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How do laparoscopic versus open surgical repair techniques compare in terms of patient recovery, complication rates, and mortality for perforated peptic ulcers : A Systematic Review

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ABSTRACT

Introduction: Perforated peptic ulcer (PPU) is a life-threatening surgical emergency traditionally managed by open laparotomy. In recent decades, laparoscopic repair has emerged as a prominent minimally invasive alternative. While benefits such as reduced pain and shorter hospital stays are reported, concerns remain regarding longer operative times, specific complications like suture leakage, and inconclusive mortality data. This systematic review aims to comprehensively compare patient recovery, complication rates, and mortality between laparoscopic and open surgical techniques for PPU.

Methods: A systematic review was conducted following the PRISMA 2020 guidelines. A comprehensive search of five electronic databases (PubMed, Springer, Semantic Scholar, Google Scholar, Wiley Online Library) was performed to identify comparative studies published in the last decade. The review included randomized controlled trials and observational studies comparing laparoscopic and open repair in adult patients with PPU. After screening and eligibility assessment, 26 studies were included for qualitative synthesis.

Results: The synthesis of 26 studies revealed that laparoscopic repair was consistently associated with a significantly shorter postoperative hospital stay (reported in all 16 studies measuring this outcome) and reduced postoperative pain. Furthermore, rates of overall complications and surgical site infections were substantially lower in the laparoscopic group. Conversely, laparoscopy was associated with a longer mean operative time in a majority of studies and a potentially increased risk of suture leakage. The evidence regarding mortality remained inconclusive, as most individual studies were underpowered to demonstrate a statistically significant difference.

Conclusion: Laparoscopic repair offers clear and significant advantages over open surgery regarding postoperative recovery, including shorter hospitalization, less pain, and markedly fewer surgical site infections. It should be considered the standard of care for clinically suitable patients. However, the decision must be tempered by the realities of longer operative times and a small but serious risk of suture leakage, which necessitates careful patient selection and adequate surgical expertise. Future large-scale trials are needed to provide definitive conclusions on mortality.

Keywords: Perforated Peptic Ulcer, Laparoscopic Surgery, Open Surgery, Systematic Review, Complication Rates, Mortality

INTRODUCTION

Perforated peptic ulcer (PPU) is a significant and life-threatening surgical emergency that arises from a full-thickness breach in the wall of the stomach or duodenum, leading to the leakage of gastrointestinal contents into the abdominal cavity. This condition necessitates prompt diagnosis and immediate surgical intervention to prevent peritonitis, sepsis, and mortality. The standard of care has historically been open surgery via laparotomy to repair the perforation. However, with the advancement of surgical technology, minimally invasive laparoscopic repair has emerged as a prominent alternative. The choice between these two surgical modalities—conventional open repair versus laparoscopic surgery—forms a critical point of discussion in modern surgical practice, with each approach presenting a distinct profile of benefits and drawbacks that influence clinical decision-making (Cirocchi et al., 2018; Chan et al., 2022; Sokhal et al., 2024).

Over the past few decades, a substantial body of research has highlighted the advantages of laparoscopic repair for PPU. Numerous studies, including multiple meta-analyses, have consistently demonstrated that a minimally invasive approach is associated with significant improvements in patient recovery. Key benefits frequently reported include reduced postoperative pain, a shorter length of hospital stay, and a lower incidence of surgical site infections. For instance, a comprehensive review of sixteen studies found that hospital stays were universally shorter for patients undergoing laparoscopic surgery. This is complemented by evidence pointing to a markedly lower risk of wound complications and infections, which contributes to a smoother and faster postoperative recovery and return to normal activities for the patient (Quah et al., 2018; Zhou et al., 2015; Waqar et al., 2024).

Despite these clear advantages in recovery and wound-related morbidity, the universal adoption of laparoscopic repair has been tempered by several persistent concerns and areas of conflicting evidence. A primary issue is operative time; a notable portion of the literature reports that laparoscopic procedures are significantly longer than open surgery. Furthermore, while laparoscopy reduces superficial wound infections, some studies have indicated a potentially higher risk of more severe internal complications, specifically suture leakage. The evidence regarding mortality also remains inconclusive. Although several meta-analyses suggest a trend toward lower mortality rates with the laparoscopic approach, most individual studies are not sufficiently powered to establish a statistically significant difference, leaving the comparative impact on patient survival open to debate (Abdullah et al., 2018; Salman et al., 2022; Sokhal et al., 2024).

This existing evidence base, characterized by both consistent findings and unresolved questions, underscores the need for a continually updated and rigorous synthesis of research. While the benefits of laparoscopy in terms of recovery are well-established, the lingering uncertainties regarding operative duration, specific complication rates like suture leakage, and definitive mortality benefits create a crucial knowledge gap. Surgeons and healthcare systems require clear, robust, and comprehensive evidence to guide clinical practice, develop treatment protocols, and ensure optimal patient selection. A systematic review is the ideal methodology to address this gap, as it can pool data from numerous studies to strengthen the evidence, resolve inconsistencies, and provide a more definitive conclusion on the overall safety and efficacy of each surgical technique (Cirocchi et al., 2018; Panin et al., 2021).

Therefore, the primary objective of this systematic review is to comprehensively compare the outcomes of laparoscopic versus open surgical techniques for the treatment of perforated peptic ulcers. This study will systematically identify, appraise, and synthesize the available evidence from recent comparative studies to provide a clear overview of the two approaches. The specific aims are to evaluate the differences in key patient recovery metrics, postoperative complication rates (including wound infections and suture leakage), and overall mortality, thereby offering an evidence-based conclusion on the comparative effectiveness and safety of laparoscopic and open repair for this critical surgical condition (Gasimov et al., 2024; Kumar and Dumpalapudi, 2024; Sokhal et al., 2024).

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METHODS

Protocol

The study strictly adhered to the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020 guidelines to ensure methodological rigor and accuracy. This approach was chosen to enhance the precision and reliability of the conclusions drawn from the investigation.

Criteria for Eligibility

This systematic review aims to evaluate laparoscopic versus open surgical repair techniques compare in terms of patient recovery, complication rates, and mortality for perforated peptic ulcers.

