



Impact of the first era of the coronavirus disease 2019 pandemic on gastric cancer patients: a single-institutional analysis in Japan

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Abstract

Background Little is known about the disadvantages of the coronavirus disease 2019 (COVID-19) pandemic in patients with gastric cancer. This study aimed to examine the negative impact of the COVID-19 pandemic on patients with gastric cancer in the first era in Japan.

Methods This retrospective study included 725 patients diagnosed with gastric cancer who visited our hospital between April 2019 and March 2021. The number of patients and their characteristics before and during the COVID-19 pandemic were compared.

Results The number of patients diagnosed with gastric cancer during the COVID-19 pandemic decreased by 26.2% (from 417 to 308; $p=0.013$) compared to that before the COVID-19 pandemic. There was a significant decrease in cStage I cancer and an increase in cStage III cancer ($p=0.004$). Patients were often symptomatic ($p=0.029$), especially those with stenosis-related symptoms ($p<0.001$) and longer symptom duration ($p<0.001$). The number of endoscopic resections was decreased by 34.8% ($p=0.005$). The number of total gastrectomy was higher than that of partial gastrectomy ($p=0.021$). The median time to treatment was significantly shorter ($p<0.001$).

Conclusions In Japan, delays diagnosing patients with gastric cancer, probably due to refraining from consultation, may have resulted in an increase in the diagnosis of advanced-stage cancer. Moreover, an increasing proportion of patients required more invasive gastrectomy. Therefore, it may be necessary to educate patients not to refrain from consultation, even during the COVID-19 pandemic, as it can have a negative impact on treatment, policy decision, and prognosis of gastric cancer.

Keywords Coronavirus · COVID-19 · Gastric cancer

Introduction

Gastric cancers remains the fifth most common cancer and the fourth most common cause of death worldwide [1]. The incidence rate of gastric cancer is highest in East Asia, including Japan, Korea, and China, where more than half of new cases worldwide have been diagnosed [2]. In

Japan, the first case of coronavirus disease 2019 (COVID-19) was reported on January 15, 2020, and the first state of emergency was declared in seven prefectures, including Tokyo and Saitama (where our hospital is located) on April 7, 2020. Since then, lifestyle and medical conditions have changed; although the state of emergency was lifted on May 25, 2020. The number of COVID-19 infections was gradually decreased during the emergency period. However, it increased again, and a second state of emergency was declared from January 7 to March 21, 2021.

Due to the COVID-19 pandemic, many people may have canceled their annual health check-up, which includes gastric cancer screening, resulting in smaller numbers of new gastric cancer diagnoses, compared to those in previous years [3]. In Hong Kong, the mean number of upper endoscopies performed weekly decreased by 51.0% ($p<0.001$), and the mean number of gastric cancers diagnosed weekly

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decreased by 46.2% ($p < 0.001$) [4]. A UK study regarding endoscopic activity and cancer detection during the COVID-19 pandemic revealed a 12% decrease (vs. pre-COVID-19 levels) in endoscopic activity and a 58% decrease in weekly cancer diagnoses with a specific reduction of 52% for gastric cancers [5].

Although there was no indication of widespread serious medical disruption in Japan by April 2021, patients might have refrained from visiting hospitals to receive medical checkups, including gastric cancer screening, because of the COVID-19 pandemic. In Japan, a significant decrease in the mean number of stage I gastric cancer cases and an increase in the number of symptomatic gastric cancer patients were observed during the COVID-19 pandemic from March to December 2020 [6]. In another Japanese study, the number of gastrectomies was $< 80\%$, and there was a 50% decrease from May to August 2020 in Tokyo when compared to the previous year as determined using questionnaires [7]. However, there is little clarity on how the COVID-19 pandemic affected patients with gastric cancer. Therefore, this study aimed to examine the impact of the COVID-19 pandemic on patients with gastric cancer in the first era in Japan. To our knowledge, this is the first study to evaluate whether the COVID-19 pandemic affected the clinical features and treatments of patients with gastric cancer for 1 year.

Patients and methods

Study design and patients

We screened 801 patients who were diagnosed with gastric cancer at our hospital between April 2019 and March 2021. Of these patients, 76 were excluded due to esophagogastric junctional cancer ($n = 17$), synchronous double primary cancer ($n = 35$), residual gastric cancer ($n = 20$), and neuroendocrine carcinoma ($n = 4$). As a result, 725 patients were eligible for inclusion in the present study. The period from April 2019 to March 2020 was classified as before the COVID-19 pandemic, whereas the period from April 2020 to March 2021 was classified as during the COVID-19 pandemic. We retrospectively compared patients with gastric cancer at the time of their first visit before and during the COVID-19 pandemic. As an additional analysis, we divided the duration of the COVID-19 pandemic into the first (April–September 2020) and second halves (October 2020–March 2021), and compared each of them with the corresponding duration before the COVID-19 pandemic.

