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Role of mini-invasive technologies in the treatment of colon cancer in the aged patient population

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Abstract

Aim – to evaluate the effectiveness of surgical treatment for colorectal cancer in patients aged 75–90 years (WHO, 2002) in the early postoperative period after laparoscopic and open surgeries. The primary outcome was the total length of hospital stay (bed-days). Secondary outcomes included intraoperative blood loss, C-reactive protein (CRP) levels, postoperative pain (VAS), and the incidence of general and surgical complications.

Material and methods. The study included colorectal cancer (CRC) patients (75–90 years old) who underwent laparoscopic (LS) or laparotomic (LT) surgery. A comparative analysis of demographic, clinical-laboratory, and surgical data was performed.

Results. The LS group demonstrated a shorter hospital stay (10 (3) vs. 10 (7) days, p≤0.001) and lower intraoperative blood loss (50 (20) vs. 150 (150) ml, p≤0.001) compared to the LT group. The LT group had significantly higher CRP levels on days 3 and 5 (p≤0.001) and a higher incidence of complications (pneumonia, anemia, acute urinary retention), 18 (33.9%) vs. 6 (7.2%), p≤0.001. Operative time (p=0.002) and postoperative complications significantly influenced hospital stay duration.

Conclusion. Laparoscopic surgery results in a shorter hospital stay, reduced intraoperative blood loss, lower inflammatory response, and decreased postoperative pain and complication rates. These advantages make it the preferred method for treating elderly patients with colorectal cancer, especially in the presence of comorbidities.

Keywords: colon cancer, laparoscopy, hospital stay duration, blood loss volume, operative time.

Conflict of Interest: nothing to disclose.

Citation
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Роль малоинвазивных технологий в лечении рака ободочной кишки у пациентов старческой возрастной группы

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Аннотация

Цель – оценить эффективность хирургического лечения колоректального рака у пациентов 75–90 лет (ВОЗ, 2002) в раннем послеоперационном периоде после лапароскопических и открытых операций. Основной показатель – общая продолжительность госпитализации (койко-дни), которая является первичной конечной точкой исследования. Вторичные показатели: интраоперационная кровопотеря, уровень С-реактивного белка, послеоперационная боль, частота общих и хирургических осложнений.

Материал и методы. В исследование включены пациенты с КРР 75–90 лет, перенесшие лапароскопические (ЛС) и лапаротомные (ЛТ) операции. Проведен сравнительный анализ демографических, клинико-лабораторных и хирургических данных.

Результаты. Группа ЛС показала короткие сроки общей продолжительности госпитализации (10 (3) против 10 (7) дней, p≤0,001) и меньшие цифры интраоперационной кровопотери (50 (20) против 150 (150) мл, p≤0,001) по сравнению с группой ЛТ. В группе ЛТ отмечен более высокий уровень СРБ на 3-и и 5-е сутки (p≤0,001), частые осложнения (пневмония, анемия, острая задержка мочи) в группе ЛТ – 18 (33,9%) против 6 (7,2%), p≤0,001. Существенно влияли на продолжительность госпитализации общая время операции (p=0,002) и послеоперационные осложнения.

Заключение. Лапароскопический доступ обеспечивает более короткую продолжительность госпитализации, снижает интраоперационную кровопотерю, уменьшает выраженность воспалительного ответа и болевого синдрома, а также сокращает частоту ранних послеоперационных осложнений. Эти преимущества делают ее предпочтительным методом в лечении пациентов старческой возрастной группы колоректальным раком, особенно при наличии коморбидного фона.

Ключевые слова: рак ободочной кишки, лапароскопия, продолжительность госпитализации, объем кровопотери, продолжительность операции.

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КРР – колоректальный рак; РОК – рак ободочной кишки; ЛС – лапароскопия; ЛТ – лапаротомия; ИМТ – индекс массы тела; Hb – гемоглобин; СРБ – С-реактивный белок; ASA – Американское общество анестезиологов; ОПГ – общая продолжительность госпитализации; ППГ – постоперационная продолжительность госпитализации.

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INTRODUCTION

Colorectal cancer (CRC) is one of the most common malignant neoplasms in the world, ranking third in incidence among both sexes after breast cancer and lung cancer. In terms of mortality, CRC ranks second in the structure of all malignant neoplasms, second only to lung cancer [1, 2]. The main method of radical treatment of CRC remains surgical intervention, while improvements in surgical technologies have significantly improved patient outcomes. Traditionally, open laparotomy (LT) has been and remains the standard surgical procedure for colon resection. However, with the advent of minimally invasive technologies such as laparoscopy (LS), surgical practice has improved significantly over the past few decades.

