

# Surgery for Gastric Cancer Combined With Cardiac and Aortic Surgery

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**Hypothesis:** Therapeutic strategies for patients who require procedures for both cardiac or aortic diseases and gastric cancer are controversial. Prognostic factors for them should be clearly identified.

**Design:** Retrospective review of 14 patients who underwent surgical intervention for both gastric cancer and cardiac or aortic diseases between January 1, 2000, and June 30, 2004.

**Setting:** Tertiary referral university hospital.

**Patients:** Cardiac and aortic diseases included coronary artery disease in 5 patients, thoracic aortic aneurysms in 3 patients, and abdominal aortic aneurysms in 6 patients. Coronary artery bypass graftings were performed with an off-pump procedure, and aneurysms were replaced with prosthetic grafts in all of the cases. The surgical stages of gastric cancers were stage I in 8 patients, stage II in 2 patients, stage III in 3 patients, and stage IV in 1 patient. According to our original therapeutic strat-

egies, 4 patients underwent simultaneous procedures and 10 received staged procedures.

**Main Outcome Measure:** Overall survival rates.

**Results:** There was 1 hospital death caused by multiple organ failure. No prosthetic graft infection was noted. Thirteen patients were discharged, and 3 died of cancer recurrence during an average follow-up period of 26.3 months. The cumulative survival rate was 76.6% at 1 year and 68.1% at 3 years. One-year survival rates were 90.0% in stages I and II gastric cancer and 50.0% in stages III and IV gastric cancer.

**Conclusion:** Prognosis of patients who underwent surgical intervention for both gastric cancer and cardiac or aortic diseases was mainly limited by the clinical stage of gastric cancer.

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**T**HE OPERATIVE MORTALITY and morbidity associated with elective cardiovascular procedures have decreased recently; however, a therapeutic dilemma remains in patients with concomitant occurrence of intra-abdominal malignancies.<sup>1-10</sup> Therapeutic priority should be judged with precise assessment of the severity and urgency of both gastric cancer and cardiac or aortic disorders, and simultaneous or staged procedures must then be selected. The use of simultaneous procedures for both disorders has several advantages. It eliminates various complications related to performing 2 procedures that both require total anesthesia, and it prevents disease progression of the untreated lesion. Furthermore, the anxiety of patients who are facing 2 life-threatening lesions is resolved at 1 time. On the contrary, the occurrence of infec-

tious complications, such as prosthetic graft infection or mediastinitis, remains a major disadvantage of simultaneous procedures.

In this study, details of the procedures and prognoses of patients who required procedures for cardiac or aortic diseases and gastric cancer were retrospectively investigated. The reasons for including gastric cancer in this study are that this is one of the most common intra-abdominal malignancies in Japan, its operative maneuver has been standardized, and the prognosis of this malignancy has been clarified.<sup>11,12</sup>

## METHODS

### PATIENT CHARACTERISTICS

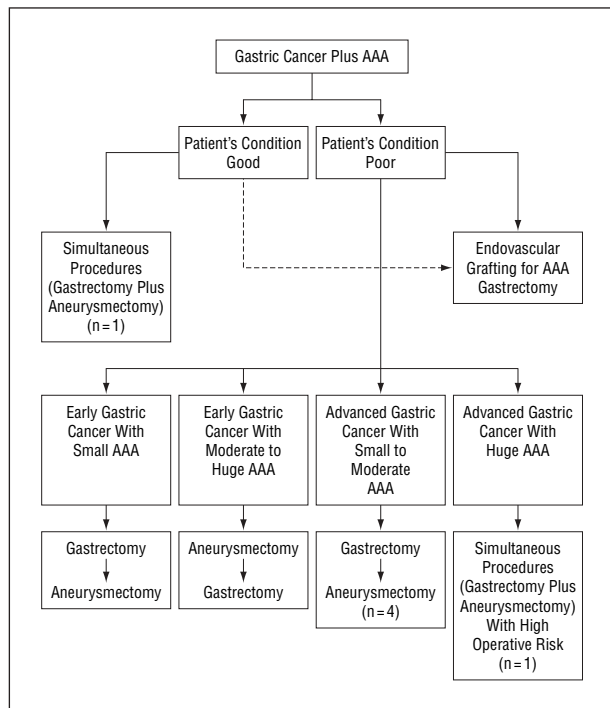
Between January 1, 2000, and June 30, 2004, 906 patients with various cardiac or thoracic aortic disorders and 228 patients with abdomi-

