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How has the COVID-19 pandemic affected gastrointestinal surgery for malignancies and surgical infections?

Yusuke Ishibashi[1], Hironori Tsujimoto[1,2], Hidekazu Sugasawa[1], Satsuki Mochizuki[1], Koichi Okamoto[1], Yoshiki Kajiwara[1], Eiji Shinto[1], Risa Takahata[1,2], Minako Kobayashi[2], Yuji Fujikura[2], Kazuo Hase[1], Yoji Kishi[1] and Hideki Ueno[1]

[1]*Department of Surgery, National Defense Medical College, Tokorozawa, Japan*
[2]*Department of Medical Risk Management and Infection Control, National Defense Medical College, Tokorozawa, Japan*

ABSTRACT

The coronavirus disease 2019 (COVID-19) pandemic has affected infection control and prevention measures. We investigated the impact of the COVID-19 pandemic on postoperative infections and infection control measures in patients underwent gastrointestinal surgery for malignancies. We retrospectively evaluated changes in clinicopathological features, frequency of alcohol-based hand sanitizer use, frequency of postoperative complications, and microbial findings among our patients in February–May in 2019 (Control group) and 2020 (Pandemic group), respectively. Surgical resection in pathological stage III or IV patients was more frequently performed in the Pandemic group than in the Control group (P = 0.02). The total length of hospitalization and preoperative hospitalization was significantly shorter in the Pandemic group (P = 0.01 and P = 0.008, respectively). During the pandemic, hand sanitizer was used by a patients for an average of 14.9±3.0 times/day during the pandemic as opposed to 9.6±3.0 times/day in 2019 ($p<0.0001$). Superficial surgical site infection and infectious colitis occurred less frequently during the pandemic (P = 0.04 and P = 0.0002, respectively). In Pandemic group, Enterobacter, Haemophilus, and Candida were significantly decreased in microbiological cultures ($P < 0.05$, $P < 0.05$, P = 0.02, respectively) compared with Control group. Furthermore, a significant decrease in Streptococcus from drainage cultures was observed in the Pandemic group ($P < 0.05$). During the COVID-19 pandemic, a decrease in nosocomial infections was observed in the presence of an increase in alcohol-based hand sanitizer use.

Keywords: COVID-19, gastrointestinal surgery, surgical infection

Abbreviations:
COVID-19: coronavirus disease 2019
SARS-CoV-2: syndrome coronavirus 2
WHO: World Health Organization
CT: computed tomography
RT-PCR: real-time PCR
SSI: surgical site infections

Received: January 5, 2021; accepted: February 25, 2021
Corresponding Author: Hironori Tsujimoto, MD, PhD
Department of Surgery, National Defense Medical College, 3-2 Namiki, Tokorozawa 359-8513, Japan
Tel: +81-4-2995-1637, Fax: +81-4-2996-5205, E-mail: tsujihi@ndmc.ac.jp

INTRODUCTION

The first outbreak of coronavirus disease 2019 (COVID-19) was officially reported in Wuhan, China in December 2019. The disease is due to the virus referred to as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), according to the World Health Organization (WHO).[1] In Japan, the strategy to control COVID-19 has included proper hand hygiene, the use of face masks, and social distancing, which have all been reported to be useful in the control and prevention of COVID-19.[2-4] Health care workers should protect themselves and the patients from potentially infectious body fluids by complying with these infection control measures.[5] These measures have already been demonstrated to reduce transmission of bacteria, leading to a reduction in nosocomial infections.[6,7] During the ongoing COVID-19 pandemic, the awareness of the significance of infection control is dramatically increasing worldwide, especially among health care workers.

It is necessary to secure sufficient medical equipment and human resources to successfully fight COVID-19. To achieve this, surgery should be triaged so that surgery for benign diseases and early-stage cancers may be postponed. Thus, the COVID-19 pandemic has had a wide impact not only on the type and number of operations, but also on infection control in gastrointestinal wards.

We hypothesized that increased infection control and/or changes in surgical triaging during the COVID-19 pandemic might affect the number and type of postoperative infections. In the present study, we retrospectively investigated the changes occurring during the COVID-19 pandemic in our gastrointestinal surgery unit.

