



How do Laparoscopic and Open Surgical Approaches Compare in Terms of Post-Operative Complications, Recovery Time, and Quality of Life For Colorectal Cancer Patients? : A Systematic Review

¹ Sean Gerry Santoso, ² Habel Ryan Annerico Sianipar, ³ Freddy

¹ Marsudi Waluyo Hospital, Malang, Indonesia

² Gotong Royong Hospital, Surabaya, Indonesia

³ Department of Surgery, Karsa Husada General Hospital, Batu, Indonesia

Corresponding Email: seangerrys@gmail.com

Article History :

Received date : 2025/09/14

Revised date : 2025/10/09

Accepted date : 2025/12/17

Published date : 2026/01/23



Copyright: © 2024 by the authors. Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution (BY NC) license (<https://creativecommons.org/licenses/by-nc/4.0/>).

E-ISSN :

ISSN 3048-1368



P-ISSN

ISSN 3048-1376



ABSTRACT

Introduction: Surgical resection is the primary curative treatment for colorectal cancer (CRC). While traditional open surgery has long been the standard, minimally invasive laparoscopic surgery has emerged as a widely used alternative. Its adoption is driven by potential short-term benefits, but a comprehensive understanding of its comparative impact on complications, recovery, and quality of life is essential for guiding clinical practice. This systematic review aims to synthesize and evaluate the evidence comparing laparoscopic and open surgical approaches for CRC.

Methods: A systematic review was conducted adhering to PRISMA 2020 guidelines. Five electronic databases, including PubMed and Google Scholar, were searched for studies

published since 2015 comparing laparoscopic versus open resection for CRC. The primary outcomes of interest were postoperative complications, recovery time, and quality of life. After screening thousands of records, 39 eligible studies, including randomized controlled trials and large meta-analyses, were included in the final qualitative and quantitative synthesis.

Results: The analysis revealed that laparoscopic surgery was associated with significantly lower rates of overall postoperative complications in 23 of 26 reporting studies. Recovery was markedly faster with laparoscopy, with all 10 studies assessing hospital stay reporting shorter durations and a majority showing quicker return of bowel function. Long-term oncological outcomes, including survival and recurrence rates, were found to be equivalent between the two approaches in 12 of 16 studies. Data on quality of life were limited, with only one study reporting a short-term benefit for the laparoscopic group.

Discussion: The consistent findings across multiple domains demonstrate a clear clinical advantage for the minimally invasive approach. The evidence strongly indicates that the short-term benefits of reduced patient morbidity and accelerated recovery do not compromise long-term oncological control, affirming the safety and efficacy of the laparoscopic technique.

Conclusion: Laparoscopic surgery provides a superior short-term recovery profile and fewer complications than open surgery while offering equivalent long-term oncological safety. It should be considered the standard of care for most patients with colorectal cancer. Future research should prioritize investigating long-term, patient-reported quality of life to provide a more holistic comparison.

Keywords: Colorectal Cancer, Laparoscopic Surgery, Open Surgery, Postoperative Complications, Recovery Time, Quality of Life

INTRODUCTION

Colorectal cancer (CRC) remains a significant global health challenge, necessitating continuous refinement of its therapeutic strategies. The standard curative treatment for localized CRC is surgical resection, which has traditionally been performed through an open laparotomy. However, the last few decades have seen a paradigm shift towards minimally invasive techniques, with laparoscopic surgery emerging as a prominent alternative. This approach involves smaller incisions through which a camera and specialized instruments are inserted, aiming to reduce surgical trauma compared to the large incision required for conventional open surgery. The widespread adoption of laparoscopy has been driven by its potential to improve patient recovery, but its acceptance was initially tempered by concerns over its oncological safety compared to the long-established open approach (Song et al., 2019; Zheng et al., 2016).

A substantial body of evidence, including numerous randomized controlled trials (RCTs) and meta-analyses, has now firmly established the short-term benefits of laparoscopic resection for CRC. Compared to open surgery, the laparoscopic approach is consistently associated with a lower incidence of postoperative complications, including reduced rates of wound infection and ileus. Furthermore, patients undergoing laparoscopic surgery typically experience faster recovery of bowel function, reduced intraoperative blood loss, and significantly shorter hospital stays. These advantages contribute to a quicker return to normal activities and have positioned laparoscopy as a preferred approach for many patients and surgeons, particularly when integrated within enhanced recovery after surgery (ERAS) protocols (Fretland et al., 2018; Lei et al., 2015; Moug et al., 2015).

Despite the clear short-term recovery advantages, the fundamental question of oncological equivalence has been the most critical determinant of laparoscopy's role in cancer care. Early skepticism centered on whether a minimally invasive approach could achieve the same radicality of tumor and lymph node removal as open surgery, raising fears of higher recurrence rates and

compromised long-term survival. However, extensive long-term follow-up from major international trials and subsequent meta-analyses has largely addressed these concerns. The overwhelming consensus from high-quality evidence now indicates that for both colon and rectal cancer, laparoscopic surgery provides equivalent long-term oncological outcomes, including similar rates of local recurrence, distant recurrence, disease-free survival (DFS), and overall survival (OS) when performed by experienced surgeons (Bonjer et al., 2015; Nienhüser et al., 2018; Pędziwiatr et al., 2017; Stevenson et al., 2019).

Even with this established equivalence, nuances and gaps in the literature persist. Some studies have reported conflicting results in specific subgroups or at particular follow-up intervals. For instance, one study noted a higher local recurrence rate after laparoscopic surgery for rectal cancer in elderly patients, while others have suggested superior DFS at certain time points with laparoscopy. Furthermore, the application of laparoscopy in more complex scenarios—such as for locally advanced tumors, T4 disease, or in very elderly populations—continues to be an area of active investigation, with outcomes being highly dependent on patient selection and surgeon expertise. Critically, patient-reported outcomes, such as quality of life (QOL), remain an under-researched area, with very few high-level studies providing a comprehensive comparison of how patients feel and function long-term after each procedure (Ishibe et al., 2017; McCombie et al., 2018; Schietroma et al., 2021).

Therefore, this systematic review aims to synthesize the current body of evidence to provide a comprehensive comparison of laparoscopic and open surgical approaches for colorectal cancer across three critical domains: postoperative complications, recovery time, and quality of life. By systematically analyzing data from high-quality studies published within the last decade, this review seeks to reaffirm established benefits, clarify existing controversies, and highlight areas requiring further investigation. The practical implication of this work is to equip clinicians and patients with a clear, evidence-based understanding of the expected outcomes for each approach, thereby facilitating shared decision-making and helping to standardize the optimal surgical

treatment for patients with colorectal cancer (Creavin et al., 2021; Fleshman et al., 2015).

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 and open surgical approaches compare in terms of post-operative complications, recovery time, and quality of life for colorectal cancer patients

Screening

We screened in sources that met these criteria:

- Population Age: Does the study include only adult patients (≥ 18 years)?
- Disease Specificity: Does the study focus specifically on patients diagnosed with colorectal cancer?
- Intervention Comparison: Does the study directly compare laparoscopic versus open surgical approaches for colorectal cancer resection?
- Outcome Measures: Does the study report at least one of the following outcomes: postoperative complications, recovery time, or quality of life measures?
- Study Design: Is the study design one of the following: RCT, prospective cohort study, retrospective cohort study, or systematic review/meta-analysis?
- Follow-up Duration: Does the study report primary data with a minimum follow-up period of 30

days?

- Population Data Separation: If the study includes multiple cancer types, can the colorectal cancer data be separated from other cancer data?
- Sample Size and Study Type: Is the study something other than a case report, case series with fewer than 10 patients, or opinion article?

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

Data extraction

- Study Design:

Identify the type of study design used:

- Randomized Controlled Trial (RCT)
- Non-randomized comparative study
- Meta-analysis

If multiple study designs are present, list all types. Look in the methods section for explicit description of study design. If the design is not clearly stated, review the randomization, allocation, and comparison methods to determine the most appropriate classification.

