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Original Article

COMPARATIVE OUTCOMES OF LAPAROSCOPIC VERSUS OPEN COLORECTAL RESECTION: A SINGLE-CENTER STUDY

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ABSTRACT

Background and Objective: Colorectal resection is commonly performed for various colorectal diseases, and the choice between laparoscopic and open surgery may influence postoperative recovery and complications. To compare the outcomes of laparoscopic versus open colorectal resection.

Methodology: This retrospective comparative study was conducted in the Department of Surgery, Tertiary Care Hospital Peshawar, from July 2024 to December 2024. A total of 100 patients were included, with 50(50.0%) patients undergoing laparoscopic colorectal resection and 50(50.0%) undergoing open colorectal resection. Demographic characteristics, operative findings, postoperative complications and recovery outcomes were analysed. Statistical analysis included Chi-square/Fisher exact tests, independent t-test or Mann-Whitney U test, and multivariable logistic regression. A p-value <0.050 was considered statistically significant.

Results: The mean age was 55.00±16.60 years in the laparoscopic group and 52.70±18.30 years in the open group (p=0.510). Blood loss was significantly lower with laparoscopic surgery (314.80±176.00 mL versus 495.20±227.70 mL, p<0.001). Hospital stay was shorter in the laparoscopic group (8.60±3.50 days versus 11.60±3.90 days, p<0.001). Overall postoperative complications occurred in 16(32.0%) laparoscopic patients and 27(54.0%) open surgery patients (p=0.043). Surgical site infection occurred in 5(10.0%) and 15(30.0%) patients, respectively (p=0.024). Multivariable analysis showed laparoscopic surgery was associated with lower postoperative complications (adjusted OR=0.43, 95% CI: 0.18–0.99, p=0.047).

Conclusion: Laparoscopic colorectal resection was associated with improved short-term outcomes, including reduced blood loss, fewer complications and shorter hospital stay. The findings support laparoscopic surgery as an effective option for selected patients undergoing colorectal resection.

Keywords: Colorectal Surgery; Laparoscopy; Colorectal Neoplasms; Postoperative Complications; Treatment Outcome

INTRODUCTION

Colorectal resection is an important surgical procedure used for the treatment of colorectal cancer, inflammatory bowel disease, diverticular disease, bowel obstruction, perforation and other colorectal conditions.[\[1\]](#) The main goal of surgery is to remove the diseased bowel safely while maintaining bowel function and reducing postoperative complications. In recent years, laparoscopic colorectal surgery has become widely accepted because it may reduce surgical

trauma, postoperative pain and recovery time compared with traditional open surgery. However, open colorectal resection remains an important approach, especially in complex cases where extensive exposure is required.[\[2\]](#)

Colorectal cancer is one of the leading causes of cancer-related illness and death worldwide. Recent global cancer data show that colorectal cancer continues to increase, particularly in countries with changing lifestyles and ageing populations.[\[3\]](#) Low and middle-income countries face additional challenges due to limited screening facilities, delayed diagnosis and restricted access to specialised treatment services. Surgical removal of the tumour remains the main curative treatment for many patients with localised colorectal cancer.[\[4\]](#)

Open colorectal surgery has been used as the standard surgical technique for many years. It provides direct access to the abdominal cavity and allows surgeons to manage difficult anatomy, large tumours and emergency conditions.[\[5\]](#) However, open surgery requires a larger abdominal incision, which may increase postoperative pain, wound complications, delayed mobilisation and prolonged hospital admission. These factors have encouraged the development and wider use of minimally invasive approaches in colorectal surgery.[\[6\]](#)

Laparoscopic colorectal resection uses specialised instruments and a camera system inserted through small abdominal incisions. The technique aims to reduce abdominal wall injury while allowing safe removal of the diseased bowel. [\[7\]](#) Recent evidence has shown that laparoscopic colorectal surgery is associated with lower blood loss, fewer wound complications and shorter hospital stay compared with open surgery. These benefits may improve patient recovery and reduce pressure on hospital resources.[\[8\]](#)