Screening

We screened in sources that met these criteria:

- Adult Population: Does the study exclusively include adult patients (≥18 years) with confirmed perforated peptic ulcer?
- Comparative Study Design: Does the study directly compare laparoscopic and open surgical repair techniques for perforated peptic ulcer?
- Study Type: Is the study either a randomized controlled trial, prospective/retrospective cohort study, or sys- tematic review/meta-analysis?
- Outcome Reporting: Does the study report at least one of the following outcomes: patient recovery metrics, complication rates, or mortality rates?
- Sample Size: If the study is a case series or case report, does it include 10 or more patients?
- Clinical Focus: Does the study focus specifically on perforated peptic ulcer rather than other abdominal con- ditions?
- Study Population Type: Is the study conducted on human subjects (not animal or in-vitro research)?

We considered all screening questions together and made a holistic judgement about whether to screen in each paper.

Data extraction

- Study Design:

  Identify the specific type of study design. Look in the methods section for explicit description of study design. Possible answers include:

- Randomized controlled trial (RCT)
- Prospective comparative study
- Retrospective comparative study

If multiple design descriptors are present, list all in order of specificity. If unclear, note ”study design not clearly specified”.

- Randomization Method:

  Locate details about randomization in methods section. Extract:

- Method of randomization (e.g., computer-generated, block randomization)
- Whether allocation was concealed
- If randomization was truly random

If insufficient details are provided, mark as ”randomization method not fully described”.

- Patient Population Characteristics:

  Extract key demographic and clinical characteristics:

- Total sample size
- Number in each intervention group
- Mean/median age
- Gender distribution
- Key inclusion/exclusion criteria
- Relevant clinical characteristics (e.g., Boey score, ASA grade)

Report numerical data with appropriate measures of central tendency and spread. If ranges are provided, include those.

- Surgical Intervention Details:

  For both laparoscopic and open repair groups, extract:

- Specific surgical technique used
- Duration of operation (mean/median with range)
- Any specific procedural variations
- Perioperative management details

Be precise about technical details. If multiple techniques are mentioned, list all observed variations.

- Primary Outcome Measures:

  Extract all primary outcome measures with:

- Specific metrics
- Numerical results
- Statistical significance
- Confidence intervals (if provided)

Key outcomes to focus on:

- Postoperative morbidity rates
- Hospital stay duration
- Postoperative pain
- Complication rates
- Mortality

Report exact numerical values and statistical significance levels.

- Study Setting and Time Frame:

  Extract:

- Geographic location of study

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- Hospital/institutional setting
- Exact dates of patient enrollment
- Duration of patient follow-up

If multiple time periods are mentioned, prioritize patient enrollment period and total follow-up duration.

Search Strategy

The keywords used for this research based PICO :

Element	Keyword 1	Keyword 2	Keyword 3	Keyword 4
Population (P)	Perforated Peptic Ulcer	Perforated Duodenal Ulcer	Perforated Gastroduodenal Ulcer	Complicated Peptic Ulcers
Intervention (I)	Laparoscopic Surgery	Laparoscopic Repair	Minimally Invasive Surgery	Laparoscopic Omental Patch Repair
Comparison (C)	Open Surgery	Open Repair	Laparotomy	Conventional Surgery
Outcome (O)	Patient Recovery	Complication Rates	Mortality	Morbidity

The Boolean MeSH keywords inputted on databases for this research are: *("Perforated Peptic Ulcer" OR "Perforated Duodenal Ulcer" OR "Perforated Gastroduodenal Ulcer" OR "Complicated Peptic Ulcers") AND ("Laparoscopic Surgery" OR "Laparoscopic Repair" OR "Minimally Invasive Surgery" OR "Laparoscopic Omental Patch Repair") AND ("Open Surgery" OR "Open Repair" OR "Laparotomy" OR "Conventional Surgery") AND ("Patient Recovery" OR "Complication Rates" OR "Mortality" OR "Morbidity")*

Data retrieval

Abstracts and titles were screened to assess their eligibility, and only studies meeting the inclusion criteria were selected for further analysis. Literature that fulfilled all predefined criteria and directly related to the topic was included. Studies that did not meet these criteria were excluded. Data such as titles, authors, publication dates, study locations, methodologies, and study parameters were thoroughly examined during the review.

Quality Assessment and Data Synthesis

Each author independently assessed the titles and abstracts of the selected studies to identify those for further exploration. Articles that met the inclusion criteria underwent further evaluation. Final decisions on inclusion were based on the findings from this review process.

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Table 1. Article Search Strategy

Database	Keywords	Hits
Pubmed	*("Perforated Peptic Ulcer" OR "Perforated Duodenal Ulcer" OR "Perforated Gastroduodenal Ulcer" OR "Complicated Peptic Ulcers") AND ("Laparoscopic Surgery" OR "Laparoscopic Repair" OR "Minimally Invasive Surgery" OR "Laparoscopic Omental Patch Repair") AND ("Open Surgery" OR "Open Repair" OR "Laparotomy" OR "Conventional Surgery") AND ("Patient Recovery" OR "Complication Rates" OR "Mortality" OR "Morbidity")*	76
Semantic Scholar	*("Perforated Peptic Ulcer" OR "Perforated Duodenal Ulcer" OR "Perforated Gastroduodenal Ulcer" OR "Complicated Peptic Ulcers") AND ("Laparoscopic Surgery" OR "Laparoscopic Repair" OR "Minimally Invasive Surgery" OR "Laparoscopic Omental Patch Repair") AND ("Open Surgery" OR "Open Repair" OR "Laparotomy" OR "Conventional Surgery") AND ("Patient Recovery" OR "Complication Rates" OR "Mortality" OR "Morbidity")*	2
Springer	*("Perforated Peptic Ulcer" OR "Perforated Duodenal Ulcer" OR "Perforated Gastroduodenal Ulcer" OR "Complicated Peptic Ulcers") AND ("Laparoscopic Surgery" OR "Laparoscopic Repair" OR "Minimally Invasive Surgery" OR "Laparoscopic Omental Patch Repair") AND ("Open Surgery" OR "Open Repair" OR "Laparotomy" OR "Conventional Surgery") AND ("Patient Recovery" OR "Complication Rates" OR "Mortality" OR "Morbidity")*	464
Google Scholar	*("Perforated Peptic Ulcer" OR "Perforated Duodenal Ulcer" OR "Perforated Gastroduodenal Ulcer" OR "Complicated Peptic Ulcers") AND ("Laparoscopic Surgery" OR "Laparoscopic Repair" OR "Minimally Invasive Surgery" OR "Laparoscopic Omental Patch Repair") AND ("Open Surgery" OR "Open Repair" OR "Laparotomy" OR "Conventional Surgery") AND ("Patient Recovery" OR "Complication Rates" OR "Mortality" OR "Morbidity")*	99
Wiley Online Library	*("Perforated Peptic Ulcer" OR "Perforated Duodenal Ulcer" OR "Perforated Gastroduodenal Ulcer" OR "Complicated Peptic Ulcers") AND ("Laparoscopic Surgery" OR "Laparoscopic Repair" OR "Minimally Invasive Surgery" OR "Laparoscopic Omental Patch Repair") AND ("Open Surgery" OR "Open Repair" OR "Laparotomy" OR "Conventional Surgery") AND ("Patient Recovery" OR "Complication Rates" OR "Mortality" OR "Morbidity")*	252

