ORIGINAL RESEARCH

Effect of Time (Season, Surgical Starting Time, Waiting Time) on Patients with Gastric Cancer

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Purpose: The purpose of the present study was to evaluate the effect of time (season, surgical starting time in the daytime, preoperative waiting time) on patients with gastric cancer.

Methods: A retrospective collection of medical records of patients who underwent gastrectomy at a single clinical center from January 2013 to December 2018 was performed. Medical records were collected, and short-term outcomes and long-term survival were analyzed by different time groups.

Results: A total of 586 patients were included in this study. In terms of surgical starting time, the midday group had a shorter operation time (p=0.017) but more complications (p=0.048) than the non-midday group. No significant difference was found based on the season of gastrectomy. The long preoperative waiting group had a shorter postoperative hospital stay than the short waiting group (p=0.026). No significant difference was found between the short-waiting group and long-waiting group in overall survival for all clinical stages. Age (p=0.040, HR=1.017, 95% CI=1.001–1.033), BMI (p<0.001, HR=0.879, 95% CI=0.844–0.953) and clinical stage (p<0.001, HR=2.053, 95% CI=1.619–2.603) were independent prognostic factors predicting overall survival; however, season of gastrectomy, surgical starting time and preoperative waiting time were not identified as independent prognostic factors.

Conclusion: Surgical starting time at the midday could cause more complications, and surgeons should be careful when the surgical starting time is midday.

Keywords: gastric cancer, season, waiting time, surgical starting time

Introduction

Gastric cancer is generally acknowledged as one of the most common malignant tumors in the world, with approximately 1 million new cases diagnosed every year.[1,2] Radical gastrectomy is still a recommended method for curable gastric cancer.[3] There are a multiple number of factors that can affect short-term and long-term outcomes, including BMI, age, pathological tumor stage, and histologically differentiated types.[4–6]

The workload of surgeons and anesthesiologists can increase the adverse events of surgeries.[7] Patients who are anesthetized at different times of the day may experience different clinical outcomes.[8] Long working hours of work can cause loss of concentration, lack of sleep and fatigue.[7,9] There is a clear correlation between the start time of surgery and adverse events, with the highest adverse events in the afternoon.[8] Prior studies reported that the surgery starting time affected the prognosis of patients in general surgery, heart surgery, gynecologic surgery, orthopedic surgery and neurosurgery.[10–12]

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The preoperative waiting time before surgery might also affect the short-term and long-term outcomes. However, as previously described, a waiting time beyond more than 90 days before surgery would not affect overall survival in patients with clinical stages I, II and III.[13–15] Previous studies have proven that the birth season may affect the incidence of tumors, and furthermore, tumors diagnosed in winter may affect the prognosis as well.[16,17] However, one study reported that the diagnosis season did not affect the prognosis of gastric cancer.[18]

The effect of preoperative waiting time, surgical staring time in the daytime and season of gastrectomy remain unclear because of limited research. Therefore, the purpose of the present study was to explore the effect of time (season, surgical starting time, preoperative waiting time) on patients with gastric cancer.

Patients and Methods

Patients

A retrospective collection of medical records of patients who underwent gastrectomy at a single clinical center from January 2013 to December 2018 was performed. This study was approved by the ethics committee (2020–649), and all patients signed informed consent forms. The inclusion criteria were as follows: 1. Patients were diagnosed with gastric cancer by pathology biopsy; and 2. Patients underwent gastrectomy for clinical stage I/II/III disease. The exclusion criteria were as follows: 1. Incomplete

medical records; 2. Neoadjuvant chemotherapy before gastrectomy; 3. Combination with other cancers; and 4. Gastrectomy started at night or evening. A total of 751 patients met the inclusion criteria of 803 patients in the database. Of these, 165 patients were excluded. Finally, a total of 586 patients were included in the study (Figure 1).

Definition

The season of gastrectomy was defined according to the location of the clinical center: spring was from March to May, summer was from June to August, autumn was from September to November and winter was from December to February. The preoperative waiting time was defined as the time from pathological diagnosis of gastric cancer to gastrectomy. The surgical starting time was divided into two groups: the midday group (12 to 14 o'clock) and the non-midday group (8 to 12, 14–18 o'clock). Complications were evaluated by Clavien-Dindo classification, and the grades I–V were included in this study.[19] TNM stage was based on the UICC tumor lymph node metastasis classification system definition. Overall survival was defined as the time from gastrectomy to death or the end of the study if the patient was still alive.

