

SHORT-TERM OUTCOMES OF LAPAROSCOPIC COLORECTAL RESECTIONS FOR CANCER: A FIVE-YEAR SINGLE-CENTRE EXPERIENCE FROM SERBIA

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КРАТКОРОЧНИ ИСХОДИ ЛАПАРОСКОПСКЕ РЕСЕКЦИЈЕ КОЛОРЕКТАЛНОГ КАРЦИНОМА: ПЕТОГОДИШЊЕ ИСКУСТВО ЈЕДНОГ ЦЕНТРА У СРБИЈИ

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ABSTRACT

Objective. To evaluate the short-term outcomes of laparoscopic colorectal resections for colorectal cancer in a single Serbian tertiary centre.

Methods. A retrospective cohort study included 97 patients who underwent elective laparoscopic colorectal resections between January 2013 and March 2018. Demographic, perioperative, and oncologic data were analysed. Primary outcomes were 30-day morbidity and mortality; secondary outcomes included operative time, conversion, re-intervention, length of stay, and lymph-node yield. Logistic regression identified independent predictors of complications.

Results. The cohort comprised 59 men (60.8%) and 38 women (39.2%), with a median age of 71 years. Conversion to open surgery occurred in 6 patients (6.1%), while re-intervention was required in 3 (3.1%). The median operative time was 120 minutes for colonic and 175 minutes for rectal resections. Median lymph-node yield was 15, with all achieving R0 resection. The overall 30-day morbidity rate was 17.5%, with no perioperative deaths. General complications occurred in 12.4% and surgery-specific complications in 11.3%, with partial overlap. Median length of stay was 9 days, significantly longer in men and diabetic patients. Logistic regression confirmed cardiomyopathy as an independent predictor of postoperative complications (OR 7.5, $p = 0.008$).

САЖЕТАК

Циљ. Процена краткорочних исхода лапароскопске ресекције колоректалног карцинома у једном терцијарном центру у Србији.

Метод. Ретроспективна кохортна студија обухватила је 97 болесника оперисаних елективно методом лапароскопске ресекције колоректалног карцинома у периоду јануар 2013. – март 2018. године. Анализирани су демографски, периперативни и онколошки параметри. Примарни исходи били су тридесетодневни морбидитет и морталитет; секундарни исходи обухватали су време операције, конверзију, реинтервенцију, дужину хоспитализације и број уклоњених лимфних чворова. Логистичка регресија коришћена је за идентификацију независних предиктора компликација.

Резултати. У испитивање је укључено 59 мушкараца (60,8%) и 38 жена (39,2%), медијана старости 71 година. Конверзија у отворену операцију учињена је код шест болесника (6,1%), док је реинтервенција била потребна код три (3,1%). Медијано време операције износило је 120 минута за колонске и 175 минута за ресекције ректума. Медијано број лимфних чворова био је 15, уз постизање R0 ресекције код свих болесника. Укупан тридесетодневни морбидитет износио је 17,5%, без периперативних смрти. Опште компликације јавиле су се код 12,4%, а специфичне код 11,3% болесника. Медијана дужине хоспитализације била је девет дана, значајно дужа код мушкараца и оболелих од дијабетеса. Логистичка регресија потврдила је кардиомиопатију као независни предиктор компликација (OR = 7,5; $p = 0,008$).

Conclusion. Laparoscopic colorectal resections in this series were associated with acceptable morbidity, no mortality, low conversion, and adequate oncologic quality. Cardiomyopathy was identified as a major perioperative risk factor, highlighting the need for tailored perioperative management.

Key words: colorectal neoplasms; laparoscopy; postoperative complications; anastomotic leak; lymph nodes.

INTRODUCTION

Colorectal cancer (CRC) represents one of the leading causes of cancer morbidity and mortality worldwide (1), with surgery remaining the cornerstone of curative treatment. Over the past three decades, laparoscopic colorectal surgery (LAC) has emerged as a minimally invasive alternative to open procedures, offering reduced blood loss, faster recovery, and shorter hospital stay without compromising oncologic outcomes (2). Multiple randomized controlled trials and meta-analyses have confirmed the oncological safety of LAC, demonstrating comparable long-term survival and recurrence rates to open colectomy, while achieving superior perioperative recovery profiles (3-6). Despite these advances, the adoption of LAC has varied across centres, depending on surgeon expertise, institutional resources, and perioperative management protocols (1, 7). In Serbia and the broader Balkan region, published evidence on real-world outcomes of LAC remains limited. Evaluating feasibility, safety, and short-term oncologic adequacy in local cohorts is essential for benchmarking institutional performance and guiding future adoption. Therefore, the present study aimed to report perioperative results over the five years of implementing laparoscopic colorectal resections at our tertiary surgical unit, focusing on conversion rates, complications, length of stay, and lymph node yield.

