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Retrospective cohort study

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Safety and efficacy of laparoscopic colectomy in low volume centre following effective laparoscopic training. Retrospective cohort study.

The use of minimally invasive surgery in colon cancers is becoming widespread and developing day by day Laparoscopic right hemicolectomy (LRHC) with complete mesocolic excision is gradually becoming the standard oncological surgical principle for right hemicolectomy. The aim of our study was to evaluate the safety and efficacy of laparoscopic right hemicolectomy in a small-volume center.

METHODS: *Clinical outcomes were analyzed in a study comparing laparoscopic right hemicolectomy with conventional right hemicolectomy. By standardizing laparoscopic right hemicolectomy in our center, data on patient characteristics, surgical details, tumor, lymph node, and metastasis stage (TNM), postoperative recovery, and survival were retrieved and analyzed from retrospective databases.*

RESULTS: *Patients underwent open (n. 63) and laparoscopic (n. 51) right hemicolectomies in our units. In the laparoscopic group, the rate of conversion to open was 5.8%, and there was no mortality for 30 days. In the open group, the first-month mortality was 6.3%, and the rate of complications was 15.9%. The mean age of the patients in the laparoscopic group (65.7±13.46) was statistically significantly higher than that of the open group 60.49±12.67) (p=0.042). Operation time was 147.53±57 minutes in the laparoscopic group and 132.84±34 minutes in the open batch, and there was no statistically significant difference between them. Significant correlations were found between stage and cancer subgroup information (p=0.001). Adenocarcinoma (42%) and mucinous (43.8%) type cancers were found more frequently in patients with stage III, while signet ring cancers were more common (100%) in stage IV patients.*

CONCLUSIONS: *LRHC and laparoscopic conventional right hemicolectomy offered similar oncologic outcomes for right colon cancers in small volume centers. LRHC can be performed safely, and sufficient laparoscopic experience is essential for it to be considered the gold standard procedure. With an improved standard technique and systematic learning method, patient safety and surgical results can be achieved as successfully as in the open surgical approach.*

KEY WORDS: Colorectal cancer, Intracorporeal anastomosis, Right laparoscopic hemicolectomy, Side-to-side anastomosis

Introduction

The use of minimally invasive surgery in colon cancers is becoming widespread and developing day by day. Laparoscopic right hemicolectomy (LRHC) has the

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advantages of minimally invasive surgery, such as less postoperative pain and perioperative morbidity, early recovery of bowel function, comparable survival, shorter hospital stay, less wound infection, and incisional hernia [1,2]. Complete mesocolic excision is gradually becoming an established principle of oncologic surgery for right hemicolectomy. Laparoscopic execution of this procedure is technically difficult. Therefore, a standard procedure that minimizes laparoscopic hazards and facilitates the learning curve is desired in right colon surgery [3].
Laparoscopic approach is routinely applied in our center for the surgical treatment of benign and neoplastic lesions of the gastrointestinal tract. The aim of the study is to assess the safety and efficacy of laparoscopic right hemicolectomy versus open surgery in a small-volume center and to compare procedure's outcome.

Materials and Methods

Clinical outcomes were analyzed in a study comparing laparoscopic right hemicolectomy with conventional right hemicolectomy. By standardizing laparoscopic right hemicolectomy in our center, data on patient characteristics, surgical details, tumor, lymph node, and metastasis stage (TNM), postoperative recovery, and survival were retrieved and analyzed from retrospective databases. The cohort study was carried out in the education research and city hospitals of the Ministry of Health in Turkey. The scientific study form was approved by the Provincial Health Directorate. The operator Doctor's participating in the study were experienced in colorectal surgery and had good laparoscopic expertise.

Statistical Analysis

Whether the data followed a normal distribution was checked using the Shapiro–Wilk test. The Student's t-test and Mann–Whitney U test were used to compare the data with normal distribution between two independent groups. Kruskal-Wallis and one-way analysis of variance methods were used to compare the parameters for variables with more than two categories. Correlation analyses of the categorical variables observed in two independent groups were analyzed by Pearson-chi square and Fisher's exact tests. Mean ± standard deviation for numerical variables and number and percentage values for categorical variables were presented as descriptive statistics. The SPSS version 23.0 software package was used for statistical analyses and a P value less than 0.05 was considered statistically significant.