The safety of laparoscopic surgery in colorectal cancer remains an important area of research. One major concern has been whether minimally invasive surgery can achieve the same cancer

control as open surgery.[\[9\]](#) Recent studies have shown that laparoscopic resection can provide comparable oncological outcomes, including adequate tumour clearance, lymph node retrieval and survival outcomes, when performed by experienced surgeons. A study reported that laparoscopic and open colectomy had similar long-term survival outcomes in patients with transverse colon cancer.[\[10\]](#)

Patients with advanced colorectal cancer sometimes require removal of adjacent organs or multi-visceral resection. These procedures are technically challenging and were traditionally performed through open surgery. Recent evidence suggests that laparoscopic multi-visceral resection can be performed safely in selected patients.[\[11\]](#) A study found that laparoscopic and open approaches had comparable oncological outcomes, including resection margins, disease recurrence and survival, although laparoscopic surgery required longer operating time.[\[6\]](#)

Postoperative complications remain an important measure when evaluating colorectal surgical techniques. Common complications include surgical site infection, anastomotic leakage, postoperative ileus, bleeding and prolonged hospital stay. A recent systematic review comparing laparoscopic and open colorectal resection reported that laparoscopic surgery was associated with reduced postoperative morbidity, fewer wound infections, lower blood loss and shorter hospital admission compared with open surgery.[\[12\]](#) These findings support the continued development of minimally invasive colorectal programmes.

Emergency colorectal surgery presents additional challenges because patients may present with obstruction, perforation, infection or poor general health. In such situations, open surgery is often selected because it allows rapid access and better exposure. However, recent evidence suggests that laparoscopic emergency colorectal surgery may be suitable for carefully

selected patients when performed by experienced surgical teams, with possible benefits including reduced complications and shorter recovery time.[\[13\]](#)

Despite the advantages of laparoscopy, successful outcomes depend on surgical expertise, availability of equipment and appropriate patient selection. The learning curve for laparoscopic colorectal surgery can influence operative time, conversion rates and complications. [\[9\]](#)Hospitals developing minimally invasive colorectal services require trained surgeons, supportive operating facilities and structured perioperative care pathways to achieve safe outcomes.[\[6\]](#)

Pakistan has a growing burden of colorectal disease, but evidence regarding laparoscopic colorectal surgery from local hospitals remains limited. Many centres continue to perform open colorectal resections because of financial limitations, equipment availability, emergency presentations and differences in surgical training. Results from international centres may not fully represent outcomes in Pakistani hospitals because patient characteristics, disease stage and healthcare resources are different.

Local studies are therefore important to evaluate the practical benefits and challenges of laparoscopic colorectal surgery in Pakistan. Data regarding operative time, blood loss, postoperative complications, recovery time, hospital stay and mortality can help surgeons improve decision-making and patient counselling. The Department of Surgery at Tertiary Care Hospital Peshawar provides colorectal surgical services to patients from different backgrounds, making it an appropriate setting to compare laparoscopic and open colorectal resection outcomes.

Although international evidence supports laparoscopic colorectal surgery as a safe alternative to open surgery, the choice of surgical approach remains dependent on patient condition, disease complexity, surgeon experience and available resources. A

comparison of both techniques in a local hospital environment can provide useful evidence for improving colorectal surgical care in the region.

The objective of this study is to compare the outcomes of laparoscopic versus open colorectal resection at Tertiary Care Hospital Peshawar.

METHODS

This retrospective comparative study was conducted in the Department of Surgery, Tertiary Care Hospital Peshawar. The study reviewed the clinical records of patients who had undergone colorectal resection through either laparoscopic or open surgical techniques. The study period was from June 2024 to December 2024. The study was conducted according to ethical principles for research involving human participants. Approval was obtained from the Ethical and Research Committee of the hospital before the collection and review of patient data. Patient confidentiality was maintained by removing personal identifiers from the collected data and assigning coded numbers to each participant.