Laparoscopic surgery offers several potential advantages over LT, including smaller incisions, reduced postoperative pain, faster recovery, and shorter hospital stay [3–5]. A study by Chinese scientists has demonstrated the superiority in efficacy and safety of laparoscopic techniques over open laparotomy operations in the surgical treatment of colorectal cancer in the elderly, namely in terms of accelerated recovery and fewer complications in the early postoperative period [4]. Despite the above advantages, the use of laparoscopic techniques is not yet the method of absolute choice and mainly depends on the patient selection criteria, available surgical skill, and availability of equipment in the medical institution.

An important indicator of postoperative recovery and the effectiveness of healthcare management is the length of a patient's stay in hospital [6]. In addition, reduction of hospital days is one of the effective results noted in LS surgery [7]. Although existing studies show that LS methods reduce the length of hospital stay compared with LT, the extent of this benefit and the factors influencing it continue to be investigated in different populations and real-world clinical practice [7].

AIM

To compare early postoperative outcomes in elderly patients undergoing laparoscopic and open surgery for CRC [8] and to evaluate the recovery benefits of LS surgery within our clinical context.

MATERIAL AND METHODS

Study design and conditions

This retrospective cohort study included 140 patients diagnosed with colon cancer who underwent LS and traditional LT surgeries. The data for the study were retrospectively collected from medical records of patients who underwent surgery at the Oncology Center No. 1 of the S.S. Yudin City Clinical Hospital over a five-year period (from October 2019 to October 2024). Ethical approval for the study was obtained from the local ethics committee of the Sechenov University on 16.11.23, and confidentiality of patient data was respected throughout the study.

Study population and inclusion criteria

The study included 140 patients aged 75–90 years with histologically confirmed colon cancer. Random simple sampling was used to include patients in the study. Inclusion criteria: histologically confirmed CRC, planned surgical

treatment using LS or LT approaches, availability of complete medical records and discharge summaries, including preoperative, intraoperative and early postoperative data (up to 9 days after surgery). Patients undergoing emergency intervention, with primary multiple malignancies and with stage IV disease *were excluded*.

Data collection and characteristics

The patient data was taken from electronic patient records using a standardized data collection form. Demographic characteristics such as age, gender and body mass index (BMI) were recorded as well as the following clinical data: clinical diagnosis, tumor stage, concomitant diseases and perioperative laboratory findings, namely, hemoglobin (Hb) and C-reactive protein (CRP) levels. To determine the tumor stage, the TNM-8 (2017) classification was used [9]. The general functional status of patients was assessed using the Karnofsky score [10]. Perioperative surgical risk was assessed using the American Society of Anesthesiologists scale (ASA) [10].

The anamnesis included preoperative intestinal obstruction, as well as previous surgical operations on the abdominal organs and pelvic organs. Intraoperative data included total operative time in minutes and intraoperative blood loss in milliliters.

Postoperative outcomes included total length of hospital stay and postoperative Hb and CRP levels, general and abdominal postoperative complications. In addition, the total length of hospital stay was chosen as the primary endpoint, while intraoperative blood loss, inflammatory response, severity of postoperative pain and postoperative complications were considered as secondary endpoints.

Statistical analysis

Quantitative variables are presented as mean and standard deviation (M±SD) for normally distributed data. In cases where the normality assumption was violated, the values were described by the median and interquartile range (Me (Q1–Q3)). Normality of distribution was tested using the Shapiro–Wilk test.

For qualitative variables, absolute frequencies and percentages were used (n (%)). The t-test or nonparametric Mann–Whitney test were used to compare baseline demographic, clinical, and perioperative characteristics depending on the data distribution. The categorical variables were compared using the χ^2 test or Fisher's exact test depending on expected frequencies.

Comparison of quantitative variables before and after surgery was performed using the paired t-test or Wilcoxon test, depending on normality. For the analysis of paired categorical data before and after surgery, the McNemar test was used.

To identify the factors related to the total duration of hospitalization and to assess their independent effect, the multivariate linear regression analysis (MLR) was used. Variables that showed statistical significance in the univariate analysis, as well as variables of clinical significance, were included in the model as predictors.

