Original Article

Minor versus Major Hepatectomy in Simultaneous Operation with Rectal Cancer: Is it Comparable in Terms of Oncological Outcomes?

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Background: Hepatectomy in simultaneous operation with rectal cancer is technically challenging. It is feasible and safe in selected patients when the operations are performed in experienced centers. However, oncological outcomes of this operation have been inconclusive, especially in the type of hepatectomy that is combined with rectal cancer surgery.

Objective: To evaluate the perioperative and oncological outcomes of minor and major hepatectomy in simultaneous operation with rectal cancer.

Materials and Methods: Patients with synchronous rectal cancer with liver metastasis that underwent simultaneous resection between October 2005 and October 2019 were enrolled into the present study. The patients were divided into two groups, major and minor hepatectomy. Clinicopathological characteristics and surgical outcomes including complications, overall survival (OS) and progression-free survival (PFS) between the two groups were analyzed.

Results: Seventy-two patients, which included 54 patients in the minor hepatectomy group and 18 patients in the major hepatectomy group, were included in the present study. A comparative analysis of patient and tumor characteristics between the two groups found that the CEA level (p=0.023), the number (p=0.010), and size of liver metastasis (p=0.006) were higher in the major hepatectomy group. There was no difference in both minor and major complication rates between the two groups. The OS and PFS rates were significantly better in the minor hepatectomy group compared to the major hepatectomy group at 50.23 versus 24.03 months (p<0.001 and 21.60 versus 15.73 months (p=0.015), respectively. Multivariate analysis showed that primary tumor staging, diabetes, and major hepatectomy impacted both OS and PFS.

Conclusion: Minor hepatectomy in simultaneous operation with rectal cancer provides more favorable oncological outcomes. In case of rectal cancer associated with high tumor burden of liver metastasis, which required major hepatectomy, stage operation with either rectal-first or liver-first approach is more appropriate.

Keywords: Rectal cancer; Synchronous liver metastasis; Simultaneous operation

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Liver is the second most common target site of metastasis from colorectal cancer, descending from the lymph nodes. At the time of diagnosis, 15% to 25% of colorectal cancer patients have synchronous liver metastasis, which not only implies poor tumor biology but impacts survival[1,2]. At present, curative resection of both primary tumor and liver metastasis remains the best treatment option to achieving long-term survival with overall 5-year survival rates at 40% to 50%[3,4].

Regarding the timing of surgery for synchronous colorectal liver metastasis (SCRLM), there are alternative options to treating these conditions. Conventionally, the traditional approach or colon/rectal-first consists of resection of primary colorectal cancer, followed by systemic chemotherapy and then, resection of liver tumor[5]. In 2006, the liver-first approach called reverse strategy was proposed and involves removing the liver metastasis prior to performing colorectal resection. The concept of this strategy is to remove the liver metastasis, which has been the most prognostically relevant disease in comparison to the colorectal cancer. This approach is more popular for rectal cancer associated with liver metastasis[6]. Simultaneous operation is another option to treating SCRLM. Simultaneous operation,

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which involves resection of the colon or rectal cancer including the liver metastasis in the same operation, has been well documented as a means of reducing costs and hospital stay. In addition, the improvement in liver surgery has led experienced centers reporting on the safety of the simultaneous approach[5,7,8].

The primary concerns regarding simultaneous approach in rectal cancer and liver metastasis have been the surgical risk of combining two major surgeries, the rectal surgery and the liver resection. The literature has reported the safety and feasibility of the simultaneous rectal cancer surgery and liver resection, even in major liver resection[9,10]. However, few studies have elucidated the outcomes in the aspects of oncological results of simultaneous rectal and liver resection. The aim of the present study was to evaluate the outcomes of simultaneous rectal and liver resection, especially the perioperative and oncological outcomes between minor and major hepatectomy.

Materials and Methods

Study design and patients

The authors retrospectively reviewed SCRLM database of the Department of Surgery at King Chulalongkorn Memorial Hospital (KCMH), Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand between October 2005 and October 2019. Synchronous colorectal metastasis patients that underwent simultaneous resection were included in this retrospective observational cohort. The authors excluded patients with primary tumor site apart from rectum. The Institutional Ethics Committee approved the present study data collection and analysis by IRB number 695/63.

