Impact of the COVID-19 Pandemic on Elective Surgery for Colorectal Cancer

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Abstract
Purpose To investigate the impact of the COVID-19 pandemic on patients with colorectal cancer undergoing elective surgery.
Methods The medical records of patients with colorectal cancer who underwent elective surgery in our department during the COVID-19 pandemic (February 1 to May 31, 2020) were collected and analyzed. We compared the clinical data with colorectal cancer during the same 4-month period in 2018 and 2019.
Results Sixty-seven patients with colorectal cancer underwent elective surgery during the COVID-19 pandemic. This was 66% of the number of patients that underwent the procedure during the same period in 2018 and 2019. During the COVID-19 pandemic, the proportion of patients without any digestive system symptoms decreased to 3% and severe clinical symptoms decreased by 20.9%. The proportion of right colon cancer decreased by 17.9%, while the proportion of rectal cancer increased by 52.2%, as compared with 2018 and 2019. The fraction of protective stoma was significantly higher than in 2018 (23.9% vs. 8.7%, \( p = 0.011 \)). Compared with 2019, the average post-operative stay was significantly shorter than in 2018 (9.6 ± 3.7 vs. 12.1 ± 9.1, \( p = 0.015 \)). Compared with 2019, the number of patients with perineural invasion (a feature of adverse prognosis) significantly increased (\( p = 0.009 \)).
Conclusion During the COVID-19 pandemic, the number of patients undergoing elective surgery for colorectal cancer was reduced. However, the tumor stage of patients did not change substantially. We suggest that the clinical diagnosis and treatment of colorectal cancer should strictly comply with national and professional standards.

Keywords COVID-19 pandemic · Impact · Colorectal cancer · Elective surgery

Introduction
The worldwide spread of the novel coronavirus disease 2019 (COVID-19) has brought along a huge shock to non-urgent, elective surgeries across all specialties and had a substantial socioeconomic impact in most hospitals. The Chinese government and population have made unprecedented efforts in controlling the epidemic and proposed to effectively protect the treatment needs of non-COVID-19 patients with the alleviation of the epidemic. When advancing the resumption of work and production, each region adopted a precise approach based on local health risks. For non-emergent patients with colorectal cancer, the approach suggested that surgical indications should be strictly and adequately controlled, and the necessary selective surgical treatments carried out upon strict compliance with the epidemiological and pathogenic screening stipulated by the health department. The treatment of malignant tumors remains an urgent need during the COVID-19 pandemic. Colorectal cancer is often accompanied by low immunity, poor nutritional status, and primary diseases of other systems, thus demanding a considerable amount of medical resources.

The COVID-19 pandemic has had a severe impact on all aspects of colorectal cancer patients’ medical care, including diagnosis, treatment, reexamination, and prognosis. A cross-sectional survey of 1147 colorectal cancer patients across the country showed that the treatment or follow-up of 78.1% of patients was affected, and 22.1% of patients were forced to change their treatment regimens [1]. Oncology societies and national authorities issued general surgery guidelines and key points for the clinical care of cancer patients during the...
COVID-19 pandemic. These stated that surgical intervention for benign colorectal tumors should be postponed, and early tumor patients could undergo endoscopic intervention [2]. Multidisciplinary therapy (MDT) was recommended for malignant tumors, as well as that non-surgical anti-tumor therapy be selected with higher priority. Neoadjuvant therapy was highly recommended for advanced stages of colorectal cancer that meet the indications of the National Comprehensive Cancer Network (NCCN) guidelines (i.e., rectal cancer with T stage ≥ 3/unresectable colon cancer) [3–5].

Most of the studies that focus on the impact of the COVID-19 pandemic on the surgical treatment of colorectal cancer patients use epidemiological surveys. There are no reports on the processes that underlie elective surgery, and especially the influence on diagnosis and treatment. Therefore, in this study, we analyzed the clinical data of patients with colorectal cancer who underwent elective surgery from February 1 to May 31, 2020 and retrospectively compared the data gathered during the same 4-month period in 2018 and 2019 (Tables 1 and 2).