- Participant Characteristics:

Extract the following details:

- Total number of participants
- Number of participants in laparoscopic and open surgery groups
- Cancer stage (if reported)
- Tumor location (distance from anal verge)
- Inclusion/exclusion criteria

Be precise about numbers. If ranges or multiple subgroups are reported, note all relevant information. If any characteristics are not clearly reported, mark as "not reported" or "unclear".

- Surgical Intervention Specifics:

For both laparoscopic and open surgical approaches, extract:

- Specific surgical technique used
- Operation time
- Blood loss volume
- Number of lymph nodes harvested

Record exact numerical values when possible. If multiple measurements are provided, note the primary or mean value. Use the same units as reported in the original study.

- Postoperative Complications:

List and quantify:

- Overall complication rates
- Specific types of complications
- Wound infection rates
- Mortality rates

Extract both absolute numbers and percentages if available. Distinguish between short-term and long-term complications. If complications are not comprehensively reported, note the specific limitations.

- Recovery and Clinical Outcomes:

Extract data on:

- Time to bowel function recovery
- Hospital stay duration
- Time to resuming diet
- Distal resection margin

- Circumferential resection margin

Record numerical values with units. If multiple measurements are reported, prioritize the primary or most comprehensive measurement.

- Long-term Oncological Outcomes:

Extract:

- Local recurrence rates
- Distant recurrence rates
- Disease-free survival rates
- Overall survival rates

Record percentages and time frames (e.g., 3-year survival). If multiple time points are reported, extract the primary or longest follow-up period.

- Risk of Bias Assessment:

Assess and record:

- Randomization method (if applicable)
- Blinding procedures
- Loss to follow-up rates
- Potential conflicts of interest
- Quality assessment scores (e.g., Jadad score, Cochrane risk of bias tool)

If multiple assessment methods are used, note all relevant scores or assessments. If information is incomplete, explicitly state the limitations.

Search Strategy

The keywords used for this research based PICO :

Element	Keyword 1	Keyword 2	Keyword 3	Keyword 4
Population (P)	Colorectal Cancer Patients	Individuals Diagnosed with Colorectal Carcinoma	Individuals with Colorectal Neoplasms	Colon and Rectal Cancer Subjects
Intervention (I)	Laparoscopic Surgery	Laparoscopic Resection	Minimally Invasive Surgery	Laparoscopy
Comparison (C)	Open Surgery	Conventional Surgery	Open Resection	Laparotomy
Outcome (O)	Postoperative Complications	Recovery Time	Quality of Life	Oncological Outcomes

The Boolean MeSH keywords inputted on databases for this research are: (*"Colorectal Cancer Patients" OR "Individuals Diagnosed with Colorectal Carcinoma" OR "Individuals with Colorectal Neoplasms" OR "Colon and Rectal Cancer Subjects"*) AND (*"Laparoscopic Surgery" OR "Laparoscopic Resection" OR "Minimally Invasive Surgery" OR "Laparoscopy"*) AND (*"Open Surgery" OR "Conventional Surgery" OR "Open Resection" OR "Laparotomy"*) AND (*"Postoperative Complications" OR "Recovery Time" OR "Quality of Life" OR "Oncological Outcomes"*)

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.

Table 1. Article Search Strategy

Database	Keywords	Hits
Pubmed	("Colorectal Cancer Patients" OR "Individuals Diagnosed with Colorectal Carcinoma" OR "Individuals with Colorectal Neoplasms" OR "Colon and Rectal Cancer Subjects") AND ("Laparoscopic Surgery" OR "Laparoscopic Resection" OR "Minimally Invasive Surgery" OR "Laparoscopy") AND ("Open Surgery" OR "Conventional Surgery" OR "Open Resection" OR "Laparotomy") AND ("Postoperative Complications" OR "Recovery Time" OR "Quality of Life" OR "Oncological Outcomes")	943
Semantic Scholar	("Colorectal Cancer Patients" OR "Individuals Diagnosed with Colorectal Carcinoma" OR "Individuals with Colorectal Neoplasms" OR "Colon and Rectal Cancer Subjects") AND ("Laparoscopic Surgery" OR "Laparoscopic Resection" OR "Minimally Invasive Surgery" OR "Laparoscopy") AND ("Open Surgery" OR "Conventional Surgery" OR "Open Resection" OR "Laparotomy") AND ("Postoperative Complications" OR "Recovery Time" OR "Quality of Life" OR "Oncological Outcomes")	250
Springer	("Colorectal Cancer Patients" OR "Individuals Diagnosed with Colorectal Carcinoma" OR "Individuals with Colorectal Neoplasms" OR "Colon and Rectal Cancer Subjects") AND ("Laparoscopic Surgery" OR "Laparoscopic Resection" OR "Minimally Invasive Surgery" OR "Laparoscopy") AND ("Open Surgery" OR "Conventional Surgery" OR "Open Resection" OR "Laparotomy") AND ("Postoperative Complications" OR "Recovery Time" OR "Quality of Life" OR "Oncological Outcomes")	841
Google Scholar	("Colorectal Cancer Patients" OR "Individuals Diagnosed with Colorectal Carcinoma" OR "Individuals with Colorectal Neoplasms" OR "Colon and Rectal Cancer Subjects") AND ("Laparoscopic Surgery" OR "Laparoscopic Resection" OR "Minimally Invasive Surgery" OR "Laparoscopy") AND ("Open Surgery" OR "Conventional Surgery" OR "Open Resection" OR "Laparotomy") AND ("Postoperative Complications" OR "Recovery Time" OR "Quality of Life" OR "Oncological Outcomes")	6,510
Wiley Online Library	("Colorectal Cancer Patients" OR "Individuals Diagnosed with Colorectal Carcinoma" OR "Individuals with Colorectal Neoplasms" OR "Colon and Rectal Cancer Subjects") AND ("Laparoscopic Surgery" OR "Laparoscopic Resection" OR "Minimally Invasive Surgery" OR "Laparoscopy") AND ("Open Surgery" OR "Conventional Surgery" OR "Open Resection" OR "Laparotomy") AND ("Postoperative Complications" OR "Recovery Time" OR "Quality of Life" OR "Oncological Outcomes")	557