PATIENTS AND METHODS

This was a retrospective, single-centre cohort study conducted at the Clinic for General Surgery, Military Medical Academy, Belgrade, Serbia. The study included all consecutive patients who underwent elective laparoscopic colorectal resections for histologically confirmed CRC between January 2013 and March 2018.

Eligible patients were adults (≥ 18 years) with histopathologically proven CRC scheduled for elective laparoscopic resection. Patients were excluded if they required emergency surgery (perforation, obstruction, or uncontrolled bleeding), underwent synchronous procedures precluding laparoscopic access, or had incomplete perioperative data. Demographic and clinical variables, including age, sex, and comorbidities, were

Закључак. Лапароскопска ресекција колоректалног карцинома у овој серији показала је прихватљив морбидитет, без морталитета, ниску стопу конверзије и задовољавајућу онколошку адекватност. Кардиомиопатија је идентификована као значајан периоперативни ризик, што наглашава потребу за индивидуализованом периоперативном негом.

Кључне речи: колоректалне неоплазије; лапароскопија; постоперативне компликације; анастомотско цурење; лимфни чворови.

collected from medical records. All patients underwent standardized preoperative staging (TNM) with colonoscopy and biopsy, contrast-enhanced CT of the abdomen and pelvis, and chest imaging as indicated. Tumour localization was classified into five anatomical regions: descending colon, sigmoid colon, rectosigmoid/proximal rectum, mid/distal rectum, and anal canal. The type of laparoscopic resection was selected according to the tumour location, following standard oncologic principles. Perioperative care was provided in accordance with institutional protocols aligned with enhanced recovery after surgery (ERAS) principles, where feasible.

All procedures were performed under general anaesthesia with patients in modified lithotomy and appropriate Trendelenburg or lateral tilt positioning. Pneumoperitoneum was established with a Veress needle to 12 mmHg. Trocar placement followed side-specific configurations (three ports for right colectomy, four for left-sided or rectal resections). Specimens were retrieved via a protected mini-laparotomy (right subcostal for right colon, suprapubic for left-sided resections). Anastomoses were predominantly stapled using the double-stapling technique. A diverting stoma was fashioned selectively. Intra-abdominal drains were placed at the surgeon's discretion. Conversion to open surgery was defined as any unplanned laparotomy required to complete the planned resection.

The primary endpoints were 30-day morbidity (≥ 1 complication) and 30-day mortality. Complications were categorized as general (urinary tract infection, pneumonia, venous thromboembolism, myocardial infarction, Clostridioides difficile colitis, urethral stricture) or surgery-specific (anastomotic leak, surgical-site infection, port-site haematoma, paralytic ileus, position-related nerve injury). Secondary outcomes included operative time, conversion rate, need for re-intervention, length of hospital stay (LOS), and lymph-node (LN) yield. Oncologic quality was assessed by LN harvest and resection margins, where available.

Continuous variables were reported as mean $\pm$ standard deviation (SD) or median (range), depending on distribution assessed by the Shapiro-Wilk test. Categorical variables were presented as counts and percentages. Group comparisons were performed using

the Student's t-test or Mann–Whitney U test for continuous data and the χ^2 test or Fisher's exact test for categorical variables. Logistic regression was applied to identify independent predictors of complications; candidate covariates included age, sex, comorbidities, type of procedure, and operative time. Odds ratios (OR) with 95% confidence intervals (CI) were reported. A p-value <0.05 was considered statistically significant. Analyses were conducted using SPSS software version 25.0.

RESULTS

Patient characteristics

A total of 97 patients underwent elective laparoscopic colorectal resections during the study period. The cohort included 59 men (60.8%) and 38 women (39.2%), with a median age of 71 years (range, 31–88). At least one comorbidity was present in 46 patients (47.4%), while 10 patients (10.3%) had three or more concomitant diseases. The most frequent comorbidities were arterial hypertension (41.2%), anaemia (22.7%), diabetes mellitus (9.7%), cardiomyopathy (9.3%), and chronic obstructive pulmonary disease (4.1%) (Table 1).

