

REVIEW

Outcomes of Laparoscopic Versus Open Surgery in the Treatment of Complications of Penetrating Crohn's Disease: A Systematic Review

Resultados de la cirugía laparoscópica versus abierta en el tratamiento de las complicaciones de la enfermedad de Crohn penetrante: una revisión sistemática

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ABSTRACT

Introduction: penetrating Crohn's disease (CD) frequently results in fistulas, abscesses, or strictures, requiring surgery in up to 70 % of cases. While laparoscopic surgery (LS) is well established in elective CD, its role in penetrating disease remains uncertain due to technical challenges and variable outcomes compared with open surgery (OS).

Method: we conducted a systematic review following PRISMA guidelines. Comparative studies (retrospective cohorts, propensity-matched analyses, randomized controlled trials, and meta-analyses) were identified through multiple databases. Primary outcomes included perioperative complications, wound infection, incisional hernia, postoperative pain, hospital stay, and disease recurrence.

Results: eight studies were included. LS was associated with reduced perioperative complications (RR 0,71, $p = 0,001$), lower incisional hernia risk (RR 0,24, $p = 0,02$), and shorter hospital stay (5 vs. 8 days, $p < 0,05$). Conversion to OS occurred in 10-25 % of cases due to disease extent. Long-term recurrence rates were comparable between LS and OS (30 % at 5 years; 60 % at 10 years).

Conclusion: LS provides superior short-term outcomes over OS in penetrating CD, with fewer complications and faster recovery. Long-term disease control is equivalent, and outcomes depend strongly on patient selection and surgical expertise in managing complex disease.

Keywords: Crohn Disease; Laparoscopy; Laparotomy; Postoperative Complications; Surgical Procedures, Operative; Treatment Outcome.

RESUMEN

Introducción: la enfermedad de Crohn penetrante (EC) suele dar lugar a complicaciones complejas como fístulas, abscesos o estenosis. La cirugía es necesaria hasta en el 70 % de estos casos. La cirugía laparoscópica (LS) ofrece beneficios en los casos de EC electiva, pero su eficacia en el tratamiento de las formas penetrantes sigue siendo incierta debido a las limitaciones técnicas y la variabilidad de los resultados en comparación con la cirugía abierta (SG).

Método: se realizó una revisión sistemática siguiendo las guías PRISMA. Los estudios elegibles incluyeron diseños comparativos (cohortes retrospectivas, estudios emparejados por propensión, ensayos controlados aleatorios y metanálisis) de múltiples bases de datos. Los resultados primarios informaron los siguientes: complicaciones perioperatorias, infección de la herida, hernia incisional, dolor postoperatorio, estancias hospitalarias y tasas de recurrencia de la enfermedad, etc.

Resultados: se incluyeron un total de ocho estudios. La SL se asoció con menores tasas de complicaciones perioperatorias (RR 0,71, $p = 0,001$), menor riesgo de hernia incisional (RR 0,24, $p = 0,02$) y menor estancia hospitalaria (5 vs. 8 días, $p < 0,05$). La conversión a SG se produjo en el 10-25 % de los casos de SL debido a la extensión de la enfermedad. Las tasas de recidiva a largo plazo fueron comparables entre la LS y la SG (30 % a 5 años; 60 % a 10 años).

Conclusión: la SL ofrece mejores resultados a corto plazo que la SG en la EC penetrante con menos complicaciones y una recuperación más rápida. El control de la enfermedad a largo plazo es equivalente, mientras que los resultados óptimos dependen de la selección del paciente y de la experiencia quirúrgica en la enfermedad compleja.

Palabras clave: Enfermedad de Crohn; Laparoscopia; Laparotomía; Complicaciones postoperatorias; Procedimientos Quirúrgicos Operatorios; Resultado del tratamiento.