The accuracy of the constructed model was assessed using the model specificity analysis (linktest) and the Nagelkerke's determination coefficient R^2. The criterion of statistical significance were p-values below 0.05 and 95% confidence interval.

The calculations were performed in the Stata software suite, ver. 16.1 (StataCorp, Texac, USA).

RESULTS

Descriptive statistics and comparative analysis of basic demographic and clinical data

The patients were grouped depending on the method of surgical treatment; therefore, the comparative analysis was performed in the LS and LT groups. Due to urgency of the operations and lack of clear histological confirmation, two patients from the LS group and two patients from the LT group were excluded from the study. The final cohort included 53 patients in the LT group and 83 patients in the LS group who met the criteria. The groups were comparable in age (p=0.53) and sex (p=0.85). The median age was 83 (6) years, and women prevailed (61.1%) in the total population. BMI categories were also equally distributed across groups (p=0.91). The majority of patients had a normal BMI value (n=59, 43.7%). The results are shown in **Table 1**.

The classification as per TNM-8 (2017) before the operation showed the prevalence of stage III in the total cohort (64 (47%)), the distribution is comparable in the groups (p=0.26). Despite the prevalence of patients with tumors of the right half of the colon in the overall cohort 71 (52.2%) over patients with tumors of the left half of the colon, 54 (39.7%), no statistical difference was found (p=0.53). According to the Karnofsky's functional performance scale, the groups are comparable (p=0.10), the score of the majority patients being 90…100 points (94 (69%)). The overall baseline status of the patients did not show significant differences between the groups, with the majority of patients being in satisfactory or moderate condition (p=0.24).

Practically all patients had at least one concomitant disease (99.2%). Among the comorbidities, arterial hypertension, coronary heart disease (CHD) and chronic heart failure (CHF) were prevalent (116 (85.9%), 73 (53.6%) and 71 (52.2%), respectively).

As shown in Table 1, most of the comorbidities were related to atherosclerosis and cardiovascular diseases. Comparative analysis of various comorbidities showed that the groups were comparable without statistically significant differences (p>0.05). Only the CHD was more frequent in the LT group than in the LS group ((67.9%) vs. 37 (44.5%) cases, respectively, p=0.009). Mild anemia was found in 89 (65.4%) patients, and severe anemia in 22 (16.1%), with no significant differences (p=0.23). Chronic comorbidities of the gastrointestinal tract were found in 41 (30.1%) patients, the distribution between groups not being different (p=0.70).

Overall, before the operation, 71 (52%) patients were found to have complications of the colon cancer such as toxic anemic syndrome, tumor lysis syndrome, or cachexy, the complications being distributed evenly between the groups (p=0.06). Complications requiring surgical intervention, such as intestinal obstruction, tumor stenosis, or perifocal inflammation, were also found. The surgeries done on the abdominal organs and pelvic organs were performed equally in both groups (p=0.21).

Descriptive statistics and comparative analysis of surgical, laboratory and early postoperative data

Similar to the TNM-8 (2017) classification before surgery, the groups showed no significant differences in the pathological stage of the disease according to the TNM-8

