192 (4.7%)	0.069
High (≥ 45)				
PNI	30-day mortality	4/44 (9.1%)	40/144 (27.8%)	0.018
Low (< 45)				
Perforation size	Major complication	4/160 (2.5%)	37/258 (14.3%)	< 0.001
≤ 10 mm				
Perforation size	Major complication	8/21 (38.1%)	35/62 (56.5%)	0.229
> 10 mm				
Perforation size	30-day mortality	1/160 (0.6%)	22/258 (8.5%)	0.001
≤ 10 mm				
Perforation size	30-day mortality	4/21 (19.0%)	26/62 (41.9%)	0.104
> 10 mm				

LG: Laparoscopic Group; OG: Open Group; ASA: American Society of Anesthesiologists; PNI: Prognostic Nutritional Index; PULP: Peptic Ulcer Perforation score. Subgroup comparisons are exploratory and hypothesis-generating; the corresponding interaction tests are reported in Table 3.

Taken together, the unadjusted results clearly favored laparoscopy, yet none of the scores or markers could reliably separate the patients who would do better with one operation than the other.

Discussion

PPU is still among the hardest and most dangerous problems in emergency surgery, and its morbidity and mortality have stayed high. Laparoscopic repair has grown more popular for being less invasive, but it is still unclear which patients genuinely gain from it. Ours is one of the few studies to ask whether the traditional risk scores devised for PPU (the Boey score [7], the PULP score [8], and other simplified perforation scores [13]), along with the ASA classification and the newer inflammatory and nutritional markers (NLR, SII, PNI), can actually discriminate between patients in terms of how they fare with one operation versus the other. The key result is that, even though laparoscopy looked better overall, no score or marker showed a significant interaction that would tell us when to choose it over open surgery. The laparoscopic group (36.0%) had fewer major complications (Clavien-Dindo ≥ III; 6.3% vs. 22.3%), lower 30-day mortality (2.6% vs. 14.6%), less need for intensive care, and a shorter stay than the open group

(64.0%). These numbers, though, reflect a strong selection bias more than any direct superiority of laparoscopy. The laparoscopic patients were considerably younger (39.3 vs. 49.8 years), which suggests that surgeons leaned toward laparoscopy for the hemodynamically stable patients with more reserve and kept open surgery for the sicker ones.

Large database studies back up this selection bias. Jayaraman et al., drawing on the ACS-NSQIP database, found that only about 10% of repairs were laparoscopic; once comorbidities were balanced by propensity matching, mortality no longer differed between the groups (3.8% vs. 5.9%), and laparoscopy meant a longer operation but a shorter stay [14]. Akin et al. likewise reported that, in patients matched for preoperative risk such as comparable Boey and Mannheim Peritonitis Index (MPI) values, laparoscopy lowered morbidity (4% vs. 14.6%) and gave a safe, dependable repair [15]. Our subgroup data agree: in the low-risk groups (Boey 0–1, PULP < 8, PNI ≥ 45) laparoscopy significantly reduced morbidity.

The interaction analyses that tested our main hypothesis, however, showed that no score (Boey, PULP, ASA, and the rest) or marker could reliably guide the choice of operation; none of them answered who should have laparoscopy and who should have open surgery. In the high-risk group (Boey ≥ 2, PULP ≥ 8, low PNI) the outcome gap between techniques lost significance. That fits the idea that, in the severe sepsis a PPU can cause, what drives mortality is the degree of systemic derangement, not the length of the incision. Patel et al., in a prospective validation study, identified advanced age, serum creatinine above 1.47 mg/dL, preoperative shock, and more than 24 hours from symptom onset to surgery as the strongest markers of a poor outcome [16]. In Buck et al.'s Danish national cohort of 2,668 patients, every additional hour between admission and surgery raised the adjusted relative risk of death by 2.4%. When inflammation is severe and peritonitis is established, the destructive course of the disease itself outweighs whatever the choice between laparoscopic and open repair might add [17].

The prognostic worth of these scores in PPU has been studied at length. Thorsen et al., in their review, noted that Boey and ASA are the systems used most often in PPU cohorts, though their accuracy swings widely from study to study (AUC 0.63–0.98) [18]. The PULP score, which we also tested and which Møller et al. introduced more recently, stands apart by drawing on more objective inputs such as age, serum creatinine, comorbidity, and preoperative shock [8]. In Patel et al.'s cohort the PULP score (AUC = 0.804) outperformed both Boey (AUC = 0.745) and ASA (AUC = 0.590) for predicting death [16]. Our data suggest these tools forecast survival well but are not enough, on their own, to settle the choice of operation, a distinction that to our knowledge has not previously been drawn.