This study was approved by the Institutional Review Board of the Saitama Medical University International Medical Center (approval number 2021–114). All procedures were conducted in accordance with the ethical standards of the responsible committee on human experimentation

(institutional and national) and with the 1964 Declaration of Helsinki and its later versions. The requirement for informed consent was waived owing to the retrospective nature of the study.

Data collection and outcome measures

The total number of patients, age, sex, presence of symptoms, symptom duration from awareness to consultation, serum hemoglobin, nutritional status, such as serum albumin, prognostic nutrition index (PNI) [8], and controlling nutritional status (CONUT) score [9], clinical stage, treatment content, and time to treatment were obtained from medical records. Symptom duration was defined as the time from the appearance of symptoms to the date of gastric cancer diagnosis, whereas stenosis symptoms referred to the presence of endoscopic stenosis and obstruction requiring hospital admission. The time to treatment was defined as the period from the date of diagnosis at our hospital or date of the first visit at our hospital for patients diagnosed at other hospitals to the date of treatment initiation.

Tumor, node, and metastasis (TNM) staging and treatment

Patients were treated by TNM staging according to the 15th edition of the Japanese Classification of Gastric Carcinoma (JCGC) guidelines and the 5th edition of the JGCA treatment guidelines [10, 11]. The diagnosis of clinical TNM staging included esophagogastroduodenoscopy and computed tomography of the chest and abdomen. Treatment methods were classified as endoscopic resection, radical surgery, or palliative therapy. Endoscopic resection is considered for tumors that have a very low possibility of lymph-node metastasis and are suitable for en bloc resection. Radical surgery is considered the principal surgical procedure performed with curative intent and lymph-node dissection. Gastrectomy for patients with intraoperative peritoneal lavage cytology-positive (CY1) status was classified as radical gastrectomy. For patients who underwent radical surgery, the pathological TNM staging was determined by the post-operative pathology results. The methods of radical surgery included total gastrectomy, distal gastrectomy, or proximal gastrectomy with lymph-node dissection. Distal gastrectomy was performed for gastric cancer located in the middle or lower third of the stomach. In principle, proximal gastrectomy was performed for stage I disease in the upper third of the stomach, where more than half of the distal stomach can be preserved. Total gastrectomy was performed for other types of gastric cancers, including widespread disease. Palliative therapy includes chemotherapy, palliative surgery, and supportive care.

Institution

Our institution is a university hospital in Saitama prefecture, which is located next to Tokyo. Saitama prefecture was one of the first seven prefectures in Japan to declare a state of emergency. Our hospital is a core institution for gastric cancer treatment in the secondary medical area where the hospital is located and in the adjacent secondary medical area. The proportion of patients with gastric cancer in the second medical area was > 50% in 2017. Despite caring for patients with COVID-19, our institution did not have a cluster outbreak during the study period. Therefore, our institution did not restrict medical examinations, surgeries, or chemotherapy.

Statistical analysis

Statistical analysis was performed using JMP software (SAS Institute Inc., Cary, NC, USA). We used the Wilcoxon rank-sum test to compare continuous variables and the chi-squared or Fisher's exact test to compare categorical variables between the two groups. Differences were considered statistically significant at two-tailed $p < 0.05$.

Results

Comparison of counts of patients with gastric cancer diagnosed before and during the COVID-19 pandemic

The number of patients diagnosed with gastric cancer at our institution within the past 6 years is shown in Fig. 1. The number of patients with gastric cancer was remained stable for 5 years before the COVID-19 pandemic. The total number of patients diagnosed with gastric cancer before and during the COVID-19 pandemic and the number of COVID-19 cases per 100,000 population in Japan and in Saitama prefecture between April 2020 and March 2021 are presented in Fig. 2a, b, respectively. The trends for the number of COVID-19 cases per 100,000 population in Japan as a whole and in Saitama prefecture in particular were quite similar. The total number of patients diagnosed with gastric cancer during the COVID-19 pandemic decreased by 26.2% (from 417 to 308), compared to before the COVID-19 pandemic (Fig. 2a). There was a significant difference in the number of patients diagnosed with gastric cancer per month ($p = 0.013$; Fig. 3). However, a greater decrease was observed between April and September 2020, and then between October 2020 and March 2021. A comparison of the number of patients with gastric cancer diagnosed per month before and during the COVID-19 pandemic is shown in Fig. 3. The number of patients

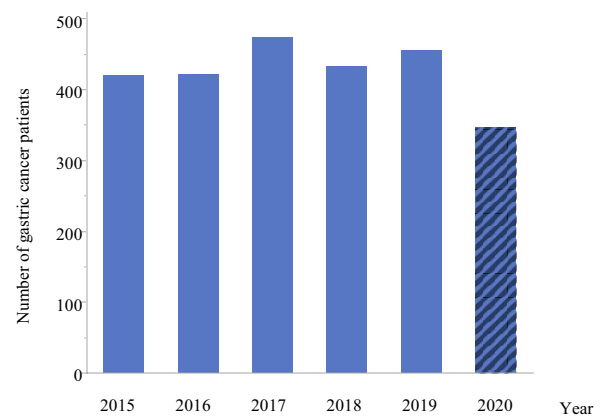


Fig. 1 Number of patients with gastric cancer diagnosed in our institution per year over 6 recent years. The number of patients with gastric cancer did not decrease in 5 years before the COVID-19 pandemic

with gastric cancer diagnosed in the first half period of the COVID-19 pandemic was significantly decreased by 44.3% compared to before the COVID-19 pandemic ($p = 0.013$). On the contrary, the number of patients diagnosed with gastric cancer during the second period of the COVID-19 pandemic did not decrease significantly compared to before the COVID-19 pandemic ($p = 0.57$).