Parameter	Total (n=136)	LS (n=83)	LT (n=53)	p-value
Age, years	83 (79–85)	83 (78–85)	83 (79–85)	0.53
Sex, % Male Female	 53 (38.9) 83 (61.1)	 33 (39.7) 50 (60.3)	 20 (37.7) 33 (62.3)	0.85
BMI, % Norm Excess weight Obesity	 59 (43.7) 47 (34.8) 29 (21.5)	 37 (45.1) 28 (34.1) 17 (20.8)	 22 (41.5) 19 (35.8) 12 (22.7)	0.91
Tumor localization Right half Left half Transverse	 71 (52.2) 54 (39.7) 11 (8.1)	 45 (54.2) 33 (39.7) 5 (6.1)	 26 (49) 21 (39.6) 6 (11.4)	0.53
Stage before operation TNM I II III	 15 (11) 57 (41.9) 64 (47.1)	 12 (14.5) 32 (38.5) 39 (47)	 3 (5.8) 25 (47.1) 25 (47.1)	0.26
Karnofsky's score, % 90–100 70–80 60–70	 94 (69.1) 38 (27.9) 4 (2.9)	 62 (74.7) 20 (24.1) 1 (1.2)	 32 (60.4) 18 (34) 3 (5.6)	0.10
Pre-operative CUD, % IO TAS CAS Cachexy PFI Apostasis Hemorrhage TLS	 31 (22.7) 15 (11) 12 (8.8) 6 (4.4) 3 (2.2) 2 (1.4) 1 (0.7) 1 (0.7)	 15 (18) 7 (8.4) 9 (10.8) 5 (6.0) 1 (1.2) 0 0 1 (1.2)	 16 (30.1) 8 (15) 3 (5.6) 1 (1.9) 2 (3.8) 2 (3.8) 1 (1.9) 0	0.06
Preoperative severity of patient condition, % Satisfactory Medium Severe	 56 (41.1) 67 (49.2) 13 (9.5)	 36 (43.3) 37 (44.5) 10 (12)	 20 (37.7) 30 (56.6) 3 (5.6)	0.24
AH, %	116 (85.9)	69 (84.1)	47 (88.6)	0.61
DM, %	25 (18.3)	17 (20.4)	8 (15)	0.50
CKD, %	13 (9.6)	8 (9.6)	5 (9.4)	0.60
CHD, %	73 (53.6)	37 (44.5)	36 (67.9)	0.009
c/a AMI, %	18 (3.2)	8 (9.6)	10 (18.8)	0.13
CCVA, %	40 (29.4)	26 (31.3)	14 (26.4)	0.54
c/a ACVA, %	12 (8.8)	8 (9.6)	4 (7.5)	0.76
CHF, %	71 (52.2)	43 (51.8)	28 (52.8)	0.90
HRD, %	41 (30.1)	27 (32.5)	14 (26.4)	0.44
GC, %	41 (30.1)	26 (31.3)	15 (28.3)	0.70
Anemia, % Minor Moderate	 89 (65.4) 22 (16.1)	 51 (61.4) 13 (15.6)	 38 (71.7) 9 (16.9)	0.23
History of AO, %	57 (42.2)	31 (37.8)	26 (49)	0.21

AH – arterial hypertension. AO – abdominal operations. GD – gastrointestinal diseases. CHF – congestive heart failure. BMI – body mass index. CHD – coronary heart disease. IO – intestinal obstruction. KPS – Karnofsky performance scale. HRD – heart rhythm disturbances. CUD – complications of the underlying disease. PFI – perifocal inflammation. CAS – cancer associated stenosis. DM – diabetes mellitus. c/a AMI – condition after acute myocardial infarction. c/a ACVA – condition after acute cerebrovascular accident. TLS – tumor lysis syndrome. TAS – toxic anemic syndrome. CKD – chronic kidney disease. CCVA – chronic cerebrovascular accidents.

Table 1. *Comparative analysis of baseline demographic and clinical characteristics of patients with colorectal cancer (CRC)*

Таблица 1. *Сравнительный анализ исходных демографических и клинических характеристик групп пациентов с раком ободочной кишки (РОК)*

(2017) classification (p=0.58). However, most patients had stage II disease. Histopathological analysis revealed adenocarcinoma in 118 (90.7%) patients, as well as rare cases of mucinous adenocarcinoma and carcinoma. The results are shown in **Tables 2** and **3**.

According to the ASA anesthetic and surgical risks, class II was found in 112 (82.3%) cases, followed by class III (21 (15.4%)).

The results of operative data and their analysis is shown in **Table 4**.

Despite similar operative time values for both groups (p=0.19), intraoperative blood loss was significantly higher in the LT group than in the LS group (p≤0.001) (**Fig. 1**). The overall postoperative status was comparable between the groups, the majority of patients being in satisfactory condition (p=0.15). Both the total hospitalization time and the postoperative hospitalization time were significantly

Parameter	Incidence (percentage)
ASA Class, % I II III IV	 1 (0.74) 112 (82.35) 21 (15.44) 2 (1.47)
Non-surgical postoperative complications, % Acute urinary retention Hemorrhagic anemia Pneumonia Pulmonary thromboembolism Encephalopathy Mesenteric thrombosis Hypoglycemia Pancreatitis Fever	 5 (3.85) 4 (3.08) 4 (3.08) 2 (1.54) 2 (1.54) 1 (0.77) 1 (0.77) 1 (0.77) 1 (0.77)
Histopathological landscape Adenocarcinoma (AC) Mucinous AC AC with mucinous component Carcinoma	 118 (90.7) 5 (3.8) 4 (3.0) 3 (2.3)