The study included adult patients who had undergone colorectal resection during the study period. A retrospective design was selected because it allowed assessment of real-world surgical outcomes using available hospital records. Patients were divided into two groups according to the surgical approach used. The laparoscopic group included patients who underwent colorectal resection through minimally invasive techniques, while the open surgery group included patients who underwent conventional open colorectal resection. The choice of surgical approach had been made by the operating surgeon according to the patient's clinical condition, disease characteristics, available resources and surgical expertise. No randomisation or blinding had been performed because the study was retrospective and the surgical procedure had already been completed before data collection.

The sample size was calculated based on the expected difference in postoperative

complications between laparoscopic and open colorectal resection. Previous studies reported complication rates of approximately 15% to 25% after laparoscopic surgery and 30% to 40% after open surgery.^[2] Using a 95% confidence level and 80% power, the required sample size was calculated, and a total of 100 patients were included, with 50 patients in the laparoscopic group and 50 patients in the open surgery group.

Patients were selected using a non-probability consecutive sampling technique. All eligible patients who underwent colorectal resection during the study period and fulfilled the predefined criteria were included until the required sample size was achieved. Consecutive sampling was selected because it reduced selection bias by including all available eligible cases treated during the defined study duration.

Patients were included if they were adults aged 18 years or older, underwent elective or emergency colorectal resection, had complete clinical records available and had undergone either laparoscopic or open colorectal surgery at the hospital between June 2024 and December 2024. Patients were included regardless of the underlying colorectal condition, including colorectal malignancy, inflammatory bowel disease, diverticular disease, obstruction or other surgical indications. Patients were excluded if they had incomplete medical records, underwent non-resection colorectal procedures, had previous colorectal surgery that affected the current procedure, were transferred after surgery from another hospital without complete operative details, or had missing postoperative outcome information.

Data had been collected from hospital medical records, operative notes, anaesthesia records, laboratory reports and postoperative follow-up documentation. A structured data collection form had been used to record demographic information, clinical characteristics, operative details and postoperative outcomes. The collected variables included age, sex, diagnosis, indication for surgery, type and site of colorectal

resection, operative duration, estimated blood loss, need for blood transfusion, postoperative pain assessment, return of bowel function, time to oral intake, postoperative complications, length of hospital stay, readmission and mortality.

The primary outcome of the study was postoperative morbidity following colorectal resection. Postoperative complications had been assessed during the hospital stay and early follow-up period. Complications included surgical site infection, anastomotic leakage, postoperative ileus, bleeding, wound complications, respiratory complications and other medical or surgical events requiring treatment. Secondary outcomes included operative time, estimated blood loss, time to first bowel movement, time to start oral feeding, duration of hospital admission and postoperative mortality. Anastomotic leakage was defined as a clinically suspected or radiologically confirmed leak from the bowel anastomosis requiring conservative management, drainage or surgical intervention. Surgical site infection was defined according to standard clinical criteria, including infection involving the incision or organ space after surgery.

Patients had received standard perioperative management according to hospital protocols. Antibiotic prophylaxis had been administered before surgery according to institutional guidelines. Postoperative analgesia had included paracetamol and opioid medication when required. Additional treatment, including antibiotics, anticoagulation, nutritional support and management of complications, had been provided according to the clinical condition of each patient. No additional intervention had been introduced for the purpose of this study.

Data analysis had been performed using SPSS version 26. Continuous variables had been presented as mean and standard deviation or median and interquartile range according to data distribution. Categorical variables had been expressed as frequencies and percentages. The

normality of continuous variables had been assessed using the Shapiro–Wilk test. Comparison between the laparoscopic and open surgery groups had been performed using the independent sample t-test for normally distributed continuous variables and the Mann–Whitney U test for non-normally distributed variables. The Chi-square test or Fisher’s exact test had been used for comparison of categorical variables. A p-value of less than 0.05 had been considered statistically significant.