Clinicopathological associations between before and during the COVID-19 pandemic

Clinicopathological associations before and during the COVID-19 pandemic are presented in Table 1. There were significant differences in cT, cN, and cStage ($p = 0.029$, 0.009, and 0.004, respectively). The results showed a significant reduction in early stage cancers, such as cT1, cN0, and cStage I, and an increase in advanced-stage cancer, such as cT3, cN2, cN3, and cStage III. For patients who underwent radical surgery, although there were significant differences in pT, no significant differences were observed in pN and pStage ($p = 0.001$, 0.099, and 0.065, respectively). However, the results showed a significant increase in pT4. Although serum hemoglobin levels of patients during the COVID-19 pandemic were lower than those before the COVID-19 pandemic, no significant differences in serum hemoglobin, serum albumin, PNI, and CONUT score were identified ($p = 0.056$, 0.717, 0.281, and 0.669, respectively).

Regarding the history of gastric cancer diagnosis during the COVID-19 pandemic, the diagnosed patients were more frequently symptomatic ($p = 0.029$), especially those with stenosis symptoms ($p < 0.001$), and had a longer symptom duration ($p < 0.001$) than patients diagnosed before the pandemic.

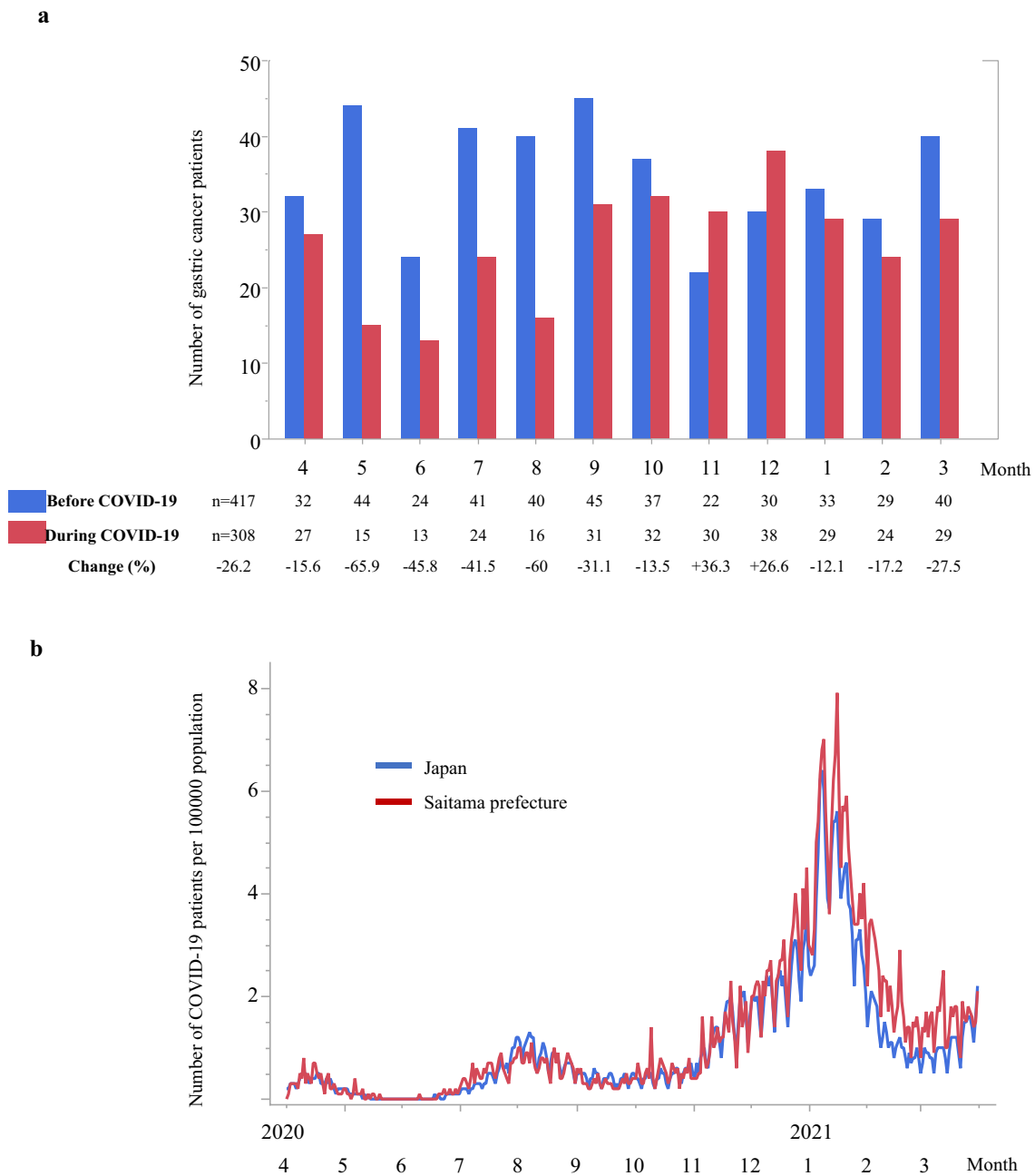


Fig. 2 a Comparison of the number of patients with gastric cancer per month before and during the COVID-19 pandemic. The total number of patients diagnosed with gastric cancer during the COVID-

19 pandemic was decreased by 26.2% (from 417 to 308), compared to the number before the COVID-19 pandemic. **b** Number of COVID-19 patients per 100,000 population in Japan and in Saitama prefecture

Treatments for gastric cancer

There were no significant differences in the proportions of the types of treatments used in each period (Table 1). However, the number of patients gastric cancer treated by endoscopy was decreased by 34.8% compared to before the COVID-19 pandemic ($p=0.005$; Fig. 4a). The number of radical gastrectomies for the year-round was decreased

by 17.3%, but the difference was not significant ($p=0.28$; Fig. 4b). However, the number of radical gastrectomies performed in the first half of the COVID-19 pandemic was significantly decreased by 38.6% compared to in the corresponding period before the COVID-19 pandemic ($p=0.045$).

Surgical procedures for radical gastrectomy are shown in Table 2. The number of total gastrectomy procedures was significantly higher than that of partial gastrectomy