Table 2. *Descriptive results of perioperative data*

Таблица 2. *Описательные результаты периоперационных данных*

Parameter	Total (n=136)	LS (n=83)	LT (n=53)	p-value
TNM stage after surgery I II III	 29 (21.3) 63 (46.3) 44 (32.3)	 20 (24.1) 36 (43.3) 27 (32.5)	 9 (16.9) 27 (50.9) 17 (32)	0.58
Hb level before surgery, mg/dl	107.2±18.3	107.7±18.2	106.3±18.5	0.68
Hb level after surgery, mg/dl	102.5±13.3	102.9±13.1	101.9±13.7	0.66
CRP on day 3 after surgery, mg/dl	106 (73–147)	93 (68–136)	127 (98–183)	≤0.001
CRP on day 5 after surgery, mg/dl	64 (35–89)	51 (25–75)	81 (50–103	≤0.001
TOT, min.	145 (122–182)	150 (125–180)	135 (115–190)	0.19
IBL, ml	60 (50–150)	50 (30–50)	150 (100–250)	≤0.001
Severity of condition after surgery, % Satisfactory Moderate Severe	 67 (49.2) 50 (36.7) 19 (13.9)	 46 (55.4) 28 (33.7) 9 (10.8)	 21 (39.6) 22 (41.5) 10 (18.8)	0.15
Postsurgical pain syndrome, % Mild Moderate Severe	 94 (69.1) 41 (30.1) 1 (0.7)	 80 (96.3) 2 (2.4) 1 (1.2)	 14 (26.4) 39 (73.5) 0	≤0.001
PNSC, %	24 (17.6)	6 (7.2)	18 (33.9)	≤0.001
Wound infections, %	13 (9.5)	5 (6)	8 (15)	0.13
Anastomotic bleeding, %	2 (1.4)	0	2 (3.7)	0.15
Anastomotic leakage	4 (2.9)	1 (1.2)	3 (5.6)	0.16
Post-operative peritonitis	6 (4.4)	3 (3.6)	3 (5.6)	0.1
Abdominal abscess	6 (4.4)	2 (2.4)	4 (7.5)	0.25
Adhesive intestinal obstruction	1 (0.73)	0	1 (1.8)	0.16
THT, days	11 (9–13)	10 (9–12)	13 (10–17)	≤0.001
PHT, days	7 (7–10)	7 (6–8)	9 (7–13)	≤0.001
Postoperative mortality	4 (2.94)	3 (3.6)	1 (1.8)	1.0

Hg – уровень гемоглобина, TOT – total operating time, IBL – intraoperative blood loss, THT – total hospitalization time, PNSC – postoperative non-surgical complications, PSC – postoperative surgical complications, PHT – postoperative hospitalization time, CRP – C-reactive protein.

Table 3. *Comparative analysis of surgical, laboratory, and early postoperative outcomes*

Таблица 3. *Сравнительный анализ хирургических, лабораторных и ранних послеоперационных результатов*

longer in the LT group (p≤0.001) (Fig. 2). Median values and interquartile ranges for the duration of hospital stay are shown in **Table 3**.

Pre- and post-operative hemoglobin values did not differ between groups (p=0.68 and p=0.66, respectively). At the same time, the CRP levels both on the third and fifth day after the surgery differed significantly between the groups and were higher in the LT group (p≤0.001 for both measurements). Mild postsurgical pain was found in 94 (69.1%) patients, moderate pain in 41 (30.1%) patients; the patients of LT group suffered more from moderate pain as compared to the patients of the LS group (39 (73.5%) vs. 2 (2.4%), p≤0.001). Overall, 67 (49.2%) patients were in satisfactory, 50 (36.7%), in moderate, and 19 (13.9%), in severe condition. Comparative analysis of the groups by general condition showed similar results without statistically significant differences (p=0.15). The comparative results are presented in **Table 3**.

A total of 24 (17.6%) non-surgical complications and 8 (5.8%) surgical complications were reported (**Table 2**). The majority of non-surgical complications were urinary retention, posthemorrhagic anemia and pneumonia, as well as isolated cases of pulmonary embolism, pancreatitis and hypoglycemia (**Table 2**). No severe complications, such as sepsis and multiple organ failure were reported. Non-surgical complications were found mainly in patients in the RT group (p≤0.001). Major surgical complications such as anastomotic leakage, postoperative peritonitis, and complications related to wound infection and abdominal abscesses were recorded without statistically significant differences between groups (p>0.05).

