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Economic Outcomes of Laparoscopic Versus Open Surgery for Colorectal Cancer in Korea

YOO SHIN CHOI[1], SANG-IL LEE[2], TAEK-GU LEE[1], SUNG-WOOK KIM[3], GUINEUM CHEON[4], and SUNG-BUM KANG[1]

Departments of [1]Surgery, [3]Cost Management, and [4]Nursing Insurance, Seoul National University Bundang Hospital, 300 Gumi-dong, Bundang-gu, Seongnam-si, Gyeonggi-do 463-707, South Korea
[2]Department of Surgery, Chungnam National University College of Medicine, 6 Munhwa 1-dong, Jung-gu, Daejeon 301-747, South Korea

Abstract

Purpose. To compare the economic outcomes of laparoscopic surgery (LAP) with those of open surgery (OS) for colorectal cancer.

Methods. We compared operating room (OR) costs, OR hospital-profits, total hospital charges, and payments made for 67 consecutive patients who underwent either OS (n = 41) or LAP (n = 26) for colorectal cancer.

Results. The operating time was longer in the LAP group ($P < 0.001$), but the hospital stay was shorter ($P < 0.001$). OR costs were higher in the LAP group, which was primarily attributed to the higher costs of consumables (LAP $1441, OS $575; $P < 0.001$) and the longer operating time (LAP 215 min, OS 155 min; $P < 0.001$). Total hospital charges were also higher after LAP (LAP $5017, OS $4093; $P < 0.001$). Patients paid more after LAP ($P < 0.001$), but there was no significant difference between the two groups in National Health Insurance Corporation payments.

Conclusion. Laparoscopic surgery is less cost-effective than OS for colorectal cancer. The higher costs of consumables and the longer operating time associated with LAP must be addressed to make LAP more cost-effective.

Key words Colorectal cancer · Laparoscopy · Cost · Economic outcome

Introduction

The laparoscopic resection of colon cancer was first reported in 1991, and it is becoming more and more popular.[1] Laparoscopic surgery (LAP) is now well established as technically feasible for the treatment of colorectal cancers, without increased morbidity.[2–6] Several randomized clinical trials have been conducted to compare oncologic outcomes between LAP and conventional open surgery (OS) in the treatment of colorectal cancer.[7–9] The Clinical Outcomes of Surgical Therapy (COST) Study Group reported that there were no differences in 5-year survival and recurrence rates between patients treated with LAP and those treated with OS.[7] Lacy et al. determined that oncologic outcomes after LAP tended to be superior to those after OS for stage III colon cancer.[8] Recently, Leung et al. demonstrated that LAP did not jeopardize survival or disease control in patients suffering from rectosigmoid cancers.[9]

To justify the routine use of laparoscopy in the management of colorectal cancer, it must be proven to be cost-effective as well as oncologically effective. The cost-effectiveness of LAP varies according to the status of each nation's medical service systems. Although some studies showed that the total cost of LAP in the treatment of colon or rectal cancer was higher than that of OS,[9,10] other studies found that LAP was not associated with any real increase in cost.[11–17] In fact, Delaney et al. reported that LAP incurred fewer direct costs than OS,[11] which they attributed to the shorter hospital stay after LAP, although the operating room (OR) costs for LAP were clearly higher. The issue of cost-effectiveness is particularly vexing, not only for health care providers, but also for those who organize and pay for health care. As health care costs play a major role in clinical decision-making, we compared the economic outcomes of patients undergoing LAP with those undergoing OS for colorectal cancer, taking into account such factors as OR costs, OR hospital-profits, total hospital charges, and payments.

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Patients and Methods

Methods

Eighty-eight consecutive patients underwent curative resection of colorectal cancer at Seoul National University Bundang Hospital, between June 2003 and January 2004. We excluded several groups of patients from the study, including 14 with adjacent organ invasion or distant metastasis, three with a history of major abdominal surgery, and four in whom LAP was converted to OS. Finally, 67 patients undergoing OS (n = 41) or LAP (n = 26) were included in the economic comparison. We compared the patients' age, sex, body mass index (BMI), tumor location, operative procedure, operative time, postoperative course, hospital stay, and complications. With the notable exceptions of surgical access and the approach to the main lymphovascular pedicle, all of the other surgical methods used were similar in the two groups. Access in LAP was gained using four or five trocars, and the diseased bowel was resected extracorporeally. In OS, the main pedicles were dissected via a lateral-to-medial sequence, whereas in LAP a medial-to-lateral sequence was used for the pedicular approach. The study period started on the day of admission for surgery and finished on the day of discharge from hospital.