The patients were divided into two groups according to the operation, which were major hepatectomy with 3 or more Couinaud segments, and minor hepatectomy with less than 3 Couinaud segments. The following parameters were collected from the database. Baseline characteristics included patient's gender, age, underlying diseases, alcohol consumption, and smoking. Serum CEA at diagnosis and viral hepatitis profiles were extracted from hospital laboratory information system. Perioperative chemotherapy data were obtained. Patients received different types of regimens such as XELOX, FOLFOX, FOLFIRI, or FLOX regimens depending on the criteria based on the patient's reimbursement plan. Number of tumors and tumor size were obtained from the pathological reports. Pathological staging was classified according to the Eighth edition of the TNM Staging Manual, American Joint Committee on Cancer (AJCC).

The primary endpoints were the overall survival (OS) and the progression-free survival (PFS). The OS was defined as the time interval between the date of diagnosis and the date of death. The PFS was defined as the time interval between the date of diagnosis and the date of disease progression or death, whichever occurred first. The secondary endpoints were postoperative complications. All postoperative complications were classified according to the Clavien-Dindo Classification[11]. Complications were considered "major" if they were of Clavien-Dindo Classification grades III or more. The International Study Group for Liver Surgery (ISGLS) definition of post-hepatectomy liver failure (PHLF)[12] was applied in the present study.

Statistical analysis

Patients' characteristics were summarized using absolute and relative frequencies for categorical variables, mean with standard deviation for continuous variables with normal distribution data, and median with interquartile range for continuous variables with non-normal distribution data. For categorical variables, the comparisons between the two groups were performed using the Fisher's exact test. And for continuous variables, the comparisons were performed using the unpaired t-test or the Mann-Whitney U test. Both OS and PFS were analyzed using the Kaplan-Meier method. Multivariate survival analysis was performed using the Cox proportional hazards regression model. All statistical analysis were conducted by the Stata Statistical Software, version 16 (StataCorp LLC, College Station, TX, USA).

Results

Study cohort and baseline characteristics

Of the 136 SCRLM patients that underwent simultaneous resection at King Chulalongkorn Memorial Hospital between October 2005 and October 2019, 72 rectal cancer patients were included in the study. There were 54 patients in the minor hepatectomy group and 18 patients in the major hepatectomy group as shown in Figure 1.

An overview of demographic and clinico-pathological characteristics is provided in Table 1. Baseline characteristics were comparable between the two groups, except the CEA level at diagnosis, the number of tumors as liver metastasis, and the tumor size. The mean age at diagnosis was

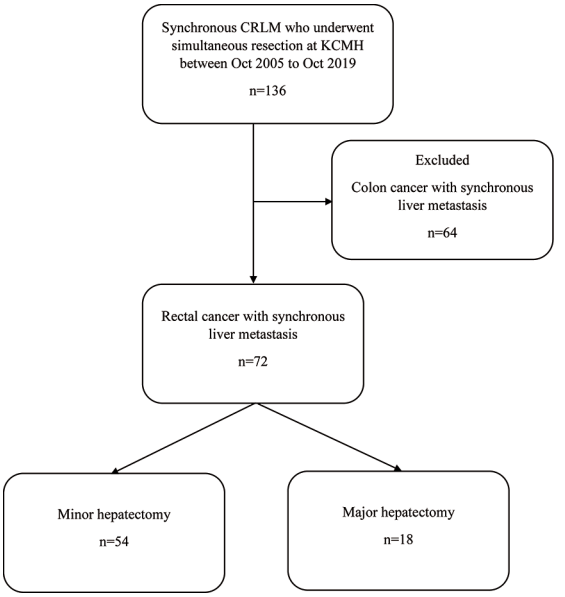

Figure 1. Flowchart of synchronous CRLM who underwent simultaneous resection at KCMH between October 2005 and October 2019.

62.50±10.16 years and 63.83±10.97 years in the minor hepatectomy group and the major hepatectomy group, respectively. There were 38 men (70.4%) in the minor hepatectomy group and nine men (50%) in the other group. The CEA level at diagnosis was 16.33 (6.40 to 77.25) U/mL in the major hepatectomy group, which was significantly higher than in the other group (p=0.023). The underlying diseases, viral hepatitis profile, alcohol consumption, smoking, pre-operative chemotherapy, post-operative chemotherapy, T stage, and N stage were not different between the two groups. There were more liver metastatic tumors, and the larger tumors size in the major hepatectomy group (p=0.010 and 0.006, respectively).