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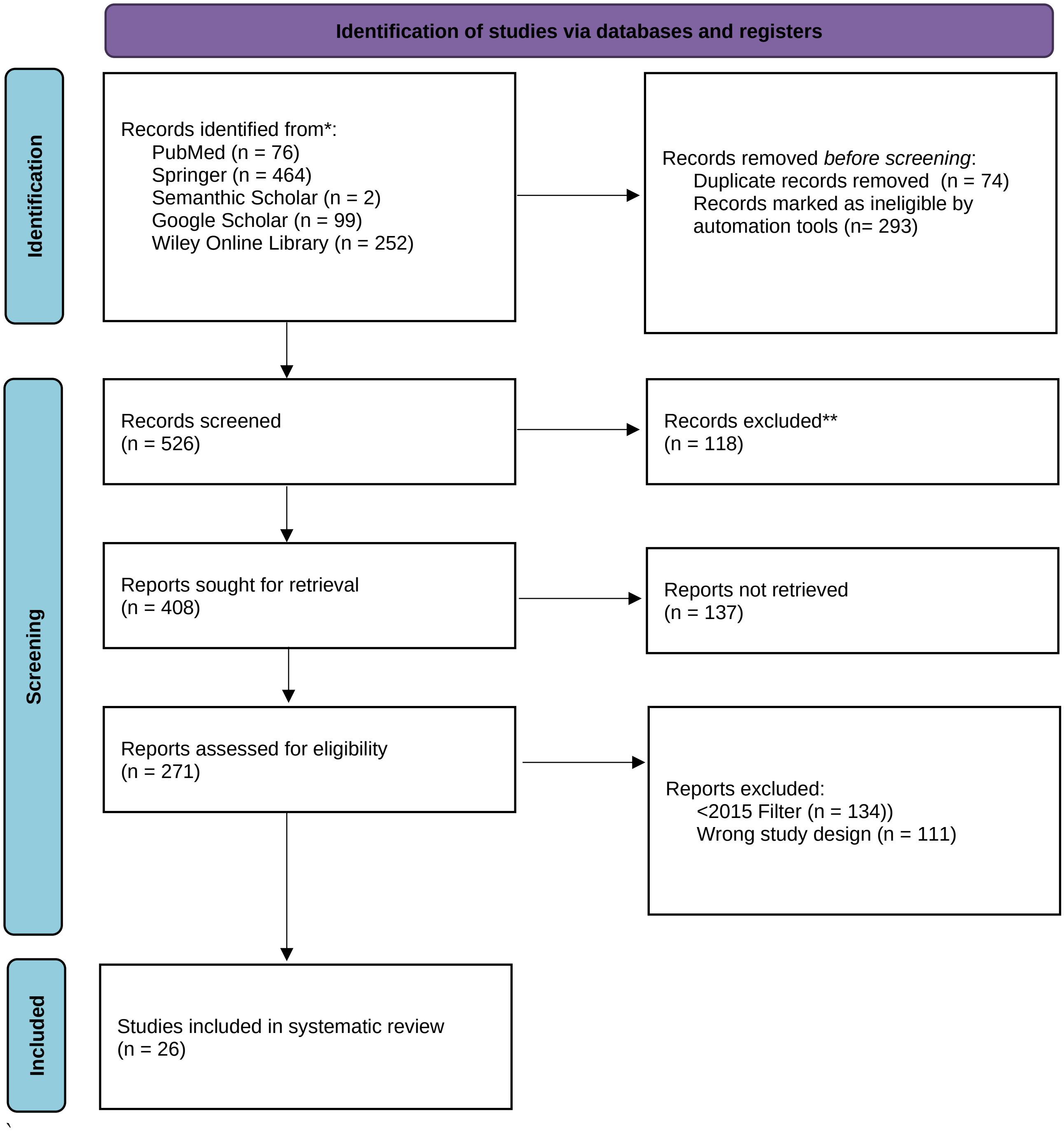

Figure 1. Article search flowchart

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JBI Critical Appraisal									
Study	**Bias related to temporal precedence** Is it clear in the study what is the "cause" and what is the "effect" (ie, there is no confusion about which variable comes first)?	**Bias related to selection and allocation** Was there a control group?	**Bias related to confounding factors** Were participants included in any comparisons similar?	**Bias related to administration of intervention/exposure** Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?	**Were there multiple measurements of the outcome, both pre and post the intervention/exposure?**	**Were the outcomes of participants included in any comparisons measured in the same way?**	**Were outcomes measured in a reliable way?**	**Bias related to participant retention** Was follow-up complete and, if not, were differences between groups in terms of their follow-up adequately described and analyzed?	**Statistical conclusion validity** Was appropriate statistical analysis used?
Siew et al., 2016	✓	✓	✓	✗	✓	✗	✓	✓	✓
Quah et al., 2018	✓	✓	✓	✗	✓	✗	✓	✓	✓
Abdullah et al., 2018	✓	✓	✓	✗	✓	✗	✓	✓	✓
Cirocchi et al., 2018	✓	✓	✓	✗	✓	✗	✓	✓	✓