Materials and Methods

Study Population

We obtained the medical records of consecutive patients with colorectal cancer who underwent elective surgery in single hospital during the COVID-19 pandemic (February 1 to May 31, 2020), and also obtained data for the same period (i.e., February 1 to May 31) in 2018 and 2019. The inclusion criteria were (1) primary colorectal adenocarcinoma or mucinous adenocarcinoma confirmed by a pathological assessment, (2) surgical management of colorectal cancer by radical surgical resection as indicated during preoperative evaluation, and (3) no suspicion of a COVID-19 infection. We screened patients with the principle as following: (1) no symptoms of pneumonia, such as cough, fever, or dyspnea in 2 weeks before admission; (2) a negative nucleic acid testing for COVID-19 in 7 days; and (3) exception of COVID-19 in a chest CT scan (Tables 3 and 4).

We excluded patients who underwent emergency operation due to a digestive tract hemorrhage and acute intestinal obstruction or underwent reoperation for recurrent colorectal cancer.

Outcome Variables

The following clinical hospitalization data were collected retrospectively: general information (i.e., gender, age, height, weight, and type of medical insurance), clinical features and exams (i.e., initial symptom and its duration, tumor location, preoperative examination, and laboratory tests), surgical data (i.e., surgical procedure, the extent of curative resection, post-operative complications, the length of hospital stay before and after surgery), and post-operative pathological data (i.e., TNM stages, the number of lymph node dissections, and pathological characters).

Table 1 Comparison of general information of patients before and during COVID-19 pandemic

|                      | 2018 (n = 104) | 2019 (n = 101) | 2020 (n = 67) | 2018 vs 2020 | 2019 vs 2020 |
|----------------------|---------------|---------------|--------------|--------------|--------------|
| Age, x±s             | 64.3±11.2     | 67.0±12.0     | 67.1±11.4    | 0.121        | 0.937        |
| Gender (%)           |               |               |              | 0.106        | 0.300        |
| Female               | 50(48.1)      | 44(43.6)      | 23(34.3)     |              |              |
| Male                 | 54(51.9)      | 57(56.4)      | 44(65.7)     |              |              |
| BMI, x±s             | 24.0±3.3      | 24.1±3.5      | 24.6±3.6     | 0.262        | 0.349        |
| Medical insurance (%)|               |               |              | 0.493        | 0.401        |
| Local residents      | 60(57.7)      | 57(56.4)      | 43(64.2)     |              |              |
| Non-local resident   | 44(42.3)      | 44(43.6)      | 24(35.8)     |              |              |
Results

General Information and Hospitalization Data

Sixty-seven patients with colorectal cancer who underwent elective surgery during the COVID-19 pandemic (i.e., February 1 to May 31, 2020) were included in our study. They consisted of 44 (65.7%) males and 23 (34.3%) females. Their mean age was $67.1 \pm 11.9$ years, and their average body mass index (BMI) was $24.6 \pm 3.6$ kg/m$^2$. There were 43 (64.2%) patients with local resident medical insurance and 24 (35.8%) patients with non-local medical insurance (including out-of-pocket payment). The numbers of patients that underwent elective colorectal surgery during the same period in 2018 and 2019 were 104 and 101, respectively. No significant differences were found in age, gender, BMI, and type of medical insurance between the 67 patients who underwent elective surgery during the COVID-19 pandemic and the patients from 2018 and 2019 (Table 1 and Table 2).

Clinical Features and Examinations

Only two (3.0%) patients did not present with a digestive system symptom as their initial symptom. Instead, they were identified as having elevated tumor markers upon regular physical examination or a tumor during colonoscopy. Fifty-one (76.1%) patients had a hospital visit owing to mild clinical symptoms such as bloody stool, melena, increasing frequency of defecation, and changes in defecation habits and characteristics. Severe clinical symptoms such as abdominal pain, emesis, no longer flatulating, and lower digestive tract hemorrhage were the reasons that the remaining 14 (20.9%) patients visited a hospital. The proportions of patients who had no digestive system symptoms and who had severe clinical symptoms during the COVID-19 pandemic decreased by