Data Collection

The baseline information was retrospectively collected, including sex, age, BMI, season of gastrectomy, comorbidity, preoperative waiting time, surgical starting time and
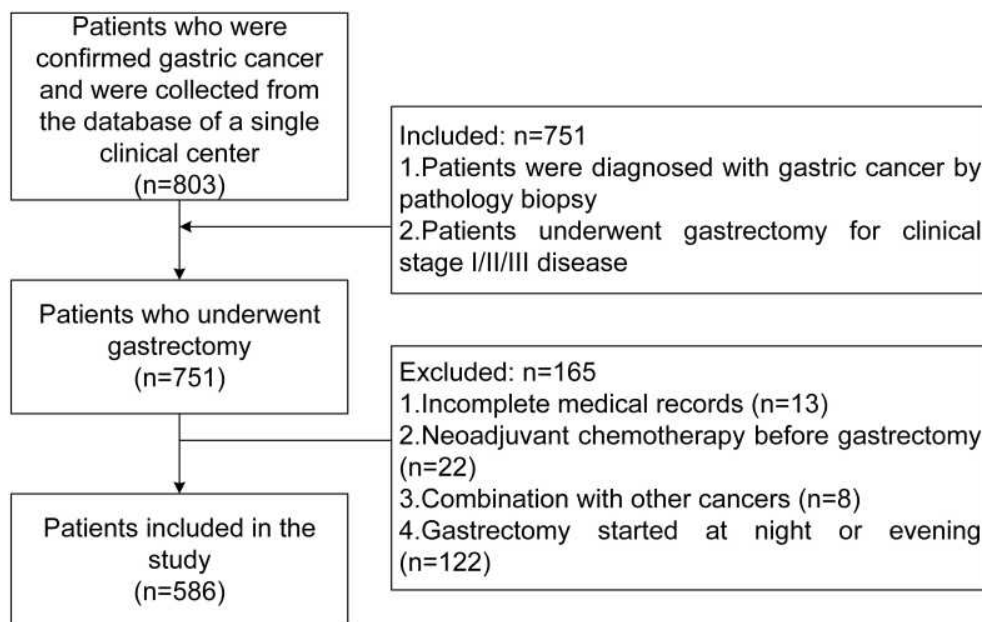

Figure 1 Inclusion and exclusion criteria of patients with gastric cancer.

preoperative clinical stage. The operation information included surgical procedure, reconstruction method, operation time, estimated blood loss and number of retrieved lymph nodes. The postoperative information included postoperative hospital stay, pathological stage and overall survival time.

Statistical Analysis

The median and range or the mean and standard deviation were used for continuous variables. The preoperative waiting time was divided into a long-waiting group and a short-waiting group according to the median. The surgical starting time was divided into a midday group and a non-midday group. The Mann–Whitney-U test and chi-square test were used to compare the differences between the two groups. The season of gastrectomy was divided into four groups: spring, summer, autumn and winter. The Kruskal–Wallis test and chi-square test were used to compare the differences across the four groups. The Log-rank test and Cox-proportional hazards model were used to analyze overall survival. Data were analyzed using SPSS (version 20.0) statistical software. A bilateral p value of <0.05 was considered statistically significant.

Results
Clinical Characteristics of the Patients

A total of 586 patients were included in this study, and all the patients underwent gastrectomy by two experienced surgeons on the same team in this study. Sex, age, BMI, season of gastrectomy, comorbidity, preoperative waiting time, surgical starting time, preoperative clinical stage, surgical procedure, reconstruction method, operation time, estimated blood loss, number of retrieved lymph nodes, postoperative hospital stay, complications and the pathological stage are shown in Table 1.

Outcomes Associated with the Surgical Starting Time

The surgical starting time was divided into a midday group and a non-midday group according to the median. The operation time, estimated blood loss, number of retrieved lymph nodes, complications and postoperative hospital stay were compared between the two groups. The midday group had a shorter operation time (p=0.017) but more complications (p=0.048) (Table 2).

