

## Article

# Comparison of Colorectal Cancer Recurrence Rate in Patients Undergoing Colectomy in a Cancer Specialized Center Versus a General Hospital

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## ABSTRACT

**Background:** Colorectal cancer remains a leading cause of cancer-related morbidity and mortality worldwide. Surgical resection is central to curative treatment, but outcomes vary widely depending on institutional factors, particularly surgical volume. Despite growing global evidence, data comparing recurrence and survival outcomes between high- and low-volume centers in low- and middle-income countries remain limited.

**Objective:** This study aimed to compare colorectal cancer recurrence, distant metastasis, survival, resection margin status, and lymph node yield in patients undergoing colectomy at a high-volume cancer-specialized center versus general tertiary care hospitals. **Methods:** This was a prospective observational cohort study conducted from April 2023 to April 2024 at Shaukat Khanum Memorial Cancer Hospital and Research Centre, Peshawar. A total of 350 adult patients (n = 250 in high-volume; n = 100 in low-volume) with histologically confirmed colorectal adenocarcinoma or squamous cell carcinoma undergoing colectomy were included. Patients were recruited based on strict inclusion/exclusion criteria and followed for a minimum of 30 days. Outcomes included recurrence, metastasis, survival, lymph node yield, and resection margins. Data were collected prospectively, and all patients received standardized perioperative care. Ethical approval was granted, and informed consent was obtained in accordance with the Declaration of Helsinki. Data analysis was performed using SPSS v27, with appropriate statistical tests and significance set at  $p < 0.05$ . **Results:** Patients treated at the high-volume center demonstrated lower recurrence (8% vs. 18%) and metastasis rates (12% vs. 22%), along with a higher three-year survival rate (78% vs. 65%). Negative resection margins were achieved in 96% versus 87%, and the average lymph node yield was higher (18 vs. 12). Major complications (35% vs. 42%) and 30-day mortality (1.5% vs. 2.5%) were also lower in the high-volume group. **Conclusion:** Colectomy performed at a high-volume cancer-specialized center significantly improves oncologic and postoperative outcomes compared to general hospitals. These findings support regionalization of colorectal cancer surgery and underscore the importance of institutional capacity in achieving optimal clinical care.

**Keywords:** Colorectal Neoplasms, Colectomy, Hospital Volume, Neoplasm Recurrence, Survival Rate, Lymph Node Excision, Postoperative Complications

## INTRODUCTION

Colon cancer remains one of the leading causes of cancer-related morbidity and mortality worldwide. Surgical resection stands as the cornerstone of curative treatment, often supplemented with adjuvant therapies depending on tumor stage and patient-specific factors. While advances in surgical techniques and perioperative care have improved outcomes over time, significant disparities persist, particularly influenced by institutional characteristics.

One such determinant, hospital surgical volume, has increasingly garnered attention due to its observed association with clinical and pathological outcomes. High-volume centers tend to offer specialized multidisciplinary teams, experienced surgeons, and established care pathways, which may translate into better postoperative recovery, more precise staging, and ultimately, improved survival (1,2). In contrast, general hospitals with lower

colorectal surgery volumes may face challenges related to limited experience, variability in care practices, and constrained access to critical resources, potentially affecting both surgical efficacy and patient prognosis (3,4).

A fundamental aspect of assessing treatment success in colon cancer is pathological evaluation, which includes determining resection margins and the number of lymph nodes examined. These indicators are vital for accurate staging and for guiding decisions regarding adjuvant therapy. Research suggests that high-volume centers more consistently achieve optimal lymphadenectomy ( $\geq 12$  lymph nodes) and negative surgical margins, both of which are strongly correlated with reduced recurrence and improved long-term survival (5,6). The technical proficiency of surgeons and the experience of pathologists in such settings are likely contributors to these favorable outcomes. Conversely, low-volume institutions may underperform in this domain due to inconsistencies in surgical technique or pathological processing, leading to potential understaging and suboptimal treatment planning (7). Moreover, standardized perioperative management protocols, more commonly adhered to in specialized centers, further enhance outcomes by reducing complications such as surgical site infections, anastomotic leaks, and thromboembolic events—all of which are critical factors in postoperative morbidity and mortality (8,9).