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Table 2: Comparison of clinical features and examinations before and during COVID-19 pandemic

|                      | 2018  | 2019  | 2020  | 2018 vs 2020 | 2019 vs 2020 |
|----------------------|-------|-------|-------|--------------|--------------|
|                      | (n=104) | (n=101) | (n=67) | p            | p            |
| Initial symptom, (%) |       |       |       |              |              |
| Regular physical examination |   |       |       |              |              |
| Mild                  | 61(58.7) | 66(65.3) | 51(76.1) | 0.131        |              |
| Severe                | 25(24.0) | 24(23.8) | 14(20.9) |              |              |
| Median days from symptom to medical visit (P25, P75) | 90.00 (50.00, 180.00) | 90.00 (30.00, 150.00) | 90.00 (30.00, 165.00) | 0.290 | 0.857 |
| Median day from diagnosis to admission (P25, P75) | 7.00 (4.00, 12.00) | 8.00 (5.00, 14.00) | 13.50 (8.00, 27.00) | <0.001 | <0.001 |
| Tumor circumference of the lumen, (%) |       |       |       |              |              |
| 1/4                   | 22(21.2) | 14(13.9) | 6(9.1) |              |              |
| 1/2                   | 26(25.0) | 23(22.8) | 13(19.7) |              |              |
| 3/4                   | 17(16.3) | 32(31.7) | 17(25.8) |              |              |
| Total                 | 39(37.5) | 32(31.7) | 30(45.5) |              |              |
| Ileus, (%)            |       |       |       |              |              |
| No                    | 97(93.3) | 94(93.1) | 63(94.0) | 0.100 | 1.000 |
| Incomplete or complete ileus | 7(6.7) | 7(6.9) | 4(6.0) |              |              |
| Hb, g/L, $\bar{x}\pm s$ | 121.2±26 | 119.1±25.23 | 121.0±23.1 | 0.956 | 0.620 |
| Alb, g/L, $\bar{x}\pm s$ | 39.0±5.1 | 38.7±3.5 | 38.5±3.7 | 0.462 | 0.670 |
| CEA, ng/mL, $\bar{x}\pm s$ | 12.0±18.1 | 24.±143.0 | 40.8±72.0 | 0.390 | 0.659 |
| CA19-9, U/L, $\bar{x}\pm s$ | 18.5±45.3 | 18.3±41.3 | 196.8±1464.4 | 0.323 | 0.322 |
| Tumor location, (%)   |       |       |       |              |              |
| Ileocecal junction    | 5(4.8) | 0 | 1(1.5) |              |              |
| Ascending colon       | 11(10.6) | 23(22.8) | 9(13.4) |              |              |
| Hepatic flexure of colon | 9(8.7) | 0 | 1(1.5) |              |              |
| Transverse colon      | 2(1.9) | 0 | 1(1.5) |              |              |
| Splenic flexure of colon | 2(1.9) | 0 | 3(4.5) |              |              |
| Descending colon      | 5(4.8) | 6(5.9) | 3(4.5) |              |              |
| Sigmoid colon         | 28(26.9) | 24(23.8) | 14(20.9) |              |              |
| Rectum               | 42(40.4) | 48(47.5) | 35(52.2) |              |              |
14.3% and 3.1%, respectively ($p = 0.010$), as compared with those from 2018 (Table 2).

The median duration of the initial symptom was 3 months. However, there was a statistically significant difference in the median time from diagnosis to admission between the groups. The median time from diagnosis to admission was 13.5 days during the COVID-19 pandemic and 9.0 days ($p < 0.001$) and 10.5 days ($p < 0.001$) in 2018 and 2019, respectively.