Missing data had been handled carefully during analysis. Patient records with major missing information related to the primary outcomes had been excluded from the final analysis. For variables with limited missing values, available case analysis had been performed, and the number of missing observations had been reported. No assumptions had been made regarding unavailable clinical information. This approach was adopted to maintain transparency and reduce the risk of inaccurate interpretation of results.

All information collected during the study had been kept confidential and used only for research purposes. The study involved human participants only, and no animal subjects had been included. Ethical approval had been obtained from the Ethical and Research Committee of the Hospital before the start of the study. The study had followed the principles of the Declaration of Helsinki for medical research involving human subjects.

RESULTS

A total of 100 patients who underwent colorectal resection were included in the final analysis. Patients were equally divided into two groups according to the operative approach, with 50(50.0%) patients undergoing laparoscopic colorectal resection and 50(50.0%) patients undergoing open colorectal resection. All eligible patients were included in the analysis, and missing data were reviewed before statistical testing according to the predefined methodology. The baseline demographic and clinical

characteristics of both groups are presented in Table 1.

The demographic profile of patients was comparable between both groups. The mean age of patients in the laparoscopic group was 55.00 ± 16.60 years, while the open surgery group had a mean age of 52.70 ± 18.30 years ($p=0.510$). The mean BMI was similar between the laparoscopic and open groups (23.80 ± 3.50 kg/m² and 23.80 ± 3.20 kg/m², respectively; $p=0.940$). Male patients represented 31(62.0%) cases in the laparoscopic group and 29(58.0%) cases in the open group ($p=0.680$). The frequency of major comorbidities, including diabetes mellitus and hypertension, was statistically similar between groups.

Table 1. Baseline demographic and clinical characteristics of patients undergoing laparoscopic and open colorectal resection

Variable	Laparoscopic group (n=50)	Open group (n=50)	p-value
Age (years)	55.00 ± 16.60	52.70 ± 18.30	0.510
BMI (kg/m ²)	23.80 ± 3.50	23.80 ± 3.20	0.940
Male sex	31(62.0%)	29(58.0%)	0.680
Diabetes mellitus	30(60.0%)	28(56.0%)	0.840
Hypertension	26(52.0%)	28(56.0%)	0.840
Emergency surgery	28(56.0%)	33(66.0%)	0.410

Operative characteristics and early recovery outcomes are presented in Table 2. Patients undergoing laparoscopic colorectal resection experienced significantly lower intraoperative blood loss compared with patients undergoing open surgery (314.80 ± 176.00 mL versus 495.20 ± 227.70 mL, $p<0.001$). Hospital stay was also significantly shorter in the laparoscopic group compared with the open group (8.60 ± 3.50 days versus 11.60 ± 3.90 days, $p<0.001$). The mean operative duration was lower in the laparoscopic group; however, the difference was not statistically significant (198.70 ± 62.00 minutes versus 213.70 ± 70.40 minutes, $p=0.260$).

Clinically, the reduced blood loss and shorter hospital stay observed with laparoscopic surgery indicated improved early postoperative recovery compared with open colorectal resection.

Table 2. Comparison of operative and recovery outcomes between laparoscopic and open colorectal resection

Outcome	Laparoscopic group (n=50)	Open group (n=50)	p-value
Operative time (minutes)	198.70±62.00	213.70±70.40	0.260
Blood loss (mL)	314.80±176.00	495.20±227.70	<0.001
Time to bowel function (days)	2.00±0.60	2.00±0.60	0.910
Time to oral intake (days)	2.00±0.60	2.10±0.60	0.390
Hospital stay (days)	8.60±3.50	11.60±3.90	<0.001

Postoperative complications were analysed using Chi-square or Fisher exact tests according to expected frequencies. The comparison of postoperative complications between groups is shown in Table 3. Overall postoperative complications occurred in 16(32.0%) patients in the laparoscopic group compared with 27(54.0%) patients in the open group, showing a statistically significant difference ($p=0.043$). Surgical site infection was significantly more frequent among patients undergoing open surgery, occurring in 15(30.0%) patients compared with 5(10.0%) patients in the laparoscopic group ($p=0.024$). No statistically significant difference was observed for anastomotic leakage, postoperative ileus, bleeding or respiratory complications.