METHODS

Study design and setting

This single center study used a retrospective design and was performed in the National Defense Medical College (Tokorozawa, Saitama, Japan). Written informed consent was obtained from all study participants. The Institutional Review Board of the National Defense Medical College Hospital approved the study protocol, and the study was performed in accordance with the Declaration of Helsinki.

Patients

A total of 113 patients who underwent surgical resection for gastrointestinal cancers at our department from February, when we accepted the first patient of COVID-19, to May 2020 were included in this study (Pandemic group). One hundred six patients who underwent surgical resection from February to May 2019 served as controls (Control group).

Clinical staging was determined preoperatively using computed tomography (CT), positron emission tomography, and endoscopy. The tumor–node–metastasis criteria from the 8th edition of the UICC Classification for tumor staging were used.[8]

In this study, the eligibility criteria were as follows: (i) open or laparoscopic gastrointestinal resection (ii) being out of hospital by July 1, 2020 (iii) written informed consent available. We obtained data on pathological findings, demographics, surgical procedures, and on any postoperative complications or results of microbial culture tests from our hospital database. Using clinical findings and results of laboratory and other tests, postoperative complications defined as > Grade II in the Clavien–Dindo classification system.[9] Microbial culture tests were performed when the physicians considered these to be clinically necessary. The result “Normal flora” was treated as a negative microbial culture.

Infection control and prevention measures during the pandemic of COVID-19

In the period of the COVID-19 pandemic, all patients underwent a preoperative COVID-19 screening in our hospital one week before surgery, including chest CT and real-time PCR (RT-PCR) for the detection of SARS-CoV-2.

As the infection controls, both medical workers and patients were strictly required to use alcohol-based hand sanitizer in the hospital and wear a surgical mask if possible. In 2019, the patients were not encouraged to use hand sanitizer, although hand sanitizer was put in front of the patient's room. After pandemic, patients were educated to use of hand sanitizer at the timing of in and out of the patient's room, surgical ward, and the hospital. Furthermore, they were advised to avoid situations that could cause infectious clusters, such as closed spaces, crowded areas, and close-contact settings.

Evaluation of the frequency of hand sanitizer usage

Purell Instant Hand Sanitizer (Gojo Industries, Inc, Akron, Ohio) was used in our surgical ward. The in-vitro antibacterial and antifungal efficacy of the sanitizer was certificated by BioScience Laboratories, Inc. (Bozeman, Mont).[10] About 1.3 mL gel liquid come out at one push, and the frequency of hand sanitizer use per patient per day was calculated as follows; total amount of hand sanitizer reduction per day divided by the number of inpatients and amount of hand sanitizer per push. Division of Infection Control in our hospital monitor the hand sanitizer use in all ward of our hospital as the part of activities for preventing any infectious disease before 2019, not limited to COVID-19.

Statistical analysis

Using the Mann–Whitney *U*-test, χ^2 test, or paired t test as appropriate, we evaluated the changes in clinicopathological features, hand sanitizer use, postoperative complications, and microbial findings between the Control and the Pandemic groups. In this study, all probability (P) values < 0.05 were considered statistically significant. All statistical analyses were performed using JMP Pro 14.0 software (SAS Institute Inc., Cary, NC).

RESULTS

No decrease was observed in the number of surgeries during the COVID-19 pandemic (106 vs. 113 patients). None of the patients screened for COVID-19 were positive, and all patients underwent surgical resection as scheduled. The clinicopathological findings are depicted in Table 1. There were no differences in sex, age, cancer site, surgical procedure, operation time, and the estimated intraoperative bleeding between the two groups. We found that surgical resection in pathological stage III or IV patients was more frequently performed in the Pandemic group than in the Control group (P = 0.02). In addition, the length of total and preoperative hospitalization was significantly shorter in the Pandemic group than in the Control group (P = 0.01 and P = 0.008, respectively).