Overall survival

The OS was significantly better in the minor hepatectomy group (log-rank p<0.001). The median survival time was 50.23 (95% CI 35.10 to N/A) months, and 24.03 (95% CI 17.73 to 34.40) months with the 5-year survival rate of 43.95% and 7.48%

Table 1. Demographic and clinicopathological characteristics according to type of resection

Characteristics	Total (n=72)	Minor hepatectomy (n=54)	Major hepatectomy (n=18)	p-value
Age (years); mean±SD	62.83±10.31	62.50±10.16	63.83±10.97	0.638
Sex; n (%)				0.155
Male	47 (65.3)	38 (70.4)	9 (50.0)	
Female	25 (34.7)	16 (29.6)	9 (50.0)	
CEA (U/mL); median (IQR)	9.03 (3.49 to 37.55)	6.85 (2.80 to 32.71)	16.33 (6.40 to 77.25)	0.023
Underlying diseases; n (%)				
Diabetes	7 (9.7)	4 (7.4)	3 (16.7)	0.356
Hypertension	25 (34.7)	17 (31.5)	8 (44.4)	0.394
Dyslipidemia	9 (12.5)	5 (9.3)	4 (22.2)	0.214
Chronic kidney disease	0 (0.0)	0 (0.0)	0 (0.0)	1.000
Cardiovascular disease	3 (4.2)	1 (1.9)	2 (11.1)	0.152
Stroke	2 (2.8)	1 (1.9)	1 (5.6)	0.440
Viral hepatitis; n (%)				
Hepatitis B	2 (2.8)	2 (3.7)	0 (0.0)	1.000
Hepatitis C	1 (1.4)	1 (1.9)	0 (0.0)	1.000
Alcohol consumption; n (%)	4 (5.6)	4 (7.4)	0 (0.0)	0.566
Smoking; n (%)	6 (8.3)	6 (11.1)	0 (0.0)	0.326
Pre-operative chemotherapy; n (%)	22 (30.6)	17 (31.5)	5 (27.8)	1.000
Post-operative chemotherapy; n (%)	66 (97.1)	49 (90.7)	17 (94.4)	0.462
Number of tumors (liver metastasis); median (IQR)	2 (1 to 3)	2 (1 to 3)	3.5 (2 to 6)	0.010
Tumor size (cm); median (IQR)	2.5 (1.3 to 3.9)	2 (1.2 to 3)	3.9 (2.5 to 5.1)	0.006
AJCC 8th T stage; n (%)				0.229
T2	3 (4.2)	2 (3.7)	1 (5.6)	
T3	54 (75.0)	43 (79.6)	11 (61.1)	
T4	15 (20.8)	9 (16.7)	6 (33.3)	
AJCC 8th N stage; n (%)				0.933
N0	10 (13.9)	8 (14.8)	2 (11.1)	
N1	30 (41.7)	23 (42.6)	7 (38.9)	
N2	32 (44.4)	23 (42.6)	9 (50.0)	

SD=standard deviation; IQR=interquartile range; CEA=carcinoembryonic antigen; AJCC=American Joint Committee on Cancer

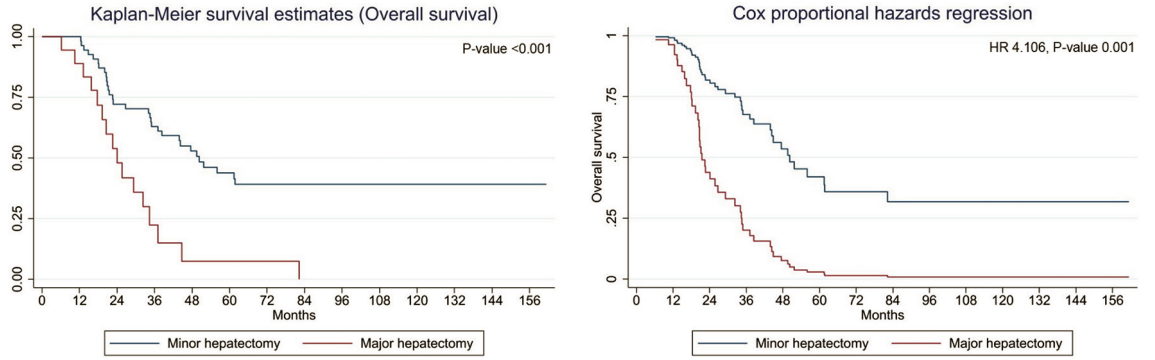

Figure 2. Kaplan-Meier survival estimate and Cox proportional hazard regression of the overall survival (OS).