### Table 3  Comparison of surgical results before and during COVID-19 pandemic

|                  | 2018          | 2019          | 2020          | 2018 vs 2020 | 2019 vs 2020 |
|------------------|---------------|---------------|---------------|--------------|--------------|
|                  | ($n=104$)     | ($n=101$)     | ($n=67$)      | $p$          | $p$          |
| Durations of surgery, min, $x\pm s$ | 226.30 ± 80.80 | 206.21 ± 63.64 | 245.22 ± 88.94 | 0.162        | 0.002        |
| Radical surgical, (%) |              |               |               | 0.328        | 0.577        |
| Yes              | 102(98.1)     | 98(97.0)      | 63(94.0)      | 0.212$^a$    | 0.439$^a$    |
| No               | 2(1.9)        | 3(3.0)        | 4(6.0)        |              |              |
| Type of surgery, (%) |              |               |               | 0.502        | 0.628        |
| Laparoscopic     | 64(61.5)      | 76(75.2)      | 47(70.1)      |              |              |
| Open             | 33(31.7)      | 18(17.8)      | 16(23.9)      |              |              |
| Laparoscopic convert to open | 7(6.7) | 7(6.9)        | 4(6.0)        |              |              |
| Protective stoma, (%) |              |               |               | 0.011        | 0.897        |
| No               | 95(91.3)      | 79(78.2)      | 51(76.1)      |              |              |
| Yes              | 9(8.7)        | 22(21.8)      | 16(23.9)      |              |              |
| Postoperative complication, (%) |              |               |               | 1.000        | 0.369        |
| No               | 90(87.4)      | 93(92.1)      | 58(86.6)      |              |              |
| Yes              | 13(12.6)      | 8(7.9)        | 9(13.4)       |              |              |
| Days of pre-operative stay, $x\pm s$ | 9.2 ± 6.3     | 8.1 ± 4.3     | 8.9 ± 4.9     | 0.689        | 0.248        |
| Days of post-operative stay, $x\pm s$ | 12.1 ± 9.1    | 9.2 ± 4.2     | 9.6 ± 3.7     | 0.015        | 0.587        |

$^a$Fisher’s exact tests

### Table 4  Comparison of pathological data before and during COVID-19 pandemic

|                  | 2018          | 2019          | 2020          | 2018 vs 2020 | 2019 vs 2020 |
|------------------|---------------|---------------|---------------|--------------|--------------|
|                  | ($n=104$)     | ($n=101$)     | ($n=67$)      | $p$          | $p$          |
| pT stage, (%)    |              |               |               | 0.060        | 0.152        |
| T0               | 2(1.9)        | 0             | 1(1.5)        |              |              |
| T1               | 14(13.5)      | 6(5.9)        | 1(1.5)        |              |              |
| T2               | 13(12.5)      | 18(17.8)      | 7(10.4)       |              |              |
| T3               | 55(52.9)      | 56(55.4)      | 47(70.1)      |              |              |
| T4               | 20(19.2)      | 21(20.8)      | 11(16.4)      |              |              |
| pN stage, (%)    |              |               |               | 0.298        | 0.481        |
| N0               | 55(52.9)      | 62(61.4)      | 42(62.7)      |              |              |
| N1               | 32(30.8)      | 24(23.8)      | 19(28.4)      |              |              |
| N2               | 17(16.3)      | 15(14.9)      | 6(9.0)        |              |              |
| pM stage, (%)    |              |               |               | 0.166        | 1.000        |
| M0               | 101(97.1)     | 91(90.1)      | 61(91.0)      | 0.157$^a$    | 1.000$^a$    |
| M1               | 3(2.9)        | 10(9.9)       | 6(9.0)        |              |              |
| Lymph node harvested, $x\pm s$ | 18.52 ± 12.02 | 19.40 ± 8.67  | 19.37 ± 7.86  | 0.575        | 0.9859       |
| Lymphovascular invasion, (%) |              |               |               | 0.124        | 0.949        |
| No               | 66(65.3)      | 51(50.5)      | 35(52.2)      |              |              |
| Yes              | 35(34.7)      | 50(49.5)      | 32(47.8)      |              |              |
| Perineural invasion, (%) |              |               |               | <0.001       | 0.009        |
| No               | 85(85.0)      | 67(66.3)      | 30(44.8)      |              |              |
| Yes              | 15(15.0)      | 34(33.7)      | 37(55.2)      |              |              |

$^a$Fisher’s exact tests
Approximately half (52.5%) of patients had a positive preoperative serum tumor marker CEA (> 5 ng/mL). The proportion of patients with positive CA19-9 (> 37 U/mL) was 10.4%. The average level of preoperative serum albumin (Alb) was 38.5 ± 3.7 g/L, and nine (13.4%) suffered from moderate to severe anemia (hemoglobin, Hb < 90 g/L). The distribution of tumor location included 17.9% with right colon cancer (ileocecal junction, n = 1; ascending colon, n = 9; hepatic flexure of colon, n = 1; and transverse colon, n = 1), 29.9% with left colon cancer (splenic flexure, n = 3; descending colon, n = 3; and sigmoid, n = 14), and 52.5% with rectal cancer (n = 35). Most patients (71.3%) had a tumor that occupied more than three-quarters of the total circumference of the lumen examined by colonoscopy, but only four (6.0%) showed symptoms of incomplete or complete ileus. In 2018 and 2019, the proportion of right colon cancer was 27.9% and 22.8%, respectively, and rectal cancer was 40.4% and 47.5%, respectively.