Table 1 Comparison of clinicopathological features between 2019 and 2020

Variable		Total		Control		Pandemic		*P*-value
		n = 219	(%)	n = 106	(%)	n = 113	(%)	
Age	<70	104	47.4	51	48.1	53	46.9	0.892
	≥70	115	52.5	55	51.8	60	53.1	
Sex	Male	132	60.2	63	59.4	69	61.0	0.890
	Female	87	39.7	43	40.5	44	38.9	
Cancer site	Colorectal	151	68.9	72	67.9	79	69.9	0.489
	Gastric	50	22.8	27	25.4	23	20.3	
	Esophageal	15	6.8	5	4.7	10	8.8	
	EGJ	3	1	2	1.8	1	0.8	
Pathological stage	I/II	127	57.9	70	66.0	57	50.4	**0.020**
	III/IV	92	42.0	36	33.9	56	49.5	
Operation procedure	Open	91	41.7	67	63.2	60	53.5	0.170
	Laparoscopy	127	58.2	39	36.7	52	46.4	
Operation time		272.0±7.1		272.6±10.2		271.6±9.9		0.944
Bleeding		231.5±28.8		225.2±41.4		237.5±40.3		0.831
Total hospitalization days		19.2±0.8		21.3±1.1		17.1±1.1		**0.010**
Preoperative hospitalization days		5.1±0.2		5.7±0.3		4.5±0.3		**0.008**

EGJ: esophagogastric junction

The frequency of alcohol-based hand sanitizer used by the two groups was compared (Figure 1). The frequency of hand sanitizer used in the Pandemic group was significantly higher compared with the Control group in each month; an average of 14.9 ± 3.0 times/patient/day of hand sanitizer were used in the Pandemic group, which was significantly higher than that in the Control group (9.6 ± 3.0 times/patient/day) (P < 0.0001).

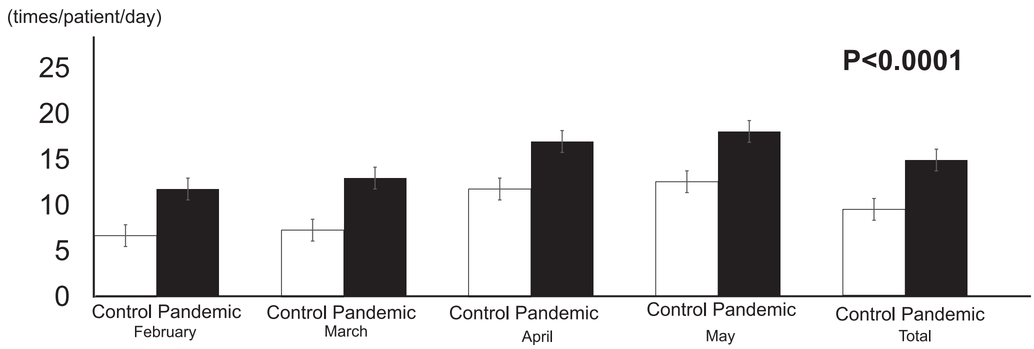

Fig. 1 Comparison of hand sanitizer use between the Pandemic group and the Control group

An overview of postoperative infectious complications is provided in Figure 2. The numbers of superficial surgical site infections (SSI) and infectious colitis cases were significantly lower in the Pandemic group than in the Control group (P = 0.04 and P = 0.0002, respectively); however, no differences between the two groups regarding the frequency of anastomotic leakage, pneumonia, and other infectious complications (urinary tract infection, remnant abscess, pancreatic fistula, and biliary fistula were observed.