After surgery, slightly more patients were recorded with severe condition, but no significant differences were observed (p=0.25). In contrast, laboratory parameters changed significantly depending on the period: the level of Hb in the blood decreased significantly after surgery (107.2±18.3 vs. 102.5±13.3 mg/dL, respectively, p≤0.001), while the level of

Parameter	Before the surgery (n=136)	After the surgery (n=136)	p-value
Severe patients	13 (9.5)	19 (13.9)	0.25
Intestinal obstruction	32 (27.1)	1 (0.7)	≤0.001
Hemoglobin	107.2±18.3	102.5±13.3	≤0.001
C-reactive protein	106 (73–147)*	64 (35–89)**	≤0.001

**day 3, **day 5*

Table 4. *Comparative analysis of clinical, laboratory, and surgical characteristics before and after surgery*

Таблица 4. *Сравнительный анализ клинических, лабораторных и хирургических характеристик до и после операции*

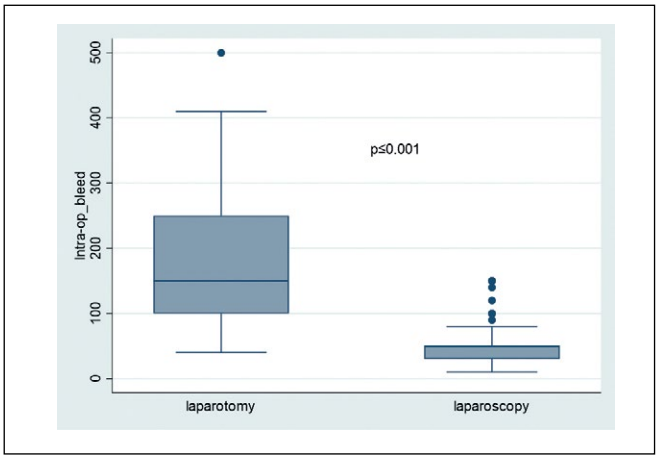

Figure 1. *The total intraoperative blood loss was higher in the LT group.*

Рисунок 1. *Общая интраоперационная кровопотеря была выше в группе ЛТ.*

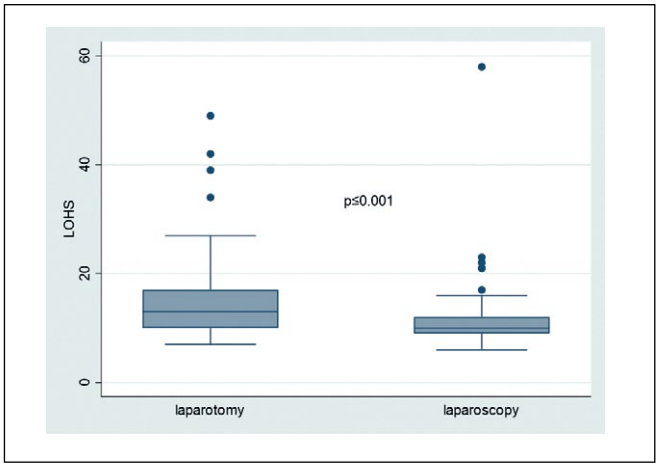

Figure 2. *The duration of postoperative hospital stay (DPHS) was shorter in the LS group than in the LT group.*

Рисунок 2. *Длительность послеоперационного пребывания в стационаре (ДППС) была короче в группе ЛС, чем в группе ЛТ*

Factor	Variable type	Coding
Age	Quantitative	-
Sex	Qualitative	Male Female
CKD	Qualitative	No Yes
Surgical approach	Qualitative	LS LT
TOT	Quantitative	-
CRP-3	Quantitative	-
PSC	Qualitative	No complications Pneumonia MT Hypoglycemia Pancreatitis Fever HA

HA – hemorrhagic anemia, LS – laparoscopy, LT – laparotomy, MT – mesenteric thrombosis, TOT – total operating time, PSC – postsurgical complications, CKD – chronic kidney disease, CRP-3 – C-reactive protein on the third day

Table 5. *Characteristics and coding of independent variables in the selected multiple logistic regression model*

Таблица 5. *Характеристика и кодировка независимых переменных выбранной модели МЛР*

CRP decreased significantly from the third to the fifth day (p≤0.001).

Postoperative mortality in the main group was 3.61% (3/83), while in the control group it was 1.89% (1/53). The statistical analysis of the frequency of deaths between the groups did not reveal any significant differences (p=1.0). This indicates the absence of a statistically significant effect of the studied factor on postoperative mortality.