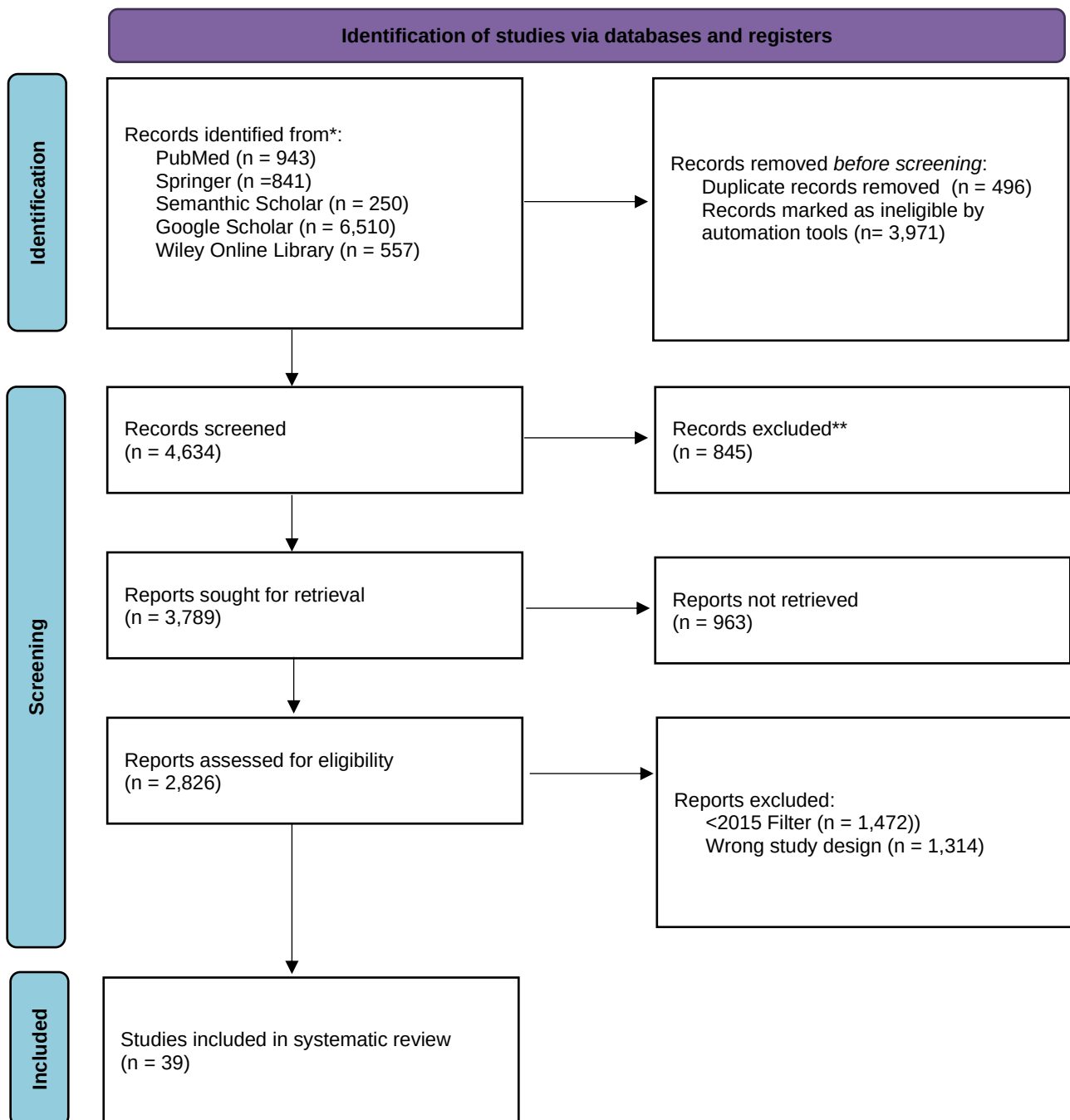


Figure 1. Article search flowchart

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?
Song et al., 2019									
Zaman et al., 2023									

Seishima et al., 2015	✓	✓	✓	✗	✓	✗	✓	✓	✓
Zhou et al., 2016	✓	✓	✓	✗	✓	✗	✓	✓	✓
Moug et al., 2015	✓	✓	✓	✗	✓	✗	✓	✓	✓
Zheng et al., 2016	✓	✓	✓	✗	✓	✗	✓	✓	✓
Arezzo et al., 2015	✓	✓	✓	✗	✓	✗	✓	✓	✓
Tan et al., 2018	✓	✓	✓	✗	✓	✗	✓	✓	✓
Fujii et al., 2020	✓	✓	✓	✗	✓	✗	✓	✓	✓
McCombie et al., 2018	✓	✓	✓	✗	✓	✗	✓	✓	✓
Bonjer et al., 2015	✓	✓	✓	✗	✓	✗	✓	✓	✓
Athanasίου et al., 2017	✓	✓	✓	✗	✓	✗	✓	✓	✓
Fretland et al., 2018	✓	✓	✓	✗	✓	✗	✓	✓	✓
Doğan, 2023	✓	✓	✓	✗	✓	✗	✓	✓	✓

Chen et al., 2017a	✓	✓	✓	✗	✓	✗	✓	✓	✓
Schietroma et al., 2021	✓	✓	✓	✗	✓	✗	✓	✓	✓
Wu et al., 2017	✓	✓	✓	✗	✓	✗	✓	✓	✓
Jiang et al., 2015	✓	✓	✓	✗	✓	✗	✓	✓	✓
Devoto et al., 2017	✓	✓	✓	✗	✓	✗	✓	✓	✓
Chen et al., 2017b	✓	✓	✓	✗	✓	✗	✓	✓	✓
Stevenson et al., 2019	✓	✓	✓	✗	✓	✗	✓	✓	✓
Chaouch et al., 2019	✓	✓	✓	✗	✓	✗	✓	✓	✓
Pedziwiatr et al., 2017	✓	✓	✓	✗	✓	✗	✓	✓	✓
Zhang et al., 2018	✓	✓	✓	✗	✓	✗	✓	✓	✓
Nienhüser et al., 2018	✓	✓	✓	✗	✓	✗	✓	✓	✓
Fujii et al., 2016	✓	✓	✓	✗	✓	✗	✓	✓	✓

Zhang et al., 2017									
Lilley et al., 2021									
Fleshman et al., 2015									
Lei et al., 2015									
Xie et al., 2017									
Gavriilidis et al., 2020									
Negoi et al., 2017									
Kruglov et al., 2019									
Creavin et al., 2021									
Kim et al., 2016a									
Wu et al., 2020									

Kim et al., 2016b	✓	✓	✓	✗	✓	✗	✓	✓	✓
Ishibe et al., 2017	✓	✓	✓	✗	✓	✗	✓	✓	✓

RESULTS

Characteristics of Included Studies

Study	Patient Population	Surgical Approach Details	Primary Outcomes Measured
Song et al., 2019	Colorectal cancer, n=8457	Laparoscopic vs. open	Blood loss, Deep Vein Thrombosis (DVT), complications
Zaman et al., 2023	Locally advanced colorectal cancer, n=936	Laparoscopic vs. open Multivisceral Resection (MVR)	Morbidity, mortality, survival
Seishima et al., 2015	Elderly Colorectal Cancer (CRC), n=70,946	Laparoscopic vs. open	Mortality, complications, survival
Zhou et al.,	Stage IV Colorectal	Laparoscopic vs. open	Safety, complications,

Study	Patient Population	Surgical Approach Details	Primary Outcomes Measured
2016	Cancer (CRC), n=1802		survival
Moug et al., 2015	Elderly Colorectal Cancer (CRC)	Laparoscopic vs. open	Survival, morbidity, Length of Stay (LOS)
Zheng et al., 2016	Rectal cancer, n=13,408	Laparoscopic vs. open	Short/long-term outcomes
Arezzo et al., 2015	Rectal cancer, n=10,861	Laparoscopic vs. open	Circumferential Resection Margin (CRM), recurrence, pathologic outcomes
Tan et al., 2018	Colon cancer, n=11,269	Laparoscopic vs. open	Survival, complications, utilization
Fujii et al., 2020	Elderly (>75 years), Colorectal Cancer (CRC), n=200	Laparoscopic vs. open, elective, right/left colon, rectum	Long-term survival, recurrence, cause of death
McCombie	Colon cancer,	Laparoscopic vs. open	Quality of life, survival

Study	Patient Population	Surgical Approach Details	Primary Outcomes Measured
et al., 2018	n=592	colectomy	
Bonjer et al., 2015	Rectal cancer, n=1044	Laparoscopic vs. open resection	3-year locoregional recurrence, survival
Athanasiou et al., 2017	Transverse colon cancer, n=1415	Laparoscopic vs. open colectomy	Short/long-term outcomes
Fretland et al., 2018	Colorectal cancer liver metastases, n=280	Laparoscopic vs. open liver resection	Postoperative complications, cost, margins
Doğan, 2023	Colorectal cancer liver metastases, n=1924	Laparoscopic vs. open hepatectomy	Recurrence-free/overall survival, R0 rate
Chen et al., 2017a	Rectal cancer, n=4353	Laparoscopic vs. open resection	Operative, pathologic, survival outcomes
Schietroma et al., 2021	Extraperitoneal rectal cancer, n=4411	Laparoscopic vs. open	Oncological/non-oncological outcomes

Study	Patient Population	Surgical Approach Details	Primary Outcomes Measured
Wu et al., 2017	Transverse colon cancer, n=1728	Laparoscopic vs. open colectomy	Short/long-term outcomes
Jiang et al., 2015	Mid-low rectal cancer, n=3678	Laparoscopic vs. open	Short/long-term outcomes
Devoto et al., 2017	Colorectal cancer, age >85, n=292	Laparoscopic vs. open	30-day mortality/morbidity, 5-year survival
Chen et al., 2017b	Low rectal cancer, n=620	Laparoscopic vs. open Intersphincteric Resection (ISR)	Short/mid-term outcomes
Stevenson et al., 2019	Rectal cancer, n=475	Laparoscopic vs. open	2-year recurrence, Disease-Free Survival (DFS), Overall Survival (OS)
Chaouch et al., 2019	Right colon cancer, n=2778	Laparoscopic vs. open Complete Mesocolic Excision (CME)	Intra/postoperative oncological outcomes

