

## Cost Comparison between Surgical Treatments and Endoscopic Submucosal Dissection in Patients with Early Gastric Cancer in Korea

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**Background/Aims:** This study was conducted to evaluate whether medical costs can be reduced using endoscopic submucosal dissection (ESD) instead of conventional surgeries in patients with early gastric cancer (EGC). **Methods:** Patients who underwent open gastrectomy (OG), laparoscopy-assisted gastrectomy (LAG), and ESD for EGC were recruited from three medical institutions in 2009. For macro-costing, the medical costs for each patient were derived from the expenses incurred during the patient's hospital stay and 1-year follow-up. The overall costs in micro-costing were determined by multiplying the unit cost with the resources used during the patients' hospitalization. **Results:** A total of 194 patients were included in this study. The hospital stay for ESD was 5 to 8 days and was significantly shorter than the 12-day hospital stay for OG or the 11- to 17-day stay for LAG. Using macro-costing, the average medical costs for ESD during the hospital stay ranged from 2.1 to 3.4 million Korean Won (KRW) per patient, and the medical costs for conventional surgeries were estimated to be between 5.1 million and 8.2 million KRW. There were no significant differences in the 1-year follow-up costs between ESD and conventional surgeries. **Conclusions:** ESD patients had lower medical costs than those patients who had conventional surgeries for EGC with conservative indications. (*Gut Liver*, 2015;9:174-180)

**Key Words:** Stomach neoplasms; Endoscopic submucosal dissection; Gastrectomy; Costs and cost analysis

### INTRODUCTION

Since gastroscopy has become the standard national screening process for gastric cancer in Korea, the diagnosis of early gastric cancer (EGC) has rapidly increased.<sup>1,2</sup> Previously, the standard treatment for EGC was surgical treatment.<sup>3</sup> Although open gastrectomy (OG) has a high survival rate,<sup>4</sup> mortality and morbidity related to the surgery has also been reported. In addition, postoperative weight loss or difficulty with food intake negatively impacts patients' quality of life. In an efforts to address these issues, minimally invasive treatments have been developed, resulting in the increased laparoscopy-assisted surgeries and endoscopic resections.<sup>5,6</sup>

Currently, laparoscopy-assisted gastrectomy (LAG) has shown the advantage of improving short-term quality of life for at least 3 months postsurgery including pain reduction, a rapid recovery of gastrointestinal functions, and a short hospitalization period as compared with OG.<sup>5</sup> Moreover, multiple studies demonstrated that there is no significant difference in the complications observed after LAG when compared to OG.<sup>7,8</sup> Recently, a randomized prospective clinical trial reported that LAG showed similar disease-free survival and overall survival compared to OG in treating distal EGC.<sup>9</sup>

Endoscopic resection is a treatment modality for EGC without any risk of lymph node metastasis.<sup>10</sup> The procedure can be broadly classified into endoscopic mucosal resection (EMR) and endoscopic submucosal dissection (ESD).<sup>11-13</sup> *En bloc* resection rates are reported to be 50% to 80% and complete resection rates to be 53% to 77% in EMR.<sup>11,14,15</sup> Because an *en bloc* resection or complete resection raises the accuracy of pathological

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Received on August 12, 2013. Revised on October 28, 2013. Accepted on December 26, 2013. Published online on June 18, 2014

pISSN 1976-2283 eISSN 2005-1212 <http://dx.doi.org/10.5009/gnl13299>

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assessment and lowers the risk of relapse, the success of treatment increases with increased *en bloc* resection or complete resection rate. ESD is a method in which various endoscopic incision blades can be used to make direct incisions on the submucosa of gastric cancer. This has the advantage of performing an *en bloc* resection of the large lesion regardless of the gastric cancer size.<sup>10</sup> The *en bloc* resection rate of ESD is 86% to 100%,<sup>6,16-19</sup> and the complete resection rate is 80% to 95%,<sup>6,20,21</sup> which is higher than those of EMR.<sup>22</sup> Further, the 3-year post-ESD survival rate is over 98%.<sup>23</sup> However, the resection rate with ESD depends on the size, location, and shape of the tumor, and the procedure is more difficult to perform and the complication risk is higher due to the large and deep dissection.<sup>24</sup>