Surgery Technique

We standardized our laparoscopic technique in the right colon with a systematic learning method. Usually, four or sometimes five port techniques were used. A 10mm camera port in the left McBurney's point, a 10 mm port (for the surgeon's left hand) in the 2-3 cm upper part of the symphysis, a 10 mm port in the left subcostal-midclavicular line (for the surgeon's right hand) and a 5mm assistant port from the right upper quadrant anterior axillary line were placed. The reason why the three ports were 10 mm in size was that the camera could be used from different ports during the operation. However, in each case (according to the anatomical characteristics, body mass index, and tumor location of the patient), we designed a special port entry site. We applied the right/left side and Trendelenburg/reverse Trendelenburg position during the operation stages. The main difference in our modified method includes the lateral approach, which can be applied if the standard medial process is difficult due to the tumor.
The main points we have developed by modifying the laparoscopic approach are as follows:
– Port location selection according to the patient's anatomy;
– For the camera to provide a good view by using different ports, three of the four ports are 10mm in size. The use of the umbilical port was not considered appropriate in this approach;
– If the LRHC medial approach is not suitable, we proceeded with the lateral approach;
– Ia in extended LRHC was performed from the right side of the patient;
– During the laparoscopic surgery stages, the patient was given a change of position to facilitate access and dissection to the operation area;
– Surgical specimens were removed with a Pfannenstiel incision or a 6-8 cm cut from the right upper port site;
– The anastomosis was performed intracorporeally / extracorporeal side-to-side isoperistaltically. The mesenteric defect may be closed by suturing.

Results

Patients with open (n. 63) and laparoscopic (n. 51) right hemicolectomies performed in our clinic. There was a total of 114 right colectomy patients with ileotransverse anastomosis. Tumors were localized in Caecum in 51 (44.7%) patients, in the Ascending Colon in 32 patients (28.1%), in Hepatic Flexure in 19 patients (16.7%), and in other areas in 12 patients (10.5%) (Table I). In the laparoscopic group, the rate of conversion to open was 5.8%, and there was no mortality for 30 days. In the open group, the first-month mortality was 6.3%, and the rate of complications was 15.9%. The rate of lymphovascular invasion in the laparoscopic group (63.5%) was found to be statistically significantly higher than the open batch (44.0%) (p=0.039). The rate of need for adjuvant chemotherapy in the laparoscopic group

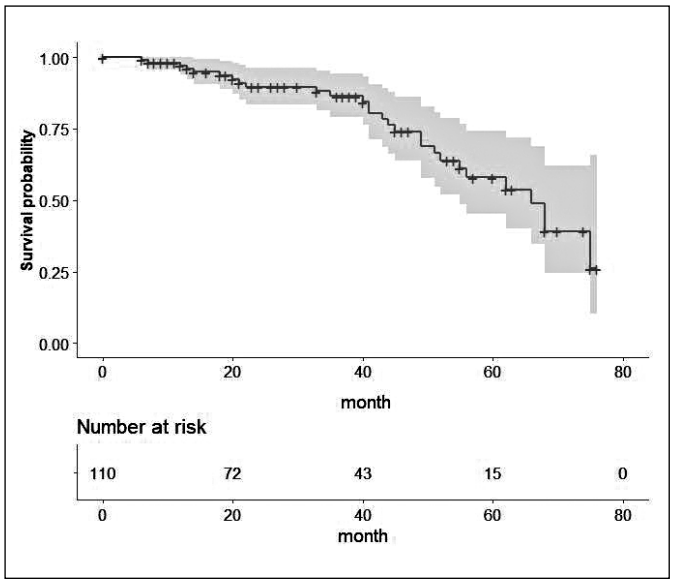

Fig. 1: Survival analyses for malignant patients.

Fig. 2: Study flow chart.

(63.5%) was found to be statistically significantly higher than the open batch (39.2%) (p=0.010). The number of patients with an ASA score of 1: 2: 3: 4 was 34: 30: 45: 6, respectively. According to the Clavien-Dindo scale, the number of patients with Grade 1: 2: 3b: 5 was 8: 7: 1: 4, respectively (Table II). Table III shows the TNM staging between open and laparoscopic groups. The mean age of the patients in the laparoscopic group (65.7 ± 13.46) was statistically significantly higher than that of the open batch (60.49±12.67) (p=0.042). Operation time was 147.53±57 minutes in the laparoscopic group and 132.84±34 minutes in the open batch, and there was no statistically significant difference between them (Table IV). Significant correlations were found between stage and cancer subgroup information (p=0.001). Anenocarcinoma (42%) and mucinous (43.8%) type cancers were found more frequently in patients with stage III, while signet ring cancers were more common (100%) in stage IV patients (Table V). Survival analysis for malignant patients in our study is shown in (Fig. 1). The five-year overall survival rate was 57.9%. While the median survival was 23 months (95% CI; 15.7-30.3) in the laparoscopic group, it was 30 (95% CI; 10.4-49.6) months in the open batch, and there was no statistically significant difference (p>0.05) (Fig. 1). The flow chart of our study is shown in (Fig. 2).