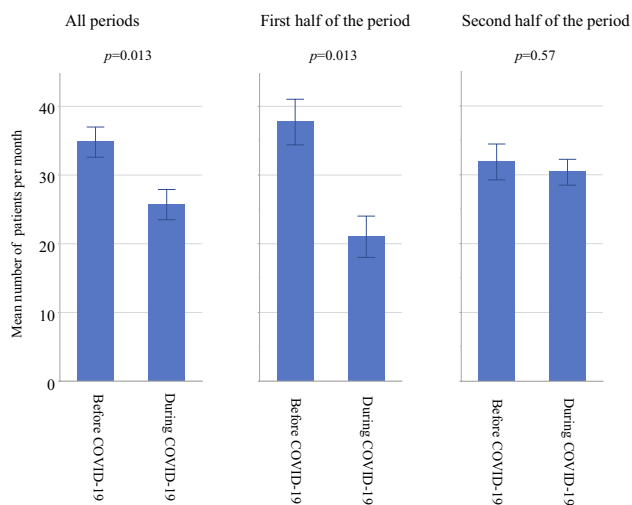


Fig. 3 Comparison of the mean number of patients with gastric cancer per month diagnosed before and during the COVID-19 pandemic according to each period. Throughout the year, the number of patients diagnosed during the COVID-19 pandemic was decreased, compared to that before the COVID-19 pandemic (34.8 ± 2.2 vs. 25.7 ± 2.2 , $p=0.013$). Similarly, the number of patients was decreased during the first half of the period during compared to before the COVID-19 pandemic (37.7 ± 3.3 vs. 21.0 ± 3.0 , $p=0.013$). On the other hand, in the second half of the period, the number of patients was almost the same during the COVID-19 pandemic compared to before the pandemic (31.8 ± 2.6 vs. 30.3 ± 1.9 , $p=0.571$)

procedures performed during the COVID-19 pandemic ($p=0.021$).

Time to treatment

The median time to treatment was significantly shorter in patients during the COVID-19 pandemic ($p < 0.001$; Table 1). The waiting times for each initial treatment and cStage are shown in Table 3. In this table, patients treated by palliative surgery and supportive care were excluded. The waiting times for endoscopy ($p=0.012$), surgery ($p < 0.001$), cStage I ($p < 0.001$), and cStage II or III ($p < 0.001$) were significantly shorter during the COVID-19 pandemic than before the COVID-19 pandemic. There were no significant differences in the waiting time for chemotherapy or for those with cStage IV.

Discussion

Our study revealed that the number of patients diagnosed with gastric cancer during the COVID-19 pandemic was decreased by 26.2%, compared to before the COVID-19 pandemic. The number of patients with gastric cancer was significantly decreased during the first half period of the COVID-19 pandemic, but not in the second half period

compared to before the COVID-19 pandemic. Symptomatic patients, including those with stenosis and longer symptom duration, were diagnosed with gastric cancer more often during the COVID-19 pandemic than before. There was a significant decrease in early stage cancer and an increase in advanced-stage cancer. The number of patients with gastric cancer treated by endoscopy in all periods and radical gastrectomy in the first half of the COVID-19 pandemic was significantly decreased, compared to before the COVID-19 pandemic. However, the number of patients who underwent total gastrectomy was increased. The median time to treatment was significantly shorter in patients during the COVID-19 pandemic than before the pandemic.