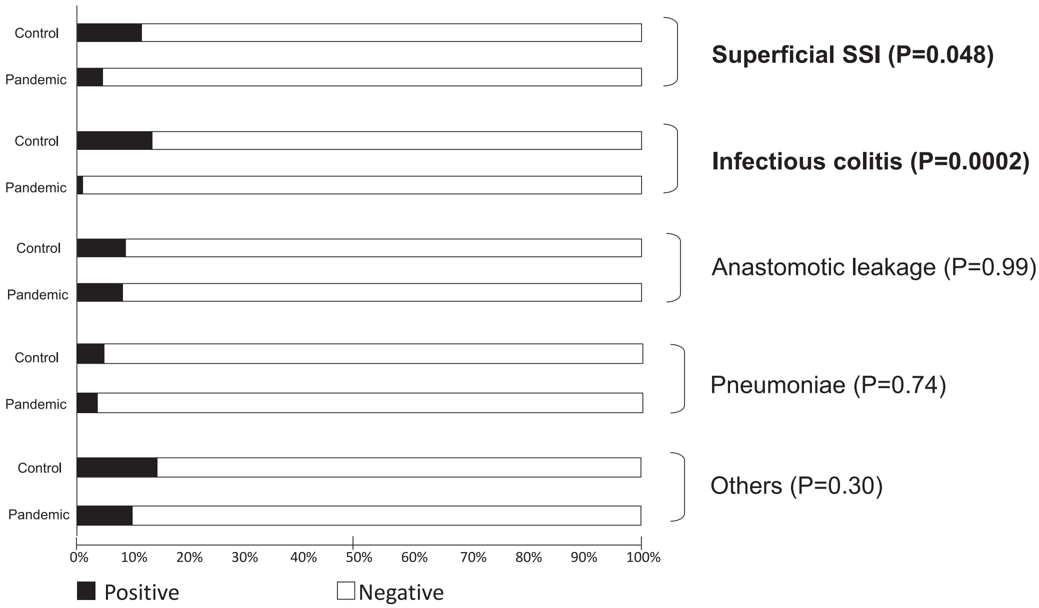

Fig. 2 Comparison of postoperative infectious complications between the Pandemic group and the Control group

A total of 60 patients (27.3%) had a positive microbial culture in the blood (N = 5, 2.2%), drainage fluid (N = 34, 15.4%), urine (N = 21, 9.5%), wound (N = 7, 3.1%), and sputum (N = 9, 4.0%) (Figure 3). There was no difference in the number of positive culture tests for drainage fluid, urine, wound discharge, or sputum between the two groups; meanwhile, none of the patients had a positive blood culture in the Pandemic group.

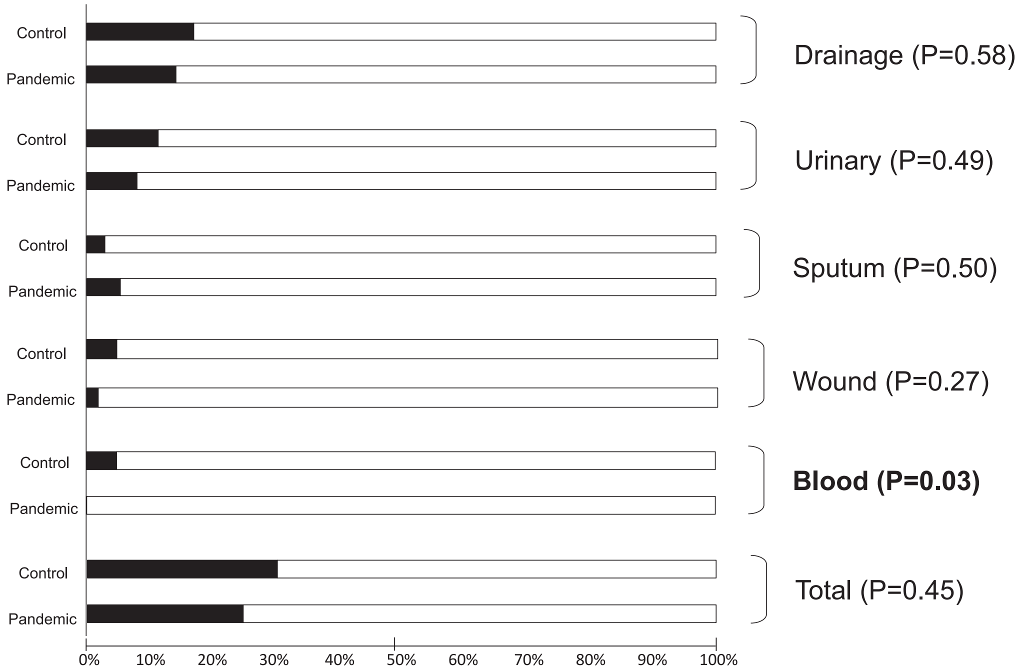

Fig. 3 Comparison of microbial culture findings between the Pandemic group and the Control group