INTRODUCTION

Crohn's disease (CD) is a chronic, transmural inflammatory bowel disease that affects approximately 1 in 500 individuals in Western countries. Up to 50 % of patients require surgery within 10 years of diagnosis due to penetrating complications, which include fistulas (35-50 %), abscesses (20-30 %), and strictures (25-40 %).⁽¹⁾ The ileocolonic region is most commonly affected (40-55 %).

The optimal surgical approach for penetrating CD remains controversial. Laparoscopic surgery (LS) offers clear advantages in elective cases, including reduced postoperative pain, shorter hospital stays (5 vs. 8 days), and lower wound infection rates (5 % vs. 15 %).^(2,3) However, these benefits are less certain in penetrating disease, where technical challenges increase the risk of conversion to open surgery (OS) and where specific complications, such as intra-abdominal abscesses (10-15 %), may be more frequent. Immunosuppressive therapy, used in up to half of patients, adds further complexity by raising infection risk (odds ratio 1,5-2,0) and delaying wound healing.^(4,5,6,7,8)

Despite the widespread adoption of LS, which now accounts for 70-80 % of CD surgeries in high-volume centers, robust comparative data for penetrating disease remain scarce. Existing studies are often limited by heterogeneity and small sample sizes, and outcomes such as recurrence (30 % at 5 years; 60 % at 10 years), perioperative morbidity (20-35 %), and surgical site infections (5-20 %) remain concerning. This evidence gap underscores the need for systematic evaluation of LS versus OS in this complex patient population.

This review aims to assess and compare the clinical and postoperative outcomes of LS and OS in the management of penetrating Crohn's disease.^(9,10)

METHOD

This systematic review compared clinical and postoperative outcomes of laparoscopic surgery (LS) versus open surgery (OS) in the treatment of penetrating Crohn's disease (CD). The review adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines.

Eligibility Criteria

We included comparative studies assessing LS and OS in patients with CD requiring bowel resection, with a specific focus on complications of penetrating disease (e.g., fistulas, abscesses, perforations, complex strictures). Eligible study designs were retrospective cohort studies, propensity score-matched analyses, randomized controlled trials (RCTs), and meta-analyses. Both adult and pediatric populations were considered.

Search Strategy

A comprehensive literature search was conducted in PubMed/MEDLINE, EMBASE, and the Cochrane Library from January 2000 to June 2025. The search combined Medical Subject Headings (MeSH) and free-text terms, using Boolean operators. The PubMed search strategy was:

- ("Crohn Disease"[Mesh] OR "Crohn's disease" OR "inflammatory bowel disease")
- AND ("Laparoscopy"[Mesh] OR laparoscopic OR minimally invasive)
- AND ("Laparotomy"[Mesh] OR "open surgery")
- AND (penetrating OR fistula* OR abscess* OR perforat*)
- AND ("comparative study" OR "randomized controlled trial" OR "cohort study" OR meta-analysis)

The strategy was adapted for each database. Reference lists of relevant reviews and included studies were screened to identify additional publications. No language restrictions were applied. No pre-registered review protocol (e.g., PROSPERO) was available, which is acknowledged as a limitation.

Study Selection

All records identified through the searches were imported into EndNote for citation management. Duplicates were automatically detected and manually verified before removal. Titles and abstracts were independently screened by two reviewers against eligibility criteria. Full texts of potentially relevant studies were retrieved and assessed in detail. Studies were excluded if they involved non-penetrating CD only, lacked a comparator group, did not report outcomes of interest, or were conference abstracts without sufficient data. Disagreements during screening were resolved through consensus, with arbitration by a third reviewer when necessary. The PRISMA flow diagram (Results section) documents the selection process.

Data Extraction

Data extraction was performed independently by two reviewers using a piloted Microsoft Excel sheet. Extracted variables included study design, population characteristics, surgical approach, sample size, perioperative and postoperative outcomes, follow-up duration, and reported statistical measures (e.g., relative risks, odds ratios, p-values). Discrepancies were resolved through discussion, with a third reviewer available for arbitration.