Tumour localization, type of resection, and oncological parameters

Tumour localization was descending colon in 5 patients (5.2%), sigmoid colon in 34 (35.1%), rectosigmoid/proximal rectum in 33 (34.0%), mid and distal rectum in 15 (15.5%), and anal canal in 10 (9.7%). Corresponding resections included left hemicolectomy (LH), sigmoid resection (SH), high anterior resection (HAR), low anterior resection (LAR), and abdominoperineal resection (APR), respectively (Table 2).

Stapled anastomoses were created in 87 patients (89.7%), and a diverting colostomy was fashioned in 12 cases (12.1%). Conversion to open surgery was required in 6 patients (6.1%), most frequently due to locally

advanced disease, dense intra-abdominal adhesions, or limited pelvic exposure. Re-intervention within 30 days was performed in 3 patients (3.1%). Median operative time was 120 minutes (range, 90–180) for colonic resections and 175 minutes (range, 120–240) for rectal resections. The median lymph-node (LN) yield was 15 (range, 3–35), and all available pathology reports confirmed microscopically negative resection margins (R0).

Oncological parameters are presented in Table 3.

Postoperative morbidity and mortality

The overall 30-day morbidity rate was 17.5% (17/97 patients), while no deaths occurred within 30 days. General complications were observed in 12 patients (12.4%), including urinary tract infection in 4 (4.1%), urethral stenosis in 3 (3.1%), pneumonia in 1 (1.0%), acute myocardial infarction in 1 (1.0%), deep venous thrombosis in 1 (1.0%), and *Clostridioides difficile* colitis in 1 (1.0%). Procedure-specific complications occurred in 11 patients (11.3%). These included anastomotic leak in 4 patients (4.1%), paralytic ileus in 3 (3.1%), port-site hematoma in 2 (2.1%), surgical site infection in 1 (1.0%), and a position-related nerve injury in 1 (1.0%). Percentages do not add up to 100% because some patients experienced more than one complication.

Length of hospital stay (LOS)

The overall median length of stay was 9 days (range, 5–29). The average LOS was significantly longer in men compared to women (12 ± 6 vs. 8 ± 2 days, $p = 0.003$; Figure 1). Patients with diabetes mellitus (DM) had a prolonged hospitalization compared to those without DM (15 ± 9 vs. 10 ± 4 days, $p = 0.040$; Figure 2A). Similarly, patients with cardiomyopathy (CMP) tended to have longer LOS compared to those without CMP (16 ± 9 vs. 10 ± 3 days), though the difference was not statistically significant ($p = 0.096$; Figure 2B). Binary logistic

Table 1. Demographic and clinical characteristics.

Variable	Value
Number of patients	97
Male	59 (60.8%)
Female	38 (39.2%)
Median age (range)	71 (31–88)
Arterial hypertension	40 (41.2%)
Anaemia	22 (22.7%)
Diabetes mellitus	10 (9.7%)
Cardiomyopathy	9 (9.3%)
Chronic obstructive pulmonary disease	4 (4.15%)
≥1 concomitant disease	46 (47.4%)
≥3 concomitant diseases	10 (10.3%)

Table 2. Tumour localisation and corresponding laparoscopic resections.

Tumour localisation and procedure	N (%)
Descendant colon (LH)	5 (5.2%)
Sigmoid colon (SH)	34 (35.1%)
Rectosigmoid and proximal rectum (HAR)	33 (34%)
Mid third and distal rectum (LAR)	15 (15.5%)
Anal canal (APR)	10 (9.7%)

*LH- left hemicolectomy;

SH- sigmoid resection;

HAR- high anterior rectal resection;

LAR- low anterior rectal resection;

APR- abdominoperineal resection.

Table 3. Oncological parameters.

Parameter	N (%)
Stapled anastomosis	87 (89.7%)
Diverting colostomy	12 (12.1%)
Conversion to open	6 (6.1%)
Re- intervention	3 (3.1%)
Median operative time (range)- colonic resections	120 minutes, (90-180)
Median operative time (range)- rectal resections	175 minutes, (120-240)
Median extirpated lymph-node (range)	15 (3-35)

Table 4. Postoperative outcomes.

