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Original Article

Does Hospital Volume Really Affect the Surgical and Oncological Outcomes of Gastric Cancer in Korea?

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ABSTRACT

Purpose: The significance of hospital volume remains inconsistent and controversial. In particular, few studies have examined whether hospital volume is associated with the outcome of gastrectomy for gastric cancer in East Asia. This study examined the effect of hospital volume on the short-term surgical and long-term oncological outcomes of patients undergoing curative gastrectomy for gastric cancer.
Materials and Methods: Between 2009 and 2011, 1,561 patients underwent curative gastrectomy for gastric cancer at Seoul St. Mary's Hospital (n=1,322) and Bucheon St. Mary's Hospital (n=239). We defined Seoul St. Mary's Hospital as a high-volume center and Bucheon St. Mary's Hospital as a low-volume center.
Results: The extent of resection, rate of combined resection, tumor stage, operating time, and hospital stay did not differ significantly between the 2 hospitals. In addition, the hospital volume was not significantly associated with the 30-day morbidity and mortality. When the overall and disease-free survival rates of the patients were stratified according to stage, hospital volume was not significantly associated with prognosis at any stage.
Conclusions: Hospital volume might not be a decisive factor with respect to the surgical and oncological outcomes of patients if well-trained surgeons perform gastrectomy for gastric cancer.

Keywords: Hospital size; Prognosis; Gastrectomy; Stomach neoplasms

INTRODUCTION

According to global cancer statistics, gastric cancer is the third leading cause of cancer-related death in men, and the fifth leading cause of death in women. Gastric cancer is especially prevalent in Korea [1]. Although the prevalence of gastric cancer is similar in all parts of Korea, most patients with gastric cancer are treated at several high-volume centers in Seoul [2]. Although it is generally accepted that the quality of care improves commensurate with the experience of those providing it, and that higher hospital volume is associated with less morbidity and mortality [3], the wait involved, and logistics required for surgery at large tertiary hospitals, can constitute a social problem, rather than a benefit.

Several studies have evaluated the clinical significance of hospital volume according to the type of operation. Based on a growing number of studies reporting inverse relationships

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Conflict of Interest
No potential conflict of interest relevant to this article was reported.

between hospital volume and surgical mortality in the US, attempts have been made to concentrate certain types of operations in high-volume hospitals [4-6]. However, findings regarding the significance of hospital volume remains inconsistent and controversial; few studies have examined whether hospital volume is associated with the outcome of gastrectomy for gastric cancer in East Asia, although this region has the highest prevalence of the disease worldwide [7-10].

Therefore, this study re-examined the effect of hospital volume on the short-term surgical, and long-term oncological outcomes of patients who underwent gastrectomy for gastric cancer in Korea.

MATERIALS AND METHODS

Between 2009 and 2011, 1,561 patients underwent curative gastrectomy for gastric cancer at Seoul St. Mary's Hospital (n=1,322) and Bucheon St. Mary's Hospital (n=239) of The Catholic University of Korea, College of Medicine.

Definition of hospital volume

The hospital volume with regard to procedures was determined as the mean annual number of gastrectomies performed over a 10-year period. Seoul St. Mary's Hospital, defined here as a high-volume center, is a tertiary hospital with 3 specialized upper gastrointestinal surgeons, in which approximately 500 surgeries for gastric cancer are performed annually. Bucheon St. Mary's Hospital, defined here as a low-volume center, is a secondary hospital with one specialized upper gastrointestinal surgeon who performs about 50 surgeries for gastric cancer annually. All surgeons in both hospitals are well-trained. Well-trained surgeons in our study are defined as surgeons who are qualified subspecialists in upper gastrointestinal surgery and have more than 7 years of gastrointestinal surgical experience. The treatment for gastric cancer was based on standard guidelines [11,12]. Therefore, in terms of the surgical procedure and treatment plan, there were no significant differences between the 2 hospitals.

Outcome measurements

Clinicopathological characteristics were compared between the 2 hospitals, including patient age and sex, tumor stage, extent of resection, and approach methods. The 5-year overall survival (OS) and disease-free survival (DFS), as well as the morbidity and mortality rates within 30 postoperative days, were calculated to illustrate the outcomes. The postoperative complications were subdivided into surgical and medical complications. Surgical complications included wound or anastomosis complications (bleeding, leakage, and stricture), abdominal bleeding, adhesive ileus or intestinal obstruction, and abdominal inflammation or abscess. Medical complications included lung complications (pneumonia, atelectasis, and pulmonary edema), urinary tract infection, bacteremia, neurological problems, cardiac problems, phlebitis, and hepatitis. Postoperative complications were graded according to the Clavien-Dindo classification [13]. Severe complications were those classified as grade III or above.