This result may be due to refraining from visiting hospitals to receive medical checkups, including endoscopy, as a result of the COVID-19 pandemic. However, when the period of the COVID-19 pandemic was divided into the first half and the second half for sub-analysis, despite the fact that the number of COVID-19 infected patients was higher in the second half, the number of patients with gastric cancer was decreased in the first half compared to the previous year, but this was not observed in the second half. A possible reason for this is that the first half of the period includes the first state of emergency period, from April 7, 2020 to May 25, 2020. During the period of the first state of emergency, postponement or cancelation of gastrointestinal endoscopy, unless urgently required, was strongly recommended by the Japan Gastroenterological Endoscopy Society to prevent the spread of infection and protect healthcare workers [3]. Visiting hospitals may have been considered to increase the risk of COVID-19 transmission, and many people refrained from visiting hospitals unless they were seriously ill. There were changes in the recovery of medical systems, such as resumption of normal gastrointestinal endoscopy, including for medical check-up, with appropriate triage and reliable infection protection measures following the lifting of the first emergency state. As the COVID-19 pandemic continued, the public may have adjusted to COVID-19 and further changes in attitudes discouraged people from visiting hospitals for infection risks.

During the first wave of the pandemic in April, the second wave of the pandemic in August, and the third wave of the pandemic in January and February, the number of patients with gastric cancer was decreased, as well. In contrast, the number of patients with gastric cancer was increased between September and December, when the number of COVID-19 patients was relatively low, and the number of patients with gastric cancer was particularly high in November and December compared to before the COVID-19 period. The possible reason was that during the first-wave of the pandemic, the number of screening or follow-up endoscopies was decreased by 51–75% in the highest number of answers for the questionnaire compared to before

Table 1 Clinicopathological associations before and during the COVID-19 pandemic

Variables	Categories	Before COVID-19 <i>n</i> = 417	During COVID-19 <i>n</i> = 308	Change, %	<i>p</i> Value
Age, median (range)		73 (27–93)	73 (25–93)		0.689
Sex	Male	298 (71.5%)	209 (67.9%)	– 29.9	0.326
	Female	119 (28.5%)	99 (32.1%)	– 16.8	
cT	1	239 (57.3%)	147 (47.7%)	– 38.5	0.029*
	2	37 (8.9%)	27 (8.8%)	– 27.0	
	3	59 (14.1%)	66 (21.4%)	11.9	
	4	82 (19.7%)	68 (22.1%)	– 17.1	
cN	0	315 (75.5%)	205 (66.6%)	– 34.9	0.009*
	1	57 (13.7%)	44 (14.3%)	– 22.8	
	2	36 (8.6%)	42 (13.6%)	16.7	
cM	0	339 (81.3%)	251 (81.5%)	– 26.0	1.00
	1	78 (18.7%)	57 (18.5%)	– 26.9	
cStage (15th)	I	265 (63.6%)	164 (53.2%)	– 38.1	0.004*
	II	41 (9.8%)	43 (14.0%)	4.9	
	III	29 (6.9%)	41 (13.3%)	41.4	
	IV	82 (19.7%)	60 (19.5%)	– 26.8	
pT (patients treated by radical gastrectomy)	1	99 (51.8%)	65 (41.1%)	– 34.3	0.001*
	2	16 (8.4%)	18 (11.4%)	12.5	
	3	47 (24.6%)	30 (19.0%)	– 36.2	
	4	29 (15.2%)	45 (28.5%)	55.2	
pN (patients treated by radical gastrectomy)	0	109 (57.1%)	77 (48.7%)	– 29.4	0.088
	1	33 (17.3%)	27 (17.1%)	– 18.2	
	2	23 (12.0%)	16 (10.1%)	– 30.4	
pStage (15th; patients treated by radical gastrectomy)	I	100 (52.4%)	69 (43.7%)	– 31.0	0.065
	II	42 (22.0%)	35 (22.1%)	– 16.7	
	III	42 (22.0%)	52 (32.9%)	23.8	
	IV	7 (3.6%)	2 (1.3%)	– 71.4	
Symptoms	Yes	174 (41.7%)	154 (50.0%)	– 11.5	0.029*
	No	243 (58.3%)	154 (50%)	– 36.7	
Symptom duration, weeks		4 (0–48)	8 (0–48)		<0.001*
Stenosis symptoms	Yes	16 (3.8%)	34 (11.0%)	112.5	<0.001*
	No	401 (96.2%)	274 (89.0%)	– 31.7	
Treatment	Endoscopy	141 (33.8%)	92 (29.9%)	– 34.8	0.335
	Radical gastrectomy	191 (45.8%)	158 (51.3%)	– 17.3	
	Palliative therapy	85 (20.4%)	58 (18.8%)	– 31.8	
Time to treatment (days), median (range)		30 (0–122)	23 (0–101)		<0.001*
Serum hemoglobin, median (range)		13.4 (6–17.4)	13.1 (3.4–17)		0.056
Serum albumin, median (range)		4.0 (1.4–5.2)	4.0 (1.9–4.9)		0.717
PNI, median (range)		48.7 (22.2–71.1)	48.2 (23.9–61.3)		0.281
CONUT score, median (range)		2 (0–9)	2 (0–8)		0.669