Table 2. Cox proportional hazard regression of the overall survival (OS)

Characteristics	Univariate			Multivariate		
	HR	p-value	95% CI	HR	p-value	95% CI
Type of liver resection						
Minor hepatectomy (reference)	-	-	-	-	-	-
Major hepatectomy	3.269	<0.001	1.742 to 6.135	4.106	0.001	1.767 to 9.539
Age (years)	1.034	0.037	1.002 to 1.066	1.028	0.185	0.987 to 1.072
Sex: male	0.667	0.179	0.370 to 1.203	0.608	0.169	0.299 to 1.235
CEA (U/mL)	1.000	0.782	0.999 to 1.001	0.999	0.255	0.997 to 1.001
Underlying diseases						
Diabetes	1.536	0.366	0.605 to 3.898	4.004	0.027	1.173 to 13.668
Hypertension	1.166	0.614	0.643 to 2.115	1.262	0.581	0.553 to 2.881
Dyslipidemia	0.532	0.229	0.191 to 1.487	0.444	0.275	0.103 to 1.908
Cardiovascular disease	1.132	0.864	0.274 to 4.675	0.490	0.478	0.068 to 3.511
Stroke	4.863	0.034	1.128 to 20.969	10.782	0.042	1.092 to 106.420
Viral hepatitis: hepatitis B	0.630	0.648	0.087 to 4.579	0.868	0.894	0.109 to 6.919
Alcohol consumption	0.226	0.142	0.031 to 1.644	0.513	0.665	0.025 to 10.534
Smoking	0.330	0.126	0.080 to 1.365	0.478	0.538	0.045 to 5.017
Pre-operative chemotherapy	0.918	0.789	0.490 to 1.719	0.491	0.082	0.220 to 1.095
Post-operative chemotherapy	0.365	0.167	0.087 to 1.523	0.243	0.110	0.043 to 1.375
Number of tumors	1.042	0.316	0.962 to 1.129	0.985	0.835	0.858 to 1.131
Tumor size (cm)	1.044	0.483	0.925 to 1.179	1.034	0.722	0.862 to 1.239
AJCC 8th T stage						
T2	0.190	0.112	0.025 to 1.470	0.066	0.026	0.006 to 0.725
T3	0.488	0.036	0.250 to 0.954	0.597	0.252	0.247 to 1.443
T4 (reference)	-	-	-	-	-	-
AJCC 8th N stage						
N0 (reference)	-	-	-	-	-	-
N1	1.066	0.899	0.395 to 2.877	0.198	0.026	0.047 to 0.820
N2	1.590	0.346	0.606 to 4.172	0.368	0.125	0.103 to 1.320

HR=hazard ratio; CI=confidence interval; CEA=carcinoembryonic antigen; AJCC=American Joint Committee on Cancer

Present with chronic kidney disease and present of viral hepatitis C were omitted

in the minor hepatectomy group and the major hepatectomy group, respectively, as shown in Figure 2. The 95% CI upper bound of median survival time in the minor hepatectomy group was not reached on this cohort. In the multivariate survival analysis, the major hepatectomy group had shorter OS (HR 4.106, 95% CI 1.767 to 9.539, p=0.001) as shown in Table 2.