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**Table 1. Preoperative Characteristics of Patients With Cardiovascular Diseases and Gastric Cancer**

Patient/Sex/Age, y	Cardiovascular Disease*	Clinical Stage of Gastric Cancer	ASA Physical Status Classification	Preoperative Comorbidity				
				CAD	PCI	CHF	CRF	CI
<b>Simultaneous Procedures (n = 4)</b>								
1/M/66	CAD	IA	III	+				
2/F/72	CAD	IV	III	+	+			
3/M/70	AAA (52 mm)	IA	III					+
4/M/68	AAA (80 mm)	II	III	+		+		+
<b>Staged Procedures (n = 10)</b>								
5/F/77	CAD	IA	III	+				
6/M/72	CAD	IA	III	+				
7/M/73	CAD	IA	III	+				
8/M/85	TAA (60 mm)+CAD	IB	III	+			+	
9/M/69	TAA (64 mm)	IA	III					
10/M/67	TAA (70 mm)	IIIA	III				+	
11/M/68	AAA (50 mm)	IA	III				+	+
12/M/74	AAA (50 mm)	IIIA	III	+	+			
13/M/77	AAA (50 mm)	IIIA	III				+	
14/M/78	AAA (45 mm)	IIIA	III	+		+		

Abbreviations: AAA, abdominal aortic aneurysm; ASA, American Society of Anesthesiologists; CAD, coronary artery disease; CHF, chronic heart failure; CI, cerebral infarction; CRF, chronic renal failure; HD, hemodialysis; PCI, percutaneous coronary intervention; TAA, thoracic aortic aneurysm. \*Values in parentheses indicate length of aneurysm.



**Figure 1.** Surgical strategy for patients with gastric cancer and infrarenal abdominal aortic aneurysm (AAA) concomitantly.

nal aortic aneurysms (AAAs) underwent procedures at our institute. Among them, 14 patients (1.2%) had also gastric cancer (Table 1). Of these 14 patients, there were 12 men and 2 women, with an average age of 72.6 years. Five of the 14 patients had coronary artery diseases requiring coronary artery bypass grafting (CABG): 3-vessel disease in 2 patients, 2-vessel disease in 2 patients, and left main trunk disease in 1 patient. All of them had angina, and CABGs were scheduled electively. Three of the 14 patients had thoracic aortic aneurysms (TAAs), with an average diameter of 64.7 mm, that were lo-

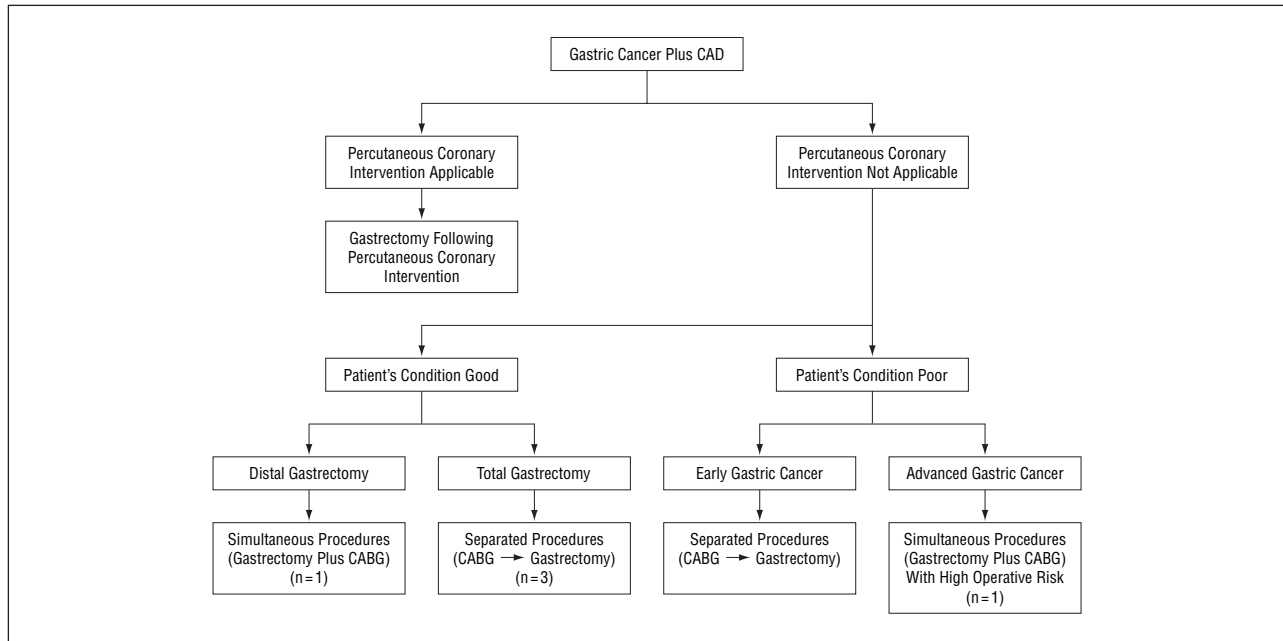
cated in the aortic arch. Six of the 14 patients had infrarenal AAAs, with an average diameter of 55.3 mm. All of these aneurysms were asymptomatic, and aortic replacement was scheduled electively.