Table 1 Clinical Characteristics of the Patients

Characteristics	No. 586
Sex Male/Female	418 (71.3%)/168 (28.7%)
Age, year (mean, SD)	60.7 (± 10.7)
BMI, kg/m^2 (mean, SD)	23.2 (± 27.9)
Season of gastrectomy Spring/Summer/Autumn/Winter	158 (27.0%)/157 (26.8%)/150 (25.6%)/121 (20.6%)
Comorbidity	216 (36.9%)
Preoperative waiting time, day (median, range)	10 (1–97)
Surgical starting time Midday/Non-midday	132 (22.5%)/454 (77.5%)
Clinical stage I/II/III	148 (25.3%)/196 (33.4%)/242 (41.3%)
Surgical procedure Distal gastrectomy/Total gastrectomy	409 (69.8%)/177 (30.2%)
Reconstruction methods B-I/B-II/R-Y	279 (47.6%)/116 (19.8%)/191 (32.6%)
Retrieved lymph nodes (median, range)	21 (3–70)
Operation time, minutes (median, range)	210.0 (70.0–895.0)
Estimated blood loss, mL (median, range)	100.0 (5.0–7000.0)
Postoperative hospital stay, day (median, range)	11 (3–159)
Pathological stage I/II/III/IV	137 (23.4%)/97 (16.6%)/345 (58.9%)/7 (1.1%)

Note: Variables are expressed as the mean ± SD, median or n (%).
Abbreviations: BMI, body mass index; B-I, Billroth I reconstruction; B-II, Billroth II reconstruction; R-Y, Roux-en-Y reconstruction.

Outcomes Associated with Different Seasons

According to the season of gastrectomy, we divided the seasons into four groups: spring, summer, autumn and winter. There was no difference in terms of operation time, estimated blood loss, number of retrieved lymph nodes, complications or postoperative hospital stay (p>0.05) (Table 3).

Outcomes of the Short and Long Preoperative Waiting Time Group

The preoperative waiting time was divided into a short-waiting group and a long-waiting group according to the

Table 2 Outcomes of Midday and Non-Midday Groups

Variable	Midday Group (132)	Non-Midday Group (454)	P value
Retrieved lymph nodes (median, range)	21 (7–47)	20 (3–70)	0.132
Operation time, minutes (median, range)	202.5 (70.0–478.0)	215.0 (90.0–895.0)	0.017*
Estimated blood loss, mL (median, range)	100.0 (20.0–1000.0)	100.0 (5.0–7000.0)	0.826
Postoperative hospital stay, day (median, range)	11 (5–66)	11 (3–159)	0.424
Complications	47	120	0.048*

Note: Variables are expressed as the median, *P-value <0.05.

Table 3 Outcomes of Different Season

Variable	Spring (158)	Summer (150)	Autumn (157)	Winter (121)	P value
Retrieved lymph nodes (median, range)	20 (5–54)	21 (6–49)	21 (3–51)	19 (3–70)	0.765
Operation time, minutes (median, range)	205.0 (90.0–422.0)	217.5 (95.0–599.0)	210.0 (70.0–895.0)	225.0 (95.0–385.0)	0.385
Estimated blood loss, mL (median, range)	100 (5–2000)	100 (20–7000)	100 (10–4000)	100 (10–2500)	0.605
Postoperative hospital stay, day (median, range)	10 (3–114)	11 (4–66)	11 (5–62)	11 (5–159)	0.334
Complications	41	47	48	31	0.406

Note: Variables are expressed as the median.

median. There was no significant difference in operation time, estimated blood loss, number of retrieved lymph nodes or complications (p>0.05). A significant difference was found in the postoperative stay, and the long-waiting group had a shorter postoperative stay than the short-waiting group (p=0.026) (Table 4).

Overall Survival

The median follow-up time was 28.5 (1–98) months. There was no significant difference between the short-waiting group and long-waiting group in terms of all-stage overall survival (p=0.680), clinical stage I overall survival (p=0.542), clinical stage II overall survival (p=0.269) or clinical stage III overall survival (p=0.815). Multivariate analyses for the identification of independent prognostic factors for overall survival in all clinical stage gastric cancer were performed. Age (p=0.040, HR=1.017, 95% CI=1.001–1.033), BMI (p<0.001, HR=0.879, 95% CI=0.844–0.953) and clinical stage (p<0.001, HR=2.053, 95% CI=1.619–2.603) were independent prognostic factors for predicting overall survival;

however, season of gastrectomy, surgical starting time and preoperative waiting time were not identified as an independent prognostic factors (Figure 2) (Table 5).

Discussion

A total of 586 patients were included in this study. Baseline information was collected, and short-term and long-term outcomes were compared between different time groups. The midday group had a shorter operation time but more complications, and no significant difference was found among the different season groups and preoperative waiting time groups. Furthermore, season of gastrectomy, surgical starting time and preoperative waiting time were not identified as independent prognostic factors.