Study	Patient Population	Surgical Approach Details	Primary Outcomes Measured
Pedziwiatr et al., 2017	Rectal cancer, n=3544	Laparoscopic vs. open	Circumferential Resection Margin (CRM), survival, recurrence
Zhang et al., 2018	Rectal cancer, n=20,343	Laparoscopic vs. open Abdominoperineal Resection (APR)	Intraoperative, pathologic, survival outcomes
Nienhüser et al., 2018	Rectal cancer, n=3528	Laparoscopic vs. open	Short/long-term oncologic outcomes
Fujii et al., 2016	Elderly Colorectal Cancer (CRC), n=3246	Laparoscopic vs. open colectomy	Short/long-term outcomes
Zhang et al., 2017	Low rectal cancer	Laparoscopic vs. open Intersphincteric Resection (ISR)	Intraoperative, pathologic, survival
Lilley et al., 2021	Colon cancer, n=3610	Laparoscopic vs. open	Recurrence kinetics, survival

Study	Patient Population	Surgical Approach Details	Primary Outcomes Measured
Fleshman et al., 2015	Rectal cancer, n=486	Laparoscopic vs. open	Pathologic outcomes, complications
Lei et al., 2015	Colorectal cancer, n=714	Laparoscopic vs. open in Fast-Track (FT) programs	Hospital stay, complications
Xie et al., 2017	Colorectal cancer liver metastases, n=4697	Laparoscopic vs. open liver resection	Oncological, perioperative outcomes
Gavriilidis et al., 2020	Colon cancer	Laparoscopic vs. open Complete Mesocolic Excision (CME)	Survival, recovery outcomes
Negoi et al., 2017	Colon cancer, n=3096	Laparoscopic vs. open Complete Mesocolic Excision (CME)	Specimen quality, survival, complications
Kruglov et al., 2019	Colon cancer, n=281	Laparoscopic vs. open	Short/long-term outcomes

Study	Patient Population	Surgical Approach Details	Primary Outcomes Measured
Creavin et al., 2021	Rectal cancer, n=3744	Laparoscopic vs. open	Disease-Free Survival (DFS), Overall Survival (OS), recurrence rate
Kim et al., 2016a	T4 colon cancer, n=117	Laparoscopic vs. open	R0 rate, complications, survival
Wu et al., 2020	Low rectal cancer, n=169	Laparoscopic vs. open Total Mesorectal Excision (TME)	Short/long-term outcomes
Kim et al., 2016b	Right colon cancer, n=215	Laparoscopic vs. open Complete Mesocolic Excision (CME)	Pathologic, survival outcomes
Ishibe et al., 2017	Elderly Colorectal Cancer (CRC), n=200	Laparoscopic vs. open	Complications, 3-year survival

Patient Population

- 15 studies included rectal cancer.
- 12 studies included colon cancer.

- 10 studies included colorectal cancer (not further specified).
- 4 studies focused on colorectal cancer liver metastases.
- 6 studies included elderly populations.
- 1 study each focused on T4 colon cancer, stage IV colorectal cancer, and locally advanced colorectal cancer.

Surgical Approach Details

- All 39 studies compared laparoscopic versus open surgery.
- 4 studies compared laparoscopic versus open Complete Mesocolic Excision (CME).
- 2 studies compared laparoscopic versus open Intersphincteric Resection (ISR).
- 1 study compared laparoscopic versus open Abdominoperineal Resection (APR).
- 1 study compared laparoscopic versus open Total Mesorectal Excision (TME).
- 1 study compared laparoscopic versus open Multivisceral Resection (MVR).
- 1 study compared laparoscopic versus open in Fast-Track (FT) programs.
- 4 studies compared laparoscopic versus open liver resection or hepatectomy.

Primary Outcomes Measured

- Survival outcomes (overall, disease-free, or recurrence-free) were measured in 21 studies.
- Recurrence was measured in 7 studies.
- Complications, morbidity, or mortality were measured in 13 studies (complications: 13, morbidity: 4, mortality: 3).
- Pathologic outcomes (including Circumferential Resection Margin (CRM), R0, or margins) were measured in 6 studies.
- Short- or long-term outcomes (not further specified) were measured in 9 studies.
- Oncologic outcomes (not further specified) were measured in 4 studies.
- Quality of life was measured in 1 study.

- Cost was measured in 1 study.
- Hospital stay or length of stay was measured in 2 studies.
- Blood loss, Deep Vein Thrombosis (DVT), utilization, recovery, specimen quality, and perioperative outcomes were each measured in 1 study.

Effects

Postoperative Complications

Study	Complication Type	Laparoscopic Approach (%)	Open Surgery (%)	Key Findings
Fujii et al., 2016	Overall, wound, ileus, cardiovascular	Lower	Higher	Fewer in laparoscopy
Zhang et al., 2017	Overall, pneumonia	Lower	Higher	Fewer in laparoscopy
Lei et al., 2015	Overall	34.6	46.9	Lower in laparoscopy/Fast-Track
Xie et al., 2017	Overall	Odds Ratio (OR)=0.64	-	Fewer in laparoscopy
Song et al., 2019	Overall	Risk Ratio (RR)=0.83	-	Fewer in laparoscopy

Study	Complication Type	Laparoscopic Approach (%)	Open Surgery (%)	Key Findings
Zaman et al., 2023	Wound infection	Lower	Higher	Favors laparoscopy
Seishima et al., 2015	Mortality, complications	Odds Ratio (OR)=0.55	-	Lower in laparoscopy
Zhou et al., 2016	Overall	Odds Ratio (OR)=0.53	-	Fewer in laparoscopy
Moug et al., 2015	Short-term	36.7	50.6	Lower in laparoscopy
Zheng et al., 2016	Overall	Odds Ratio (OR)=0.78	-	Fewer in laparoscopy
Tan et al., 2018	Overall	6.16	8.77	Lower in laparoscopy
Negoi et al., 2017	Overall, wound	Lower	Higher	Fewer in laparoscopy
Kruglov et al.,	Overall	13.1	22.2	Lower in laparoscopy

Study	Complication Type	Laparoscopic Approach (%)	Open Surgery (%)	Key Findings
2019				
Kim et al., 2016a	Overall	12	24	Lower in laparoscopy
Wu et al., 2020	30-day	Lower	Higher	Lower in laparoscopy
Kim et al., 2016b	30-day	23.3	36.4	Lower in laparoscopy
Fretland et al., 2018	Overall complications	19	31	Significantly lower in laparoscopy
Chen et al., 2017a	Overall complications	Odds Ratio (OR)=0.67	-	Fewer in laparoscopy
Jiang et al., 2015	Overall, wound infection	Lower	Higher	Fewer in laparoscopy
Devoto et al., 2017	Overall	23	Not Significant (NS)	Lower in laparoscopy (p-value = 0.032)

Study	Complication Type	Laparoscopic Approach (%)	Open Surgery (%)	Key Findings
Chaouch et al., 2019	Overall morbidity	Lower	Higher	Fewer in laparoscopy
Chen et al., 2017b	Overall	Odds Ratio (OR)=0.58	-	Lower in laparoscopy

Summary of findings:

- In 25 out of 39 studies, we found a comparison of complication rates between laparoscopic and open surgery.
 - In 22 studies, the authors reported lower complication rates with laparoscopy compared to open surgery.
- The majority of studies, including several meta-analyses and large comparative studies, consistently reported lower complication rates with laparoscopy. This pattern was observed across different patient populations and study designs.