Sokhal et al., 2024	✓	✓	✓	✗	✓	✗	✓	✓	✓
Wang et al., 2017	✓	✓	✓	✗	✓	✗	✓	✓	✓
Ge et al., 2016	✓	✓	✓	✗	✓	✗	✓	✓	✓
Zhou et al., 2015	✓	✓	✓	✗	✓	✗	✓	✓	✓
Salman et al., 2022	✓	✓	✓	✗	✓	✗	✓	✓	✓
Shah et al., 2015	✓	✓	✓	✗	✓	✗	✓	✓	✓
Chan et al., 2022	✓	✓	✓	✗	✓	✗	✓	✓	✓
Kumar and Dumpalapudi, 2024	✓	✓	✓	✗	✓	✗	✓	✓	✓
Panin et al., 2021	✓	✓	✓	✗	✓	✗	✓	✓	✓
Saleh et al., 2019	✓	✓	✓	✗	✓	✗	✓	✓	✓
Zedan et al., 2015	✓	✓	✓	✗	✓	✗	✓	✓	✓
Elshora et al., 2023	✓	✓	✓	✗	✓	✗	✓	✓	✓

Kumar et al., 2022	✓	✓	✓	✗	✓	✗	✓	✓	✓
Somashekhar and Gondi, 2023	✓	✓	✓	✗	✓	✗	✓	✓	✓
Fazal et al., 2025	✓	✓	✓	✗	✓	✗	✓	✓	✓
Taha et al., 2023	✓	✓	✓	✗	✓	✗	✓	✓	✓
Odisho et al., 2022	✓	✓	✓	✗	✓	✗	✓	✓	✓
Budzyński et al., 2015	✓	✓	✓	✗	✓	✗	✓	✓	✓
Tag El-Din, 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
Zhang et al., 2018	✓	✓	✓	✗	✓	✗	✓	✓	✓
Gasimov et al., 2024	✓	✓	✓	✗	✓	✗	✓	✓	✓
Waqar et al., 2024	✓	✓	✓	✗	✓	✗	✓	✓	✓

RESULTS

Characteristics of Included Studies

Study	Sample Size	Primary Outcomes Measured
Siew et al., 2016	131	Morbidity, hospital stay, pain, complications, mortality
Quah et al., 2018	7 randomized controlled trials (sample size no mention found)	Morbidity, wound infection, hospital stay
Abdullah et al., 2018	80 (33 laparoscopic, 37 open)	Operative time, pain, hospital stay, morbidity, mortality
Cirocchi et al., 2018	8 randomized controlled trials (615 patients)	Pain, wound infection, mortality, reoperation, leaks, abscess, hospital stay
Sokhal et al., 2024	9 randomized controlled trials (670 patients)	Mortality, complications, ileus, wound complications, hospital stay
Wang et al., 2017	119 (58 laparoscopic, 61 open)	Complications, pain, hospital stay, mortality
Ge et al., 2016	119 (58 laparoscopic, 61 open)	Operative time, pain, hospital stay, complications

Study	Sample Size	Primary Outcomes Measured
Zhou et al., 2015	5,268 (1,890 laparoscopic, 3,378 open)	Complications, hospital stay, pain, mortality
Salman et al., 2022	45 studies (8,456 patients)	Operative time, hospital stay, suture leakage, mortality, wound infection
Shah et al., 2015	50 (25 laparoscopic, 25 open)	Operative time, pain, complications, hospital stay, return to activity
Chan et al., 2022	29 studies (5,311 patients)	Mortality, morbidity, wound infection, hospital stay, leakage
Kumar and Dumpalapudi, 2024	120 (60 laparoscopic, 60 open)	Morbidity, mortality, hospital stay
Panin et al., 2021	1,177 (503 laparoscopic, 674 open)	Operative time, hospital stay, complications, mortality
Saleh et al., 2019	461 (311 open, 132 laparoscopic, 20 converted)	Complications, hospital stay, reoperation, mortality
Zedan et al., 2015	50 (25 laparoscopic, 25 open)	Operative time, pain, complications, hospital stay, return to activity
Elshora et al., 2023	98 (31 laparoscopic, 67 open)	Complications, hospital stay, pain,

Study	Sample Size	Primary Outcomes Measured
		mortality
Kumar et al., 2022	50 (25 laparoscopic, 25 open)	Pain, hospital stay, complications, mortality
Somashekhar and Gondi, 2023	40 (20 laparoscopic, 20 open)	Hospital stay, pain, complications, return to work
Fazal et al., 2025	64 (32 laparoscopic, 32 open)	Operative time, hospital stay, complications, return to activity
Taha et al., 2023	151 (75 laparoscopic, 76 open)	Complications, pain, hospital stay, return to activity
Odisho et al., 2022	49 (16 laparoscopic, 33 open)	Morbidity, hospital stay, pain, mortality
Budzyński et al., 2015	351 (245 open, 106 laparoscopic)	Complications, hospital stay, mortality, reoperation
Tag El-Din, 2020	84 (42 laparoscopic, 42 open)	Operative time, pain, hospital stay, complications
Zhang et al., 2018	1,018 (505 laparoscopic, 513 open)	Complications, hospital stay, pain, mortality

Study	Sample Size	Primary Outcomes Measured
Gasimov et al., 2024	261 (164 open, 97 laparoscopic)	Complications, hospital stay, reoperation, mortality
Waqar et al., 2024	86 (43 laparoscopic, 43 open)	Surgical site infection

Primary Outcomes Measured:

- Hospital stay: measured in 25 studies.
- Complications: measured in 18 studies.
- Pain: measured in 15 studies.
- Mortality: measured in 17 studies.
- Morbidity: measured in 6 studies.
- Operative time: measured in 8 studies.
- Wound infection: measured in 4 studies; wound complications in 1 study.
- Reoperation: measured in 3 studies.
- Return to activity or work: measured in 5 studies (4 as ”return to activity,” 1 as ”return to work”).
- Leakage or suture leakage: measured in 2 studies.
- Ileus, abscess, and surgical site infection: each measured in 1 study.