The starting time of the surgery might affect the concentration of the anesthesiologist and surgeons.[8] Previous studies have compared morning and afternoon surgical starting times, but it remains controversial whether morning surgical starting times have advantages over afternoon surgical starting times.[10–12] Similarly, surgery during the

Table 4 Outcomes of Short and Long Preoperative Waiting Time Groups

Variable	Short-Waiting Group (323)	Long-Waiting Group (263)	P value
Retrieved lymph nodes (median, range)	20 (5–49)	21 (3–70)	0.273
Operation time, minutes (median, range)	210.0 (70.0–895.0)	215.0 (90.0–422.0)	0.594
Estimated blood loss, mL (median, range)	100.0 (10.0–4000.0)	100.0 (5.0–7000.0)	0.114
Postoperative hospital stay, day (median, range)	11 (3–114)	10 (4–159)	0.026*
Complications	102	65	0.080

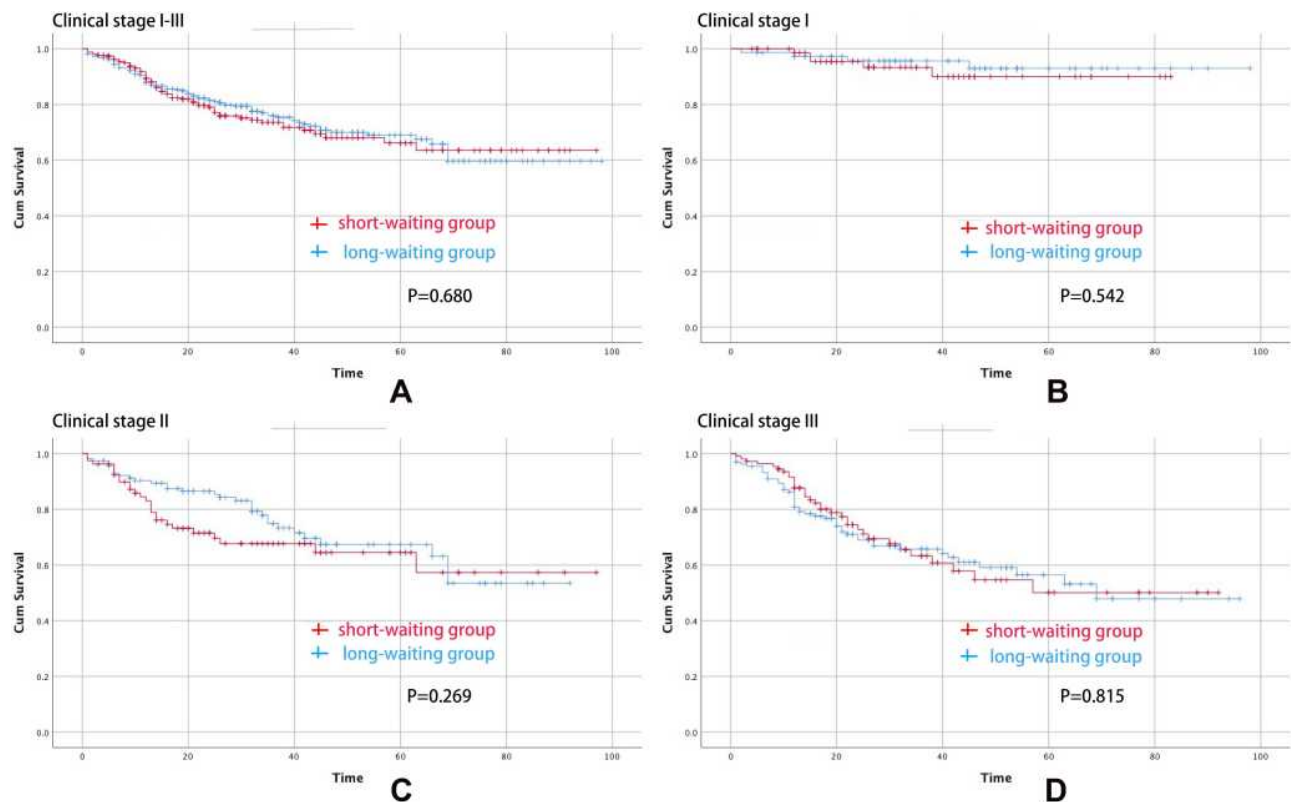**Note:** Variables are expressed as the median, *P-value <0.05.