PNI prognostic nutritional index, *CONUT* controlling nutritional status. **p* < 0.05

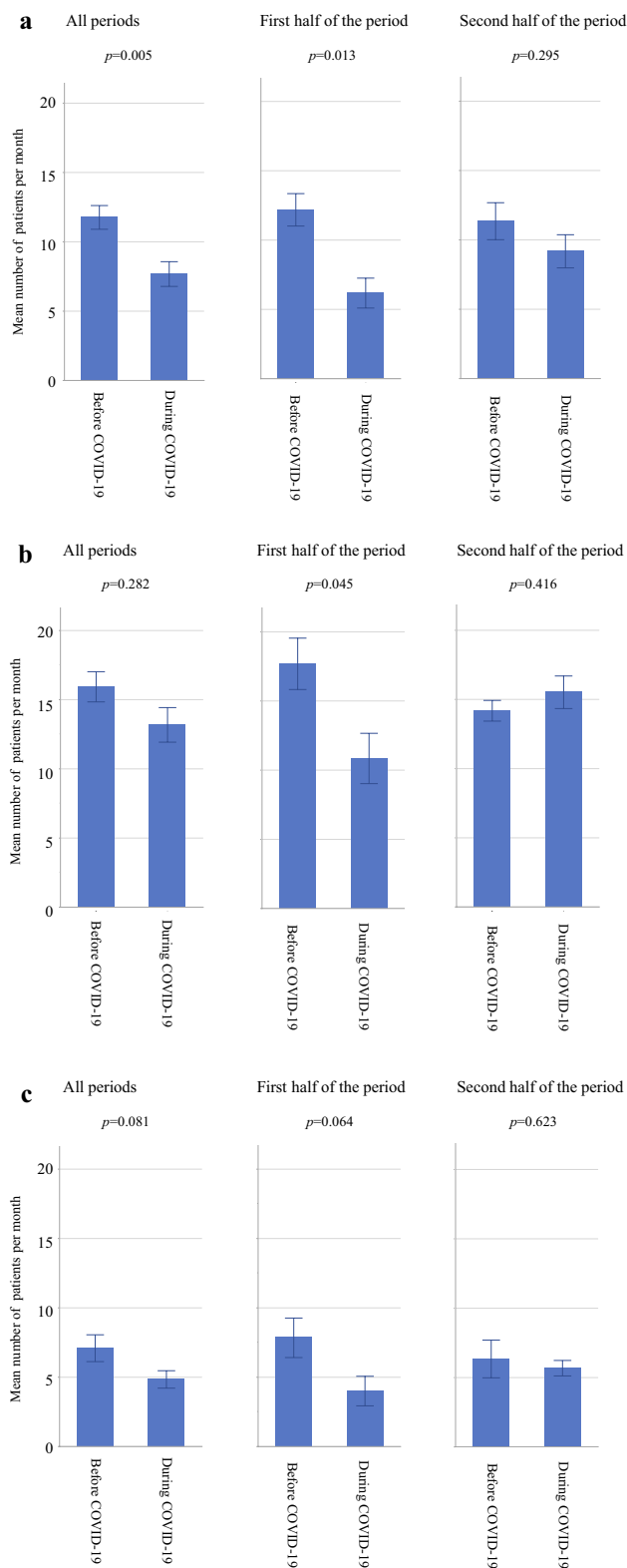
the pandemic in Japan [12]. Although no data were collected after the second wave, the same trend suggests that the number of endoscopies was decreased during the wave of the pandemic, which may have decreased the number of gastric

cancer detection. The number of patients with gastric cancer may increase due to an increase in the number of screening or follow-up endoscopies from September to December, when the number of COVID-19 patients was relatively low,