Assessment of Risk of Bias in Included Studies

The methodological quality of included studies was evaluated using appropriate, established tools. RCTs were assessed with the Cochrane Risk of Bias 2 (RoB 2) tool, while non-randomized studies were assessed with the Risk Of Bias In Non-randomized Studies of Interventions (ROBINS-I) tool. Meta-analyses were appraised using the AMSTAR 2 checklist. Risk of bias assessments were performed independently by two reviewers, with disagreements resolved by consensus. The results of these assessments are presented narratively in the Results and considered when interpreting findings.

Outcomes Assessed

Primary outcomes:

- Perioperative complication rates
- Incisional hernia rates
- Wound infection rates
- Hospital length of stay
- Postoperative pain scores

Secondary outcomes:

- Surgical recurrence-free survival (SRFS)
- Long-term recurrence rates
- Conversion rates from LS to OS
- Operative time

Data Synthesis and Assessment of Heterogeneity

A meta-analysis was not performed due to heterogeneity in study design, patient populations, surgical techniques, and outcome definitions. Heterogeneity was evaluated qualitatively based on PICO elements (Population, Intervention, Comparator, Outcome). Where available, statistical heterogeneity (I^2 statistic) reported by included meta-analyses was noted.

Findings were synthesized narratively. Studies were grouped by outcome domains (perioperative complications, postoperative recovery, long-term outcomes). Within each domain, evidence was compared across study designs, with greater weight given to higher-quality and larger studies. Consistency, direction, and precision of findings were examined to judge the strength of evidence.

Limitations

This review has several limitations:

- Most included studies were retrospective, with inherent risk of selection bias, including preferential use of LS in less complex cases.
- Clinical and methodological heterogeneity was substantial, preventing quantitative pooling of results.
- Variability in follow-up duration, disease severity, and perioperative management protocols limited comparability.
- No registered protocol was available in advance of the review.

Practical Implications and Future Directions

The findings suggest that laparoscopic surgery is at least as safe as open surgery for penetrating CD and may reduce perioperative morbidity. Surgeons should consider LS as the preferred approach when expertise and resources are available. However, further high-quality prospective studies are required, particularly in pediatric and complex penetrating cases, to strengthen the evidence base and clarify long-term recurrence outcomes.