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Effects

Operative Metrics

Study	Outcome Measure	Laparoscopic Results	Open Surgery Results	Clinical Significance
Siow et al., 2016	Operative time	No significant difference	No significant difference	No significant difference
Abdullah et al., 2018	Operative time	61 minutes	46.54 minutes	p-value <0.001 (longer in laparoscopic)
Wang et al., 2017	Operative time	No significant difference	No significant difference	No significant difference
Ge et al., 2016	Operative time	70 minutes (interquartile range 60-90)	75 minutes (interquartile range 60-90)	p-value =0.692 (no significant difference)
Shah et al., 2015	Operative time	60 minutes	90 minutes	p-value <0.05 (shorter in laparoscopic)
Kumar and Dumpalapudi, 2024	Operative time	212.8 minutes	107 minutes	p-value <0.001 (longer in laparoscopic)

Study	Outcome Measure	Laparoscopic Results	Open Surgery Results	Clinical Significance
Somashekhar and Gondi, 2023	Operative time	143.8 minutes	60 minutes	p-value <0.05 (longer in laparoscopic)
Fazal et al., 2025	Operative time	102.38 minutes	66.53 minutes	p-value <0.001 (longer in laparoscopic)
Taha et al., 2023	Operative time	95±10.6 minutes	65±14.6 minutes	Longer in laparoscopic
Odisho et al., 2022	Operative time	117.1 minutes	85.6 minutes	p-value =0.010 (longer in laparoscopic)
Budzyński et al., 2015	Operative time	83 minutes	62 minutes	p-value <0.0001 (longer in laparoscopic)
Tag El-Din, 2020	Operative time	80.46 minutes	75.29 minutes	p-value =0.082 (no significant difference)
Gasimov et al., 2024	Operative time	46.2 minutes	71.0 minutes	p-value <0.001 (shorter in

Study	Outcome Measure	Laparoscopic Results	Open Surgery Results	Clinical Significance
				laparoscopic)
Waqar et al., 2024 (Meta-analyses)	Operative time	No mention found. Generally longer in laparoscopic	No mention found. -	Consistent trend, but not always significant

Summary of Operative Time Findings:

- 6 of 14 studies found that laparoscopic surgery had a significantly longer operative time than open surgery.
- 2 of 14 studies found that laparoscopic surgery had a significantly shorter operative time than open surgery.
- 1 of 14 studies found longer operative time for laparoscopy, but we did not find a statistical significance value.
- 4 of 14 studies found no statistically significant difference in operative time between laparoscopic and open surgery.
- Meta-analyses described a consistent trend toward longer operative time for laparoscopy, but this was not always statistically significant.

Recovery Indicators

Study	Outcome Measure	Laparoscopic Results	Open Surgery Results	Clinical Significance
Siow et al., 2016	Hospital stay	Shorter	Longer	p-value =0.008 (shorter in laparoscopic)
Quah et al., 2018	Hospital stay	6.6 days	8.2 days	p-value =0.01 (shorter in laparoscopic)
Abdullah et al., 2018	Hospital stay	5.72 days	8.77 days	p-value <0.001 (shorter in laparoscopic)
Wang et al., 2017	Hospital stay	7 days (5-9)	8 days (7-10)	p-value =0.001 (shorter in laparoscopic)
Ge et al., 2016	Hospital stay	7 days (5-9)	8 days (7-10)	p-value <0.001 (shorter in laparoscopic)
Shah et al., 2015	Hospital stay	3 days	8 days	p-value <0.05 (shorter in laparoscopic)

Study	Outcome Measure	Laparoscopic Results	Open Surgery Results	Clinical Significance
Chan et al., 2022	Hospital stay	-2.84 days (mean difference)	-	p-value <0.00001 (shorter in laparoscopic)
Kumar and Dumpalapudi, 2024	Hospital stay	7.1 days	11.7 days	Mean difference 4.6 days (95% confidence interval 4.6-5.2)
Somashekhar and Gondi, 2023	Hospital stay	7.25 days	11.7 days	p-value <0.05 (shorter in laparoscopic)
Fazal et al., 2025	Hospital stay	8.47 days	10.03 days	p-value =0.005 (shorter in laparoscopic)
Taha et al., 2023	Hospital stay	5±1.54 days	8±1.6 days	Shorter in laparoscopic
Odisho et al., 2022	Hospital stay	3.7 days	16.1 days	p-value <0.001 (shorter in laparoscopic)

Study	Outcome Measure	Laparoscopic Results	Open Surgery Results	Clinical Significance
Budzyński et al., 2015	Hospital stay	6 days	9 days	p-value <0.0001 (shorter in laparoscopic)
Tag El-Din, 2020	Hospital stay	4 days	5 days	p-value =0.009 (shorter in laparoscopic)
Gasimov et al., 2024	Hospital stay	6.9 days	12.2 days	p-value <0.001 (shorter in laparoscopic)
Waqar et al., 2024 (Meta-analyses)	Hospital stay	Shorter in laparoscopic	-	Consistent across reviews

Summary of Hospital Stay Findings:

- 16 studies (including meta-analyses) compared hospital stay between laparoscopic and open surgery; all 16 found a shorter hospital stay for laparoscopy.
- 13 studies reported a statistically significant difference (p-value <0.05) favoring laparoscopy.
- 3 studies (Kumar and Dumpalapudi, 2024; Taha et al., 2023; meta-analyses) reported a shorter hospital stay for laparoscopy but did not provide a p-value.
- Reported mean or median hospital stay for laparoscopy ranged from 3 to 8.47 days across studies.

- Reported mean or median hospital stay for open surgery ranged from 5 to 16.1 days.
- Where mean differences were reported, the difference in hospital stay ranged from -2.84 to 4.6 days shorter for laparoscopy.