Changes in isolated microbial agents

The microbial agents isolated in culture are summarized in Table 2. *Enterobacter*, *Haemophilus*, and *Candida* were isolated at a significantly lower frequency in the Pandemic group than in the Control group (P < 0.05, P < 0.05, and P = 0.02, respectively). The detection rate of *Streptococcus* in drainage fluid was significantly lower in the Pandemic group than in the Control group (P < 0.05) (Table 3). No significant differences were observed with regard to microbe isolated from urine, wounds, or sputum between the two groups.

Table 2 The changes of bacterial cultures between 2019 and 2020. (In all microbial cultures)

Microbe	Control (n=106)	Pandemic (n=113)	P-value
Staphylococcus	11.3% (12)	9.7% (11)	0.82
Enterobacter	11.3% (12)	4.42% (5)	**<0.05**
Enterococcus	11.3% (12)	12.3% (14)	0.83
Klebsiella	3.77% (4)	1.77% (2)	0.43
Streptococcus	10.38% (11)	2.65% (3)	0.07
Haemophilus	3.77% (4)	0% (0)	**<0.05**
Citrobacter	0.94% (1)	0.88% (1)	0.99
Prevotella	0.94% (1)	0.88% (1)	0.99
Candida	12.2% (13)	3.54% (4)	**0.02**
Serratia	1.89% (2)	0.88% (1)	0.61

Corynebacterium	5.66% (6)	9.73% (11)	0.31
Bacteroides	9.43% (10)	5.31% (6)	0.3
Escherichia coli	4.75% (5)	3.54% (4)	0.74
Pseudomonas aeruginosa	3.77% (4)	4.42% (5)	0.99
Stenotrophomonas maltophilia	1.89% (2)	0.88% (1)	0.61
Bacillus	0.94% (1)	0.88% (1)	0.99
Anaerococcus prevotii	0.94% (1)	0% (0)	0.48
Eggerthella lenta	0.94% (1)	0.88% (1)	0.99
Micromonas micros	0.94% (1)	0% (0)	0.48
Weeksella	0.94% (1)	0% (0)	0.48
Acinetobactor	0.94% (1)	0% (0)	0.48
Neisseria	1.89% (2)	0.88% (1)	0.61
Proteus mirabilis	0.94% (1)	0% (0)	0.48
Capnocytophaga	0.94% (1)	0% (0)	0.48
Clostridium difficile	0.94% (1)	0% (0)	0.48
Eikenella corrodens	0.94% (1)	0% (0)	0.48

Table 3 The changes of bacterial cultures between 2019 and 2020. (In drainage bacterial cultures)

Bacteria	Control (n=18)	Pandemic (n=16)	P-value
Staphylococcus	33.3% (6)	18.7% (3)	0.44
Enterobacter	11.1% (2)	31.2% (5)	0.21
Enterococcus	38.8% (7)	50% (8)	0.73
Klebsiella	11.1% (2)	6.2% (1)	0.99
Streptococcus	38.8% (7)	6.2% (1)	**<0.05**
Haemophilus parainfluenzae	11.1% (2)	0% (0)	0.48
Prevotella	5.5% (1)	6.2% (1)	0.99
Candida	11.1% (2)	18.7% (3)	0.64
Serratia liquefaciens	5.5% (1)	0% 0)	0.99
Corynebacterium	5.5% (1)	31.2% (5)	0.07
Bacteroides	38.8% (7)	18.7% (3)	0.27
Escherichia coli	11.1% (2)	18.7% (3)	0.64
Pseudomonas aeruginosa	11.1% (2)	18.7% (3)	0.64
Stenotrophomonas maltophilia	11.1% (2)	0% (0)	0.48
Bacillus	5.5% (1)	0% (0)	0.99
Anaerococcus prevotii	5.5% (1)	0% (0)	0.99
Weeksella	5.5% (1)	0% 0)	0.99
Neisseria	11.1% (2)	0% (0)	0.48
Capnocytophaga	5.5% (1)	0% (0)	0.99