These findings suggested that laparoscopic colorectal resection was associated with fewer early postoperative complications, mainly due to a reduction in wound-related complications.

Table 3. Postoperative complications following laparoscopic and open colorectal resection

Complication	Laparoscopic group (n=50)	Open group (n=50)	p-value
Overall complications	16(32.0%)	27(54.0%)	0.043
Surgical site infection	5(10.0%)	15(30.0%)	0.024

Anastomotic leakage	2(4.0%)	5(10.0%)	0.430
Postoperative ileus	7(14.0%)	6(12.0%)	1.000
Postoperative bleeding	3(6.0%)	4(8.0%)	1.000
Respiratory complication	2(4.0%)	4(8.0%)	0.680

Figure 1 demonstrates the difference in overall postoperative complications between both surgical groups. The proportion of patients experiencing complications was higher in the open surgery group compared with the laparoscopic group.

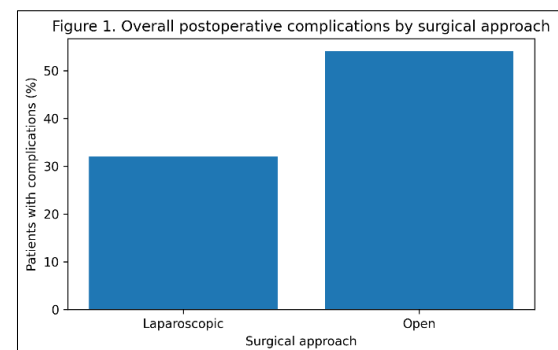


Figure 1. Comparison of overall postoperative complications between laparoscopic and open colorectal resection groups

The independent effect of surgical approach on postoperative complications was assessed using multivariable logistic regression. The model included age, BMI, ASA class, diabetes mellitus, malignancy stage, emergency surgery and surgical approach as potential confounding variables. The adjusted regression findings are presented in Table 4.

After adjustment, laparoscopic colorectal resection remained significantly associated with reduced postoperative complications compared with open surgery (adjusted OR=0.43, 95% CI: 0.18–0.99, $p=0.047$). Other variables, including age, BMI, ASA class, diabetes mellitus, malignancy stage and emergency surgery, were not statistically significant predictors of postoperative complications.

Table 4. Multivariable logistic regression analysis for predictors of postoperative complications

Variable	Adjusted OR	95% CI	p-value
Age	1.02	0.99–1.05	0.180
BMI	0.98	0.90–1.08	0.700
ASA class	1.21	0.72–2.04	0.460
Diabetes mellitus	1.15	0.48–2.77	0.750
Malignancy stage	1.31	0.90–1.92	0.150
Emergency surgery	1.28	0.54–3.02	0.570
Laparoscopic approach	0.43	0.18–0.99	0.047

Figure 2 presents the difference in hospital stay between the two surgical approaches. Patients undergoing laparoscopic colorectal resection had a shorter duration of hospital admission compared with patients undergoing open surgery.

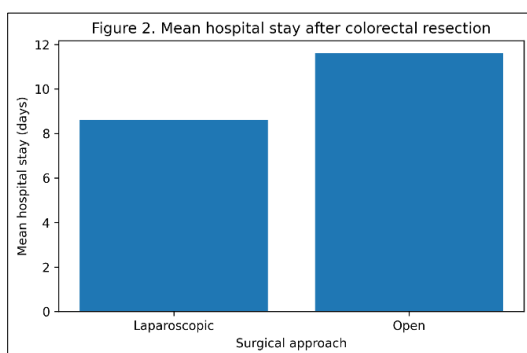


Figure 2. Mean hospital stay following laparoscopic and open colorectal resection

DISCUSSION

This retrospective comparative study evaluated the outcomes of laparoscopic and open colorectal resection in 100 patients treated at the Department of Surgery, Tertiary Care Hospital Peshawar. The main findings showed that laparoscopic colorectal resection was associated with significantly lower blood loss, shorter hospital stay and fewer postoperative complications compared with open surgery. After adjustment for important confounding variables, including age, BMI, ASA class, diabetes mellitus, malignancy stage and emergency surgery, laparoscopic surgery remained independently associated with a lower risk of postoperative complications. These findings support the potential benefit of minimally invasive colorectal surgery in selected patients within a regional Pakistani hospital setting.