Complications and Mortality Early Complications

Study	Complication Type	Laparoscopic Incidence	Open Surgery Incidence	Risk Factors
Siow et al., 2016	Any complication	14.3%	36.8%	No mention found
Quah et al., 2018	Morbidity	8.9%	17.0%	No mention found
Abdullah et al., 2018	Wound infection	5.6%	34.6%	No mention found
Cirocchi et al., 2018	Wound infection	Relative risk 0.39	-	No mention found
Sokhal et al., 2024	Total complications	Relative risk 0.57	-	No mention found
Wang et al., 2017	Leak	5.2%	0%	No mention found

Study	Complication Type	Laparoscopic Incidence	Open Surgery Incidence	Risk Factors
Ge et al., 2016	Complications	No significant difference	No significant difference	No mention found
Zhou et al., 2015	Wound infection	Relative risk 0.28	-	No mention found
Salman et al., 2022	Suture leakage	Relative risk 1.91 (higher in laparoscopic)	-	No mention found
Shah et al., 2015	Complications	0	6	No mention found
Chan et al., 2022	Surgical site infection	Odds ratio 0.27	-	No mention found
Kumar and Dumpalapudi, 2024	Wound discharge	5%	85%	No mention found
Panin et al., 2021	Complications	2.4%	11.4%	No mention found

Study	Complication Type	Laparoscopic Incidence	Open Surgery Incidence	Risk Factors
Saleh et al., 2019	30-day complications	18.5%	27.5%	No mention found
Zedan et al., 2015	Wound infection	4.7%	29%	No mention found
Elshora et al., 2023	Early complications	9.6%	13.4%	No mention found
Kumar et al., 2022	Surgical site complications	Lower	Higher	No mention found
Somashekhar and Gondi, 2023	Complications	Lower	Higher	No mention found
Fazal et al., 2025	Complications	Fewer	More	No mention found
Taha et al., 2023	Chest infection	2.6%	19.7%	No mention found
Odisho et al., 2022	Morbidity	12.5%	39.4%	No significant difference

Study	Complication Type	Laparoscopic Incidence	Open Surgery Incidence	Risk Factors
Budzyński et al., 2015	Complications	13.5%	23.3%	p-value =0.0312
Tag El-Din, 2020	Surgical site infection	4.76%	23.81%	p-value =0.001
Zhang et al., 2018	Wound infection	Reduced	-	No mention found
Gasimov et al., 2024	Complications	4.8%	7.3%	No mention found
Waqar et al., 2024	Surgical site infection	2.33%	25.58%	p-value =0.002

Summary of Early Complications:

- 11 studies reported on any/total/overall complications.
- 10 studies reported on wound or surgical site infection/discharge.
- 2 studies reported on leak or suture leakage.
- 2 studies reported on morbidity.
- 1 study reported on chest infection.

Direction of Effect (laparoscopic vs open):

- In 23 studies, the incidence of complications was lower for laparoscopic surgery compared to open surgery.

- In 2 studies (Wang et al., 2017; Salman et al., 2022), the incidence of leak or suture leakage was higher for laparoscopic surgery.
- In 1 study (Ge et al., 2016), we did not find a difference between laparoscopic and open surgery.

Effect Size Reporting:

- 15 studies reported absolute percentages or counts for both laparoscopic and open surgery.
- 4 studies reported relative risk (RR) for laparoscopic vs open surgery.
- 1 study reported odds ratio (OR).
- 4 studies provided only qualitative statements (e.g., ”lower”, ”reduced”, ”fewer”) for laparoscopic vs open surgery.

Risk Factors:

- We did not find mention of any studies specifying risk factors for complications.
- 4 studies reported p-values for the difference in complication rates, but did not specify risk factors.

Key Insights:

- Most studies reported lower rates of overall complications and wound or surgical site infections for laparo- scopic compared to open surgery.
- A small number of studies found higher rates of leak or suture leakage with laparoscopic surgery.
- We did not find mention of studies specifying risk factors for complications.

Late Complications

- We found few studies that specifically reported late complications.
- Most studies focused on early postoperative outcomes (within 30 days).
- Where late complications such as incisional hernia or long-term pain were mentioned, we did not find signifi- cant differences between groups.

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Mortality Rates

Study	Laparoscopic Incidence	Open Surgery Incidence	Risk Factors
Siow et al., 2016	2.9%	1.6%	No significant difference
Abdullah et al., 2018	0%	11.5%	No mention found
Quah et al., 2018	No significant difference	No significant difference	No mention found
Cirocchi et al., 2018	Equivalent	Equivalent	No mention found
Sokhal et al., 2024	Relative risk 0.37 (lower in laparoscopic)	-	p-value =0.03
Wang et al., 2017	1/58	1/61	No significant difference
Zhou et al., 2015	Relative risk 0.63 (lower in laparoscopic)	-	p-value =0.039
Salman et al., 2022	Relative risk 0.57 (lower in laparoscopic)	-	95% confidence interval 0.47-0.70

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Study	Laparoscopic Incidence	Open Surgery Incidence	Risk Factors
Chan et al., 2022	Odds ratio 0.57 (lower in laparoscopic)	-	p-value =0.02
Kumar and Dumpalapudi, 2024	0%	5%	No mention found
Panin et al., 2021	0.8%	8%	p-value <0.0001
Saleh et al., 2019	No significant difference	No significant difference	No mention found
Zedan et al., 2015	0%	1 death (no mention found if surgical)	No mention found
Elshora et al., 2023	0%	1 death	Deep vein thrombosis/pulmonary embolism
Budzyński et al., 2015	2.8%	10.2%	p-value =0.0192
Tag El-Din, 2020	0%	0%	-

Study	Laparoscopic Incidence	Open Surgery Incidence	Risk Factors
Gasimov et al., 2024	0%	2.4%	No significant difference
Waqar et al., 2024	No mention found	No mention found	-

Summary of Mortality Findings:

- In 9 studies, we found a lower incidence in the laparoscopic group compared to open surgery.
- In 5 studies, the incidence was equivalent or no significant difference between groups.
- In 1 study, the incidence was higher in the laparoscopic group.
- In 3 studies, we did not find clear or reported incidence data for either group.

Risk Factors:

- We found mention of statistically significant risk factors or differences in 7 studies.
- In 3 studies, risk factors were analyzed but not found to be significant.
- In 8 studies, we did not find mention of risk factors.

Synthesis of Findings:

- Across the included studies, there is consistent reporting of shorter hospital stay, lower wound infection rates, and reduced postoperative pain with laparoscopic repair compared to open repair for perforated peptic ulcer.
- Most studies report longer operative time for laparoscopy, but this is not associated with worse recovery or complication rates.
- Mortality is low in both groups, with some studies reporting a trend toward lower rates in laparoscopy, though most are underpowered for this outcome.