All of the 14 patients were preoperatively examined by gastrofiberscopy, and pathological diagnosis of gastric cancer was obtained from biopsy specimens. Four patients were asymptomatic, with gastric cancer detected by routine gastrofiberscopic examination. Ten patients had various symptoms of gastric cancer, including epigastralgia, appetite loss, vomiting, weight loss, hematoemesis, tarry stool, and anemia. Patients who had liver metastasis, carcinomatous peritonitis, pulmonary metastasis, or brain metastasis detected by computed tomography were excluded from this study.

Preoperative comorbidities affecting surgical strategies were chronic renal failure (serum creatinine levels >3.0 mg/dL) in 4 patients, hemiplegia by recent cerebral infarction in 3 patients, percutaneous coronary intervention within 6 months in 2 patients, and chronic heart failure following myocardial infarction in 2 patients.

## SURGICAL STRATEGIES

Our surgical strategy for gastric cancer with co-occurring infrarenal AAA is demonstrated in Figure 1. When a patient does not have serious preoperative comorbidities, gastrectomy and aneurysmectomy are performed simultaneously. In such cases, the abdominal aorta is first reconstructed through median laparotomy, and then gastrectomy with lymph node dissection is performed after closure of the retroperitoneum. When a patient has serious comorbidities, staged procedures are selected, and therapeutic priority is decided by the severity of both lesions. In the case of staged procedures, it is preferable that gastrectomy is performed through median laparotomy and that the AAA is replaced through a retroperitoneal approach. When a patient with serious comorbidities has advanced gastric cancer and huge AAA concomitantly, simultaneous procedures should be selected with increased risk of postoperative complications. Another optional treatment for AAA is endovascular grafting. In fact, 20 cases of endovascular grafting for AAA



**Figure 2.** Surgical strategy for patients with gastric cancer and coronary artery disease (CAD) concomitantly. CABG indicates coronary artery bypass grafting.

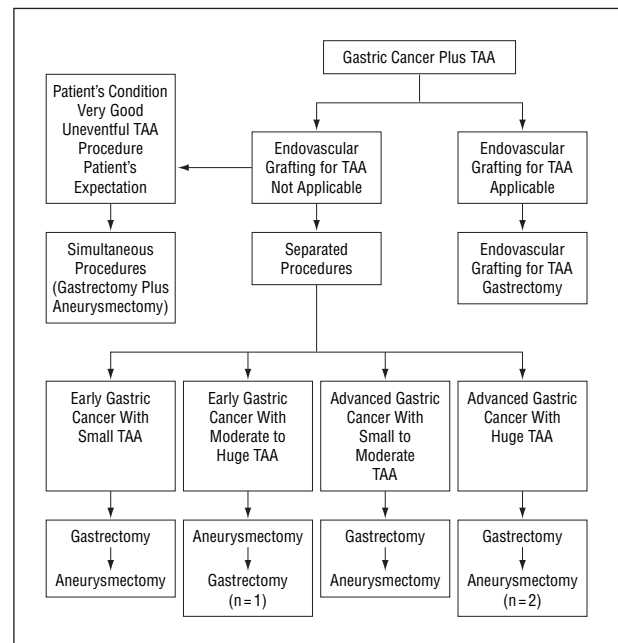
were performed at our institution during the same period. However, our first choice of treatment for AAA is aneurysmectomy with prosthetic graft replacement. Endovascular grafting is applied only for very high-risk patients who cannot tolerate laparotomy or for patients who have a localized aneurysm with a sufficient aneurysmal neck for the landing of the endovascular graft.