Although active, randomized controlled trials on OG and LAG are under way, clinical studies comparing ESD and LAG have not yet been conducted. When comparing the three procedures, efficacy and safety are important, but comparisons on the economic impact of these procedures will also help patients and doctors in choosing an appropriate treatment, and may provide important information for making health policy and resource allocation. Therefore, this study was conducted to compare the cost of OG, LAG, and ESD, the current treatment options for EGC.

## MATERIALS AND METHODS

### 1. Patients and study period

Patients from three medical institutions (two university hospitals and a cancer center hospital) with EGC who underwent an OG, LAG or ESD were included in this study. To enhance the comparability between the three interventions, only patients with EGC, as determined by clinician judgment or clinical symptoms/stages were included in the study. The medical costs for the intervention (OG, LAG or ESD) from admission to discharge and those that occurred during the 1-year scheduled follow-up period after discharge were collected.

### 2. Costing method

The costs were investigated using the micro-costing and macro-costing method. The micro-costing method calculates the costs after listing the total resources used and matching the unit cost of each component. On the other hand, macro-costing selects more comprehensive items (e.g., cost per patient and cost per 1 hospitalization day) and checks all expenses that occurred during a certain time period.<sup>25-27</sup>

Micro-costing is a method of separately checking and quantifying all cost items. Although more effort is exerted to determine costs, insight into the specific details of all the medical resources used is gained. If the purpose of a study is to make a macroscopic comparison of the total cost, macro-costing can be more appropriate. It has the advantage of being relatively simple, although specific components contributing to the cost

cannot be identified.<sup>25-27</sup>

For the macro-costing method in this study, costs based on patient-level were collected, and average cost of patients was calculated. Although the collection period was diverse, ranging from 2 to 9 months in consideration of the number of patients of each medical institution, the basic rule was to collect the data of all patients who got the intervention during the specific period so that selection bias could be minimized. The costs for the year following discharge, including the medical costs due to incomplete resection or recurrence as well as periodic management were also collected.

The cost data was extracted from medical bill from medical institutions. The medical bills were classified into National Health Insurance (NHI) covered payment and NHI non-covered payment on specific items such as physician services, hospitalization, injection, medication, anesthesia, procedure and surgery, radiation therapy, and diagnostic test. The average, median, and standard deviation at each medical institution were calculated, respectively, considering the heterogeneity of patients. The hospitalization period, the total medical costs excluding the upper level ward fee, and the medical costs covered by NHI were compared.

The micro-costing method was conducted based on the medical records of patients who underwent an OG, LAG, ESD. The period from admission to discharge was the same as the patient-level data in the macro-costing. The medical records included the procedure, medicine, and medical material that patients received from admission to discharge. Based on the resources used, the unit cost was matched using the procedure fee schedule, medicine and material cost code. The fees schedule in the general hospital in 2010 was used.

### 3. Statistical analysis

The statistical comparison was not conducted between medical institutions, because the data was provided under the condition that no comparison between medical institutions would be performed. In addition, these costs data cannot be pooled because the heterogeneity of the treatment pattern between medical institutions. Therefore, the results were presented respectively by each medical institution. The mean difference in medical cost and hospitalization period between ESD and conventional surgeries were estimated within each medical institution. The cost and hospitalization days were compared using the Mann-Whitney U test (two-sided). A p-value less than 0.05 was considered statistically significant.

## RESULTS

### 1. Patient recruitment and characteristics

The number of participants and hospitalization periods are shown in Table 1. Medical institution A provided data on 15 patients that underwent ESD and conventional surgery, respec-

tively. And medical institution B provided cost data on 37 EGC patients who underwent ESD, 51 gastric cancer patients who underwent LAG, and 21 gastric cancer patients who received OG in January and February of 2009. Cost data from medical institution C was received for 30 patients who underwent ESD and 25 patients who received LAG.