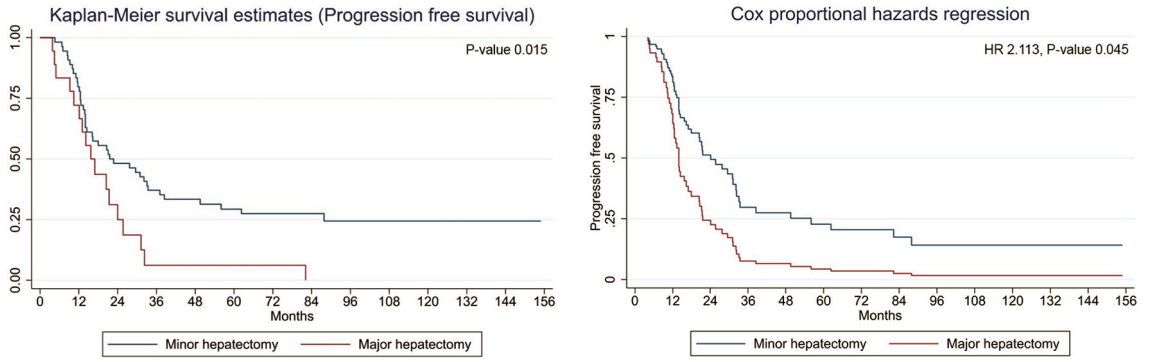

Figure 3. Kaplan-Meier survival estimate and Cox proportional hazard regression of the progression-free survival (PFS).

Table 3. Cox proportional hazard regression of the progression-free survival (PFS)

Characteristics	Univariate			Multivariate		
	HR	p-value	95% CI	HR	p-value	95% CI
Type of liver resection						
Minor hepatectomy (reference)	-	-	-	-	-	-
Major hepatectomy	2.041	0.017	1.138 to 3.661	2.113	0.045	1.018 to 4.388
Age (years)	1.015	0.260	0.989 to 1.042	1.027	0.187	0.987 to 1.067
Sex: male	0.717	0.233	0.416 to 1.239	0.533	0.063	0.275 to 1.035
CEA (U/mL)	1.000	0.715	0.999 to 1.001	0.999	0.556	0.998 to 1.001
Underlying diseases						
Diabetes	1.886	0.143	0.807 to 4.410	5.778	0.001	2.085 to 16.013
Hypertension	1.039	0.891	0.602 to 1.791	1.004	0.992	0.449 to 2.245
Dyslipidemia	0.870	0.749	0.371 to 2.040	1.620	0.497	0.403 to 6.508
Cardiovascular disease	0.677	0.589	0.165 to 2.781	0.181	0.120	0.020 to 1.564
Stroke	2.483	0.211	0.597 to 10.330	2.136	0.570	0.155 to 29.370
Viral hepatitis: hepatitis B	2.482	0.217	0.586 to 10.514	3.145	0.166	0.623 to 15.884
Alcohol consumption	0.552	0.409	0.134 to 2.266	1.614	0.728	0.108 to 24.053
Smoking	0.512	0.260	0.160 to 1.641	0.223	0.233	0.019 to 2.619
Pre-operative chemotherapy	1.238	0.448	0.716 to 2.152	1.032	0.931	0.511 to 2.083
Post-operative chemotherapy	0.538	0.392	0.130 to 2.227	0.596	0.546	0.111 to 3.190
Number of tumors	1.012	0.742	0.944 to 1.084	0.958	0.402	0.865 to 1.060
Tumor size (cm)	1.010	0.867	0.896 to 1.139	1.069	0.421	0.909 to 1.257
AJCC 8th T stage						
T2	0.129	0.049	0.017	0.050	0.011	0.005 to 0.507
T3	0.516	0.030	0.284	0.751	0.476	0.341 to 1.653
T4 (reference)	-	-	-	-	-	-
AJCC 8th N stage						
N0 (reference)	-	-	-	-	-	-
N1	1.090	0.842	0.469 to 2.531	0.204	0.025	0.050 to 0.816
N2	1.296	0.543	0.562 to 2.989	0.276	0.038	0.081 to 0.932

HR=hazard ratio; CI=confidence interval; CEA=carcinoembryonic antigen; AJCC=American Joint Committee on Cancer
Presence with chronic kidney disease and presence of Viral hepatitis C were omitted

Progression-free survival

The median PFS time was 21.60 (95% CI 14.03 to 33.37) months, and 15.73 (95% CI 10.53 to 24.03) months with the 5-year PFS rate of 29.33% and 6.36% in the minor hepatectomy group and the major hepatectomy group, respectively. The PFS was significantly better in the minor hepatectomy group (log-rank p=0.015) as shown in Figure 3. In the

multivariate survival analysis, the major hepatectomy group has shorter PFS (HR 2.113, 95% CI 1.018 4.388, p=0.045) as shown in Table 3.