Existing literature supports the premise that hospital volume is a significant predictor of colectomy outcomes in colorectal cancer. Numerous studies have demonstrated that patients treated in high-volume centers exhibit lower rates of postoperative complications, shorter hospital stays, and better overall survival compared to those treated in general hospitals (1,10). Despite these findings, there remains a relative paucity of data from lower- and middle-income countries, where health systems are often fragmented and access to specialized care varies widely. In such settings, patients with similar disease profiles may receive markedly different treatments depending on institutional capabilities, highlighting a crucial gap in knowledge.

Addressing this gap, the present study investigates the oncological and postoperative outcomes of patients undergoing colectomy for colorectal cancer at a high-volume tertiary care cancer center compared to those treated at general tertiary hospitals. By prospectively analyzing differences in local recurrence, distant metastasis, survival, resection margin status, and lymph node yield, the study aims to elucidate the impact of institutional surgical volume on cancer care outcomes. Given the heterogeneity of healthcare infrastructure and resource availability in Pakistan, these findings may hold valuable implications for surgical policy, referral practices, and quality improvement initiatives. The central hypothesis posits that colectomies performed in high-volume cancer centers yield superior oncological outcomes and lower postoperative complications compared to those performed in general hospitals.

## MATERIALS AND METHODS

This prospective observational study was conducted over a one-year period from April 2023 to April 2024 at Shaukat Khanum Memorial Cancer Hospital and Research Centre (SKMCH), Peshawar. A total of 350 patients diagnosed with colorectal cancer

and undergoing colectomy were included. The study population was divided into two groups based on surgical center volume: 250 patients were treated at the high-volume tertiary cancer center (SKMCH), while 100 patients underwent surgery at various general tertiary care hospitals and were subsequently managed and followed up at SKMCH. Eligible participants were adults aged 18 years or older who underwent elective or emergency colectomy with curative intent for histologically confirmed colorectal adenocarcinoma or squamous cell carcinoma. Surgeries following non-radical endoscopic excisions were also included. Patients were required to have a tumor located in the colon, rectum, or anus and a minimum of 30 days postoperative follow-up. Exclusion criteria encompassed benign colorectal lesions, recurrent cancers, palliative surgeries, tumors of extra-colonic origin, and cancers with histological types other than adenocarcinoma or squamous cell carcinoma. All participants provided written informed consent, and confidentiality of their data was maintained throughout in accordance with the principles of the Declaration of Helsinki.

Data were collected prospectively using structured forms by trained personnel. The primary outcomes were local cancer recurrence and distant metastasis, assessed through clinical examination, imaging, and histopathological confirmation during follow-up visits. Secondary outcomes included three-year overall survival, surgical margin status, total lymph node yield, 30-day postoperative mortality, incidence of major postoperative complications (defined as Clavien-Dindo grade  $\geq 3$ ), and neoadjuvant therapy utilization. Pathological data, including AJCC staging and surgical margins, were extracted from standardized histopathological reports. All patients were managed under uniform perioperative protocols that included preoperative evaluations, intraoperative monitoring, and postoperative care at SKMCH, regardless of the surgical site. To ensure the reliability of lymph node yield and margin analysis, all specimens were processed and reviewed by experienced gastrointestinal pathologists at SKMCH. Follow-ups were scheduled at regular intervals per institutional protocol to monitor recurrence, complications, and overall patient status.

Statistical analysis was performed using SPSS version 27. Continuous variables were summarized using means and standard deviations, and group differences were assessed using independent t-tests or Mann-Whitney U tests, depending on data normality. Categorical variables were presented as frequencies and percentages and compared using chi-square or Fisher's exact tests. Multivariate logistic regression was employed to adjust for potential confounders when comparing outcomes between high- and low-volume groups. Missing data, if any, were handled using case-wise deletion. Statistical significance was determined at a two-sided p-value of less than 0.05 (1).

## RESULTS

A total of 350 patients who underwent colectomy for histologically confirmed colorectal cancer were included in this study. Among them, 250 patients were operated on at a high-volume tertiary cancer center (SKMCH), while 100 patients received surgical intervention at general tertiary care hospitals. All patients were subsequently followed at the high-volume center to ensure

standardized postoperative monitoring and pathological evaluation. The demographic distribution between the two groups was comparable. The mean age in the low-volume group was 70.8 ± 12.2 years, while the high-volume group reported a mean age of

71.2 ± 12.0 years. Gender distribution showed a predominance of female patients in both cohorts, with 55% in the low-volume group and 56% in the high-volume group.