Results of multivariate linear regression analysis (MLR)

Multivariate linear regression analysis was performed to identify factors that influence the overall length of hospital stay, other than surgical approaches. In addition to surgical approach, variables that showed statistical significance in univariate analysis were selected as independent variables: sex, age, presence of chronic kidney disease (CKD), total operative time, CRP, and presence of non-surgical postoperative complications (**Table 5)**.

The regression model demonstrated acceptable accuracy: the hat value was p=0.96, and the hatsq value was p=0.007 in the linearity test (linktest). The level of explainability of the model, estimated through the Nagelkerke R^2 coefficient, was 0.42. Among the independent variables, the following were statistically significant factors: method of laparoscopy (β = -2.62; p = 0.03; 95% CI: -4.999 – -0.250), CRP level on the third day (β = 0.03; p = 0.002; 95% CI: 0.016 – 0.063), total operating time (β = 0.03; p = 0.002; 95% CI: 0.011 – 0.050), and postoperative complications, including pneumonia (β = 0.01; p = 0.001; 95% CI: 1.205 – 11.328), mesenteric thrombosis (β = 22.49; p ≤ 0.001; 95% CI: 13.843 – 31.146), and hemorrhagic anemia (β = 6.69; p = 0.01; 95% CI: 1.439 – 11.952). Postoperative hypoglycemia and pancreatitis showed borderline statistical significance (p=0.05). At the same time, such variables as sex, age and presence of CKD did not demonstrate significant interaction with the total duration of hospitalization within this model (p>0.05). The data are presented in Table 6.

DISCUSSION

The results of our study showed that the groups of patients operated by laparoscopic and laparotomic methods were comparable in key parameters, which allowed us to conduct a comparative assessment of the impact of surgical access on early postoperative outcomes. The absence of significant differences in such parameters as age, sex, BMI, functional status and comorbidities confirms the balance of the initial data between the groups.

The histopathological analysis confirmed the predominance of adenocarcinoma in both groups, which is consistent with the literature data on CRC [1, 11, 12]. At the same time, despite similar demographic characteristics, the LS and LT groups differed significantly in a number of operative and early postoperative factors. One of the most significant differences was the difference in the volume of blood loss, which was significantly higher in the LT group.

This fact confirms the advantages of the laparoscopic method known for its lower trauma and better visualization due to optical magnification. This allows for less intraoperative blood loss, which also contributes to faster recovery of patients [3, 13, 14].

Besides, the patients of the LT group showed longer hospital stay periods and higher CRP levels on the third and fifth days after the operation, which shows a demonstrated inflammatory response and prolonged recovery [15–17]. The patients in the LT group reported moderate postoperative pain more frequently, which might be related to a more traumatic character of surgical access. These differences highlight not only the advantages of laparoscopic surgery in terms of minimizing trauma, but also a more comfortable recovery in a complex category of patients with multiple comorbidities [14, 18].

Regarding complications, non-surgical complications such as urinary retention, anemia and pneumonia were more prevalent in the LT group, which is associated with the more traumatic nature of this approach and an increased inflammatory response [13, 18]. At the same time, no serious complications such as sepsis or multiple organ failure were registered, indicating the high safety of both techniques. In addition, isolated complications were noted without significant differences between the groups, indicating the safety of both types of surgical approaches.

Parameter	ncβ	cβ	SE	Z/T	p	95% CI
Age		0.14	0.14	0.99	0.32	-0.142 – 0.426
Male sex		-0.07	1.16	-0.07	0.94	-2.396 – 2.240
CKD		3.23	1.87	1.73	0.08	-0.475 – 6.953
LC	-4.18	-2.62	1.19	-2.19	**0.03**	-4.999 – -0.250
TOT		0.03	0.01	3.40	**0.001**	0.016 – 0.063
Pneumonia	5.98	6.26	2.55	2.45	**0.01**	1.205 – 11.328
MT	24.5	22.49	4.36	5.15	**≤0.001**	13.843 – 31.146
Hypoglycemia	15.5	11.64	6.06	1.92	0.05	-0.379 – 23.670
Pancreatitis	10.5	8.28	4.32	1.92	0.05	-0.286 – 16.847
HA	11.2	6.69	2.65	2.53	**0.01**	1.439 – 11.952
Fever		5.95	6.01	0.99	0.32	-5.96 – 17.864
CRP-3	0.04	0.03	0.009	3.19	**0.002**	0.011 – 0.050

HA – hemorrhagic anemia, LS – laparoscopy, MT – mesenteric thrombosis, TOT – total operating time, CRP-3 – C-reactive protein on the third day, CKD – chronic kidney disease; ncβ – non-corrected beta, cβ – corrected beta, SE – standard error, CI – confidence interval, Z/T – Z/T test.