Variable		N (%)	
The 30-day morbidity		17/97 (17.5%)	
The 30-day mortality		0/97 (0%)	
General complications	N (%)	Specific complications	n (%)
Urinary tract infection	4/97 (4.1%)	Anastomotic leak	4/97 (4.1%)
Urethral stenosis	3/97 (3.1%)	Paralytic ileus	3/97 (3.1%)
Pneumonia	1/97 (1%)	Port-site hematoma	2/97 (2.1%)
Acute myocardial infarction	1/97 (1%)	Surgical site infection	1/97 (1%)
Deep venous thrombosis	1/97 (1%)	Nerve injury	1/97 (1%)
C. difficile colitis	1/97 (1%)	Total	11/97 (11.3%)
Total	12/97 (12.4%)		

percentages may not add up to 100% due to overlap between general and procedure-specific complications

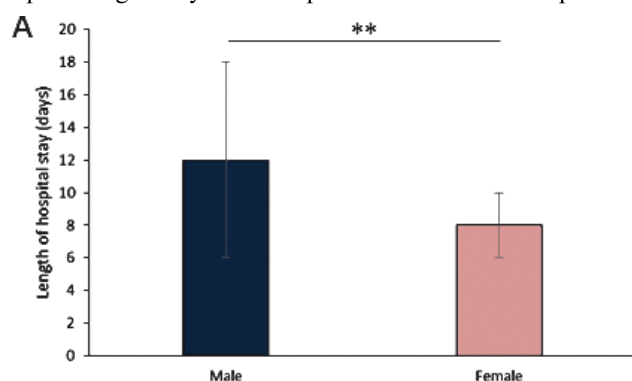


Figure 1. Sex distribution in study group and LOS - men had significantly longer LOS compared to women (12 ± 6 vs. 8 ± 2 days, $p = 0.003$, **).

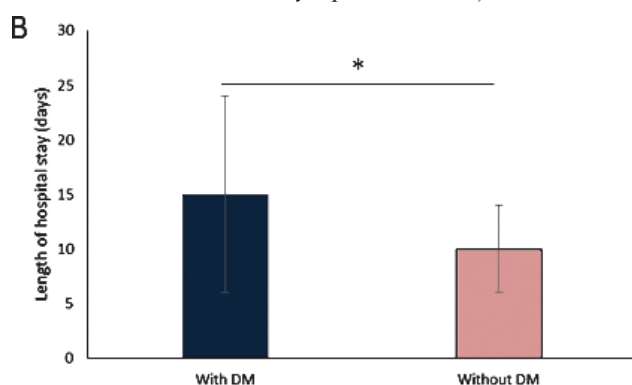


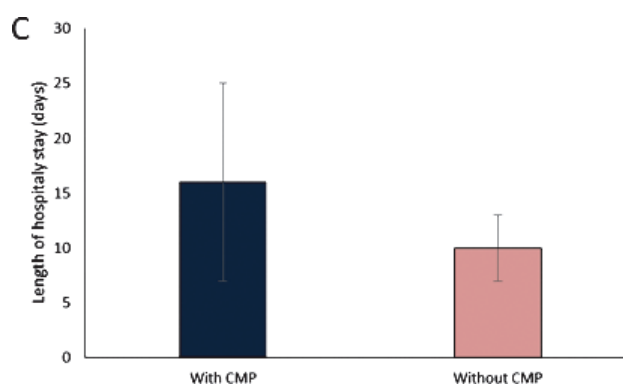
Figure 2. Duration of LOS according to sex, DM, and CMP. (A) Patients with DM had significantly longer LOS than those without DM (15 ± 9 vs. 10 ± 4 days, $p = 0.040$, *). (B) Patients with CMP tended to have longer LOS than those without CMP (16 ± 9 vs. 10 ± 3 days), although this difference did not reach statistical significance ($p = 0.096$). Data are presented as mean $\pm$ SD.

* DM- diabetes mellitus; CMP- cardiomyopathy

regression confirmed only CMP as an independent predictor of postoperative complications (OR 7.50, 95% CI).

DISCUSSION

CRC is one of the leading causes of cancer-related morbidity and mortality worldwide, ranking third in incidence and second in mortality (1). Surgical resection of the colon and rectum, therefore, represents a cornerstone of curative treatment. Since the first LAC was reported in 1991 (8), debate has persisted regarding its advantages over the traditional open approach. In our institution, LAC has been performed since 1995, in line



with global surgical trends. The present study adds to this body of evidence by reporting outcomes from 97 consecutive CRC patients who underwent LAC.

Numerous studies have consistently demonstrated that LAC is associated with improved short-term recovery compared to open colectomy (9-14). Benefits include superior intra-abdominal visualization and more precise tumour margin assessment, reduced intraoperative blood loss, shorter hospital stay, and faster return of bowel function, postoperative morbidity and mortality, as well as reducing the total cost of treatment. In our study, the overall 30-day morbidity was 17.5%, with no perioperative mortality. Procedure-specific complications occurred in 11.3% of patients, while general complications were observed in 12.4%, with partial overlap between categories. These rates are in line with previously published studies, which reported morbidity between 18-21% (11, 12, 15) and perioperative mortality of less than 1% after LAC (11, 12). Importantly, our findings confirm that elective LAC can be performed safely, even in a medium-volume centre, with outcomes comparable to larger institutional cohorts.