Discussion

Colorectal cancer is one of the big killers worldwide and its growth could be correlated to several factors. Several studies, both clinical and basic science are undergoing to establish the reason for this steep increase. The accumulation of mutations in various oncogenes and tumor suppressor genes in colorectal cancers directs the development of cancer. Various intherleukin, including Interleukin-21 promotes a protumorigenic inflammatory circuit that ultimately sustains the development of sporadic CRC [11]. Furthermore, different histotype are related to the clinical picture and hey a might affect oncological outcomes and survival [9]. Mucinous adenocarcinoma and signet-cell adenocarcinoma are distinct subtypes of colon cancer associated with a worse prognosis [10].

Another aspect that certainly affect prognosis is tumor's staging. A correct staging is also mandatory in planning a correct surgical strategy. For better evaluation of preoperative staging, computed tomography colonography is recommended. In our study, all patients were evaluated with computer tomography: elective patients were evaluated with double-contrast computed tomography and acute cases were evaluated with iv-contrast CT [14].

In this article, although it from a low-volume center, we report our minimally invasive approach to treat right colon cancer after standardizing our minimally invasive surgical operations with a modified technique.

General surgery education is 5 years in our country. After the training is completed, 2 more years and an exam are required to work as a gastroenterological surgeon. One of the aims of this study was to evaluate the contribute to the development of a minimally invasive approach by standardizing minimally invasive surgical operations and modifying some surgical points by fully trained gastroenterological surgeons.

Laparoscopic surgery has become the standard right hemicolectomy surgery, including traditional laparoscopy,

TABLE I - *Demographic data*

		N	%
Gender	Male	64	56,5
	Female	50	43,5
Laparoscopic	Yes	51	44,7
	No	63	55,3
Wound Infection	Yes	17	14,8
	No	98	85,2
Change in Bowel Habits	Yes	81	70,4
	No	34	29,6
Bleeding In Combination With Change In Bowel Habits	Yes	63	54,8
	No	52	45,2
Abdominal Pain as A Single Symptom	Yes	58	50,4
	No	57	49,6
Tumor Localization	Caecum	51	44,7
	Ascending Colon	32	28,1
	Other	12	10,5
	Hepatic Flexure	19	16,7
Metastasis	Yes	6	5,2
	No	109	94,8
Survival	Ex	28	25,5
	Follow-up	82	74,5
Re-Operation	Yes	4	3,5
	No	110	96,5
Complication	Yes	20	17,4
	No	95	82,6
Mortality Ex in The First Month	Yes	5	4,3
	No	110	95,7
Claviendindo	Grade 1	8	40,0
	Grade 2	7	35,0
	Grade 3b	1	5,0
	Grade 5	4	20,0

	Mean	Standard Deviation	Percentile 25	Median	Percentile 75
Age	63,46	13,29	54,00	64,00	74,00
Operation Time (min.)	139	46	100	130	178
Costs	10757,82	6994,10	6770,44	8335,47	14006,99

hand-assisted laparoscopic surgery (HALS), single port laparoscopic surgery (SPLS), natural orifices transluminal endoscopic surgery (NOTES), and robotic laparoscopy. High volume centers are reported to lower complications and mortality for high risk and complex surgical operations, including colorectal surgery. However, a linear relationship between volume and outcome could not be demonstrated. Retrofitting lower-volume surgical units may yield optimal perioperative results [5]. Yasunaga et al. study found no significant relationship between volume and postoperative complications. Results of his study do not support the efficacy of regionalizing rectal cancer surgery to high-volume centers, at least not in the Japanese clinical setting [6]. One of the aspects of centralization is that of standardizing most protocols such as ERAS pathways.