The strategy for gastric cancer with co-occurring coronary artery disease is demonstrated in **Figure 2**. When a patient does not have a serious comorbidity, distal gastrectomy and CABG can be done simultaneously. In such cases, off-pump CABG is performed first, and then gastrectomy with lymphatic dissection is done after closure of the median sternotomy. When a patient has serious comorbidities or needs total gastrectomy, staged procedures are recommended, and CABG has priority over gastrectomy. Simultaneously performing CABG and total gastrectomy is avoided to decrease the risk of mediastinitis. When a patient with serious comorbidities has symptomatic, advanced gastric cancer and coronary artery disease, simultaneous procedures should be selected with increased risk of postoperative complications.

Our strategy for the treatment of gastric cancer with co-occurring TAA is demonstrated in **Figure 3**. Staged procedures are generally recommended, and therapeutic priority is decided by the severity of both disorders. Another optional treatment for TAA is endovascular grafting, and 37 cases were treated at our institution during the same period. Endovascular grafting for TAA is considered to be particularly useful for patients with severe preoperative comorbidities; however, indications of this minimally invasive treatment are generally limited to patients who have a TAA in the descending thoracic aorta.

## RESULTS

According to our surgical strategies, 4 of the 14 patients underwent simultaneous procedures, and the other 10 patients received staged procedures. The 5 CABGs were performed by off-pump procedures, the 3 TAAs were treated with total arch replacement through median



**Figure 3.** Surgical strategy for patients with gastric cancer and thoracic aortic aneurysm (TAA) concomitantly.

sternotomy, and the AAAs were replaced by prosthetic graft through median laparotomy in 3 patients and through the retroperitoneal approach in 3 patients. Based on the location and extension of gastric cancer, 8 of the patients received resections by distal gastrectomy, and 6 patients required total gastrectomy. The surgical stage of gastric cancers expressed by the Japanese Gastric Cancer Association classifications were stage IA (T1N0M0) in 7 patients, stage IB (T2N0M0) in 1 patient, stage II (T2N1M0) in 2 patients, stage IIIA (T3N1M0 or T2N2M0) in 3 patients, and stage IV (T4N2M0) in 1 patient.<sup>13</sup>

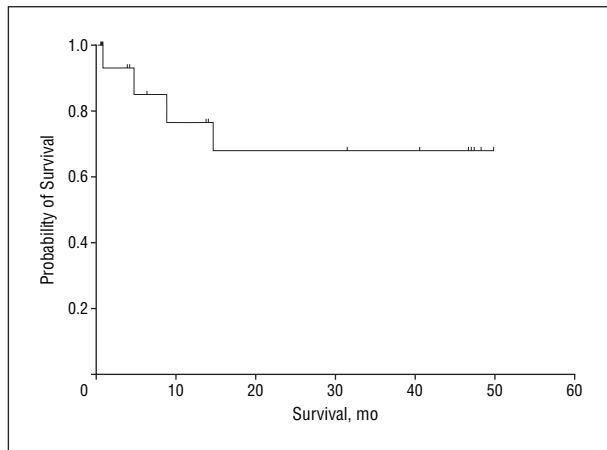
**Table 2. Postoperative Complications**

Postoperative Complication	Patients, No.
Simultaneous procedures (n = 4)	
Anastomotic insufficiency of the colon	1*
Cerebral infarction	1*
Wound infection	1*
Staged procedures (n = 10)	
MOF, bleeding from gastric cancer	1†
Mediastinitis	1
Spinal cord infarction	1

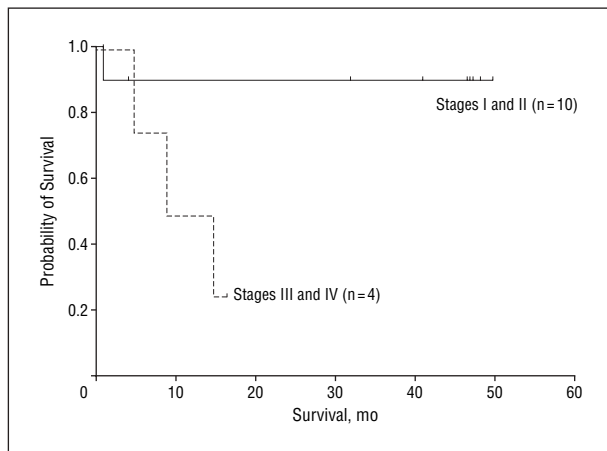
Abbreviation: MOF, multiple organ failure.