We also examined the systemic inflammatory and immunonutritional indices (NLR, SII, and PNI) that have drawn so much interest in surgery lately [19–23]. The PNI in particular carries prognostic weight in this setting: in a recent series of 320 PPU patients, Jia and Li found that a low preoperative PNI was an independent predictor of both postoperative morbidity and mortality, with areas under the curve of 0.73 and 0.81, respectively, and with mortality climbing from 1.3% in patients with a normal PNI to 28.7% in those with a severely low value [24]. NLR and SII are likewise recognized markers of surgical stress and

systemic inflammation in intra-abdominal sepsis. In our hands, however, none of these indices reliably guided the choice between laparoscopic and open repair, which fits the view that they capture the host's systemic immune response rather than anything anatomical or specific to the procedure.

Several limitations apply. The design is retrospective and observational. The operating surgeon decided the approach, which left the groups unevenly matched for age and comorbidity and introduced real selection bias. And converted cases were kept within the laparoscopic group under intention-to-treat; although conversions carried higher morbidity than completed laparoscopic repair (14.3% vs. 4.1%), their complication rate remained lower than that of primary open repair (22.3%), so retaining them within the intention-to-treat group modestly diluted, rather than reversed, the observed advantage of completed laparoscopy, as confirmed by the per-protocol sensitivity analysis. Finally, this was a single-center study conducted at a tertiary referral hospital, so surgeon experience, case-mix, and perioperative protocols may not reflect other settings; the findings should be validated in multicenter cohorts before being generalized.

Conclusions

Unadjusted analyses suggest a relative advantage for laparoscopic repair; however, this apparent benefit is primarily attributable to differences in patient selection rather than the procedure itself. Although the prognostic scores and biomarkers we evaluated demonstrate strong predictive validity, they do not provide guidance regarding the optimal surgical approach. Consequently, the development of more sophisticated, patient-specific decision-support tools remains an unmet need in the management of perforated peptic ulcer. Laparoscopy may be considered a reliable first-line surgical approach in low-risk patients (e.g., Boey 0–1, PULP < 8). In high-risk cases, however, morbidity and mortality are driven mainly by delayed presentation and the severity of systemic physiological derangement, rather than by the choice of incision.

Abbreviations

ASA
American Society of Anesthesiologists
AUC
Area Under the Curve
CD
Clavien-Dindo classification
CI
Confidence Interval
CRP
C-Reactive Protein
ICU
Intensive Care Unit

IQR
Interquartile Range
LG
Laparoscopic Group
MPI
Mannheim Peritonitis Index
NLR
Neutrophil-to-Lymphocyte Ratio
OG
Open Group
OR
Odds Ratio
PNI
Prognostic Nutritional Index
PPU
Perforated Peptic Ulcer
PULP
Peptic Ulcer Perforation score
SD
Standard Deviation
SII
Systemic Immune-Inflammation Index
WBC
White Blood Cell count.

Declarations

Ethics approval and consent to participate

The study was approved by the Clinical Research Ethics Committee of Prof. Dr. Cemil Taşçıoğlu City Hospital (Approval No: 91, Date: 23.02.2026) and was conducted in accordance with the principles of the Declaration of Helsinki. Owing to the retrospective design of the study, the requirement for individual informed consent to participate was waived by the ethics committee.

Consent for publication

Not applicable. This manuscript does not contain any individual person’s data in any form (including individual details, images, or videos).

Competing interests

The authors declare that they have no competing interests.

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Author Contribution

MY: concept, design, data collection, analysis and interpretation, writing, critical review. EOY: design, data collection, analysis and interpretation, literature search, critical review.

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Not applicable.

Data Availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

References

1. Johnson CH, McLean RC, McCallum I, Perren D, Phillips AW. An evaluation of the epidemiology, management and outcomes for perforated peptic ulcers across the North of England over 15 years: A retrospective cohort study. Int J Surg. 2019;64:24–32.
2. Dadfar A, Edna TH. Epidemiology of perforating peptic ulcer: A population-based retrospective study over 40 years. World J Gastroenterol. 2020;26:5302–13.
3. Mouret P, François Y, Vignal J, Barth X, Lombard-Platet R. Laparoscopic treatment of perforated peptic ulcer. Br J Surg. 1990;77:1006.
4. Cirocchi R, Soreide K, Di Saverio S, Rossi E, Arezzo A, Zago M, et al. Meta-analysis of perioperative outcomes of acute laparoscopic versus open repair of perforated gastroduodenal ulcers. J Trauma Acute Care Surg. 2018;85:417–25.
5. Quah GS, Eslick GD, Cox MR. Laparoscopic repair for perforated peptic ulcer disease has better outcomes than open repair. J Gastrointest Surg. 2019;23:618–25.