It has been reported that preoperative immunonutrition (IN) and in-hospital length of stay (LOS) decrease with the progression of ERAS in normo-fed patients undergoing laparoscopic colorectal cancer resection [7]. IN seems to reduce infective complications after major gastrointestinal surgery, but its use in normo-fed patients is still controversial [8]. In our practice, oral water was started in all patients within the first 24 hours, and oral liquid food was started after an average of 48 hours after colon surgery. We interrupted oral food due to ileus in only 4 of our patients.

Laparoscopic complete mesocolic excision (CME) right hemicolectomy provides pathologic and oncologic outcomes comparable to open surgery. The pathological and short-term outcomes of laparoscopic CME are comparable to open surgery. Laparoscopic CME still cannot be considered a routine elective approach for right colon cancers. However, right hemicolectomy with CME offers an additional 10% advantage of four-year disease-free survival [12]. LRHC provides the advantages of laparoscopic surgery to the patient if the oncological principles of CME are followed. Systematic training of colorectal surgeons is required for the routine application of LRHC [13]. After completing a proper training on CME

TABLE II - *Laparoscopic and non-laparoscopic properties*

		Laparoscopic				
		Yes		No		
		N	%	N	%	P
Gender	Male	24	47,1	40	63,5	0,079
	Female	27	52,9	23	36,5	
Wound Infection	Yes	8	15,7	8	12,7	0,648
	No	43	84,3	55	87,3	
Change in Bowel Habits	Yes	32	62,7	49	77,8	0,078
	No	19	37,3	14	22,2	
Bleeding In Combination With Change In Bowel Habits	Yes	25	49,0	37	58,7	0,301
	No	26	51,0	26	41,3	
Abdominal Pain as A Single Symptom	Yes	25	49,0	32	50,8	0,851
	No	26	51,0	31	49,2	
Lymphovascular Invasion	Yes	22	44,0	40	63,5	0,039
	No	28	56,0	23	36,5	
Perineural Invasion	Yes	21	42,9	38	61,3	0,053
	No	28	57,1	24	38,7	
Chemotherapy	Yes	20	39,2	40	63,5	0,010
	No	31	60,8	23	36,5	
ASA	1	13	25,5	20	31,7	0,692
	2	12	23,5	18	28,6	
	3	23	45,1	22	34,9	
	4	3	5,9	3	4,8	
Metastasis	Yes	4	7,8	2	3,2	0,267
	No	47	92,2	61	96,8	
Survival	Ex	11	23,4	16	25,8	0,774
	Follow-up	36	76,6	46	74,2	
Re-operation	Yes	0	0,0	4	6,3	0,067
	No	51	100,0	59	93,7	
Complication	Yes	9	17,6	10	15,9	0,800
	No	42	82,4	53	84,1	
Mortality in The First Month	Yes	0	0,0	4	6,3	0,067
	No	51	100,0	59	93,7	
Claviendindo	Grade 1	5	55,6	3	27,3	0,109
	Grade 2	4	44,4	3	27,3	
	Grade 3b	0	0,0	1	9,1	
	Grade 5	0	0,0	4	36,4	

P value was obtained from Exact and Pearson Chi-square analysis.

TABLE III - *TNM Stage Classification*

Stage	Laporoscopic				
	Yes		No		
	N	%	N	%	P
Stage 0	2	3,9	1	1,6	0,429
Stage 1a	1	2,0	1	1,6	
Stage1b	3	5,9	0	0,0	
Stage2-A	19	37,3	30	47,6	
Stage2-B	1	2,0	2	3,2	
Stage3	0	0,0	2	3,2	
Stage3-A	1	2,0	0	0,0	
Stage3-B	16	31,4	16	25,4	
Stage3-C	5	9,8	9	14,3	
Stage4	2	3,9	2	3,2	
Stage4 b	1	2,0	0	0,0	

TNM staging between open and laparoscopic groups

principles, we offered all patients in our study Laparoscopic CME.

Surgical resection is the only curative treatment for localized colon cancers. The purpose of surgical resection in primary colon cancers is to completely remove the tumor, large vascular pedicles, and lymphatic drainage pool together with the affected colon segment. The laparoscopic procedure is technically difficult and should therefore only be performed by surgeons experienced in laparoscopy [15,16]. Even with an experienced surgeon, laparoscopic completion of the surgery should not be insisted in a possibly difficult dissection caused by the tumor. In this case, conversion to open surgery should be considered by taking into account the oncological principles. Even if minimally invasive surgical training is sufficient in basic training programs, there are some shortcomings in practice. It would be beneficial to include a minimally invasive training program based on CME in the development of basic oncological principles [17].