Statistical analysis

The 2 groups were compared using the Student's t-test for continuous variables, and the results are expressed as means±standard deviation. Categorical variables were compared using the χ^2 test. Kaplan-Meier curves were used to examine the OS and DFS in each group,

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and differences in survival rates between the groups were compared using the log-rank test. Significance was defined as $P<0.05$. All statistical analyses were performed using the SPSS software for Windows (ver. 18.0; SPSS Inc., Chicago, IL, USA).

RESULTS

Clinicopathological characteristics

At the high- and low-volume centers, 1,322 and 239 procedures were performed, respectively. Compared with the low-volume center, younger age, female gender, less extensive lymph node dissection, a more open approach, more retrieved lymph nodes, and greater estimated blood loss were significantly associated with the high-volume center. The extent of resection, rate of combined resection, tumor stage, operating time, and hospital stay did not differ significantly between the 2 hospitals (**Table 1**).

Postoperative surgical outcomes

The morbidity rate within 30 postoperative days in the high- and low-volume centers was 8.6% (n=114) and 9.2% (n=22), respectively. The severe complication rate in the high-volume center was 2.7% (n=36), with the most common type of severe complication being anastomotic. In the low-volume center, the severe complication rate was 2.9% (n=7), with the most common type of severe complication being lung-related. The differences in the total and severe complication rates were not significant. In the high-volume center, 2 (0.2%) patients died within 30 days postoperatively: one of aspiration pneumonia and the other of

Table 1. Clinicopathological characteristics

Characteristics	High-volume center (n=1,322)	Low-volume center (n=239)	P-value
Age (yr)	58.9±11.9	62.5±11.6	0.000
Gender			0.009
Male	859 (65.0)	176 (73.6)	
Female	463 (35.0)	63 (26.4)	
Extent of resection			0.051
Distal gastrectomy	990 (74.9)	195 (81.5)	
Total gastrectomy	332 (25.1)	44 (18.5)	
Extent of lymph node dissection*			0.000
D1	67 (5.1)	3 (1.3)	
D1+	635 (48.0)	61 (25.5)	
D2 or D2+	620 (46.9)	175 (73.2)	
Approach method			0.000
Open	822 (62.2)	91 (38.1)	
Laparoscopy	484 (36.6)	148 (61.9)	
Robotic	16 (1.2)	0 (0)	
Combined resection			0.441
No	1,255 (94.9)	224 (93.7)	
Yes	67 (5.1)	15 (6.3)	
Stage*			0.236
I	836 (63.2)	156 (65.3)	
II	292 (22.1)	42 (17.6)	
III	194 (14.7)	41 (17.1)	
No. of retrieved lymph nodes	42.5±16.8 (range 10–120)	39.2±17.4 (range 11–101)	0.006
Operative time (min)	195.7±51.7	185.4±66.1	0.072
Estimated blood loss (mL)	192.8±216.1	109.6±264.7	0.000
Hospital stay (day)	9.0±8.5	9.7±5.0	0.422

Data are shown as mean±standard deviation or number (%).
AJCC = American Joint Committee on Cancer; TNM = tumor, node, metastasis.
*According to the 7th edition of the AJCC TNM classification.

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Table 2. Postoperative morbidity and mortality

Morbidity/Mortality	High-volume center	Low-volume center	P-value
Severe complications	36 (2.7)	7 (2.9)	0.858
1. Surgical			
Anastomotic complication (bleeding, leakage, stricture)	16 (IIIa, 16)	2 (IIIa, 1, IIIb, 1)	
Abdominal bleeding	4 (IIIa, 1, IIIb, 3)	1 (IIIb, 1)	
Adhesive ileus or intestinal obstruction	5 (IIIb, 5)		
Abdominal inflammation or abscess	3 (IIIa, 1, IIIb, 2)	1 (IIIb, 1)	
2. Medical			
Lung complications (pneumonia, atelectasis, pulmonary edema)	8 (IIIa, 5, IVa, 2, IVb, 1)	3 (IVa, 2, IVb, 1)	
Mortality	2 (0.15)	2 (0.84)	0.054

Data are shown as number (CDC, number) or number (%).
CDC = Clavien-Dindo classification [13].

hospital-acquired pneumonia. Similarly, in the low-volume center, 2 patients (0.8%) also died within 30 days postoperatively, of hospital-acquired pneumonia and acute respiratory distress syndrome (**Table 2**).