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- Most studies report lower rates of overall complications and wound or surgical site infections for laparoscopic compared to open surgery, while a small number of studies found higher rates of leak or suture leakage with laparoscopic surgery.
- We found few studies that specifically reported late complications, and where mentioned, no significant dif- ferences were found between groups.

Generalizability:

- The included studies report that laparoscopic repair is at least equivalent, and often superior, to open repair for selected patients with perforated peptic ulcer, particularly regarding recovery and wound complications.
- However, generalizability to all settings and patient risk profiles is limited by study design and reporting.

DISCUSSION

This systematic review consolidates the evidence from 26 recent studies comparing laparoscopic and open surgical repair for perforated peptic ulcer (PPU), revealing a clear and consistent pattern of outcomes. The synthesis of findings indicates that the laparoscopic approach is not merely an alternative but is frequently a superior option concerning key patient recovery indicators. The data robustly supports that laparoscopic repair leads to reduced postoperative morbidity, faster recovery, and lower rates of certain complications. However, the analysis also highlights important nuances, including longer operative times and a potential, though small, increased risk for specific severe complications like suture leakage, which temper the universal application of the technique and underscore the importance of careful patient selection and surgical expertise (Cirocchi et al., 2018; Sokhal et al., 2024; Chan et al., 2022).

The most definitive and consistent finding across the entirety of the reviewed literature is the significantly shorter duration of postoperative hospital stay for patients undergoing laparoscopic repair. An overwhelming sixteen separate studies, including several large meta-analyses, unanimously reported this benefit, with thirteen demonstrating a statistically significant difference. The reported mean hospital stay for laparoscopic surgery ranged from as short as 3 days to approximately 8.5 days, starkly contrasting with the 5 to 16.1 days reported for open surgery. This outcome is not just a statistical observation; it carries profound clinical and economic implications, translating to reduced healthcare costs, a lower risk of acquiring hospital-associated infections, and a more rapid return to normalcy and productivity for the patient (Quah et al., 2018; Budzyński et al., 2015; Odisho et al., 2022).

In contrast to the clear advantage in recovery time, the metric of operative duration presents a more complex and debated picture. The data from this review shows that laparoscopic surgery often requires more time to complete than the traditional open approach. Six of the fourteen studies that measured this outcome found a significantly longer operative time for the laparoscopic group, while only two found the opposite. This finding likely reflects the inherent technical demands of minimally invasive surgery, which requires advanced skills for intra-corporeal suturing and manipulation of instruments through trocars. The learning curve associated with these techniques is a well-established phenomenon and can contribute to longer procedure times, particularly in centers or with surgeons still developing their expertise (Abdullah et al., 2018; Kumar and Dumpalapudi, 2024; Somashekhar and Gondi, 2023).

Crucially, however, the longer operative time associated with laparoscopy does not appear to translate into inferior clinical outcomes. In fact, the evidence points to the contrary; despite spending more time in the operating room, patients in the laparoscopic groups consistently experienced faster recoveries and fewer complications. This suggests that operative duration, when considered in isolation, may be a poor surrogate for the overall quality or success of the surgical intervention. The intrinsic benefits of a minimally invasive approach—namely reduced tissue trauma, diminished physiological stress, and preservation of abdominal wall integrity—appear to comprehensively outweigh the potential disadvantages of a longer procedure duration (Gasimov et al., 2024; Budzyński et al., 2015; Waqar et al., 2024).

A primary driver of the enhanced recovery seen with laparoscopy is the significant reduction in postoperative pain, an outcome measured in fifteen of the included studies. Although detailed pain scores were not uniformly reported across all studies, the synthesis of findings confirms a consistent trend toward lower pain levels in the laparoscopic cohort. This is an expected consequence of replacing a large laparotomy incision with small keyhole ports, which results in substantially less muscle and fascial trauma. Reduced pain facilitates earlier patient mobilization, deeper breathing exercises which can lower pulmonary complications, and a decreased need for opioid analgesics, all of which are cornerstones of modern enhanced recovery after surgery (ERAS) protocols (Siow et al., 2016; Shah et al., 2015; Zedan et al., 2015).

Perhaps one of the most significant advantages of laparoscopic repair identified in this review is the dramatic reduction in surgical site infections (SSIs). Ten studies specifically investigated wound-related complications, and the results overwhelmingly favored the minimally invasive approach. The effect size was substantial, with meta-analyses reporting relative risks as low as 0.28 and odds ratios of 0.27 for SSIs in the laparoscopic group compared to the open group. Studies reported absolute infection rates dropping from as high as 34.6% in open surgery to 5.6% in laparoscopy, a difference that is both statistically and clinically profound. This reduction in wound infections is a direct benefit of avoiding a large, contaminated abdominal wound (Abdullah et al., 2018; Cirocchi et al., 2018; Waqar et al., 2024).

Beyond just wound infections, the benefit of laparoscopy extends to a lower rate of overall postoperative complications. When examining any or total complications, the evidence from 23 included studies consistently demonstrated a lower incidence in the laparoscopic group. For instance, Panin et al. (2021) documented a complication rate of just 2.4% for laparoscopy versus 11.4% for open surgery, while Budzyński et al. (2015) found a statistically significant difference with rates of 13.5% and 23.3%, respectively. This broad reduction in morbidity, encompassing issues from minor wound discharge to more significant chest infections, reinforces the conclusion that the minimally invasive approach confers a tangible safety benefit to the patient (Panin et al., 2021; Saleh et al., 2019; Taha et al., 2023).

However, this favorable safety profile is challenged by a critical and recurring concern: the risk of suture leakage at the repair site. While the overall complication rate is lower with laparoscopy, two key studies in this review highlighted a potentially increased risk of this specific, and often devastating, complication. The meta-analysis by Salman et al. (2022) calculated a relative risk of 1.91 for suture leakage in the laparoscopic group, suggesting the risk may be nearly doubled compared to open repair. This alarming finding likely stems from the technical challenges of achieving a secure, tension-free, and well-vascularized repair using long-handled instruments in a two-dimensional view, and it serves as a crucial counterpoint to the otherwise widespread benefits of the technique (Wang et al., 2017; Salman et al., 2022).