The average hospitalization period of ESD patients was 5 to 8 days. The hospitalization period was longer at medical institution C because patients are not immediately admitted to the division of surgery, but rather transferred after inpatient check-ups. At the other medical institutions, however, patients were admitted after outpatient checkups were performed. Although the hospitalization period varied by treatment at each medical institution, the difference between ESD and conventional surgery such as OG or LAG was similar at approximately 7 to 9 days ( $p < 0.0001$  and  $p < 0.0001$ , respectively).

A similar result was obtained when analyzing the median hospitalization period. The hospitalization period was shorter for patients who underwent ESD than for those who had conventional surgery. The results were not adjusted for cancer stage.

## 2. Macro-costing

### 1) The comparison of medical cost per patient during the hospitalization period

The difference in medical cost depended on whether patients used the upper level ward. To control for this difference, the average medical costs were determined excluding the upper level ward costs. However, because extra fee for clinical professional is usually required at general hospitals, this fee was included in the analysis.

The medical cost of patients with ESD was between 2.1 million and 3.4 million Korean Won (KRW) including both hospitalization costs and procedure costs which are described in Table 2. The cost of conventional surgery, such as OG or LAG, had varied by medical institution and ranged from 5.1 million to 8.2 million KRW. The difference in cost between ESD and conventional surgeries was statistically significant at each medical institution ( $p < 0.0001$  and  $p < 0.0001$ , respectively). That is to say, in all three medical institutions, the cost of ESD was significantly lower than the cost of conventional surgeries.

Although the subjects were limited to patients with EGC,

**Table 1.** Number of Participants and Hospitalization Days

Classification	Conventional surgery		ESD	p-value	
	OG	LAG		OG vs ESD	LAG vs ESD
Medical institution A					
No. of patients	15		15	-	-
Hospitalization days	11.6 (9-17)		5 (4-8)	<0.0001	-
Medical institution B					
No. of patients	21	51	37	-	-
Hospitalization days	11.7 (10-22)	11 (9-23)	4.9 (4-12)	<0.0001	<0.0001
Medical institution C					
No. of patients	-	25	30	-	-
Hospitalization days	-	16.7 (9-31)	7.7 (6-10)	<0.0001	<0.0001

Data are presented as mean (range). Medical institution A provided the data without separating the patients with laparoscopy-assisted gastrectomy from the patients with open gastrectomy.

OG, open gastrectomy; LAG, laparoscopy-assisted gastrectomy; ESD, endoscopic submucosal dissection.

**Table 2.** Comparisons of Medical Costs during Hospital Stays Using Macro-Costing

Classification	Conventional surgery, KRW		ESD, KRW	p-value	
	OG	LAG		OG vs ESD	LAG vs ESD
Medical institution A	5,050,016		2,088,519	<0.0001	-
Medical institution B	5,971,756	6,830,096	2,378,742	<0.0001	<0.0001
Medical institution C	-	8,249,502	3,379,556	<0.0001	<0.0001

Data are presented as the mean values excluding the upper level ward fee. 1 USD=1,275.82 Korean Won (KRW) in 2009.

OG, open gastrectomy; LAG, laparoscopy-assisted gastrectomy; ESD, endoscopic submucosal dissection.

because the data was not adjusted for patient severity, a direct comparison between these medical institutions is required to be cautious.

**2) A comparison of medical cost by item during the hospitalization period**

In this study, cost was determined by classifying the cost into hospitalization, injection, medication, anesthesia, procedure and surgery, radiation therapy, diagnostic test, and other NHI uncovered items (Table 3). However, it was difficult to make a direct comparison between costs by items due to the slight differences in classification by each medical institution. Therefore, a comparison was made using data from medical institution B which provided data for the greatest number of patients.