Figure 2 Overall survival curves for patients undergoing gastrectomy. (**A**) Overall survival curves for the waiting groups among all patients. (**B**) Overall survival curves for the waiting groups among clinical stage I patients. (**C**) Overall survival curves for the waiting groups among clinical stage II patients. (**D**) Overall survival curves for the waiting groups among clinical stage III patients.
Note: The red line is the short-waiting group, and the blue line is the long-waiting group.

daytime had fewer complications than at nighttime.[20,21] Workload and fatigue may be major contributors to these outcomes. China is a populous country and has the largest number of gastric cancer patients worldwide. The workload of surgeons is heavy, especially in large hospitals and can result in fatigue in surgeons.[7,9] In this study, we

Table 5 Multivariate Analyses for the Identification of Independent Prognostic Factors for Overall Survival in All Clinical Stage Gastric Cancer

Variables	Multivariate Analyses		
	HR	**95%CI**	**p**
Sex (male/female)	1.003	0.690–1.459	0.987
Age (year)	1.017	1.001–1.033	0.040*
BMI (kg/m^2)	0.879	0.844–0.953	<0.001**
Surgical starting time	1.355	0.888–2.069	0.159
Season of gastrectomy	0.969	0.835–1.126	0.684
Comorbidity	1.049	0.741–1.484	0.788
Preoperative waiting time (day)	1.004	0.990–1.019	0.570
Clinical stage (I/II/III)	2.053	1.619–2.603	<0.001**

Notes: *P-value <0.05, **P-value <0.01.
Abbreviations: BMI, body mass index; HR, hazard ratio; CI, confidence interval.

compared the midday group and the non-midday group, and we found that the midday group had shorter operation time but more complications. In addition to workload and fatigue, the post-lunch sleepiness might account for the outcomes. Napping is common in southern China, and post-lunch sleepiness occurs whether lunch is consumed or not.[22,23] There may be reasons why the midday surgical starting group might have more complications, and the careless surgical procedures might cause less surgical time.

Patients experienced a period of waiting time from diagnosis to gastrectomy. Limited hospital capacity, family members' consideration of whether to undergo surgery and preoperative comorbidity of patients can prolong the preoperative waiting time. However, the patient's psychological condition is anxious when waiting for gastrectomy. Patients worried about the tumor progression in the case of a long preoperative waiting time, especially during the coronavirus disease 2019 (COVID-19) pandemic, when the preoperative waiting time was prolonged.[24] In this study, we found that the long-waiting group had a shorter postoperative hospital stay than the short-waiting group,

however, a significant difference was not found in terms of complications and long-term survival. The cause of the shorter postoperative hospital stays of the long-waiting group remained unclear, and adequate preoperative preparation might shorten the postoperative hospital stay. Previous studies reported than a half-year wait time for surgery was not independently associated with the survival of patients with clinical stage I gastric cancer,[13] and a preoperative wait time up to 90 days did not affect survival in patients with clinical stage II/III gastric cancer.[14] The results in this study were consistent with previous studies. However, delayed gastrectomy is not recommended because of the preoperative waiting time-related psychological distress and displeasure.[25,26]

The season correlates with the temperature and sunlight.[27] Studies on the relationship between seasons and tumors have mainly focused on the birth season and the incidence of tumors.[16] Previous studies reported that persons born in spring have a higher risk of skin cancer than those born in summer,[28] and for persons born in winter, the risk of lung cancer and squamous cell carcinoma was lower than those born in other seasons.[17] However, there have been few reports on the impact of surgery season on patients with tumors. We hypothesized that different seasons might affect the wound healing and short-term complications. However, there was no significant difference in short-term postoperative complications between different surgical seasons in this study, which was also consistent with a previous related study.[18] Therefore, our results suggested no association between the season of gastrectomy and short-term outcomes, and furthermore, season was not a risk factor for postoperative complications.

Some limitations existed in this study as well. First, this was a retrospective single-center study with 586 patients, and the number of data samples was limited. Second, the median preoperative waiting time was 10 days, which was relatively shorter than that in previous studies. Third, patients with neoadjuvant chemotherapy before gastrectomy were excluded from this study because of the prolonged preoperative waiting time. Finally, for the purpose of comparing surgical starting time in the midday group with that in the non-midday group in the daytime, we excluded gastrectomy started at night and evening; however, this might introduce some selection bias.

Conclusion

Surgical starting time at the midday could cause more complications, and a longer preoperative waiting time

could shorten the postoperative hospital stay; therefore, surgeons should be careful when surgical starting time at the midday.

Disclosure

The authors declare no conflicts of interest.

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