6. Vakayil V, Bauman B, Joppru K, Mallick R, Tignanelli C, Connett J, et al. Surgical repair of perforated peptic ulcers: laparoscopic versus open approach. Surg Endosc. 2019;33:281–92.
7. Boey J, Choi SK, Poon A, Alagaratnam TT. Risk stratification in perforated duodenal ulcers. A prospective validation of predictive factors. Ann Surg. 1987;205:22–6.
8. Møller MH, Engebjerg MC, Adamsen S, Bendix J, Thomsen RW. The Peptic Ulcer Perforation (PULP) score: a predictor of mortality following peptic ulcer perforation. A cohort study. Acta Anaesthesiol Scand. 2012;56:655–62.
9. Saklad M. Grading of patients for surgical procedures. Anesthesiology. 1941;2:281–4.
10. Hu B, Yang XR, Xu Y, Sun YF, Sun C, Guo W, et al. Systemic immune-inflammation index predicts prognosis of patients after curative resection for hepatocellular carcinoma. Clin Cancer Res. 2014;20:6212–22.
11. Onodera T, Goseki N, Kosaki G. Prognostic nutritional index in gastrointestinal surgery of malnourished cancer patients. Nihon Geka Gakkai Zasshi. 1984;85:1001–5.
12. Costa G, Fransvea P, Lepre L, Liotta G, Mazzoni G, Biloslavo A, et al. Perforated peptic ulcer (PPU) treatment: an Italian nationwide propensity score-matched cohort study investigating laparoscopic vs open approach. Surg Endosc. 2023. 10.1007/s00464-023-09998-5.
13. Koranne A, Byakodi KG, Teggimani V, Kamat VV, Hiregoudar A. A comparative study between Peptic Ulcer Perforation Score, Mannheim Peritonitis Index, ASA Score, and Jabalpur Score in predicting the mortality in perforated peptic ulcers. Surg J (N Y). 2022;8:e162–8.
14. Jayaraman SS, Allen R, Feather C, Turcotte J, Klune JR. Outcomes of laparoscopic vs open repair of perforated peptic ulcers: An ACS-NSQIP study. J Surg Res. 2021;265:13–20.
15. Akin E, Altintoprak F, Akdeniz Y, Mantoglu B, Ozdemir K, Firat N, et al. Open versus laparoscopic technique in peptic ulcus perforation, how effective are score systems? Single-center experience and literature review. Ulus Travma Acil Cerrahi Derg. 2022;28:1437–41.
16. Patel S, Kalra D, Kacheriwala S, Shah M, Duttaroy D. Validation of prognostic scoring systems for predicting 30-day mortality in perforated peptic ulcer disease. Turk J Surg. 2019;35:252–8.
17. Buck DL, Vester-Andersen M, Møller MH. Danish Clinical Register of Emergency Surgery. Surgical delay is a critical determinant of survival in perforated peptic ulcer. Br J Surg. 2013;100:1045–9.
18. Thorsen K, Søreide JA, Søreide K. Scoring systems for outcome prediction in patients with perforated peptic ulcer. Scand J Trauma Resusc Emerg Med. 2013;21:25.
19. Tanrikulu Y, Sen Tanrikulu C, Sabuncuoglu MZ, Kokturk F, Temi V, Bicakci E. Is the neutrophil-to-lymphocyte ratio a potential diagnostic marker for peptic ulcer perforation? A retrospective cohort study. Am J Emerg Med. 2016;34:403–6.
20. Salciccioli JD, Marshall DC, Pimentel MA, Santos MD, Pollard T, Celi LA, et al. The association between the neutrophil-to-lymphocyte ratio and mortality in critical illness: an observational cohort study. Crit Care. 2015;19:13.

21. Feng JF, Chen S, Yang X. Systemic immune-inflammation index (SII) is a useful prognostic indicator for patients with squamous cell carcinoma of the esophagus. Med (Baltim). 2017;96:e5886.
22. Kanda M, Fujii T, Kodera Y, Nagai S, Takeda S, Nakao A. Nutritional predictors of postoperative outcome in pancreatic cancer. Br J Surg. 2011;98:268–74.
23. Mohri Y, Inoue Y, Tanaka K, Hiro J, Uchida K, Kusunoki M. Prognostic nutritional index predicts postoperative outcome in colorectal cancer. World J Surg. 2013;37:2688–92.
24. Jia G, Li K. Prognostic Nutritional Index is a useful predictive marker for morbidity and mortality in surgery for perforated peptic ulcer. J Inflamm Res. 2025;18:11021–8.