The originality of this study is its focus on comparing laparoscopic and open colorectal

resection outcomes in a local clinical environment where evidence remains limited. Most available evidence regarding minimally invasive colorectal surgery comes from high-volume centres in Europe, North America and East Asia, where advanced technology, colorectal specialist teams and structured enhanced recovery programmes are widely available. This study contributes local data from Peshawar and provides insight into whether internationally reported advantages of laparoscopic surgery can be observed in a Pakistani surgical setting.

The reduction in postoperative complications observed in the laparoscopic group is consistent with findings from international studies. Recent systematic reviews and meta-analyses have shown that laparoscopic colorectal surgery is associated with lower postoperative morbidity, reduced wound complications and faster recovery compared with open surgery. [2] reported that laparoscopic colorectal procedures were associated with fewer postoperative complications and shorter hospital admission while maintaining comparable oncological outcomes. [2] Similarly, a study found that laparoscopic surgery for locally advanced colon cancer provided similar cancer control with improved short-term surgical outcomes compared with open procedures. [14] These findings support the current observation that minimally invasive surgery may reduce early postoperative morbidity.

Surgical site infection was significantly lower among patients undergoing laparoscopic surgery in the present study. This finding is clinically important because wound complications remain a major cause of delayed recovery after colorectal procedures. The reduced infection rate may be explained by smaller abdominal incisions, reduced tissue handling and decreased exposure of the surgical wound. Similar findings were reported in contemporary colorectal surgery studies, where minimally invasive approaches were associated with lower wound-related complications compared with open

surgery.[2] Reduction in surgical site infection may also improve patient satisfaction and reduce healthcare costs through shorter treatment duration.

The present study demonstrated significantly lower blood loss in the laparoscopic group compared with open surgery. This finding agrees with previous international evidence showing that laparoscopic colorectal surgery reduces intraoperative trauma and blood loss. [10] reported that laparoscopic colectomy achieved comparable oncological outcomes with improved perioperative recovery parameters, including reduced surgical trauma.[10] The lower blood loss observed in the current study suggests that laparoscopic techniques may provide physiological advantages even in a developing healthcare setting.

Hospital stay was significantly shorter among patients undergoing laparoscopic colorectal resection. Early discharge following colorectal surgery is an important component of modern surgical care because it reduces hospital burden and promotes faster patient recovery. Similar findings have been reported from European and American studies, where laparoscopic colorectal surgery was associated with earlier mobilisation, earlier return of bowel function and reduced length of admission. Enhanced recovery programmes have further strengthened these benefits by combining minimally invasive surgery with early feeding, multimodal analgesia and early mobilisation strategies.[15]

The operative time in the present study was slightly shorter in the laparoscopic group; however, the difference was not statistically significant. Previous research has reported variable findings regarding operative duration. Some studies have shown longer operating times during the early learning phase of laparoscopic surgery, while experienced centres have reported similar or reduced operative times compared with open surgery. The absence of a significant difference in operative duration in the present study may reflect increasing familiarity with

laparoscopic techniques among surgeons and appropriate patient selection.