Postoperative oncological outcomes

When the OS and DFS rates of the patients were stratified according to tumor stage, they did not differ significantly at all stages (**Figs. 1** and **2**). In the high-volume center, the 5-year survival rates for stages I, II, and III were 98.4%, 86.5%, and 63.7%, respectively, versus 96.3%, 83.6%, and 54.5% at the low-volume center. The 5-year DFS rates were similar in both groups. None of the differences were significant (**Table 3**).

DISCUSSION

Many studies have evaluated the risk factors for morbidity and mortality, as well as the predictors of survival, in patients with gastric cancer, with the aim of improving treatment outcomes. In line with this, numerous trials have demonstrated relationships between hospital volume and patient outcomes. Most of these studies have reported results in patients with pancreatic or prostatic cancer and usually concluded that higher provider volumes were associated with better outcomes [14-19]. Although there have been several studies of gastric cancer since 2000, they are mainly based on Western data and have not been conclusive [10,20-23]. Therefore, our study is meaningful because it dealt with the relationship between hospital volume and gastric cancer in a solely Korean sample. Using data from the Korea Central Cancer Registry, Yun et al. [9] reported that, unlike our results, surgical patients in low-volume hospitals had significantly worse survival for 6 cancers, including gastric cancer. However, they did not consider stages, surgeons' ability, and short-term surgical outcomes. Thus, we cannot infer an inverse relationship between hospital volume and outcomes without bias. In addition, surgeons in the present study were trained under similar conditions, and all qualified as subspecialists in upper gastrointestinal surgery. Therefore, our results might be more reliable compared with those in a previous study.

Our results suggest an answer to the question “Is it appropriate to adopt a centralization concept that concentrates patients in several high-volume centers?” Based on the inverse relationship between hospital volume and outcomes, the National Board of Health and Welfare adopted centralization for pediatric heart surgery in Sweden, with operations restricted to 2 hospitals, and reported that this decreased hospital mortality from 9% to 1.9% [24]. In Korea, however, the overflow of patients at large tertiary hospitals, located

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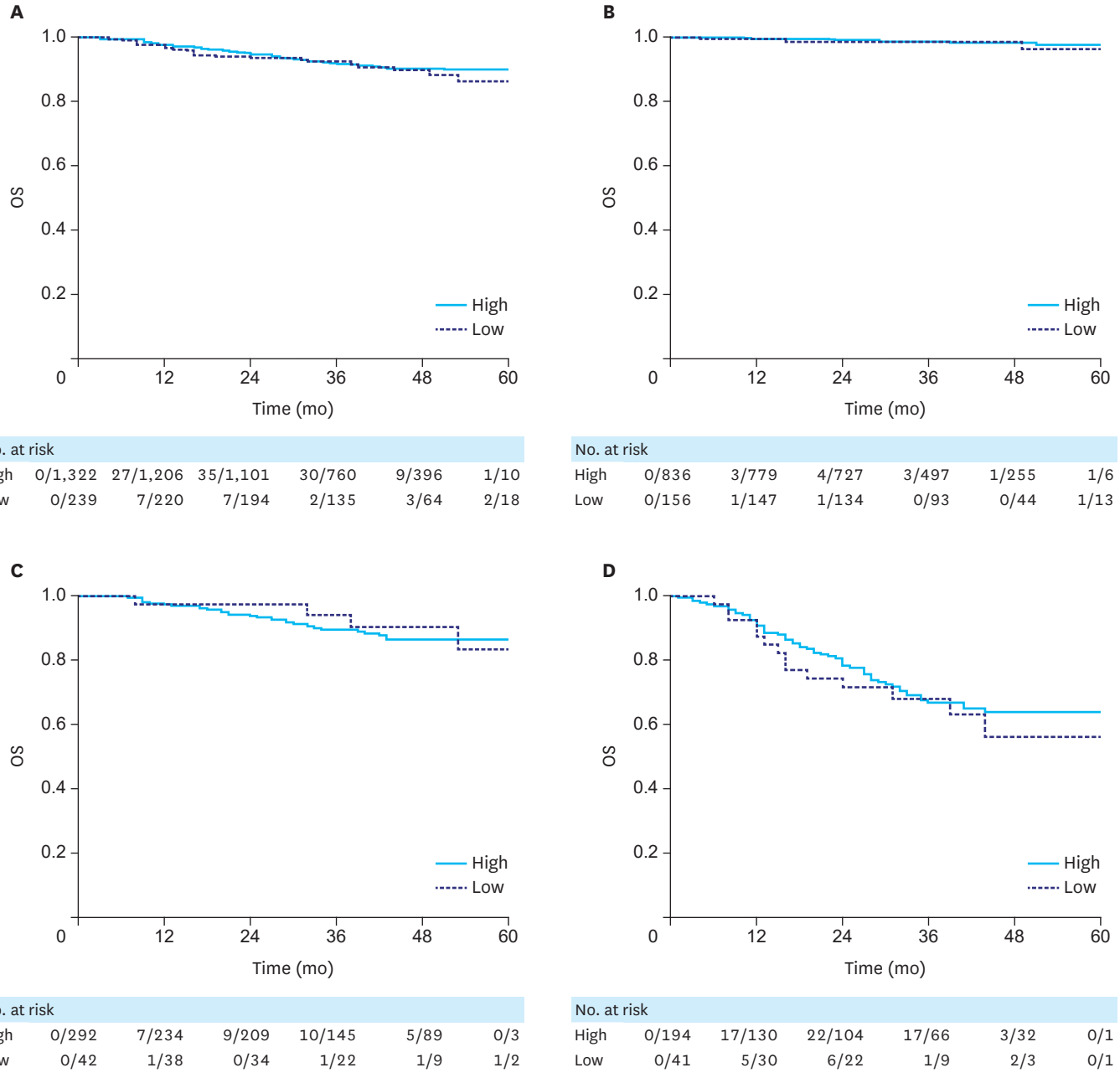