Figures

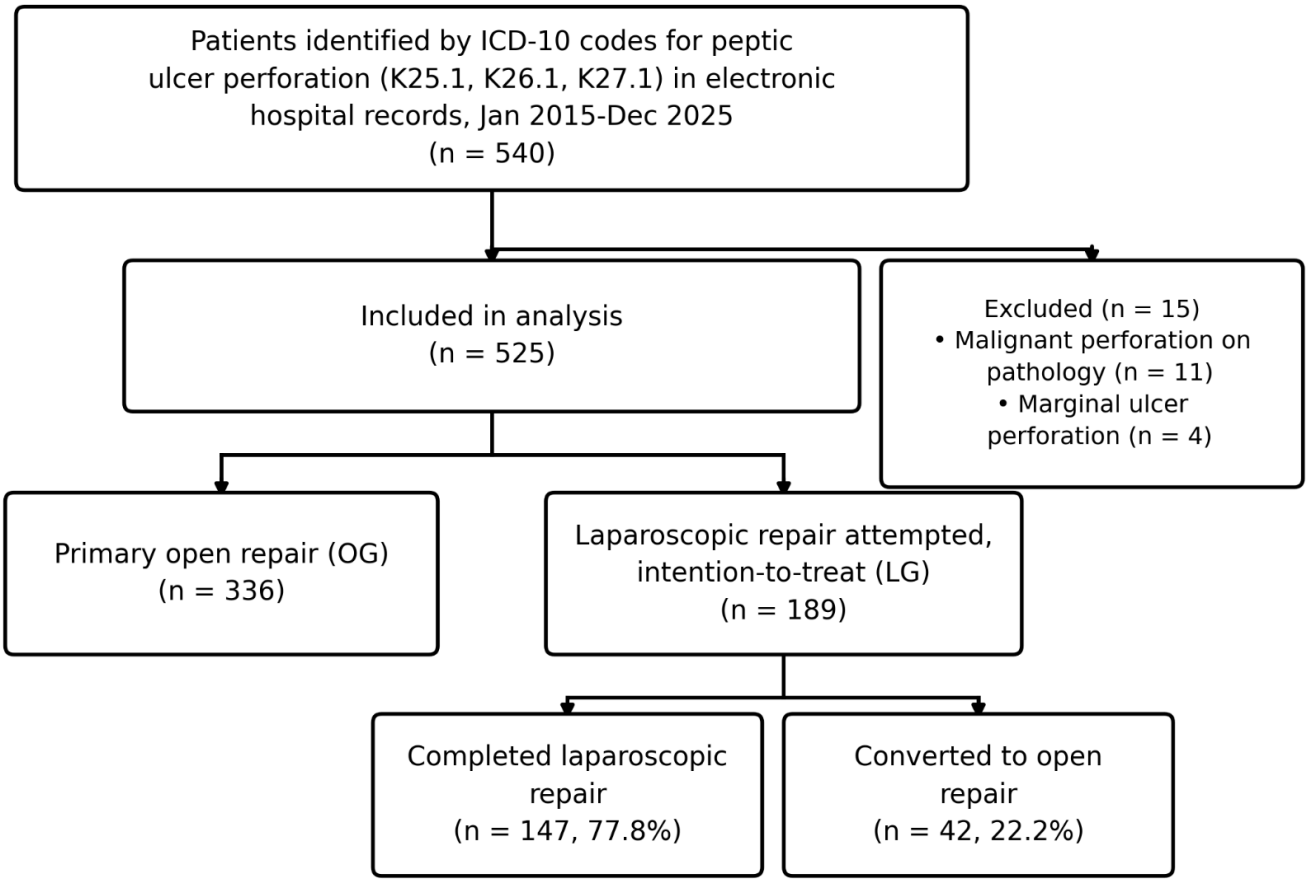


Figure 1

Flow diagram of patient selection and treatment allocation. Patients with perforated peptic ulcer were identified from electronic hospital records using ICD-10 codes K25.1, K26.1, and K27.1 (n = 540). Fifteen patients were excluded (11 with malignant perforation confirmed on pathology and 4 with marginal ulcer perforation), leaving 525 patients for analysis. Of these, 336 underwent primary open repair (OG) and 189 underwent an initial laparoscopic approach on an intention-to-treat basis (LG); within the LG cohort,

147 (77.8%) completed laparoscopic repair and 42 (22.2%) were converted to open repair. LG: Laparoscopic Group; OG: Open Group.