Due to the difference in the hospitalization period, the hospitalization costs were higher for LAG or OG than ESD. The hospitalization costs, excluding the upper level ward fee, were on average 230 thousand KRW for ESD patients, and 600 thousand

KRW for the two conventional surgeries. Although the procedure and surgery costs of ESD were 600 to 700 thousand KRW higher, the cost was offset by the cost of other items including anesthesia, injection, and medication as well as hospitalization costs. Hence, it was suggested that the total medical cost during hospital stay was 3 million to 4 million KRW lower for ESD. Since ESD itself is nonreimbursable, the amount paid by NHI was around 450 thousand KRW. However, the amount actually paid by patients (NHI copayment+NHI uncovered payments) was still lower for ESD than for LAG or OG.

**3) A comparison of medical costs for 1-year follow-up after discharge**

The costs accrued during the 1-year of follow-up for patients who underwent ESD and conventional surgery due to EGC in medical institutions B and C was tracked and analyzed (Table 4). At medical institution B, the follow-up cost for ESD was around 1.16 million KRW, 1.26 million KRW for LAG, and 1.79

**Table 3.** Comparisons of Medical Costs by Items during Hospital Stays Using Macro-Costing

Classification	Conventional surgery, KRW		ESD, KRW	Difference	
	OG	LAG		OG-ESD	LAG-ESD
Doctor's fee	3,408	4,984	1,301	2,106	3,683
Hospitalization (room and board)*	554,465	528,436	229,761	324,704	298,675
Injection	292,748	274,009	63,596	229,152	210,413
Medication	95,472	92,537	22,141	73,331	70,396
Anesthesia	328,944	323,460	0	328,944	323,460
Procedure and surgery	1,003,042	950,656	1,658,605	-655,563	-707,949
Radiation therapy	54,567	72,782	43,794	10,773	28,988
Diagnostic test (endoscopy, abdominal CT, laboratory test, pathology, etc)	672,928	754,499	271,298	401,630	483,201
Other (meal, extra fee for clinical professional, etc.)	2,966,182	3,828,732	88,244	2,877,938	3,740,488
Amount paid by NHI	3,735,397	3,927,335	450,065	3,285,332	3,477,270
Amount paid by patient* (NHI copayment and NHI uncovered payment)	2,236,359	2,902,761	1,928,677	307,682	974,084
Total medical expenses*	5,971,756	6,830,096	2,378,742	3,593,014	4,451,354

Data are presented as the mean values. 1 USD=1,275.82 Korean Won (KRW) in 2009.

OG, open gastrectomy; LAG, laparoscopy-assisted gastrectomy; ESD, endoscopic submucosal dissection; CT, computed tomography; NHI, National Health Insurance.

\*Except the upper level ward fee.

**Table 4.** Comparisons of Medical Costs for 1-Year Follow-Up after Discharge from the Hospital Using Macro-Costing

Classification	Conventional surgery, KWR		ESD, KRW	p-value	
	OG	LAG		OG vs ESD	LAG vs ESD
Medical institution B	1,787,854	1,264,707	1,158,276	0.6545	0.1627
Medical institution C	-	2,339,421	2,313,215	0.8833	-

Data are presented as the mean values. 1 USD=1,275.82 Korean Won (KRW) in 2009.

OG, open gastrectomy; LAG, laparoscopy-assisted gastrectomy; ESD, endoscopic submucosal dissection.

**Table 5.** Comparisons of Medical Costs during Hospital Stays Using Micro-Costing

Classification	Conventional surgery, KRW				ESD	Difference, KRW			
	OSG	OTG	LATG	LADG		OSG-ESD	OTG-ESD	LATG-ESD	LADG-ESD
Medical costs	2,468,740	2,861,238	5,370,008	5,642,350	1,741,619	727,121	1,119,619	3,628,389	3,900,731

Micro-costing was calculated based on the tertiary hospital excluding the upper level ward fee and extra fee for clinical professionals. 1 USD=1,275.82 Korean Won (KRW) in 2009.