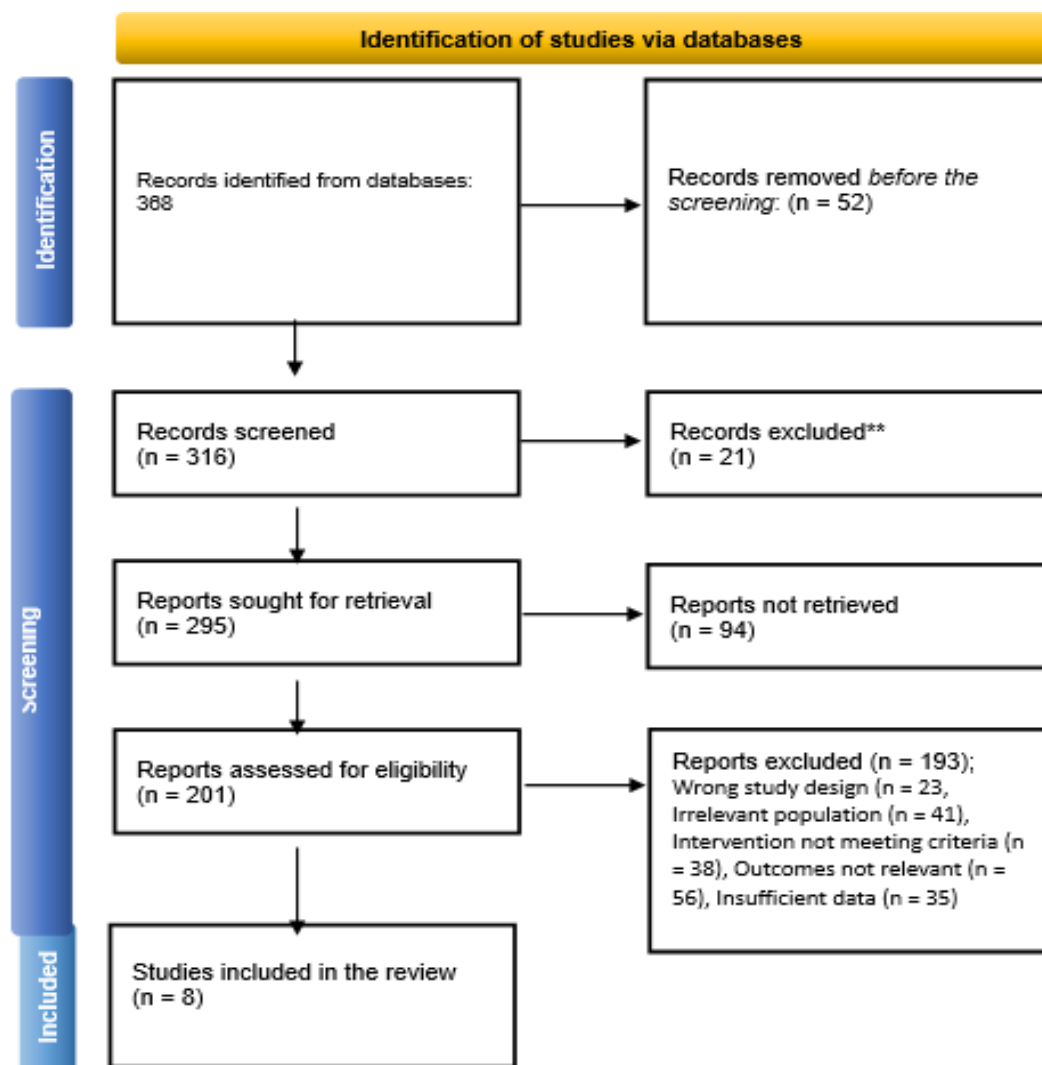


Figure 1. Prisma flow diagram detailing the screening process

RESULTS

A total of 368 records were identified; after screening and exclusions, 8 studies were included. Reports excluded (n = 193) were due to wrong design, irrelevant population, intervention mismatch, irrelevant outcomes, or insufficient data.

Perioperative complications

Across studies, LS consistently demonstrated either fewer or equivalent perioperative complications compared with OS. The largest meta-analysis reported a significant reduction in overall complications with LS (RR 0,71, P = 0,001), a finding supported by several cohort studies showing complication rates of 12-15 % with LS versus 30-60 % with OS. Pediatric and small RCT-based analyses did not demonstrate a statistical difference, likely reflecting limited sample size and statistical power.

Wound-related outcomes

The risk of incisional hernia was significantly lower in LS (RR 0,24, P = 0,02). Rates of wound infection were generally reduced in LS, though pooled analyses of smaller trials did not achieve significance (P = 0,23), again reflecting underpowered comparisons.

Length of stay and recovery

Hospital stay was consistently shorter in LS cohorts (5 vs. 8 days, $P < 0,05$), with reports also describing faster postoperative recovery and reduced pain scores in the laparoscopic group.

Recurrence

Long-term recurrence rates were broadly comparable between LS and OS, with approximately 30 % at 5 years and 60 % at 10 years, suggesting no oncologic or disease-control disadvantage to minimally invasive surgery.

Overall interpretation

Although individual studies varied in design and quality, the evidence collectively supports LS as at least as safe as OS, with clear advantages in short-term recovery and wound-related morbidity. Limitations include retrospective study designs, potential selection bias, and heterogeneity in patient populations, particularly regarding disease severity and immunosuppressive use.