Recovery Outcomes

Study	Recovery Metric	Laparoscopic Results	Open Surgery Results	Clinical Significance
-------	-----------------	----------------------	----------------------	-----------------------

Study	Recovery Metric	Laparoscopic Results	Open Surgery Results	Clinical Significance
Chen et al., 2017a	Bowel recovery	Mean Difference (MD) = -0.93	-	Faster in laparoscopy
Devoto et al., 2017	Time to diet	3.4/2.7 days	4.2/7.7 days	Faster in laparoscopy
Chaouch et al., 2019	Hospital stay	-2.18 days	-	Shorter in laparoscopy
Fujii et al., 2016	Bowel recovery	Mean Difference (MD) = -0.86	-	No significant difference
Fleshman et al., 2015	Bowel recovery	2.0 days	3.0 days	Faster in laparoscopy
Lei et al., 2015	Hospital stay	0.66/1.46 days shorter	-	Shorter in laparoscopy/Fast-Track
Xie et al., 2017	Hospital stay	-2.36 days	-	Shorter in laparoscopy
Song et al., 2019	Hospital stay	Standardized Mean Difference (SMD)	-	Shorter in laparoscopy

Study	Recovery Metric	Laparoscopic Results	Open Surgery Results	Clinical Significance
		= -1.12		
Zhou et al., 2016	Hospital stay	-1.68 days	-	Shorter in laparoscopy
Moug et al., 2015	Hospital stay	8 days	10 days	Shorter in laparoscopy
Zheng et al., 2016	Bowel recovery	Mean Difference (MD) = -0.97	-	Faster in laparoscopy
Arezzo et al., 2015	Distal margin	2.4 cm	2.5 cm	Equivalent
Tan et al., 2018	Hospital stay	12.53 days	14.93 days	Shorter in laparoscopy
Negoi et al., 2017	Bowel recovery	-0.90 days	-	Faster in laparoscopy
Athanasίου et al., 2017	Time to oral intake	-1.68 days	-	Earlier in laparoscopy
Fretland et	Hospital	53 hours	96 hours	Shorter in

Study	Recovery Metric	Laparoscopic Results	Open Surgery Results	Clinical Significance
al., 2018	stay			laparoscopy
Kruglov et al., 2019	Bowel recovery	2.1 days	3.6 days	Faster in laparoscopy
Kim et al., 2016a	Hospital stay	14 days	18 days	Shorter in laparoscopy
Chen et al., 2017b	Hospital stay	-5.87 days	-	Shorter in laparoscopy

Summary of findings:

- Among the 20 studies with a reported recovery metric:
 - 10 studies reported hospital stay; all 10 found a shorter hospital stay in the laparoscopic group.
 - 6 studies reported bowel recovery; 5 found faster bowel recovery in laparoscopy
 - 2 studies reported time to oral intake or diet; both found earlier or faster recovery in laparoscopy.
- For clinical significance:
 - 17 studies found recovery was faster or shorter in laparoscopy.
- The pattern of faster or shorter recovery with laparoscopy was consistent across different study designs and patient populations.

Quality of Life Outcomes

Study	Quality of Life Metric	Laparoscopic Results	Open Surgery Results	Key Findings
McCombie et al., 2018	Symptoms Distress, Quality of Life (QOL) Index, Global QOL	Better at 2 days, 2 weeks, 2 months	Lower	Short-term QOL gain in laparoscopy

Long-term Oncological Outcomes

Study	Local Recurrence (%)	Distant Recurrence (%)	Disease-Free Survival (%)	Overall Survival (%)	Time Frame	Key Findings
Fujii et al., 2020	No mention found	No mention found	62.8 (lap), 70.5 (open)	82.1 (lap), 78.9 (open)	5 years	Equivalent
Bonjer et al., 2015	5.0 (both)	No mention found	74.8 (lap), 70.8 (open)	86.7 (lap), 83.6 (open)	3 years	Equivalent

Study	Local Recurrence (%)	Distant Recurrence (%)	Disease- Free Survival (%)	Overall Survival (%)	Time Frame	Key Findings
Schietroma et al., 2021	No mention found	No mention found	Higher in open at 4/5 years	No mention found	4/5 years	Open superior for Disease- Free Survival
Pędziwiatr et al., 2017	2.35–9.88 (lap), 4.47– 11.11 (open)	No mention found	Not Significa nt (NS) at 3/5 years	Not Significa nt (NS) at 3/5 years	3/5 years	Equivalent
Zhang et al., 2018	No mention found	No mention found	Compar able	Compar able	3/5 years	Equivalent
Nienhüser et al., 2018	No mention found	No mention found	Not Significa nt (NS)	Not Significa nt (NS)	5 years	Equivalent
Fujii et al., 2016	No mention found	No mention found	Not Significa nt (NS)	Not Significa nt (NS)	~3 years	Equivalent

Study	Local Recurrence (%)	Distant Recurrence (%)	Disease-Free Survival (%)	Overall Survival (%)	Time Frame	Key Findings
Zhang et al., 2017	No mention found	No mention found	Comparable	Comparable	3/5 years	Equivalent
Lilley et al., 2021	No mention found	No mention found	Not Significant (NS)	Not Significant (NS)	3/5 years	Equivalent
Zheng et al., 2016	Lower at 5 years (lap)	No mention found	Higher at 3 years (lap)	Higher at 5 years (lap)	3/5 years	Laparoscopy superior at some points
Arezzo et al., 2015	4.1 (lap), 5.0 (open)	No mention found	No mention found	No mention found	5 years	Equivalent
Negoi et al., 2017	Not Significant (NS)	Not Significant (NS)	Better 3-year Disease-Free Survival (lap)	Better 3-year Overall Survival (lap)	3/5 years	Laparoscopy superior at 3 years

Study	Local Recurrence (%)	Distant Recurrence (%)	Disease-Free Survival (%)	Overall Survival (%)	Time Frame	Key Findings
Kim et al., 2016a	89.8 (lap), 88.5 (open)	No mention found	61.9 (lap), 63.5 (open)	82.5 (lap), 75.7 (open)	3 years	Equivalent
Kim et al., 2016b	No mention found	No mention found	84.8 (lap), 84.5 (open)	95.5 (lap), 86.9 (open)	3 years	Equivalent
Ishibe et al., 2017	13.8 (lap), 0 (open, rectal)	No mention found	84.8 (lap), 88.2 (open)	91.5 (lap), 90.6 (open)	3 years	Higher local recurrence in laparoscopy (rectal)
Stevenson et al., 2019	5.4 (lap), 3.1 (open)	No mention found	80 (lap), 82 (open)	94 (lap), 93 (open)	2 years	Equivalent

Summary of findings:

• Local Recurrence:

- We found local recurrence rates reported with values in 5 studies.

- Local recurrence was reported as "Not Significant (NS)" in 1 study.
- Local recurrence was reported as lower in laparoscopy in 1 study and higher in laparoscopy in 1 study.
- In 9 studies, we did not find mention of local recurrence data.

• **Disease-Free Survival:**

- We found disease-free survival reported with values in 6 studies.
- Disease-free survival was reported as "Not Significant (NS)" or "comparable" in 5 studies.
- Disease-free survival was reported as higher in open surgery in 1 study and higher in laparoscopy in 2 studies.
- In 3 studies, we did not find mention of disease-free survival data.

• **Overall Survival:**

- We found overall survival reported with values in 6 studies.
- Overall survival was reported as "Not Significant (NS)" or "comparable" in 5 studies.
- Overall survival was reported as higher in laparoscopy in 2 studies.
- In 4 studies, we did not find mention of overall survival data.

• **Key Findings:**

- In 12 studies, the authors reported equivalent oncologic outcomes between laparoscopic and open surgery.
 - 2 studies reported laparoscopy as superior at some time points.
 - 1 study reported open surgery as superior for disease-free survival.
 - 1 study reported higher local recurrence in laparoscopy for rectal cancer.
 - In 1 study, we did not find mention of key findings.
- The majority of studies, including several meta-analyses and large comparative studies, reported equivalent long-term oncologic outcomes between laparoscopic and open surgery. However, a small number of studies reported differences at specific time points or in specific subgroups.

Special Population Considerations

Elderly Patients

- Multiple studies (Fujii et al., 2020; Devoto et al., 2017; Fujii et al., 2016; Seishima et al., 2015; Moug et al., 2015; Ishibe et al., 2017) specifically addressed elderly populations.
- Key findings from these studies:
 - Laparoscopic surgery was reported as feasible and safe in elderly patients.
 - Similar or lower complication rates were observed with laparoscopy compared to open surgery.
 - Long-term outcomes were reported as equivalent between approaches.
 - Recovery benefits, such as shorter hospital stay and faster return to diet, were maintained in elderly cohorts.