Eikenella corrodens	5.5% (1)	0% (0)	0.99

DISCUSSION

The spread of SARS-CoV-2 is still taking on pandemic proportions, affecting more than 100 countries around the world.[11-14] Proper treatment for COVID-19 involves the availability of significant health care resources, such as infrastructure, beds in intensive care units, blood products, and sufficiently educated manpower.[15-18] The physicians face a dilemma regarding the rigorous triaging of surgical patients based on careful consideration of disease-related and patient-related factors.[19-21] Although patients with more advanced-stage disease more frequently underwent surgical resection in the present study, both preoperative and total hospitalization was significantly shorter in the Pandemic group. These results are quite reasonable given the strain on medical resources in the era of COVID-19.

In the present study, the frequency of alcohol-based hand sanitizer used was significantly higher during the COVID-19 pandemic, supporting a dramatic increase in awareness of infection control and prevention among the health care workers. WHO has stated that hand wash using alcohol of a purity of 60% or higher is important; hence, it does not suffice to just use water and soap to prevent the spread of SARS-CoV-2.[22] The pandemic of COVID-19 also affected the frequency of postoperative complications. Interestingly, both the number of superficial SSI and infectious colitis were significantly decreased in the Pandemic group compared with the controls, albeit there were no differences in the frequencies of anastomotic leakage, pneumonia, and other infectious complications between the two groups. Several studies reported that bedside hygiene management was important, contributing to the reduction in superficial SSI cases.[23-25] Furthermore, bedside hygiene is also considered to be effective for reducing cases of infectious colitis, especially the transmission of *Clostridium difficile*,[26-28] because this microbe often may easily be transmitted from patient to patient via the hands of the healthcare workers, resulting in nosocomial infections.[29]

In the present study, *Enterobacter*, *Haemophilus*, *Streptococcus*, and *Candida* sp. were less frequently isolated in the Pandemic group. Snyder et al highlighted the importance of hand hygiene as a key prevention measure against nosocomial infections and outbreaks of *Candida*.[30] Furthermore, several studies reported that hand hygiene intervention or practice reduced the number of *Haemophilus influenzae*, *Enterobacter*, and *Streptococcus* infections.[31-38] The benefit of alcohol-based hand hygiene has been most prominent in the prevention of multi-drug resistant bacteria or *Clostridium difficile*.[39-43] In the present study, only three patients with carbapenem-resistant *Enterobacter* infection and one patient with *Clostridium difficile* infection were observed; therefore, we could not investigate the effectiveness of alcohol-based hand hygiene on this type of infections.

Generally, patients with more advanced cancer tend to suffer more from postoperative infectious complications.[44] However, the present study demonstrated that patients in the Pandemic group, which comprised more patients with advanced-stage cancers, had less postoperative infectious complications. Thus, we speculated that thorough infection control such as hand hygiene brought about by the COVID-19 pandemic may have resulted in the reduction of postoperative infectious complications.

This study has certain limitations. First, this study was performed at a single center with a relatively small number of patients and used a retrospective design. Second, whether microbial cultures were performed depended on the attending physicians' decision and the criteria for culturing patient materials may have differed between 2019 and 2020. Therefore, false-negative patients surely existed in the present study. A more systematic approach to microbial culture screening would be needed to strengthen these results. Third, the hand sanitizer in the present study could be used both patients and hospital workers. Therefore, it is unclear whether the increased number of usages by the patients or hospital workers had much impact on the results of the present study. Finally, whether the effect of the elevated alcohol-based hand sanitizer use or other standard precautions, such as wearing a mask and social distancing, contributed to the present results remains unknown. The association between these factors and postoperative complications and microbial cultures should be investigated independently in the future study.

In conclusion, although the pandemic of COVID-19 has taken a toll on public health worldwide, it might have had a positive impact on gastrointestinal surgery and surgical infections, such as the raised awareness of infection control in healthcare staffs, shorter length of hospitalization, and reduced infectious complications.

CONFLICT OF INTEREST/DISCLOSURE

The authors declare no conflict of interest.

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