Fig. 4 Comparison of the mean number of patients with gastric cancer per month diagnosed before and during the COVID-19 pandemic according to treatments for each period. **a** Endoscopic resection: The number of patients with gastric cancer during the COVID-19 pandemic decreased compared to that before the COVID-19 pandemic (11.8 ± 0.9 vs. 7.7 ± 0.9 , $p=0.005$) throughout the year. Similarly, the number of patients decreased during the first half of the period compared to before the COVID-19 pandemic (12.2 ± 1.2 vs. 6.2 ± 1.1 , $p=0.013$). On the other hand, during the second half of the period, the number of patients was almost the same before and during the COVID-19 pandemic (11.3 ± 1.3 vs. 9.2 ± 1.2 , $p=0.295$). **b** Radical gastrectomy: The number of patients with gastric cancer who were treated with radical gastrectomies decreased during the COVID-19 pandemic, compared to before the COVID-19 pandemic (15.9 ± 1.1 vs. 13.2 ± 1.2 , $p=0.281$) throughout the year. Similarly, the number of patients was decreased in the first half of the period during compared to before the COVID-19 pandemic (17.7 ± 1.9 vs. 10.8 ± 1.8 , $p=0.045$). On the other hand, in the second half of the period, the number of patients was almost the same during compared to before the COVID-19 pandemic (14.2 ± 1.8 vs. 15.5 ± 1.2 , $p=0.416$). **c** Palliative therapy: The number of patients who underwent palliative care during the COVID-19 pandemic did not significantly decrease compared to before the COVID-19 pandemic nor during the first or second halves of the period (7.1 ± 1.0 vs. 4.8 ± 0.6 , $p=0.081$; 7.8 ± 1.4 vs. 4.0 ± 1.1 , $p=0.064$; 6.3 ± 1.4 vs. 5.7 ± 0.6 , $p=0.468$, respectively)

as a result of patients refraining from screening endoscopy before that period. Additionally, the number of esophageal cancer patients at our hospital also showed a similar trend during the same period [13].

In this study, as a result of a significant reduction in early stage cancer and an increase in advanced-stage cancer, the treatment decisions of patients with gastric cancer were greatly influenced. The decrease in the incidence of cT1 may have led to the decrease in endoscopic resections that was also apparent, especially in the first half of the year. In terms of the proportion of patients by stage, there was a clear increase in the number of patients with stage II and III disease, which is suitable for radical surgery, but the number of surgeries was decreased in the first half of the year. This result may seem divergent at first glance; however, it was probably due to the significant impact of the decrease in the number of first-time patients. For patients who underwent radical surgery, although there was a significant increase in pT4, there were no significant differences in pN and pStage. The results also showed a significant increase in pT4. The lack of a significant difference in pStage may be due to bias as a result of examining only patients who underwent radical gastrectomy. The number of patients with cStage IV gastric cancer was decreased by 26.8%, which is almost the same as the overall decrease in the number of patients with gastric cancer (26.2%). There was no significant change in the proportion of patients with cStage IV cancer, which is not indicated for curative treatment, such as endoscopic resection or surgery, or in the number of patients who chose palliative treatment. The negative impact on disease progression at the time of initial consultation of patients with gastric cancer



during the COVID-19 pandemic in Japan was certainly present, and a shift in some patients opting for more invasive surgical treatment than the least invasive endoscopic treatment due to stage progression was likely. Although the

Table 2 Surgical procedures for radical gastrectomy

Variables	Categories	Before COVID-19	During COVID-19	Change, (%)	<i>p</i> Value
		<i>n</i> = 191	<i>n</i> = 158		
Gastrectomy categories	Radical surgery	115 (60.2%)	107 (67.7%)	– 7.0	0.153
	Additional gastrectomy after endoscopic resection	23 (12.0%)	9 (5.7%)	– 61.0	
	Radical surgery with preoperative chemotherapy	8 (4.2%)	4 (2.5%)	– 50.0	
	Radical surgery with postoperative adjuvant chemotherapy	45 (23.6%)	38 (24.1%)	– 37.8	
Type of gastrectomy	Partial gastrectomy	157 (82.2%)	114 (72.1%)	– 27.4	0.028*
	Total gastrectomy	34 (17.8%)	44 (27.9%)	29.4	
Laparoscopic use	Yes	137 (71.7%)	115 (72.8%)	– 16.1	0.826
	No	54 (28.3%)	46 (27.2%)	– 14.8	

p* < 0.05Table 3** Time to treatment according to initial treatment and cStage

Variables	Categories	Before COVID-19		During COVID-19		<i>p</i> Value
		No. of patients	Time to treatment (days), median (range)	No. of patients	Time to treatment (days), median (range)	
Initial treatment	Endoscopy	164	22.5 (2–76)	101	18 (4–62)	0.012*
	Surgery	160	47 (8–122)	145	28 (4–101)	< 0.001*
	Chemotherapy	51	24 (5–60)	33	20 (5–62)	0.611
cStage (15th)	I	261	33 (2–100)	164	23.5 (4–101)	< 0.001*
	II, III	63	34 (9–122)	82	25 (4–75)	< 0.001*
	IV	51	27 (5–75)	33	20 (5–62)	0.281

**p* < 0.05

number of patients with advanced gastric cancer is increasing due to the COVID-19 pandemic, the disease has not progressed to the point of distant metastasis. However, if patients continue to refrain from visiting hospitals to receive medical checkups, there is a possibility that the percentage of cStage IV patients may increase.