The apparent paradox—lower overall complications but a higher risk of suture leakage—can be reconciled by considering the frequency of different adverse events. The substantial reduction in common, less severe complications like SSIs and chest infections, which affect a larger proportion of patients undergoing open surgery, statistically outweighs the small absolute increase in the incidence of a rare but severe complication like suture leakage. This highlights the importance of not only looking at aggregate complication rates but also analyzing the specific nature and severity of each type of complication when comparing the two procedures (Zhou et al., 2015; Salman et al., 2022;

Chan et al., 2022).

The comparative effect of the two techniques on mortality remains a subject of investigation, with the evidence being less definitive than for other outcomes. While nine studies included in this review reported a lower mortality incidence in the laparoscopic group, five found no significant difference between the approaches. The overarching consensus from the report is that most individual studies are statistically underpowered to detect a true difference in this relatively rare outcome. Mortality after PPU surgery is often low, especially in low-risk patients, making it difficult for single-center studies with limited sample sizes to demonstrate a survival benefit (Siow et al., 2016; Wang et al., 2017; Saleh et al., 2019).

Patient-centered outcomes, such as the time taken to return to normal daily activities or work, were also shown to favor the laparoscopic approach. While only measured in five studies, this metric is a direct reflection of the patient's functional recovery. The combination of reduced pain, smaller incisions, and shorter hospitalization logically leads to a quicker resumption of independence and work. This outcome has significant socioeconomic benefits for both the individual and society, further strengthening the case for laparoscopy as the preferred treatment modality when feasible (Shah et al., 2015; Zedan et al., 2015; Fazal et al., 2025).

The generalizability of these findings, while broadly positive for laparoscopy, must also be considered with caution. This review synthesized data that largely applies to a selected patient population deemed suitable for a minimally invasive approach. The applicability of these results to all patients, particularly those at high risk—such as individuals who are hemodynamically unstable, in septic shock, or present with very large perforations (>2 cm) or significant comorbidities (high ASA grades)—is limited. In these challenging clinical scenarios, the expediency and reliability of a traditional open laparotomy may still represent the safest course of action (Elshora et al., 2023).

The primary strength of this systematic review lies in its rigorous methodology, including strict adherence to the PRISMA 2020 guidelines, a comprehensive search strategy across five major databases, and a clear set of inclusion criteria. The inclusion of 26 studies published exclusively within the last decade ensures that the conclusions are based on the most current and relevant evidence available, reflecting contemporary surgical practice and technology (Siew et al., 2016; Fazal et al., 2025).

In terms of clinical practice, the evidence synthesized in this review provides a strong mandate for adopting laparoscopic repair as the primary surgical approach for the majority of patients with perforated peptic ulcer. The consistent and significant benefits in terms of shorter hospital stays, reduced pain, and markedly lower rates of surgical site infections are compelling. However, the decision must be individualized, with surgeons carefully considering patient-specific factors like hemodynamic stability and perforation size, as well as institutional factors like the availability of equipment and laparoscopic expertise (Sokhal et al., 2024; Gasimov et al., 2024).

Finally, this review highlights several key areas for future research. There is a clear need for large, multicenter, and well-designed RCTs that are adequately powered to definitively assess mortality as a primary outcome. Future studies should also focus on meticulously reporting specific complications, especially suture leakage, to better understand its true incidence and risk factors. Long-term follow-up is essential to evaluate outcomes such as incisional hernia rates and quality of life, which are currently under-reported. Stratifying results by patient risk scores (e.g., Boey score) would also help to delineate which patient subgroups benefit most from each approach (Panin et al., 2021; Zhang et al., 2018).

CONCLUSION

Based on the comprehensive analysis of 26 studies, this systematic review concludes that laparoscopic repair is a superior surgical approach for perforated peptic ulcer in the majority of patients when compared to traditional open surgery. The evidence overwhelmingly demonstrates that the minimally invasive technique offers significant advantages in patient recovery. The most consistent finding across nearly all reviewed literature is a markedly shorter postoperative hospital stay for patients undergoing laparoscopic repair. This is complemented by a significant reduction in postoperative pain, which facilitates earlier mobilization and contributes to a faster overall recovery. Consequently, patients treated with laparoscopy are able to resume normal daily activities and return to work more quickly, a crucial patient-centered outcome with substantial socioeconomic benefits.

The favorable recovery profile of laparoscopic surgery is strongly supported by a significant reduction in postoperative complications. The data reveals a dramatic and clinically important decrease in the incidence of surgical site infections, with some studies showing the risk in the laparoscopic group to be a fraction of that in the open surgery cohort. This benefit extends to a lower rate of overall morbidity, including fewer chest infections and other complications associated with major abdominal surgery. However, this positive safety profile must be interpreted with caution, as a small but significant body of evidence points to a potentially higher risk of suture leakage at the perforation site with the laparoscopic technique. While less common than wound infections, suture leakage is a severe complication that underscores the technical demands of minimally invasive repair.

Furthermore, this review clarifies the clinical relevance of operative time. While a majority of studies reported that laparoscopic procedures were significantly longer than open repairs, this increased operative duration did not translate into negative clinical outcomes. In fact, the substantial benefits of reduced tissue trauma, less pain, and shorter hospitalization appear to comprehensively outweigh the disadvantage of a longer time under anesthesia. Regarding the critical outcome of mortality, the evidence remains less definitive. Although several large meta-analyses indicated a trend toward lower mortality rates with laparoscopic repair, most individual studies lacked the statistical power to establish a significant survival benefit. Therefore, while laparoscopy appears at least as safe as open surgery concerning mortality, a definitive conclusion on its superiority cannot be drawn from the current evidence.

Laparoscopic repair should be considered the standard of care for suitable patients with perforated peptic ulcer, driven by consistent and robust evidence of faster recovery, reduced pain, and significantly lower rates of surgical site infections. The decision to proceed with a minimally invasive approach must be individualized, carefully weighing the patient's clinical stability and the surgeon's expertise against the small but serious risk of suture leakage. Future research, particularly large-scale randomized controlled trials, is essential to definitively assess the impact on mortality and to identify specific risk factors for suture leakage. Nevertheless, for the appropriate patient, the collective evidence strongly supports the adoption of laparoscopy as the preferred surgical treatment, offering a clear path to an improved and more efficient postoperative recovery.

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