OSG, open subtotal gastrectomy; OTG, open total gastrectomy; LATG, laparoscopy-assisted total gastrectomy; LADG, laparoscopy-assisted distal gastrectomy; ESD, endoscopic submucosal dissection.

million KRW for OG. Although follow-up medical cost for ESD was likely to be higher than that for conventional surgery, the difference in the 1-year follow-up cost was not statistically significant. However, such results may be influenced by additional treatment after incomplete resection or recurrence.

### 3. Micro-costing

The micro-cost analysis based on standard patients indicated that the medical cost for ESD was around 1.74 million KRW, between 5.37 and 5.64 million KRW for LAG, and between 2.47 and 2.86 million KRW for OG. The difference in medical costs between ESD and LAG was between 3.63 and 3.9 million KRW, and the difference in medical cost between ESD and OG was between 0.73 and 1.12 million KRW (Table 5).

Unlike macro-costing, the extra fee for clinical professional was excluded in the micro-cost analysis and thus a lower cost was estimated. In addition, it is possible some items might were accidentally omitted or errors occurred in the unit cost matching process. This is especially likely for items that are not covered by NHI. The differences in cost between interventions were also estimated to be lower than those obtained using macro-costing.

## DISCUSSION

Because the ESD procedure has a shorter hospital stay and requires fewer resources, it is presumed to be less expensive than surgical treatment. However, until now no studies have addressed the economic aspects of EGC treatment. In this study, we compared the medical cost of ESD, LAG, and OG using both macro- and micro-costing methods. Both methods indicated that ESD has lower medical costs. The cost difference between ESD and conventional surgeries was statistically significant within each medical institution. In contrast, there was no significant difference in the follow-up costs between the different treatments.

This study also demonstrated that medical bills can be used as a costing resource. In this study, medical bills were obtained from medical institutions based on patient level and used for macro-costing. The medical bills were classified into National Health Insurance (NHI) covered payment and NHI non-covered payment on specific items such as physician services, hospital-

ization, injection, medication, anesthesia, procedure and surgery, radiation therapy, and diagnostic test. This method was also applied to compare the medical costs for robot-assisted distal gastrectomy (RADG) and laparoscopy-assisted distal gastrectomy in Korean patients with EGC.<sup>28</sup> In these studies, it was essential to utilize the data from medical institutions because EGC could not be identified with only the ICD-10 code, and items not covered by NHI such as an ESD procedure or RADG, could not be identified in the NHI claims data. In addition, because medical bills were already established for each medical institution, it was relatively easy to acquire the data because no additional process was needed to construct a database. Due to these advantages, using medical bills for costing would be useful. A limitation to this approach is that cost analysis would be complicated when medical bills were obtained from a different time period compared to the study or episode period.

This study checked the medical records of standard patients for micro-costing, and based on this, set up cost items. However, whether the treatment that the chosen patient has received is standard was not reviewed by a third party or relevant medical society. Because medical treatment patterns vary by medical institutions and physicians, setting up model of standard medical treatment based on medical records of a patient may have limitations. Therefore, it would be more desirable to utilize the uniform medical treatment model through clinical guidelines or medical society consultation.<sup>10</sup> Hence, the applicability of the results generated using the micro-costing in this study is limited. If micro-costing is to be conducted, it is necessary to consider the following factors. First, although a standard medical treatment model for micro-costing is necessary but the process is not easy. Secondly, because it is impossible to use the medical fee schedule to identify the fees for nonreimbursable items, unit cost must be directly collected from medical institutions. However, medical institutions are likely to hesitate to provide the prevailing fees on nonreimbursable items. Thirdly, because it is difficult to estimate upper level ward fees and extra fees for clinical professional, micro-costing results will be underestimated compared to the actual cost. Of course, upper level ward fees and extra fees for clinical professional can be estimated according to assumptions, but this requires several assumptions and additional data.