\*Postoperative complications occurred in the same patient.

†Hospital death.



**Figure 4.** Cumulative survival rate for all of the patients who received a cardiovascular procedure and gastrectomy.



**Figure 5.** Cumulative survival rates for patients with stages I and II gastric cancer were superior to those for patients with stages III and IV gastric cancer. No significant differences existed between the 2 groups (log-rank test,  $P = .39$ ).

In cases of staged procedures, cardiovascular procedures preceded in 4 patients and gastrectomy preceded in 6 patients. The shortest interval was 21 days between off-pump CABG and total gastrectomy, and the longest interval was 425 days between total gastrectomy for ad-

vanced gastric cancer and aneurysmectomy for small-sized AAA. Nine (90%) of the 10 preceding procedures were uneventfully performed, and the second procedures were performed on schedule except in the case of an 85-year-old man who had a TAA of 60 mm, coronary artery disease, early gastric cancer, chronic obstructive pulmonary disease, and chronic renal failure. He first underwent total arch replacement and CABG concomitantly. His postoperative hemodynamic state had been stable; however, he suffered disseminating intravascular coagulopathy subsequent to pneumonitis and had massive bleeding from gastric cancer. Partial resection of the stomach, including early gastric cancer, was performed. He died of multiple organ failure 2 weeks after receiving his second surgical procedure.

The total operative time was 421 minutes in the group that received simultaneous procedures, and 572 minutes in the group that received staged procedures. The total amount of intraoperative bleeding was 393 g in the group that received simultaneous procedures, and 1009 g in the group that received staged procedures. There was 1 hospital death as described earlier, and there were several postoperative complications (**Table 2**). A 72-year-old woman who had chest pain after percutaneous coronary intervention and advanced gastric cancer with pyloric stenosis underwent off-pump CABG, distal gastrectomy, and transverse colectomy for direct cancer invasion simultaneously. On the seventh postoperative day, stroke and anastomotic insufficiency of the colon occurred. She also had mediastinitis; however, she returned home after colostomy and wound debridement. In the group that received staged procedures, 1 patient suffered mediastinitis following off-pump CABG, and 1 patient had spinal cord infarction following replacement of the abdominal aorta; both patients healed conservatively. No prosthetic graft infection was noted.

Thirteen of the 14 patients were discharged, and 3 of them died during the follow-up period, which was 26.3 months on average. All of the 3 late deaths were caused by cancer recurrence. The cumulative survival rates were 76.6% at 1 year and 68.1% at 3 years (**Figure 4**). One-year survival rates were 90.0% in stages I and II gastric cancer and 50.0% in stages III and IV gastric cancer (**Figure 5**). Statistically significant correlation could not be found between surgical staging of gastric cancer treatment and survival (log-rank test,  $P = .39$ ).

## COMMENT

Gastric cancer is one of the most common intra-abdominal malignancies in Japan. Its operative maneuver has been standardized, and the operative mortality and morbidity rates of gastrectomy have been low.<sup>11,12</sup> Elective surgical procedures for AAA have also become progressively safer, and some studies have shown operative mortality rates of 1% to 2% in low-risk patients.<sup>14</sup> Owing to these reasons, simultaneous resections of AAA and gastric cancer have been attempted, and excellent surgical outcome has been described, mainly in Ja-