Surgical Results

Among all patients, 63 (94.3%) underwent radical surgery, and four (6.0%) had a palliative operation. Forty-seven (70.1%) patients underwent laparoscopic surgery, four (6.0%) patients’ surgeries were converted from laparoscopy to laparotomy, and the remaining 16 (23.9%) underwent laparotomy. The proportion of protective stoma was 23.9%, which significantly increased (8.7%, \( p = 0.011 \)) as compared with 2018. There were no statistically significant differences in the proportions of laparoscopic surgery between 2018 and 2019 and 2020. In addition, two (1.9%) and three (3.0%) patients underwent palliative operations in 2018 and 2019, respectively.

During the COVID-19 pandemic, the average length of hospital stay before and after surgery was 8.9 ± 4.9 days and 9.6 ± 3.7 days, respectively. No significant differences were found between 2019 and 2020. However, the average length of hospital stay after surgery significantly shortened during the COVID-19 pandemic, as compared with 2018 (12.1 ± 9.1 days, \( p = 0.015 \)). No deaths occurred in the 30 days after surgery, and the incidence of post-operative complications was 13.4% (9/67). There were no significant differences in these variables across the 3 years (Table 3).

Post-operative Pathological Data

During the COVID-19 pandemic, the post-operative pathology of colorectal cancer included one (1.5%) patient with stage 0 (ypT0N0M0), seven (10.4%) patients with stage I, 32 (47.8%) patients with stage II, 21 (31.3%) patients with stage III, and six (9.0%) patients with stage IV. The average number of lymph node harvested was 19.4 ± 7.9, and the positivity rate of vascular tumor thrombus was 47.8% (32/67). Compared with 2019, there were no statistically significant differences between these three variables. However, as compared with 2019, the number of patients with perineural invasion (a feature of adverse prognosis) significantly increased (33.7% vs 55.2%, \( p = 0.01 \)) (Table 4).

Discussion

On February 17, 2020, The General Office of the National Health Commission issued a notice on strengthening the management of medical services to meet individuals’ basic medical needs during the COVID-19 pandemic. On February 27, it issued a further notice on implementation requirements for different regions of scientific and precise measures to prevent and control the pandemic as well as the management of medical services during the COVID-19 pandemic. As part of strict implementation of the strategy of “prevention of external import” and the requirement to fully restore the norms for production and life, our hospital comprehensively provided routine medical services for the public during the COVID-19 pandemic and continuously adjusted the provision of services based on changes to the epidemic prevention and control requirements.

This study focused on the period of February 1 to May 31, 2020 when government activated a first-level and second-level public health emergency response. As compared with the same 4-month period in 2018 and 2019, the proportion of patients with colorectal cancer [6] who underwent elective surgery decreased to 66%. The decline of hospital outpatients was widely reported at home and abroad. Potential reasons for this include (1) the number of people who underwent routine physical examinations during the COVID-19 pandemic significantly decreased; (2) to avoid long trips, patients with mild clinical symptoms chose a community hospital or nearby hospital, and non-local patients received treatment in their residence; (3) the majority of tertiary hospitals gave priority to critically ill patients; (4) hospitals limited the utilization rate of hospital beds to avoid being over-capacity [6–8].