Complications

In the postoperative complication aspect (Table 4), there was no 90-days mortality or in-hospital mortality. There was no difference in both minor and major overall complication rates between the two groups. In the major hepatectomy group, patients had more minor grade surgical site infection at 27.8% versus 7.4% (p=0.038), major grade intrabdominal collection at 27.8% versus 5.6% (p=0.021), and major grade pleural effusion at 33.3% versus 3.7% (p=0.003) compared with the minor hepatectomy group. The ICU stay and length of hospital stay were comparable between the two groups.

Table 4. Complications

Characteristics	Minor hepatectomy (n=54)	Major hepatectomy (n=18)	p-value
Mortality; n (%)			
90-days	0 (0.0)	0 (0.0)	1.000
In-hospital	0 (0.0)	0 (0.0)	1.000
Complications; n (%)			
Minor complications	8 (14.8)	5 (27.8)	0.289
Major complications	9 (16.7)	6 (33.3)	0.180
Surgical complications; n (%)			
Bile leakage			
• Minor	0 (0.0)	0 (0.0)	1.000
• Major	2 (3.7)	0 (0.0)	1.000
Anastomosis leakage			
• Minor	0 (0.0)	0 (0.0)	1.000
• Major	3 (5.6)	0 (0.0)	0.568
Intraabdominal collection			
• Minor	1 (1.9)	0 (0.0)	1.000
• Major	3 (5.6)	5 (27.8)	0.021
Surgical site infection			
• Minor	4 (7.4)	5 (27.8)	0.038
• Major	0 (0.0)	0 (0.0)	1.000
Hemorrhage			
• Minor	0 (0.0)	0 (0.0)	1.000
• Major	0 (0.0)	0 (0.0)	1.000
Liver failure			
• Minor	0 (0.0)	1 (5.6)	0.250
• Major	0 (0.0)	0 (0.0)	1.000
Non-surgical complications; n (%)			
Atelectasis/pneumonia			
• Minor	1 (1.9)	0 (0.0)	1.000
• Major	0 (0.0)	0 (0.0)	1.000
Pleural effusion			
• Minor	2 (3.7)	0 (0.0)	1.000
• Major	2 (3.7)	6 (33.3)	0.003
Acute kidney injury			
• Minor	2 (3.7)	1 (5.6)	1.000
• Major	0 (0.0)	0 (0.0)	1.000
Cardiovascular event			
• Minor	1 (1.9)	2 (11.1)	0.152
• Major	0 (0.0)	0 (0.0)	1.000
Volume overload			
• Minor	0 (0.0)	3 (16.7)	1.000
• Major	0 (0.0)	0 (0.0)	1.000
ICU stay (days); median (IQR)	0 (0 to 1)	1 (0 to 2)	0.163
Length of stay (days); median (IQR)	11.5 (8 to 19)	13.5 (10 to 21)	0.389

ICU=intensive care unit; IQR=interquartile range

Discussion

Timing of surgery in synchronous rectal cancer with liver metastasis is still controversial especially in asymptomatic rectal cancer with SCRLM. It not only impacts the clinical outcomes but also the cost of the treatment. The traditional approach or rectal-first approach consisting of resection of rectal cancer, followed by systemic chemotherapy and then resection of liver tumor, is still recommended by most centers[10,13]. However, this approach might increase the rate of metastatic after rectal surgery due to postoperative inflammatory response or loss of primary tumor-induced inhibition of angiogenesis[14,15]. Another disadvantage of this approach is the delay of liver resection or postoperative chemotherapy if complications after rectal surgery occurred. To avoid the disadvantages of the traditional approach, simultaneous resection of both rectal cancer and liver metastasis may be a viable option to improve the oncologic result[16,17]. However, the literature did not demonstrate any oncological difference in terms of OS and disease-free survival (DFS) rates between these two approaches[7,15,18-20]. Additionally, length of hospital stay, adverse psychological effect from the two major operations, operating time, and blood transfusion requirement were more prominently associated with the traditional approach in relation to the simultaneous resection[6,21,22].