The median LOS in our cohort was 9 days, which is slightly longer than the 4-6 days typically reported in high-volume Western centres (12, 21). This difference likely reflects variations in perioperative care, as ERAS protocols are not yet fully standardized in our setting. Longer LOS may also be influenced by patient expectations and healthcare system policies, rather than surgical quality. Notably, LOS was significantly longer in men and patients with diabetes mellitus, while CMP showed a trend toward prolonged hospitalization. Of particular interest, CMP emerged as an independent predictor of postoperative complications (OR 7.5, $p=0.008$). This finding highlights the vulnerability of patients with pre-existing cardiac disease, consistent with broader surgical literature showing increased perioperative risk in heart failure (16, 17). To our knowledge, few laparoscopic colorectal surgery series have specifically identified CMP as a risk factor, underlining the clinical relevance of our results. These data support the need for careful preoperative cardiovascular assessment and optimized perioperative monitoring in this subgroup.

The conversion rate in our cohort was 6.1%, which is consistent with the lower threshold of previously published ranges (5.7–21%) (10, 12, 18). Several studies have demonstrated that conversion is associated with increased postoperative morbidity and prolonged hospitalization (19). Although our sample size precluded detailed subgroup analysis, our conversion rate reflects acceptable outcomes during the implementation of LAC in a single-centre setting. With respect to oncological quality, the median lymph-node yield was 15 (range 3–35), with

the recommended threshold of ≥ 12 nodes (19) achieved in the majority of cases. This benchmark is crucial for accurate staging and prognostication, and our results align with those of other laparoscopic series (9, 10). Similarly, reoperation occurred in 3.1% of patients, which also aligns with rates reported in comparable laparoscopic colorectal surgery series and reflects acceptable outcomes for a single-centre cohort (11, 20). Importantly, R0 resection was achieved in all patients, further confirming the oncological adequacy of the laparoscopic approach in our cohort.

The median operative time was 120 minutes (range, 90–180) for colonic resections and 175 minutes (range, 120–240) for rectal resections, which is comparable to published series (11, 12). These values reflect the greater technical complexity of laparoscopic procedures and are in line with previous reports showing that operative times are generally longer than in open surgery.

Taken together, our results confirm several well-documented advantages of LAC, including reduced morbidity and oncologic safety comparable to open colectomy. The absence of perioperative mortality and the identification of CMP as a strong risk factor for complications are particularly relevant for clinical practice. Identifying patients at increased risk enables personalized perioperative management, closer monitoring, and potentially improved outcomes.

This study has several limitations. It was retrospective and conducted in a single centre with a relatively small sample size, which may limit generalizability. Furthermore, the number of events (17 complications) restricted the scope of multivariate regression, necessitating a parsimonious model. Despite these limitations, our results remain clinically relevant, as they provide real-world outcomes from a medium-volume Serbian centre, a setting underrepresented in the literature that is otherwise dominated by high-volume Western European and North American institutions. These findings carry regional importance, given the scarcity of Balkan data on laparoscopic colorectal surgery, and offer a valuable benchmark for the wider adoption of minimally invasive techniques in comparable healthcare systems. Longer follow-up in larger multicentre cohorts will be essential to further validate the oncologic safety of LAC, particularly in advanced CRC.

In conclusion, laparoscopic colorectal surgery in our series was associated with acceptable morbidity, no perioperative mortality, low conversion, and adequate oncological quality. Although LOS was somewhat longer than in Western centres, this likely reflects differences in perioperative care pathways rather than surgical outcomes. Importantly, cardiomyopathy was identified as an independent predictor of complications, emphasizing the need for targeted perioperative management in this

subgroup. This study also carries regional relevance, as data from the Balkans remain limited. Our findings confirm the feasibility and safety of LAC in this context and may serve as a foundation for future multicentre and prospective studies assessing long-term oncological outcomes.

ABBREVIATIONS

CRC – Colorectal cancer;
LAC – Laparoscopic-assisted colectomy;
LOS – Length of stay;
DM – Diabetes mellitus;
CMP – Cardiomyopathy;
OR – Odds ratio;
CI – Confidence interval;
ERAS – Enhanced Recovery After Surgery;
R0 – Complete resection with microscopically negative margins.

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