pan.<sup>2-6</sup> The use of simultaneous procedures for both lesions has several advantages. Both lesions can be resected under the same incision of median laparotomy. Risks accompanying total anesthesia, such as pneumonia or drug-induced complications, can be eliminated. Disease progression of the unresected lesion can be prevented. Surgeons have to keep in mind that there is a potential for aneurysm rupture if AAA resection is delayed by staged procedures.<sup>10</sup> Furthermore, the anxiety of patients who are facing 2 life-threatening lesions is resolved at 1 time. The major disadvantage of simultaneous resection is the risk of prosthetic graft infection; however, there have been no descriptions of graft infection following concomitant aneurysmal resection and gastrectomy.<sup>1-9</sup> Nevertheless, only 2 of 6 patients underwent simultaneous resection of both lesions in this series. All of the 4 patients who underwent staged procedures were in an aged population and had various serious comorbidities, such as end-stage renal failure, recent history of percutaneous coronary intervention, and old myocardial infarction. Three of them had symptomatic gastric cancer in the advanced stage, and all of them underwent gastrectomy first. At least 2 to 3 weeks' duration between 2 procedures is required. Another optional treatment for AAA is endovascular grafting, and this minimally invasive treatment is considered to be particularly useful for patients with various complications.<sup>15</sup> However, long-term results of endovascular grafting for AAA have not yet been satisfactory because of some incidents of endoleak.<sup>16,17</sup> Conventional prosthetic graft replacement of the abdominal aorta still remains a reliable and standard therapy. Thus, our first-choice treatment for AAA is aneurysmectomy with prosthetic graft replacement. Endovascular grafting is applied only for very high-risk patients who cannot tolerate laparotomy, or for patients who have a localized aneurysm with a sufficient aneurysmal neck for the landing of the endovascular graft.

When a patient has co-occurring gastric cancer and coronary artery disease requiring surgical revascularization, CABG is generally given therapeutic priority. Simultaneously performing CABG and distal gastrectomy might be possible when the patients do not have serious comorbidities.<sup>18</sup> In such cases, off-pump CABG is preferable to exclude the adverse effects of cardiopulmonary bypass.<sup>19,20</sup> By avoiding cardiopulmonary bypass, blood coagulation and immunological function can be kept normal, and the risk of cancer cell dissemination might be avoided. However, staged procedures are recommended when a patient has severe comorbidities or requires total gastrectomy. Simultaneously performing CABG and total gastrectomy should be avoided in consideration with the potential risk of mediastinitis. With staged procedures, gastrectomy should be performed after stabilization of the cardiovascular system. In this series, 2 patients underwent simultaneous procedures using off-pump CABG, and 3 patients underwent total gastrectomy 3 to 6 weeks after receiving CABG.

When a patient has gastric cancer and TAA concomitantly, staged procedures are generally recommended, and therapeutic priority should be decided by the ad-

vancement of both lesions. Aortic arch replacement, which requires extracorporeal circulation with profound hypothermia and circulatory arrest, or replacement of the descending thoracic aorta, which has a risk of paraplegia, are too invasive for simultaneous resection of gastric cancer. Endovascular grafting for TAA has been attempted recently, and excellent early and mid-term results have been described. This less invasive treatment seems to be especially useful for patients with complications; however, favorable indication for endovascular grafting is limited to localized aneurysms in the descending thoracic aorta. All of the 3 TAAs described in this article were located in the thoracic aortic arch, and there was no indication for endovascular grafting.

In this series, staged procedures were selected frequently because most of the patients were in the aged population and had some serious comorbidities. Although postoperative morbidity was relatively high, the overall survival rates of 92.9% at discharge, 76.6% at 1 year, and 68.1% at 3 years were considered to be satisfactory. No cardiovascular event or graft infection was recognized in the follow-up period, and all of the late deaths were caused by recurrence of gastric cancer. A significant correlation could not be found between survival rates of stages I and II gastric cancer and of stages III and IV gastric cancer in this series; however, prognoses of patients with advanced gastric cancer were undoubtedly poor compared with those of patients with early gastric cancer.

Some gastric cancers in this study had direct invasion to the neighboring organ or had multiple lymph nodes metastases, and they were in more advanced stages than they were when the preoperative diagnoses were made. However, the gastric cancers in all of the 14 patients could be resected without macroscopic cancer residue, and some patients with advanced stages were alive more than 1 year after receiving the procedures. More than anything else, all of the patients with advanced gastric cancer could return home without their preoperative symptoms. Thus, we now consider that aggressive surgical interventions for both lesions might bring a benefit to the patients whose survival periods are expected to be more than 6 months.

In conclusion, prognoses of patients who had both gastric cancer and cardiac or aortic diseases were limited by the progression of gastric cancer. Simultaneous or staged procedures must be carefully selected by considering each patient's condition and surgical strategies.

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