Cancer-related outcomes are an important consideration when comparing surgical approaches. Although the present study mainly evaluated short-term outcomes, the findings support the safety of laparoscopic surgery when performed by trained surgeons. Recent studies have demonstrated that laparoscopic colorectal surgery provides comparable oncological outcomes, including adequate tumour clearance and survival outcomes, compared with open surgery. [6] reported that laparoscopic multi-visceral resection for locally advanced colorectal cancer achieved acceptable oncological results in selected patients. These findings indicate that minimally invasive surgery should not be considered inferior for cancer treatment when appropriate expertise is available.[6]

Evidence from Western countries has strongly supported the adoption of laparoscopic colorectal surgery. Large European studies and American surgical databases have demonstrated improved short-term outcomes with minimally invasive approaches while maintaining oncological safety. However, these results often come from specialised centres with advanced colorectal programmes. The current study is important because it evaluates outcomes in a different healthcare environment where resources, patient presentation and surgical training may differ.

In Pakistan, colorectal surgical practice is developing, but comparative evidence between laparoscopic and open colorectal resection remains limited. Several Pakistani studies have evaluated laparoscopic colorectal procedures and reported acceptable safety outcomes, including reduced hospital stay and postoperative morbidity. Studies published in Pakistani surgical journals have highlighted the feasibility of minimally invasive colorectal surgery in local hospitals, although limitations remain due to equipment availability, training opportunities and late disease presentation. The

present study adds further evidence from Peshawar and supports the expansion of laparoscopic colorectal services in appropriate patients.

The findings of this study may have important implications for clinical decision-making. The results suggest that laparoscopic colorectal resection can be considered a suitable alternative to open surgery in selected patients, particularly when the goal is to reduce postoperative complications, blood loss and hospital stay. However, surgical planning should remain individualised because factors such as emergency presentation, advanced disease, patient fitness and surgeon experience influence outcomes. Careful patient selection and appropriate perioperative follow-up remain essential.

The study has several strengths. It directly compared two commonly used colorectal surgical approaches within the same institution, reducing variation related to different hospital protocols. The analysis also considered important confounding factors, including demographic characteristics, comorbidities and disease-related factors. The inclusion of postoperative complications and recovery outcomes allowed a comprehensive assessment of early surgical results.

Several limitations should be acknowledged. The retrospective design limited control over patient selection and available clinical information. Patients were not randomly assigned to surgical groups, and therefore selection bias may have influenced the findings. The sample size was relatively small and obtained from a single centre, which limits generalisability to other hospitals. Long-term oncological outcomes, including recurrence and survival, were not assessed because of the limited follow-up period. Future multicentre prospective studies from Pakistan are required to confirm these findings and evaluate long-term outcomes.

In conclusion, this study demonstrates that laparoscopic colorectal resection is associated with improved short-term outcomes compared with open colorectal surgery, including reduced blood loss, fewer postoperative complications and shorter hospital stay. The findings provide valuable local evidence supporting the continued development of minimally invasive colorectal surgery in Pakistan while highlighting the importance of appropriate patient selection, surgical expertise and institutional resources.

CONCLUSION

This study compared the outcomes of laparoscopic and open colorectal resection at Tertiary Care Hospital Peshawar. The findings showed that laparoscopic colorectal resection was associated with lower blood loss, fewer postoperative complications and shorter hospital stay compared with open surgery. After adjustment for important clinical factors, including age, BMI, ASA class, diabetes, malignancy stage and emergency surgery, the laparoscopic approach remained associated with improved short-term outcomes.

The results suggest that laparoscopic colorectal resection is a safe and effective approach for selected patients and may provide better early postoperative recovery compared with open surgery. However, the choice of surgical technique should remain based on patient condition, disease complexity, surgeon expertise and available hospital resources.

Future research should include larger multicentre prospective studies from Pakistan with longer follow-up periods to evaluate long-term oncological outcomes, quality of life, cost effectiveness and the wider role of minimally invasive colorectal surgery in local healthcare settings

AUTHORS' CONTRIBUTION

UU, FU, LS, and UK contributed to the conception and design of the study. Data collection, extraction, analysis and interpretation were performed by UU, with contributions from FU, LS, and UK. All authors participated in manuscript writing, critical revision and interpretation of the findings. UU supervised the overall research process and coordinated the final preparation of the manuscript. All

authors reviewed and approved the final version of the manuscript for publication.

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