Our study did not find any statistically significant differences in the time from symptom to examination and the time from diagnosis to admission among colorectal cancer patients with elective surgery before and during the COVID-19 pandemic. This indicates that appropriate adjustments were made to the processes used to diagnose and treat patients during the COVID-19 pandemic. Except for nucleic acid testing, patients underwent preoperative examinations after admission to avoid population flow, increased risks of exposure, and the consequences of multiple outpatient examinations. However, this may have resulted in longer preoperative hospital stays. The proportion of asymptomatic colorectal cancer patients significantly decreased, but those
with severe clinical symptoms and incomplete or complete ileus events did not increase significantly. A reduction was found in the proportion of patients with right colon cancer (i.e., of the proximal colon—transverse colon and above). The proportion of patients with rectal cancer increased, which may be explained by an easier recognition of symptoms through rectal stimulation.

Although radical surgery is the preferred choice for patients who have benign colorectal cancer and are in an early stage (T2N0M0-T3N0M0) with a good prognosis, it is often appropriate to delay treatment time when needed. The International Society of University Colon & Rectal Surgeons (ISUCRS) conducted a clinical survey of 287 surgeons, 90% of whom were a colorectal surgeon or general surgeon interested in colorectal diseases. Sixty-one percent of surgeons planned a delay in elective colorectal surgery, and 29% were even willing to postpone it until more than 8 weeks late [9]. There is controversy surrounding whether an appropriate delay in surgery date among patients with stage I to III colorectal cancer has an influence on survival time. Based on the National Cancer Database (NCDB), a study concluded that an appropriate delay of surgical date (i.e., no more than 16 days) did not affect survival [10]. In theory, any delay in treatment may lead to tumor progression and an increased risk of transformation from a resectable to an unresectable tumor. A newly published research model from the UK predicted that delays in diagnosis brought about by the COVID-19 pandemic would shorten the long-term survival time of colorectal cancer patients, potentially causing a 15.3–16.6% increase in mortality within 5 years of diagnosis [11]. When considering post-operative pathology, even though the distributions of patients with stage I to IV colorectal cancer were similar before and during the COVID-19 pandemic, the proportion of patients with perineural invasion (a feature of adverse prognosis) significantly increased during the COVID-19 pandemic. This likely contributed to a greater possibility of receiving post-operative adjuvant to a certain extent.

The proportion of laparoscopic surgeries was consistent in the study periods before and during the COVID-19 pandemic, and there were no differences in post-operative recovery and the incidence of post-operative complications. Surgical duration, amount of intraoperative bleeding, and length of post-surgical hospital stay did not change substantially. This could be attributed to a combination of enhanced recovery after surgery (ERAS) guidelines and laparoscopic minimally invasive surgery, which has a slight impact on post-operative nutritional status and shortens the length of post-operative hospital stay, especially in older patients with colorectal cancer [6]. In our study, the proportion of patients with preventative ostomy increased during the COVID-19 pandemic. Lower anastomotic stoma, intraoperative dissatisfied anastomosis, history of radiotherapy and chemotherapy, and complicated diabetes brought about a higher risk of a prophylactic protective stoma. Considering the incubation period of COVID-19 (1–14 days), patients who were an asymptomatic carrier or in the incubation period may not have been detected even through strict screening [9]. Consequently, proper expansion of indications for preventive enterostomy may encourage more patients to undergo this treatment. It can avoid confusing fever caused by post-operative abdominopelvic cavity infection or COVID-19 and reduce rehospitalization rates and reoperation [6].

The current study included patients with colorectal cancer that underwent elective surgery and were treated by a single hospital over the study period (i.e., the same 4-month period, over three consecutive years, which coincided with the initial outbreak of COVID-19). The study’s comparison of clinical data across the study periods revealed insights about the short-term influences of the COVID-19 pandemic on patients’ surgical care. The long-term effects on survival warrant further study.

**Conclusion**

To summarize, in comparing the clinical data of patients with colorectal cancer that underwent elective surgery before and during the COVID-19 pandemic, we conclude that during the pandemic, the amount of elective surgery decreased to 66%, and the median time from diagnosis to surgery had a 4-day delay, but tumor stage did not change substantially. These findings suggest that the clinical diagnosis and treatment of colorectal cancer may proceed regularly, as long as hospitals and surgeons strictly comply with their national and professional associations’ epidemic prevention and control standards.

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**Declarations**

**Consent for Publication** All the authors approved the version to be published and agreed to be accountable for all aspects of the work.

**Competing Interests** The authors declare that they have no competing interests.
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