Fig. 1. OS according to tumor stage for the 2 hospital volume groups: (A) all patients (P=0.561); patients with (B) stage I (P=0.659), (C) stage II (P=0.778), and (D) stage III tumors (P=0.430).
OS = overall survival.

in the capital or another major city, would likely cause social problems, rather than confer social benefits (as seen in other countries). Centralization can result in an unnecessary waste of time and human resources and increased financial expenditure, although variability in procedures and outcomes among hospitals is lower, as shown by our results. Therefore, hospital volume might not negatively influence patient outcomes in Korea.

Interestingly, our institute was better able to evaluate hospital volume and outcomes. Generally, when researchers classify hospital volume according to the number of procedures,

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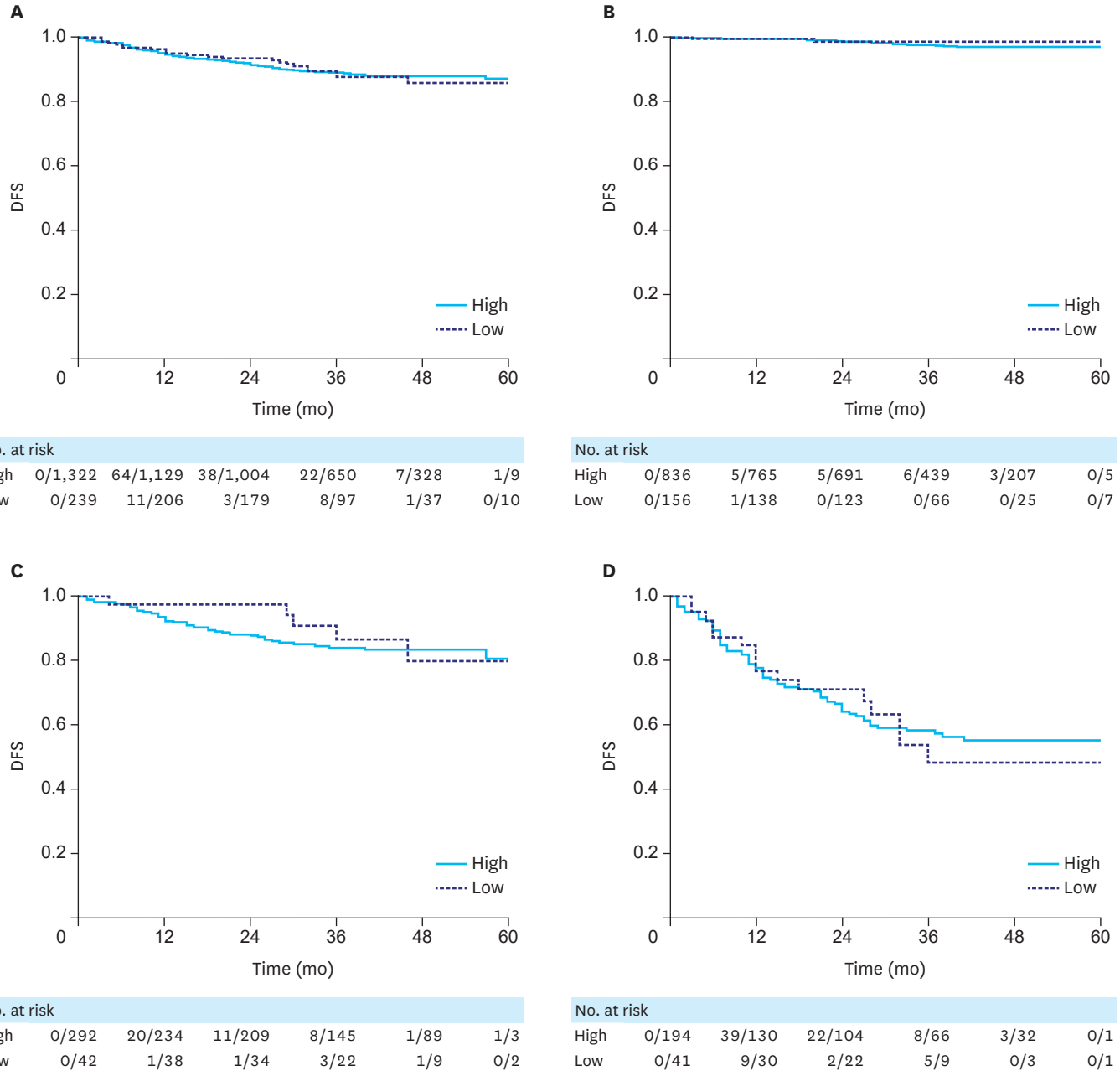