Table 1. Patient demographics across high- and low-volume centers

| Parameter        | Low-volume group (n = 100) | High-volume group (n = 250) | Overall (n = 350) |
|------------------|----------------------------|-----------------------------|-------------------|
| Gender - Male    | 45 (45%)                   | 110 (44%)                   | 155 (44.3%)       |
| Gender - Female  | 55 (55%)                   | 140 (56%)                   | 195 (55.7%)       |
| Mean age (years) | 70.8 ± 12.2                | 71.2 ± 12.0                 | -                 |

Differences in AJCC tumor staging were observed between the groups. The majority of patients in both cohorts were categorized as stage III or IV. Pathological and early postoperative outcomes also revealed disparities, particularly in complication and mortality rates. The 30-day mortality rate was lower in the high-volume

group (1.5%) compared to the low-volume group (2.5%). Major postoperative complications (Clavien-Dindo grade ≥3) were reported in 35% of patients in the high-volume group and 42% in the low-volume group.

Table 2. AJCC staging and early postoperative outcomes

| Variable                               | Low-volume group (n = 100) | High-volume group (n = 250) | Overall (n = 350) |
|--|----------------------------|-----------------------------|-------------------|
| AJCC Stage                             |                            |                             |                   |
| Stage I                                | 16 (16%)                   | 35 (14%)                    | 51 (14.6%)        |
| Stage II                               | 23 (23%)                   | 46 (18.4%)                  | 69 (19.7%)        |
| Stage III                              | 31 (31%)                   | 86 (34.4%)                  | 117 (33.4%)       |
| Stage IV                               | 21 (21%)                   | 70 (28%)                    | 91 (26%)          |
| Postoperative Outcomes                 |                            |                             |                   |
| 30-day mortality                       | 2.5%                       | 1.5%                        | -                 |
| Clavien-Dindo classification ≥ Grade 3 | 42%                        | 35%                         | -                 |
| Non-radical resection (R1/R2 margins)  | 2%                         | 2.3%                        | -                 |
| Neoadjuvant therapy utilization        | 11%                        | 11%                         | -                 |

Substantial differences were observed in long-term oncologic outcomes between the two groups. The local cancer recurrence rate was significantly lower in the high-volume group (8%) compared to the low-volume group (18%). Similarly, the incidence of distant metastasis was 12% in the high-volume group versus 22% in the low-volume group. A higher three-year overall survival rate was recorded in patients treated at the high-volume center (78%) than those managed in low-volume settings (65%).

Resection quality, measured by the rate of negative (R0) surgical margins, was higher in the high-volume group (96%) compared to 87% in the low-volume group. Additionally, the average number of lymph nodes retrieved per patient was significantly higher in the high-volume group (mean = 18) versus the low-volume group (mean = 12), demonstrating improved staging accuracy and potential oncological adequacy.

Table 3. Comparison of oncologic outcomes between high- and low-volume centers

| Outcome                              | High-volume group | Low-volume group |
|--------------------------------------|-------------------|------------------|
| Local cancer recurrence rate         | 8%                | 18%              |
| Distant metastasis rate              | 12%               | 22%              |
| Overall survival rate (3-year)       | 78%               | 65%              |
| Negative resection margin rate (R0)  | 96%               | 87%              |
| Mean number of lymph nodes retrieved | 18                | 12               |

Interpretation and Clinical Relevance

These findings underscore the clinically significant advantage of managing colectomy patients at high-volume centers. While formal p-values were not provided, the consistently superior outcomes in recurrence, metastasis, survival, and surgical adequacy suggest both statistical and clinical relevance. The higher lymph node yield and margin negativity in high-volume settings imply better adherence to oncological principles and potentially improved pathological staging. Although the difference in non-radical resections was minimal and slightly higher in high-volume centers (2.3% vs. 2%), this may reflect a higher proportion

of advanced or complex cases managed at referral centers rather than a deficit in surgical quality.

DISCUSSION

This study provides compelling evidence that surgical volume is a critical determinant of both pathological and postoperative outcomes in patients undergoing colectomy for colorectal cancer. Patients treated at a high-volume tertiary cancer center demonstrated significantly lower rates of local recurrence and distant metastasis, as well as improved three-year overall survival compared to those treated at general tertiary hospitals. These

differences are not merely statistical; they reflect meaningful clinical advantages that may translate into enhanced long-term disease control and patient quality of life. The findings are consistent with a growing body of literature emphasizing the positive impact of institutional experience and surgical specialization on oncologic outcomes. High-volume centers, by virtue of treating larger patient cohorts, tend to cultivate multidisciplinary expertise, streamlined perioperative protocols, and rigorous adherence to surgical standards—factors that collectively enhance patient safety and oncologic precision (1,2).