TABLE IV - *Some laparoscopic and non-laparoscopic properties*

Variables	Yes (n=51) Mean±sd	No (n=63) Mean±sd	P
Age	60,49 ± 12,67	65,7 ± 13,46	0,042
Operation Time(min.)	147,53 ± 57	132,84 ± 34	0,358
Costs	11552,47 ± 5294,86	10134,99 ± 8100,02	0,055
Lymph Node Count	20,36 ± 7,31	23,98 ± 13,69	0,418

The P value is derived from the mannWhitney U test. Sd standard deviation

TABLE V - *Histological subtypes of adenocarcinoma*

	Adenocarcinoma (85)	Signet ring cells (3)	Mucinous (17)	Other (8)	P
STAGE					
I	11 (13,6)	0 (0)	2 (12,5)	0 (0)	0,001
II	29 (35,8)	0 (0)	5 (31,3)	1 (25)	
III	34 (42)	0 (0)	7 (43,8)	0 (0)	
IV	7 (8,6)	3 (100)	2 (12,5)	3 (75)	
Lymphovascular invasion					
Yes	47 (56)	1 (50)	8 (47,1)	3 (42,9)	0,846
No	37 (44)	1 (50)	9 (52,9)	4 (57,1)	
Perineural Invasion					
Yes	29 (34,5)	1 (33,3)	6 (35,3)	2 (33,3)	0,990
No	55 (65,5)	2 (66,7)	11 (64,7)	4 (66,7)	
Chemotherapy					
Yes	48 (61,5)	2 (100)	10 (58,8)	2 (28,6)	0,233
No	30 (38,5)	0 (0)	7 (41,2)	5 (71,4)	
CA 19-9					
Yes	60 (70,6)	3 (100)	11 (64,7)	4 (50)	0,400
No	25 (29,4)	0 (0)	6 (35,3)	4 (50)	
ASA					
1	24 (28,2)	3 (100)	8 (47,1)	6 (75)	0,096
2	22 (25,9)	0 (0)	3 (17,6)	1 (12,5)	
3	33 (38,8)	0 (0)	6 (35,3)	1 (12,5)	
4	6 (7,1)	0 (0)	0 (0)	0 (0)	
Complication					
Yes	2 (2,4)	0 (0)	0 (0)	1 (12,5)	0,311
No	83 (97,6)	3 (100)	17 (100)	7 (87,5)	
SURVEY					
Following	70 (85,4)	3 (100)	11 (68,8)	6 (75)	0,318
Ex	12 (14,6)	0 (0)	5 (31,3)	2 (25)	

P value was obtanied from Exact or Pearson Chi Square test.

The laparoscopic approach for right colectomy is a safe surgical procedure [18]. Data on the rates of anastomotic leak in ileocolic anastomosis with a stapler and hand-sewn anastomosis are contradictory. In a Cohort review, it was shown that anastomosis with staples has twice as much anastomotic leakage as hand-sewn anastomosis [19] However, in another review, stapled anastomosis was associated with significantly less anastomotic leakage compared to handsewn anastomosis [20]. Nors J. et al [29] performed laparoscopic right colon resection in 96 patients. Ileocolic intracorporeal anastomotic leakage was 4.2% in these patients [21]. As shown in the meta-analysis study, IA in LRHC reduces short-term morbidity and hospital stay and provides faster recovery [22]. Additionally, IA includes a similar complication rate and may prevent some of the disadvantages that EA poses [23]. Following the advent of laparoscopic surgery, many surgeons do not routinely close the mesentery after colorectal resection, but this issue remains controversial. With improved techniques, it is possible to close the mesenteries even after large mesenteric excisions [4]. In our study, mesenteric closure was performed with intracorporeal suture to prevent complications such as internal hernia or volvulus.

In our study we have proven that LRHC and laparoscopic conventional right hemicolectomy offer similar oncologic outcomes for right colon cancers even in low volume centers.

We acknowledge some limitations to the work. One of them is that our study is retrospective and a disease-free survival analysis was not performed. Pathological vari-

ables and the count of lymph nodes may not always be the number we want to remove. In addition, missing data and differences in pathological analysis and interpretation between contributing institutions are other limitations of the analysis.

Conclusion

LRHC can be performed safely, after adeguate training and standardization. With an improved standard technique and systematic learning method, patient safety and surgical results can be achieved as successfully as in the open surgical approach.

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