Table 6. *Multiple logistic regression (MLR) results showed significant outcomes*

Таблица 6. *Результаты МЛР показали значимые результаты*

The obtained results of postoperative mortality show that mortality in both groups remains low and does not demonstrate significant differences.

Laboratory data, such as a decrease in Hb levels and CRP dynamics, demonstrate typical physiological responses of the body to surgical intervention [15]. Despite the increase in the number of patients with decompensation in the postoperative period, this indicator did not reach statistical significance, which highlights the importance of further research to understand the impact of the surgical method on the overall status of the patient in a better way.

The results of our study support the hypothesis that laparoscopic surgery has significant advantages over laparotomy in elderly patients. We also successfully achieved the primary endpoint of overall hospital stay, which differed significantly between groups, as well as secondary endpoints such as intraoperative blood loss, postoperative complications, inflammatory response, and postoperative pain severity. Multivariate linear regression confirmed the importance of factors such as surgical method, CRP on day 3, intraoperative blood loss and postoperative complications in determining the total length of hospital stay, which further strengthens the conclusion about the advantages of the laparoscopic method in the context of rapid recovery and minimization of complications in a complex category of patients.

Shortcomings

The limitations of our study include the limited sample size and lack of randomization, which reduces the validity of generalizations and the ability to control of all influencing variables. The study is also limited by early postoperative outcomes and the lack of long-term outcome databases.

CONCLUSION

The conclusions of this study confirm that laparoscopic access shows considerable advantages as compared to conventional laparotomy in the surgical treatment of colon cancer, especially in patients above 75 years of age. Laparoscopic surgery is associated with less intraoperative blood loss, which confirms its lower trauma. The patients who underwent a laparoscopic surgery showed better outcomes in postoperative recovery with lower levels of C-reactive protein and lower indicators of inflammatory process. Post-surgery complications were seen mainly in the laparotomy group. These data emphasize the importance of choosing a laparoscopic approach to improve postoperative recovery and reduce the risk of complications in elderly patients with colonic malignancies.

ADDITIONAL INFORMATION	ДОПОЛНИТЕЛЬНАЯ ИНФОРМАЦИЯ
Ethical Approval Statement. The study was approved by the Local Ethics Committee of Sechenov University, protocol No. 21-23, dated 16.11.2023	***Этическая экспертиза.*** Исследование одобрено локальным этическим комитетом ФГАОУ ВО «Первый Московский государственный медицинский университет имени И.М. Сеченова (Сеченовский Университет)», протокол № 21–23 от 16.11.2023.
Study funding. The study was the authors' initiative without external funding.	***Источник финансирования.*** Работа выполнена по инициативе авторов без привлечения финансирования.
Conflict of interest. The authors declare that there are no obvious or potential conflicts of interest associated with the content of this article.	***Конфликт интересов.*** Авторы декларируют отсутствие явных и потенциальных конфликтов интересов, связанных с содержанием настоящей статьи.
Contribution of individual authors. Galkin V.N.: project management, editing of the manuscript. Erygin D.V.: concept and design of the study. Orozbekov A.O., Baktybek uulu A.: data collection, writing of the original text. Sklyar I.A.: literature review. Abibillaev D.A., Konurbaev B.T.: statistical analysis, interpretation of results. The authors gave their final approval of the manuscript for submission, and agreed to be accountable for all aspects of the work, implying proper study and resolution of issues related to the accuracy or integrity of any part of the work.	***Участие авторов.*** Галкин В. Н. – руководство проектом, редактирование рукописи. Ерыгин Д.В. – концепция и дизайн исследования. Орозбеков А.О., Бактыбек уулу А. – сбор данных, написание оригинального текста. Скляр И.А. – обзор литературы. Абибиллаев Д.А., Конурбаев Б.Т. – статистический анализ, интерпретация результатов. Все авторы одобрили финальную версию статьи перед публикацией, выразили согласие нести ответственность за все аспекты работы, подразумевающую надлежащее изучение и решение вопросов, связанных с точностью или добросовестностью любой части работы.

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