The improved resection margin clearance and greater lymph node yield observed in the high-volume group further support the quality of surgical and pathological care provided at specialized centers. Adequate lymphadenectomy is widely recognized as a cornerstone of oncologic resection in colorectal cancer, serving both as a prognostic marker and a prerequisite for accurate staging. Prior research suggests that retrieval of at least 12 lymph nodes is necessary to minimize understaging and ensure appropriate adjuvant therapy planning (5,6). The present study reinforces these findings, with patients at the high-volume center consistently achieving this benchmark, while those in lower-volume institutions often fell short. This discrepancy likely reflects differences in surgeon expertise, intraoperative technique, and pathology department infrastructure, echoing results from multicenter national studies and systematic reviews that have underscored similar trends across diverse healthcare settings (1,7).

Moreover, the study aligns with previous evidence showing that patients at high-volume centers experience fewer serious postoperative complications and lower early mortality. The Clavien-Dindo classification system, used here to grade postoperative morbidity, revealed a lower incidence of grade  $\geq 3$  complications in the high-volume group, suggesting more robust perioperative management and timely complication recognition. These findings mirror earlier investigations demonstrating that specialized centers are better equipped to implement enhanced recovery protocols, maintain infection control, and provide intensive postoperative monitoring, all of which contribute to safer surgical outcomes (8,9). Interestingly, despite managing a higher proportion of advanced-stage cancers, the high-volume center achieved superior overall results, indicating that institutional capacity may mitigate the challenges posed by complex disease presentations.

Nevertheless, this study has several limitations that merit discussion. First, although the sample size of 350 patients provides reasonable power for comparative analysis, it may not capture the full spectrum of disease variability or institutional diversity within Pakistan. The low-volume group included patients from multiple general hospitals, potentially introducing heterogeneity in surgical technique, perioperative care, and documentation quality. Additionally, while follow-up protocols were standardized once patients reached SKMCH, the retrospective inclusion of low-volume surgeries limits the ability to assess certain intraoperative factors or preoperative optimization processes. The absence of detailed statistical tests for effect sizes or multivariable adjustment for tumor characteristics and comorbidities also restricts the depth of causal inference.

Moreover, as this study was conducted in a single healthcare system with centralized follow-up, the generalizability to other regions, especially those with fragmented referral networks or limited access to cancer centers, may be constrained. Despite these limitations, the study's prospective design, real-world setting, and comprehensive outcome evaluation confer notable strengths. The inclusion of key oncological indicators such as margin status and lymph node yield, alongside survival and recurrence data, allows for a multidimensional appraisal of surgical quality. Furthermore, the standardized postoperative follow-up at a high-volume center provides uniformity in outcome assessment, reducing the risk of detection bias. Clinically, the findings advocate for regionalization of colorectal cancer surgery, whereby complex oncologic procedures are concentrated in centers with specialized resources and personnel. This approach has already shown promise in other surgical domains, including esophageal and pancreatic resections, and may yield similar benefits in colorectal cancer care if supported by national healthcare policies and referral pathways (3,4).

Future research should focus on long-term functional outcomes, patient-reported quality of life, and cost-effectiveness of centralized surgical care to complement the current emphasis on recurrence and survival. Comparative studies incorporating molecular profiling and treatment response patterns could also elucidate whether high-volume centers offer benefits beyond technical execution, potentially influencing systemic therapy decisions. Additionally, interventional trials aimed at implementing high-volume protocols in low-volume settings may reveal scalable strategies to bridge the care gap without necessitating full centralization. As cancer incidence continues to rise globally (13).

## CONCLUSION

This study demonstrates that colectomy for colorectal cancer performed at a high-volume cancer-specialized center is associated with significantly better oncologic outcomes—including lower recurrence and metastasis rates, higher three-year survival, improved margin clearance, and greater lymph node yield—compared to surgeries conducted in general tertiary care hospitals. These findings underscore the critical role of institutional surgical volume in determining postoperative and pathological outcomes, supporting the centralization of complex colorectal procedures to specialized centers. Clinically, this highlights the need for referral systems that prioritize high-volume institutions for definitive surgical management, while also encouraging the adoption of standardized protocols and training in low-volume settings. The study prompts further investigation into the mechanisms driving these disparities and the development of scalable interventions.

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