There was a significant increase in the number of patients with stenosis of symptoms as a result of disease progression due to delayed diagnosis. Generally, impaired gastrointestinal transit contributes to anemia and hypotrophy, and nutritional impairment before treatment increases the risk of non-adherence to each treatment modality. Additionally, nutritional impairment is associated with short- and long-term outcomes in patients with cancer [14–16]. However, there were no significant differences in pre-treatment nutritional status or anemia. The impact of COVID-19 in Japan was relatively limited in terms of exacerbation of patient factors related to treatment decisions. Although there is a concern that prolonged time to treatment may be a direct factor in cancer disease progression [17, 18], the time to treatment in endoscopic resection and surgical treatment was reduced during the COVID-19 pandemic in our hospital. This result supports the fact that the medical system for the diagnosis

and treatment of gastric cancer was well maintained in our hospital during the study period. Although an increase in the number of advanced-stage cancers was observed in our hospital during the COVID-19 pandemic, there was no change in patient factors, such as nutritional status or any medical pressure that may have indirectly influenced the treatment strategy.

A previous study showed an increase in short-term mortality among patients diagnosed with gastric cancer, which may be explained by delays in cancer diagnosis and characteristic changes in cancer patients regarding their prognosis during the COVID-19 pandemic [19]. Our results suggest that, in addition to the decrease in endoscopic resection and an increase in the number of tumors diagnosed at stages for which gastrectomy is indicated, the COVID-19 pandemic had some effects on gastrectomy, the basis of curative treatment for advanced stages of gastric cancer. Over the years, gastrectomy with preservation of the residual stomach has been actively selected for better postoperative nutrition [20]. Compared with total gastrectomy, the advantage of preserving the residual stomach, even if it is very small, has been reported [21]. We have followed this trend and selected gastrectomy with active preservation of the residual stomach

in our institution [22]. However, total gastrectomy is still an important strategy for patients with more widespread or highly advanced-stage cancer of the upper stomach. The increase in the number of total gastrectomies performed during the COVID-19 pandemic was very suggestive, as the disease progression due to the delay in diagnosis by COVID-19 may have led to an increase in the number of total gastrectomies, compromising the mid- to long-term patient outcomes.

Overall, 55% of scheduled endoscopic resections for gastrointestinal neoplastic lesions were deferred globally after the lockdown period, which was 11 times higher than in the previous year, and the majority of postponements (80%) occurred in severely affected countries [23]. Globally, 37.7% of cancer surgeries were canceled or postponed with a 12 week peak disruption due to the COVID-19 pandemic [24]. Although providing normal medical care was also somewhat limited, the median time to treatment was significantly shorter in patients during the COVID-19 pandemic in our study. The median time to treatment was significantly shorter in patients treated with endoscopy and surgery after the initial treatment. It is possible that the impact of more advanced-stage cancers that require early treatment shortened the time to treatment. However, the time to treatment was also significantly shortened in patients with cStage I and cStage II or III disease. This may suggest that in spite of the sufficient medical resources for endoscopy and surgery, the number of patients diagnosed with gastric cancer was limited due to refraining from visiting hospitals to receive medical checkups or gastric cancer screenings.

This study had a few limitations. First, this was a single-center retrospective study of only the first year of the COVID-19 pandemic. Although it is clear that the COVID-19 infection status greatly varies depending on the time period, we considered our study to be sufficient in evaluating the impact of COVID-19 in the first era in the local area where our institution is located. Additionally, the trends of the number of COVID-19 patients per 100,000 population in Japan and in Saitama prefecture were quite similar; therefore, this study may reflect the impact of the COVID-19 pandemic in Japan. Nonetheless, a nationwide study should be conducted in Japan. Second, because age-standardized estimated morbidity rates of gastric cancer have also been declining for decades in Japan [2], we have to mention that this decrease may have been affected by the natural decrease in the number of patients with gastric cancer. However, there was no decrease in the number of patients with gastric cancer at our institution over the last 5 years, and the decrease during the COVID-19 pandemic was remarkable (Fig. 1). Third, this study was conducted only at the time of initial consultation for gastric cancer, and only a small part of the effect of COVID-19 on patients with gastric cancer was evaluated. Therefore, further studies of short- and long-term outcomes are needed in the future.

In conclusion, due to the COVID-19 pandemic, there was an increase in the number of symptomatic patients at the time of initial diagnosis of gastric cancer. This behavioral change due to the restriction of gastric cancer screening by the declaration of the first state of emergency and refraining from visiting hospitals may have resulted in a decrease in early stage cancers and an increase in advanced-stage cancer. An increase in invasive surgeries suggested that there was a significant negative impact on the treatment of patients with gastric cancer. Therefore, it may be necessary to encourage patients not to skip regular medical checkups, including gastric cancer screening, or hesitate to visit hospitals.

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Author contributions All authors contributed to the study conception and design. SF and YM: prepared the materials and conducted data collection and analysis. The first draft of the manuscript was written by SF: and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval The study protocol was approved by the Ethics Committee of the Faculty of Medicine, Saitama University (2021–114).

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