By using both macro- and micro-costing approach, we were able to clearly identify the pros and cons of each method. These results will help researchers to determine the appropriate method for cost analysis in healthcare. Macro-costing can be accomplished relatively easily by collecting medical bills, whereas micro-costing would be more useful when resource items and its usage are easily identified such as a simple procedure or outpatient drug prescriptions.<sup>25-27,29</sup>

In this study, all the relevant medical costs associated with ESD, LAG, and OG were considered. For example, the costs for medication, diagnostic test, and meal during the hospitalization period as well as surgery were included in the cost analysis. With ESD, the procedure and material costs was higher because they were not covered by NHI benefits at the time of the investigation. However, due to the shorter hospitalization period and the lower medication cost, the overall medical cost of ESD was still significantly lower than those associated with LAG and OG. For this reason, it may not be fair to compare the costs of ESD, LAG, and OG using only the procedure and surgery costs. Instead, it may be necessary to take into account all the relevant costs in considering resource allocation in medical health care.

From September 1, 2011, ESD has been reimbursed by NHI in Korea. Thus, the constitution and components in the cost of ESD will be changed and we need to re-evaluate for ESD based on the current reimbursement fee schedule. The reimbursed procedure fee is one-third of the prevailing fees. This change in reimbursement will further increase the cost difference identified in this study between ESD and surgical treatments.

There are some limitations to comparing the medical cost of ESD and surgical methods such as LAG and OG. First, the data were not adjusted for patient characteristics when comparing the costs of ESD, LAG, and OG in this study. The subjects were limited to EGC patients, and data collected on all patients treated during a specific period were included in the cost analysis to avoid selection bias. Although patient cancer stage was limited to EGC, it is difficult to make a direct comparison because unlike conventional surgeries, ESD is generally restricted to EGC patients.

Secondly, macro-costing uses patient level data and the costs associated with revision surgery due to incomplete excision were included by calculating the cost for the 1-year of follow-up period after patient discharge. However, in micro-costing, the cost associated with revision surgery was not included because the analysis period was limited to the period from admission to discharge of standard patients. If the revision surgery rate between ESD and conventional surgeries is different, macro-costing would provide a more accurate analysis. When the indications for ESD are extended, the revision surgery rate and overall cost could increase.

Thirdly, it was difficult to make a direct comparison between the three medical institutions because there were significant differences in treatment patterns. For example, the total medi-

cal costs at medical institution C included all medical examination costs because all preoperative medical checkups were performed after hospitalization for ESD. This account for the greatest difference in medical costs between the institutions because medical institutions A and B conducted preoperative checkups in outpatient settings before hospitalization for ESD. The health checkup cost before surgery at institution C could not be excluded because medical bills did not provide specific details of the preoperative checkup. In addition, the difference in the prevailing fee of the ESD procedure itself could account for some of the cost difference between medical institutions. Forth, the evaluation of clinical effectiveness of ESD is underway. Therefore, it is premature to interpret the research findings as economic evaluation which simultaneously considers the effectiveness and cost. The cost analysis can be limited in decision making before the results of the survival rate and recurrence rate of ESD, LAG, and OG in South Korea are reported. Therefore, the well-performed clinical studies would be necessary to confirm whether ESD may not potentially be inferior for the survival, recurrence, and complications within an appropriate indication. The cost-effectiveness analysis would be beneficial with the further clinical studies. After further studies on cost and clinical effectiveness of ESD have been accomplished, conclusive decisions can be made on whether and when endoscopic treatment is a beneficial alternative to existing extensive surgical treatment.

In conclusion, ESD has lower medical costs than conventional surgeries for EGC when it is done in conservative indication.

## CONFLICTS OF INTEREST

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

## ACKNOWLEDGEMENTS

This study was conducted as part of project number NA2011-001 funded by the National Evidence-based Healthcare Collaborating Agency (NECA) in Korea.

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