Since simultaneous operation is considered as a major procedure, including both rectal cancer surgery and liver resection, high rates of morbidity and mortality have been the primary concern, especially when a major liver resection is performed. Few reports demonstrated the increase in complications and mortality rates[7,23,24]. Nonetheless, recent improvements in surgical technique and perioperative care have enhanced the safety and effectiveness of

these combined major operative procedures.

Morbidity, in terms of major complication using the Clavien-Dindo classification grades of 3 or more, were at 20.8% and zero mortality in this cohort and are in line with reports[7,23,24]. Surgical site infection, intraabdominal collection and pleural effusion were the three main complications that occurred in 7.34% versus 27.8% (p=0.038), 5.6% versus 27.8% (p=0.021), and 3.7% versus 33.3% (p=0.003), respectively, in minor and major hepatectomy. Longer operative time and liver mobilization performances in major hepatectomy might be the explanation of these complications. The safety and feasibility of using simultaneous resection in carefully selected patients at high-volume centers with a high ratio of simultaneous resection, was higher than using the traditional approach over time[9].

Studies have recommended minor liver resection in the simultaneous approach due to high morbidity associated with major hepatectomy. If complications developed, a delayed systemic treatment such as chemotherapy was unavoidable and might impact the disease progression and survival[13,24]. From an oncological aspect, minor hepatectomy versus major hepatectomy associated with the simultaneous approach in rectal cancer with SCRLM is still inconclusive.

In the present study, complications between minor and major hepatectomy were not different. Minor complications developed in eight patients (14.8%) of the minor hepatectomy group versus five patients (27.8%) of the major hepatectomy group, p=0.289. Major complications developed in nine patients (16.7%) of the minor hepatectomy group versus six patients (33.3%) of the major hepatectomy group, p=0.180. For the oncological outcomes, minor hepatectomy provided a 5-year survival rate of 43.95% and 5-year PFS rate of 29.33%, which was better than the 5-year survival rate of 7.48% and 5-year PFS rate of 6.36% in the major hepatectomy group, p<0.001 and p=0.015, respectively. Moreover, multivariate analysis by the Cox proportional hazards regression showed that major hepatectomy, primary tumor staging, and diabetes mellitus affected both OS and PFS rates.

So, the controllable factor to determine oncologic outcomes is major hepatectomy. This might not relate to surgery itself. The biological tumor of liver metastasis such as number, size or bilobar disease that requires major hepatectomy[25], or occult metastasis in liver remnant might remain undetected by imaging. In the present study, number of tumors, size of tumor, and CEA level were predominant in the major hepatectomy group when compared to the minor hepatectomy group with statistical significance.

In case of an aggressive tumor biology, staged resection may be more appropriate. For asymptomatic rectal cancer without localized advanced disease with high tumor burden in the liver, the traditional approach may be useful. Intervals between rectal resection and hepatectomy enables the assessment of response to systemic treatment of liver metastasis that could preclude the patients with poor tumor biology or too advanced disease from major liver resection[26-28]. Another option is liver-first approach or chemotherapy-first approach that may be more suitable for patients in this group. This approach starts with liver resection, with or without neoadjuvant chemotherapy depending on the liver metastatic burden first and removal of rectal cancer later. The concept of this strategy is to remove the liver metastasis that has been the most prognostically relevant disease compared to the colorectal cancer. This approach avoids the complication of rectal surgery in case of the traditional approach that might delay chemotherapy and leads to liver metastasis progression[29,30].

Limitation of the present study is inherently its retrospective design and a small cohort. The regimen of the systemic treatment has not been uniformed and depended on the patient's reimbursement criteria. This may impact the oncological outcomes.

Conclusion

Although, simultaneous resection in rectal cancer with liver metastasis is feasible and safe in selected patients in high experienced centers, major hepatectomy in simultaneous operation should be avoided. The traditional approach or liver-first approach may be viable options in these patients.

What is already known on this topic?

Curative resection for both rectal cancer and liver metastasis offers long-term survival. Simultaneous operation is feasible and safe for synchronous liver metastasis and rectal cancer.

What this study adds?

Although simultaneous operation is safe for both rectal cancer and synchronous liver metastasis, the type of liver resection may impact the surgical outcomes. Minor hepatectomy in simultaneous operation with rectal cancer provides long-term survival to the patients. In case of high tumor burden

of liver metastasis, staged operation should be recommended.

Conflicts of interest

The authors declare no conflict of interest.

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