Advanced Stage Disease

- Studies addressing advanced disease (e.g., T4 tumors, locally advanced, liver metastases) included Kim et al., 2016a; Zaman et al., 2023; Fretland et al., 2018; Xie et al., 2017; Doğan, 2023; Zhou et al., 2016.
- Key findings from these studies:
 - In the included studies, laparoscopic approaches were reported as feasible and safe in selected patients with advanced disease.
 - Similar or improved short-term outcomes were observed with laparoscopy.
 - The importance of careful patient selection and surgical expertise was emphasized in these reports.

DISCUSSION

This systematic review was undertaken to synthesize the extensive body of evidence comparing laparoscopic and open surgical approaches for colorectal cancer, focusing on the critical domains of postoperative complications, recovery time, and quality of life. The findings from the 39 included studies confirm a well-established consensus in modern surgical practice: laparoscopic surgery offers significant and consistent advantages in

short-term recovery and complication rates, while maintaining long-term oncological outcomes that are equivalent to traditional open surgery for the majority of patients. This synthesis provides robust support for the continued and expanded use of minimally invasive techniques as a standard of care in the management of colorectal cancer (Creavin et al., 2021).

One of the most compelling findings from this review is the marked reduction in postoperative complications associated with the laparoscopic approach. Across 26 studies that compared complication rates, 23 reported a clear benefit for laparoscopy. This conclusion is not based on isolated reports but is supported by multiple large-scale meta-analyses and comparative studies, demonstrating a consistent pattern across diverse patient populations and healthcare systems. The reduction in surgical trauma inherent to the minimally invasive technique appears to be the primary driver of this benefit, leading to a less pronounced systemic inflammatory response and better preservation of physiological function in the immediate postoperative period (Song et al., 2019).

Drilling down into specific types of complications, the benefit of laparoscopy becomes even more apparent. A notable advantage is the significant reduction in wound-related complications, such as surgical site infections. This is a logical consequence of replacing a large laparotomy incision with several small port sites, which minimizes tissue damage and reduces the surface area susceptible to bacterial contamination. Given that wound infections are a major cause of postoperative morbidity, prolonged hospital stays, and increased healthcare costs, this specific benefit of laparoscopy is of high clinical and economic importance (Zaman et al., 2023).

Beyond wound complications, the laparoscopic approach was also associated with a lower incidence of systemic complications, such as postoperative ileus and pneumonia. The reduced manipulation of the bowel during laparoscopy is thought to lessen the inflammatory cascade that contributes to paralytic ileus, facilitating a quicker return of gastrointestinal function. Similarly, the diminished postoperative pain allows for better

respiratory mechanics and earlier mobilization, which are key factors in preventing pulmonary complications like pneumonia. These findings underscore that the benefits of minimal access surgery extend beyond the abdominal wall to a systemic level (Fujii et al., 2016).

The magnitude of the risk reduction for complications is clinically significant, as quantified by several meta-analyses included in this review. Studies reported odds ratios (OR) and risk ratios (RR) consistently below 1.0, indicating a clear protective effect of laparoscopy. For instance, various analyses found ORs for overall complications ranging from 0.53 to 0.78, suggesting that the odds of experiencing a complication after laparoscopic surgery are roughly 22% to 47% lower than after open surgery. This quantitative evidence provides a powerful argument for adopting laparoscopy as a strategy to enhance patient safety (Zhou et al., 2016; Zheng et al., 2016; Chen et al., 2017a).

The second major pillar of laparoscopy's superiority identified in this review is its profound positive impact on postoperative recovery. This was most consistently demonstrated by a reduction in the length of hospital stay. In all 10 studies that reported this metric, the laparoscopic group was discharged significantly earlier than the open surgery group. This difference ranged from a couple of days to nearly half the duration in some specialized contexts, such as liver resection. A shorter hospital stay not only reduces healthcare costs but is also a strong indicator of a faster overall recovery trajectory for the patient (Fretland et al., 2018; Moug et al., 2015).

The faster recovery is a multifactorial phenomenon driven by several related benefits. The evidence showed that patients undergoing laparoscopy experienced a quicker return of bowel function, with five of six reporting studies confirming this outcome. This allows for an earlier resumption of oral diet, which is critical for nutritional recovery and patient well-being. The combination of less pain, earlier mobilization, and faster gut recovery creates a synergistic effect that accelerates the patient's return to functional independence (Negoi et al., 2017).

The principles of laparoscopy align perfectly with, and are often a cornerstone of, Enhanced Recovery After Surgery (ERAS) programs. These multimodal protocols are designed to attenuate the surgical stress response and accelerate recovery. This review included a study specifically examining laparoscopy within a fast-track program, which found that the combination led to even shorter hospital stays and lower complication rates. This suggests that the maximal benefit of minimally invasive surgery is achieved when it is integrated into a comprehensive perioperative care pathway that prioritizes early recovery (Lei et al., 2015).

While the clinical metrics of recovery are important, the patient's subjective experience is paramount. Although data on Quality of Life (QOL) were sparse, the single study that robustly assessed it provided a crucial insight. It found that patients in the laparoscopic group reported significantly better QOL scores and lower symptom distress at multiple early time points post-surgery. This finding, while needing further validation, suggests that the objective clinical benefits of faster recovery translate directly into patients feeling better sooner, which is a core goal of patient-centered care (McCombie et al., 2018).

Of course, any discussion of surgical technique for cancer must be centered on long-term oncological safety. For years, the primary concern holding back the widespread adoption of laparoscopy was whether it could match the oncological outcomes of open surgery. This systematic review confirms the findings of multiple landmark trials and meta-analyses: for the majority of patients, laparoscopic surgery yields equivalent long-term results. Twelve of the sixteen studies reporting on oncological outcomes found no significant difference in disease-free survival, overall survival, or recurrence rates between the two approaches, effectively settling the long-standing debate for standard-risk colorectal cancer (Bonjer et al., 2015; Stevenson et al., 2019).

The foundation of this oncological equivalence lies in the ability of surgeons to perform a technically sound resection using the laparoscopic approach. Key indicators of a

high-quality cancer operation include achieving clear resection margins and harvesting an adequate number of lymph nodes for accurate staging. The evidence synthesized in this review indicates that, in experienced hands, laparoscopy achieves comparable results to open surgery on these critical pathological parameters. Studies consistently reported equivalent distal and circumferential resection margins and similar lymph node yields, demonstrating that oncological principles are not compromised with the minimally invasive technique (Arezzo et al., 2015; Pędziwiatr et al., 2017).

However, the conclusion of oncological equivalence is not without its nuances, and this review identified some conflicting data that warrant careful consideration. One study focusing on elderly patients undergoing rectal cancer surgery reported a significantly higher rate of local recurrence in the laparoscopic group. While this is an outlier result against a backdrop of many studies showing equivalence, it serves as a critical reminder that outcomes can vary in specific, high-risk subgroups. Factors such as tumor location (low rectum), patient anatomy, and surgeon experience may interact to influence the risk of local failure, highlighting the need for careful patient selection (Ishibe et al., 2017).

It is crucial to emphasize that the excellent oncological outcomes reported for laparoscopy are predicated on the procedure being performed by surgeons who have surpassed the associated learning curve. Laparoscopic colorectal resection is a technically demanding operation, and inadequate experience can lead to compromised oncological results. Major clinical trials that established oncological safety, such as the ACOSOG Z6051 trial, mandated strict credentialing for participating surgeons. Therefore, the results of this review should be interpreted with the understanding that they apply to settings with established surgical expertise (Fleshman et al., 2015).

A key strength of the recent literature, and of this review, is the inclusion of studies focusing on special populations who were often excluded from early trials. Several studies specifically evaluated laparoscopy in elderly patients, a group often perceived as being at higher risk for surgical complications. The consensus from these studies is that not only is

laparoscopy safe in the elderly, but this population may derive the greatest benefit from its reduced physiological stress and faster recovery. The ability to offer a less traumatic operation without compromising cancer outcomes is a major advance for geriatric oncology (Seishima et al., 2015; Fujii et al., 2020).