Fig. 2. DFS analysis according to tumor stage for the 2 hospital volume groups: (A) all patients (P=0.998); patients with (B) stage I (P=0.503), (C) stage II (P=0.625), and (D) stage III tumors (P=0.756).
DFS = disease-free survival.

hospital facilities and surgeon factors are the main confounders. Because our 2 hospitals are in close geographic proximity, and are run by the same affiliated organization, surgeon ability and hospital facilities were relatively homogenous compared with other studies. In addition, our study examined long-term oncological outcomes, as well as short-term surgical outcomes, while most other studies evaluated only the latter. Similar to our study, Ichikawa et al. [8] compared 2 affiliated hospitals and concluded that hospital volume had no clinical impact on the long-term prognosis of patients with gastric cancer. However, the cut-off value for dividing the centers by volume differed from ours, and they focused on patients with stage I disease and laparoscopic gastrectomy.

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Table 3. The 5-year overall and DFS rates based on tumor stage

Variables	Stage I*		Stage II*		Stage III*	
	5-YSR (%)	P-value	5-YSR (%)	P-value	5-YSR (%)	P-value
OS		0.659		0.778		0.430
High-volume center	98.4		86.5		63.7	
Low-volume center	96.3		83.6		54.5	
DFS		0.503		0.625		0.756
High-volume center	97.4		80.6		55.1	
Low-volume center	98.5		80.3		45.5	

DFS = disease-free survival; 5-YSR = 5-year survival rate; OS = overall survival; AJCC = American Joint Committee on Cancer; TNM = tumor, node, metastasis.
*According to the 7th edition of the AJCC TNM classification.

This study had several limitations. First, there is no reference cut-off point by which to define high- and low-volume centers according to the number of procedures. The number of operations used to define a high-volume hospital has been a point of discussion, with studies suggesting between 10 and 100 operations per year as the cut-off value for gastric cancer [10,20-23]. This variation in threshold makes it difficult to draw conclusions regarding whether or not a hospital has a sufficient number of patients to guarantee quality, or the ability to improve and develop surgical techniques. The cut-off value is likely to be different in East Asia, because the prevalence of gastric cancer is higher and surgeons have more experience in performing gastrectomy for the disease in Korea.

Our study also found significant differences in the approach method, estimated blood loss, and numbers of retrieved lymph nodes between the low- and high-volume centers. The laparoscopic approach was significantly more frequent in the low-volume center, likely because one of the surgeons in the high-volume center preferred the laparoscopic technique. It was also difficult to compare estimated blood loss between the centers, because the study was limited by its retrospective design. In addition, the mean number of retrieved lymph nodes at both centers exceeded 15, which is the number recommended by the guidelines [25]. Hence, the significant difference between centers in the number of retrieved lymph nodes is not an important problem. Lastly, the survival rate of stage III gastric cancer in the low-volume center was relatively lower than the rate in the high-volume center. The difference was not significant, and might be attributed to the small sample size in the low-volume center. For a convincing analysis, a larger sample size of each stage would be needed in the future.

In conclusion, hospital volume might not be an important factor in patient outcome if well-trained surgeons perform gastrectomy for gastric cancer. Gastrectomy can have satisfactory outcomes at low-volume hospitals. In the future, a well-designed, prospective study should be conducted to address the question of the role of hospital volume as a prognostic factor.

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