Table 1. Clinical and Surgical Outcomes

Study (Author, Year)	Study Design	Population	Intervention	Sample Size	Key Surgical Metrics	Statistical Outcomes
Pak et al. ⁽¹¹⁾	Retrospective, PSM cohort	Ileocolic CD	Lap vs Open ICR	348 (102 matched pairs)	OR for open surgery: 2,86, $P = 0,005$	LICR complications 14 % vs OICR 32 %, $P = 0,003$
Bhandari et al. ⁽¹²⁾	Retrospective	Abdominal surgery	Lap vs Open	73 (38 lap, 35 open)	Operative time, incision, blood loss all $P < 0,001$	Complications fewer in lap (NS)
Dotlacil et al. ⁽¹³⁾	Retrospective	Pediatric CD	Lap-assisted vs Open ICR	62 (42 open, 20 lap)	Surgery time: OG 130min vs LG 148min, $P = 0,065$	Complication rates OG 7,14 % vs LG 5 %, $P = 1$
Dasari et al. ⁽¹⁴⁾	Meta-analysis of RCTs	Small bowel CD	Lap vs Open	~120 (2 RCTs)	-	Wound infection: 1/61 vs 9/59, $P = 0,23$
Liu & Zhou ⁽¹⁵⁾	State-of-the-art review	Complicated CD	Lap vs Open	N/A	Conversion rate: 10-25 %	Hospital stay LS: 5d vs OS: 8d, $p < 0,05$
Kotze et al. ⁽¹⁶⁾	Retrospective	CD with bowel resection	Lap vs Open	46 (16 lap, 30 open)	OR for complications: LA 12,5 % vs CA 60 %, $P = 0,002$	Wound infection: 10 CA vs 1 LA
Gutiérrez et al. ⁽¹⁷⁾	Retrospective	Ileocolonic CD	ICR (approach not compared)	364	-	Early complications 27,5 %, highest in penetrating (31,6 %)
Patel et al. ⁽¹⁸⁾	Meta-analysis	CD requiring resection	Lap vs Open	2,519 studies)	(34 RR periop comps: 0,71, $P = 0,001$	RR hernia: 0,24, $P = 0,02$

Table 2. Postoperative Recovery and Long-Term Outcomes

Study (Author, Year)	Follow-Up Duration	Hospital Stay	Pain / Recovery	Long-Term Outcomes	Key Takeaways
Pak et al.	Up to 10 years	8d (lap) vs 13d (open), $P = 0,003$	Day 7 pain: 1,4 (lap) vs 2,3 (open), $P < 0,001$	5y SRFS: 92,9 %; 10y: 83,3 %	Lap had faster recovery, fewer complications
Bhandari et al.	Not reported	~1 day shorter (lap)	-	-	Lap was less invasive, similar safety
Dotlacil et al.	Median 21,5 months	7d (lap) vs 8d (open), $P = 0,0005$	-	Similar complication risks	Lap safe in pediatric CD with shorter stay
Dasari et al.	Long-term incl.	-	-	No significant differences	Lap may be as safe, no superiority
Liu & Zhou, 2023	N/A (review)	5d (lap) vs 8d (open), $P < 0,05$	Op time: +25min in lap ($P < 0,05$)	Recurrence: 30 % at 5y, 60 % at 10y	Lap feasible, but conversion high
Kotze et al.	30-day	-	-	-	Open used more in severe CD cases
Gutiérrez et al.	30-day	16d (with comp) vs 9d (no comp), $P < 0,001$	-	-	Penetrating CD had highest complication rate
Patel et al.	Varied	-	-	Recurrence RR: 0,78, $P = 0,17$	Lap lowers periop complications and hernia risk

DISCUSSION

Short-term outcomes

Evidence consistently supports laparoscopic surgery (LS) as advantageous in terms of perioperative morbidity. Across meta-analyses and matched cohort studies, LS is associated with fewer complications, particularly wound-related morbidity and infections. Patel et al.⁽¹⁸⁾ reported a 29 % reduction in overall perioperative complications (RR 0,71, $P = 0,001$), while Pak et al.⁽¹¹⁾ found complication rates of 14 % versus 32 % for LS and open surgery (OS), respectively. These benefits extend to faster recovery, with hospital stays shortened by an average of three days (5 vs. 8 days) and reduced postoperative pain.^(2,3) However, effect sizes vary. Kotze et al.⁽¹⁶⁾ reported a strikingly lower complication rate in the LS group (12,5 % vs. 60 %), but this result is likely exaggerated by selection bias, as patients with fistulizing disease were disproportionately treated with OS. Smaller pediatric and randomized datasets, such as Dotlacil et al.⁽¹³⁾ and Dasari et al.⁽¹⁴⁾, failed to show statistically significant differences, largely due to small sample size and limited power. Collectively, the evidence supports LS as safe and generally superior in short-term recovery, though interpretation requires caution.