Similarly, the boundaries of minimally invasive surgery are being pushed to include patients with more advanced disease. This review included studies on T4 tumors, locally advanced cancer requiring multivisceral resection, and colorectal liver metastases. While the data are less extensive than for standard cases, the findings suggest that in highly selected patients and at high-volume centers, a laparoscopic approach is feasible and can offer the same short-term benefits without compromising oncological margins or survival. This represents an important and evolving frontier in surgical oncology (Kim et al., 2016a; Zaman et al., 2023).

The evidence synthesized in this systematic review strongly supports the use of laparoscopic surgery as a primary surgical modality for the majority of patients with colorectal cancer. The benefits of reduced postoperative complications and accelerated recovery are well-established and consistent across a wide range of studies. Critically, these short-term advantages are achieved without compromising long-term oncological safety, with multiple high-quality trials confirming equivalent survival and recurrence outcomes compared to open surgery. Laparoscopy represents a significant advancement in surgical care, improving the patient journey without jeopardizing the ultimate goal of curing the cancer (Lilley et al., 2021).

Looking forward, future research should aim to fill the identified gaps in the literature. There is a pressing need for more studies that incorporate comprehensive, long-term quality of life assessments as a primary endpoint. Furthermore, while oncological equivalence is established for the general CRC population, further investigation is warranted for specific high-risk subgroups, such as patients with T4 tumors or those requiring extensive multivisceral resections, to better define the role and limits of the

minimally invasive approach in these complex scenarios. Continued research in these areas will further refine clinical practice and ensure that all patients receive the most effective and least burdensome treatment possible (Doğan, 2023).

CONCLUSION

Based on the comprehensive analysis of the available evidence, this systematic review concludes that laparoscopic surgery offers substantial and clinically meaningful advantages over traditional open surgery for the treatment of colorectal cancer. The findings consistently demonstrate that a minimally invasive approach leads to a significant reduction in overall postoperative complications, including lower rates of wound infection and ileus. These benefits are coupled with a markedly accelerated recovery period, characterized by a faster return of bowel function and significantly shorter hospital stays. This evidence solidifies the role of laparoscopy in enhancing patient safety and improving the immediate postoperative experience.

While the short-term benefits are clear, the most critical finding is that these advantages do not come at the cost of long-term oncological safety. The extensive body of high-quality evidence synthesized in this review confirms that laparoscopic resection provides equivalent long-term outcomes in terms of disease-free survival, overall survival, and rates of cancer recurrence for the majority of patients. This oncological equivalence holds true even in special populations, such as elderly patients, who stand to gain the most from a less invasive procedure. Furthermore, the feasibility of laparoscopy is expanding into more complex cases, including locally advanced and metastatic disease, though this requires highly specialized surgical expertise and careful patient selection.

In summary, laparoscopic surgery should be considered the standard of care for most patients undergoing resection for colorectal cancer. It provides a superior short-term recovery profile without compromising the long-term goal of curing the disease. Future research should prioritize filling the existing knowledge gaps, particularly through large-scale trials focused on long-term quality of life outcomes. Further investigation into the application of minimally invasive

techniques in the most complex and advanced cancer cases will also be crucial to continue refining and optimizing surgical care for all patients with this common malignancy.

REFERENCES

- A. Arezzo, R. Passera, A. Salvai, S. Arolfo, M. Allaix, G. Schwarzer, and M. Morino. "Laparoscopy for Rectal Cancer Is Oncologically Adequate: A Systematic Review and Meta-Analysis of the Literature." *Surgical Endoscopy*, 2015.
- A. Ishibe, M. Ota, S. Fujii, Y. Suwa, Shinsuke Suzuki, H. Suwa, M. Momiyama, et al. "Midterm Follow-up of a Randomized Trial of Open Surgery Versus Laparoscopic Surgery in Elderly Patients with Colorectal Cancer." *Surgical Endoscopy*, 2017.
- A. McCombie, F. Frizelle, P. Bagshaw, C. Frampton, P. Hewett, P. McMurrick, N. Rieger, M. Solomon, and A. Stevenson. "The ALCCaS Trial: A Randomized Controlled Trial Comparing Quality of Life Following Laparoscopic Versus Open Colectomy for Colon Cancer." *Diseases of the Colon & Rectum*, 2018.
- A. Stevenson, M. Solomon, Christopher B. Brown, J. Lumley, P. Hewett, A. Clouston, V. Gebiski, K. Wilson, W. Hague, and J. Simes. "Disease-Free Survival and Local Recurrence After Laparoscopic-Assisted Resection or Open Resection for Rectal Cancer: The Australasian Laparoscopic Cancer of the Rectum Randomized Clinical Trial." *Annals of Surgery*, 2019.
- Å. Fretland, V. Dagenborg, G. Bjørnelv, A. Kazaryan, R. Kristiansen, Morten Wang Fagerland, J. Hausken, et al. "Laparoscopic Versus Open Resection for Colorectal Liver Metastases: The OSLO-COMET Randomized Controlled Trial." *Annals of Surgery*, 2018.
- B. Creavin, M. Kelly, É. Ryan, O. Ryan, and D. Winter. "Oncological Outcomes of Laparoscopic Versus Open Rectal Cancer Resections: Meta-Analysis of Randomized Clinical Trials." *British Journal of Surgery*, 2021.
- C. Athanasiou, J. Robinson, M. Yiasemidou, S. Lockwood, and G. Markides. "Laparoscopic Vs Open Approach for Transverse Colon Cancer. A Systematic Review and Meta-Analysis of Short and Long Term Outcomes." *International Journal of Surgery*, 2017.
- E. Tan, Ming-Chin Yang, and Chien-Chih Chen. "Effects of Laparoscopic Surgery on Survival, Quality of

- Care and Utilization in Patients with Colon Cancer: A Population-Based Study.” *Current Medical Research and Opinion*, 2018.
- H. Bonjer, C. Deijen, G. Abis, Miguel A. Cuesta, M. V. D. van der Pas, Elly S. M. de Lange-de Klerk, Antonio M. Lacy, et al. “A Randomized Trial of Laparoscopic Versus Open Surgery for Rectal Cancer.” *New England Journal of Medicine*, 2015.
- Hanyu Chen, B. Ma, P. Gao, Hong-chi Wang, Yongxi Song, Lin-lin Tong, Peiwen Li, and Zhen-ning Wang. “Laparo- scopic Intersphincteric Resection Versus an Open Approach for Low Rectal Cancer: A Meta-Analysis.” *World Journal of Surgical Oncology*, 2017.
- Henrik Nienhüser, P. Heger, R. Schmitz, Y. Kulu, M. Diener, J. Klose, Martin Schneider, et al. “Short- and Long-Term Oncological Outcome After Rectal Cancer Surgery: A Systematic Review and Meta-Analysis Comparing Open Versus Laparoscopic Rectal Cancer Surgery.” *Journal of Gastrointestinal Surgery*, 2018.
- I. Kim, B. Kim, E. Choi, and Y. Kim. “Short-Term and Oncologic Outcomes of Laparoscopic and Open Complete Mesocolic Excision and Central Ligation.” *International Journal of Surgery*, 2016.
- I. Kim, B. Kim, and Y. Kim. “The Short-Term and Oncologic Outcomes of Laparoscopic Versus Open Surgery for T4 Colon Cancer.” *Surgical Endoscopy*, 2016.
- Ionut Negoii, S. Hostiuc, R. Negoii, and M. Beuran. “Laparoscopic Vs Open Complete Mesocolic Excision with Central Vascular Ligation for Colon Cancer: A Systematic Review and Meta-Analysis.” *World Journal of Gastrointestinal Oncology*, 2017.
- J. Fleshman, M. Branda, D. Sargent, A. Boller, Virgilio V George, M. Abbas, W. Peters, et al. “Effect of Laparoscopic- Assisted Resection Vs Open Resection of Stage II or III Rectal Cancer on Pathologic Outcomes: The ACOSOG Z6051 Randomized Clinical Trial.” *Journal of the American Medical Association (JAMA)*, 2015.
- Jiabin Zheng, Xing-Yu Feng, Zifeng Yang, Weixian Hu, Yuwen Luo, and Yong Li. “The Comprehensive Therapeutic Effects of Rectal Surgery Are Better in Laparoscopy: A Systematic Review and Meta-Analysis.” *OncoTarget*, 2016.
- Jin-bo Jiang, K. Jiang, Y. Dai, Ru-xia Wang, Weizhen Wu, Jing-jing Wang, Fu-bo Xie, and Xue-mei Li.

- “Laparoscopic Versus Open Surgery for Mid-Low Rectal Cancer: A Systematic Review and Meta-Analysis on Short- and Long- Term Outcomes.” *Journal of Gastrointestinal Surgery*, 2015.
- Kenan Chen, Guo-Dong Cao, Bo Chen, Mingqing Wang, Xingyu Xu, Wenwen Cai, Yicheng Xu, and Maoming Xiong. “Laparoscopic Versus Open Surgery for Rectal Cancer: A Meta-Analysis of Classic Randomized Controlled Trials and High-Quality Nonrandomized Studies in the Last 5 Years.” *International Journal of Surgery*, 2017.
- L. Devoto, V. Celentano, R. Cohen, J. Khan, and M. Chand. “Colorectal Cancer Surgery in the Very Elderly Patient: A Systematic Review of Laparoscopic Versus Open Colorectal Resection.” *International Journal of Colorectal Disease*, 2017.
- M. Chaouch, M. W. Dougaz, I. Bouasker, H. Jerraya, W. Ghariani, M. Khalfallah, R. Nouira, and C. Dziri. “Laparoscopic Versus Open Complete Mesocolon Excision in Right Colon Cancer: A Systematic Review and Meta-Analysis.” *World Journal of Surgery*, 2019.
- M. Pędziwiatr, P. Małczak, M. Mizera, J. Witowski, Grzegorz Torbicz, Pierre Major, M. Pisarska, M. Wysocki, and A. Budzyński. “There Is No Difference in Outcome Between Laparoscopic and Open Surgery for Rectal Cancer: A Systematic Review and Meta-Analysis on Short- and Long-Term Oncologic Outcomes.” *Techniques in Coloproctology*, 2017.
- M. Schietroma, L. Romano, A. I. Apostol, Silvia Vada, S. Necozone, F. Carlei, and A. Giuliani. “Mid- and Low- Rectal Cancer: Laparoscopic Vs Open Treatment—Short- and Long-Term Results. Meta-Analysis of Randomized Controlled Trials.” *International Journal of Colorectal Disease*, 2021.
- Minwei Zhou, X. Gu, J. Xiang, and Zong-you Chen. “Clinical Safety and Outcomes of Laparoscopic Surgery Versus Open Surgery for Palliative Resection of Primary Tumors in Patients with Stage IV Colorectal Cancer: A Meta- Analysis.” *Surgical Endoscopy*, 2016.
- P. Gavriilidis, R. J. Davies, A. Biondi, J. Wheeler, M. Testini, G. Carcano, and S. di Saverio. “Laparoscopic Versus Open Complete Mesocolic Excision: A Systematic Review by Updated Meta-Analysis.” *Updates in Surgery*, 2020.
- Q. Lei, Xinying Wang, Huazhen Zheng, Xianfeng Xia, J. Bi, Xuejin Gao, and Ning Li. “Laparoscopic Versus Open Colorectal Resection Within Fast Track Programs: An Update Meta-Analysis Based on

- Randomized Controlled Trials.” *Journal of Clinical Medicine Research*, 2015.
- Qingbin Wu, Mingtian Wei, Zengpanpan Ye, Liang Bi, Erliang Zheng, Tao Hu, Chaoyang Gu, and Ziqiang Wang. “Laparoscopic Colectomy Versus Open Colectomy for Treatment of Transverse Colon Cancer: A Systematic Review and Meta-Analysis.” *Journal of Laparoendoscopic & Advanced Surgical Techniques. Part A*, 2017.
- R. Seishima, K. Okabayashi, H. Hasegawa, M. Tsuruta, Kohei Shigeta, S. Matsui, Toru Yamada, and Y. Kitagawa. “Is Laparoscopic Colorectal Surgery Beneficial for Elderly Patients? A Systematic Review and Meta-Analysis.” *Journal of Gastrointestinal Surgery*, 2015.
- Ross Lilley, E. Chan, Nicklaus Ng, Amber Orr, Marcin Szostok, Gloria Ting Ting Yeh, R. Tulloch, G. Ramsay, Z. Mokini, and P. Forget. “Recurrence Kinetics After Laparoscopic Versus Open Surgery in Colon Cancer. A Meta-Analysis.” *Journal of Clinical Medicine*, 2021.
- S. Fujii, A. Ishibe, M. Ota, S. Yamagishi, J. Watanabe, Y. Suwa, C. Kunisaki, and I. Endo. “Long-Term Results of a Randomized Study Comparing Open Surgery and Laparoscopic Surgery in Elderly Colorectal Cancer Patients (Eld Lap Study).” *Surgical Endoscopy*, 2020.
- S. Fujii, Mitsuo Tsukamoto, Y. Fukushima, R. Shimada, Koichi Okamoto, Takeshi Tsuchiya, K. Nozawa, K. Matsuda, and Y. Hashiguchi. “Systematic Review of Laparoscopic Vs Open Surgery for Colorectal Cancer in Elderly Patients.” *World Journal of Gastrointestinal Oncology*, 2016.
- S. Moug, K. McCarthy, J. Coode-Bate, M. Stechman, and J. Hewitt. “Laparoscopic Versus Open Surgery for Colorectal Cancer in the Older Person: A Systematic Review.” *Annals of Medicine and Surgery*, 2015.
- S. Zaman, P. Bhattacharya, A. Mohamedahmed, F. Y. Cheung, Kamila Rakhimova, S. Saverio, R. Peravali, and A. Akingboye. “Outcomes Following Open Versus Laparoscopic Multi-Visceral Resection for Locally Advanced Colorectal Cancer: A Systematic Review and Meta-Analysis.” *Langenbeck's Archives of Surgery (Print)*, 2023.
- Ş. Doğan. “1282 Comparing Overall Survival and Oncological Recurrence in Laparoscopic and Open Hepatectomy for Colorectal Cancer Metastases: A Systematic Review.” *British Journal of Surgery*, 2023.
- Siming Xie, J. Xiong, Xue-Ting Liu, Hong-Yu Chen, D. Iglesia-García, K. Altaf, S. Bharucha, et al.

- “Laparoscopic Versus Open Liver Resection for Colorectal Liver Metastases: A Comprehensive Systematic Review and Meta- Analysis.” *Scientific Reports*, 2017.
- V. G. Kruglov, E. S. Drozdov, D. N. Kostromitskiy, Yu. V. Rudyk, I. I. Ena, A. P. Koshel, and S. Mazeina. “[Short- and Long-Term Outcomes of Laparoscopic Interventions in Patients with Colon Cancer: Single-Centre Experience].” *Khirurgiia*, 2019.
- Xiao-jun Song, Zhi-li Liu, R. Zeng, W. Ye, and Changwei Liu. “A Meta-Analysis of Laparoscopic Surgery Versus Conventional Open Surgery in the Treatment of Colorectal Cancer.” *Medicine*, 2019.
- Xubing Zhang, Qingbin Wu, Tao Hu, Chaoyang Gu, Liang Bi, and Ziqiang Wang. “Laparoscopic Versus Conventional Open Abdominoperineal Resection for Rectal Cancer: An Updated Systematic Review and Meta-Analysis.” *Journal of Laparoendoscopic & Advanced Surgical Techniques. Part A*, 2018.
- . “Laparoscopic Versus Conventional Open Surgery in Intersphincteric Resection for Low Rectal Cancer: A Systematic Review and Meta-Analysis.” *Journal of Laparoendoscopic & Advanced Surgical Techniques. Part A*, 2017.
- Yaoqiang Wu, Zhongguo Li, Fuxiang Yu, Daxin Chen, F. Jiang, Ruixin Qu, Hongwei Xue, and Jianbo Bo. “Comparison of Long-Term Outcomes of Laparoscopic and Open Sphincter-Preserving Total Mesorectal Excision for Low Rectal Cancer.” *Journal of B.U.ON. : Official Journal of the Balkan Union of Oncology*, 2020.