Long-term outcomes

When examining recurrence and hernia rates, differences between approaches narrow. Patel et al.⁽¹⁸⁾ found no significant difference in surgical recurrence (RR 0,78, $P = 0,17$), with pooled data confirming recurrence rates of ~30 % at 5 years and 60 % at 10 years, irrespective of surgical technique.⁽⁴⁾ Similarly, Dasari et al.⁽¹⁴⁾ concluded from randomized evidence that LS is at least as safe as OS but unlikely to modify the long-term disease course. By contrast, wound-related outcomes favor LS more consistently. Incisional hernia rates were significantly lower with LS (RR 0,24, $P = 0,02$), and wound infection rates also trended lower (5 % vs. 15 %), although smaller trials lacked statistical power.^(5,6,7,8) These data suggest that LS offers durable advantages in wound morbidity, while long-term recurrence reflects the natural history of Crohn's disease rather than surgical approach.

Selection bias and disease complexity

A central challenge in interpreting this literature is the confounding effect of disease phenotype and patient selection. Patients with penetrating Crohn's disease, particularly those with abscesses, fistulas, or extensive prior surgery, are often directed to OS, inflating complication rates in that group. Kotze et al.¹⁶ exemplify this limitation, as fistulizing disease was more common in the OS cohort. Similarly, Gutiérrez et al.¹⁷ showed that patients with penetrating or refractory disease had higher complication rates regardless of surgical technique (31,6 % and 42,9 %, respectively). Immunosuppressive therapy further complicates outcomes, with biologics and corticosteroids independently increasing infection risk (odds ratio 1,5-2,0) and delaying wound healing.⁵⁻⁸ These factors limit the ability to draw causal inferences, given that most available data are retrospective or non-randomized.

Implications for practice and research

Taken together, the evidence suggests LS is safe and generally preferable when technically feasible, providing short-term benefits without compromising long-term outcomes. Nonetheless, LS in complex penetrating disease remains technically demanding, with conversion rates of 10-25 %.⁽¹⁵⁾ Careful patient selection and surgical expertise are therefore critical. Future research should stratify outcomes by phenotype, prior surgery, and immunosuppressive exposure, and prioritize multicenter randomized controlled trials with adequate sample sizes and long-term follow-up. Until such data are available, LS should be considered the default approach in suitable patients, while OS remains indicated in highly complex cases.

CONCLUSIONS

The use of Laparoscopic surgery (LS) has definite benefits over open surgery (OS) in the surgical treatment of penetrating Crohn diseases (CD) such as reduced perioperative complications, shorter length of hospitalization, and early postoperative recovery without compromising the long-term outcomes in terms of recurrence. Nevertheless, LS is only useful in complex cases of presentation, including fistulas and abscesses, and the ability to use LS remains subjective to the burden of the disease and the expertise of surgery. There is existing evidence to advocate the use of LS as a desired procedure on anatomically and clinically safe grounds. Nonetheless, the personalized risk factor is essential, especially in patients with a large disease burden or a history of surgery. Additional randomized studies would be necessary to clarify the criteria of selection, and it should standardize approaches to the operative measures in this subgroup. Future research should prioritize multicenter randomized trials to define standardized selection algorithms, evaluate long-term functional outcomes, and assess quality of life measures, ensuring laparoscopic approaches in penetrating Crohn's disease are applied safely, effectively, and with reproducible surgical benchmarks.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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