Operating Room (OR) Costs and OR Hospital-Profit

Operating room costs were defined as direct costs, which are different from the indirect costs or intangible costs described by Krahn.[18] Our analyses of OR costs were predicated primarily using the method developed by Cokins.[19] Operating room costs consisted of labor costs, supply costs, and consumables costs. Labor costs were calculated based on the hourly rate of pay according to the salaries of the medical officers, nursing staff, physician's assistants, and other personnel in the OR, by referencing the numbers and types of personnel listed on the OR records. These records were also used in the calculation of OR utilization time. OR resources and some reusable equipment used in LAP were calculated as supply costs per hour, paid by the hospital to the supplier. This category included some relatively expensive equipment, regulated as "unchargeable materials" by the national government. The capital costs of this expensive equipment were calculated after estimating the yearly use of these items, and including a 5-year depreciation schedule. Consumables costs included stapling devices, suture materials, and disposable drapes used in the OR, as well as other reusable laparoscopic instruments, including bowel graspers and laparoscopic clips, both of which are classed as chargeable items.

Operating room hospital profits were calculated by subtracting operation charges from the labor and supply costs of the OR. Operation charges are one of the many categories shown on the hospital bill. Consumable costs were excluded from the calculation for OR hospital-profits, as they were refunded as benefit-service or nonbenefit-service charges to the hospital.

Total Hospital Charges and Payments

Total hospital charges were divided into several categories, including charges per case for the operation, anesthesia, laboratory, radiology, nursing care, medical therapy, and consumables. In Korea, the operation charges for LAP and OS are the same. Charges associated with chemotherapy or radiotherapy, both of which may be necessary in patients with pathological stage II or III disease, were not included in this analysis. Each charge per item was determined by a review of both the medical records and the ultimate hospital bill. Hospital charges were divided into benefit-service charges, and nonbenefit-service charges. In Korea, 80% of the benefit-service charges are reimbursed by the National Health Insurance (NHI) Corporation, and all nonbenefit-service charges are paid by the patients. Patients pay 20% of the benefit services.

Statistical Analysis

Cost data tend to be extremely skewed, which renders the use of nonparametric statistical tests appropriate. Nonparametric data are expressed as medians and interquartile ranges. We used the Mann–Whitney U-test to compare the LAP and OS groups with regard to differences in costs and charges. Differences were considered significant if the estimated P value was less than 0.05. All costs and charges are expressed in US dollars at the December 2003 exchange rate (1180 won = 1 dollar).

Results

The patient demographics and tumor locations were similar in the two groups, with the exception of their sex (Table 1). Operating room utilization time was significantly longer in the LAP group than in the OS group (155 min vs 215 min; $P < 0.001$) (Table 2). However, the LAP group had a significantly shorter length of stay than the OS group ($P < 0.001$). Postoperative recovery of the LAP patients, principally with regard to return of bowel function and recommencement of oral intake, was significantly superior to that in the OS group. Analgesic requirements did not differ significantly between the groups. There were no differences in postoperative complications between the groups. There was one case of wound infection and four cases of early postoperative

Table 1. Demographics of the patients

	OS (n = 41)	LAP (n = 26)	P value
Male/female ratio	34:7	15:11	0.046
Age (years)	64.0 (40–84)	64 (30–83)	NS
BMI (kg/m^2)	22.2 (15.8–31.8)	22.6 (18.6–29.3)	NS
Tumor location			NS
A- and T-colon	6	5	
S-fl and D-colon	2	1	
Sigmoid colon	13	10	
Rectum	20	10	

Data are expressed as median values with range
OS, open surgery; NS, not significant; LAP, laparoscopic surgery; BMI, body mass index; A, ascending; T, transverse; S-fl, splenic flexure; D, descending

Table 2. Operating times and postoperative basic data

	OS (n = 41)	LAP (n = 26)	P value
Operation time (min)	155 (121–209)	215 (193–263)	<0.001
Flatus passed (POD)	5.0 (2–16)	3 (2–5)	<0.001
Recommencement of oral intake (POD)	5.0 (2–17)	4 (2–6)	<0.001
Requirement of analgesics (frequency)	2.04 (0–22)	1.7 (0–6)	NS
Hospital stay (days)	9 (7–20)	7 (5–14)	<0.001

Data are expressed as median values with interquartile ranges (1st–3rd quartile)
OS, open surgery; LAP, laparoscopic surgery; POD, postoperative days; NS, not significant

Table 3. Comparison of operating room (OR) costs

	OS (range)	LAP (range)	P value
OR costs ($)	1347 (1165–1796)	2709 (1353–3137)	<0.001
Labor costs ($)	551 (427–734)	763 (691–928)	<0.001
Supply costs ($)	331 (267–447)	466 (423–553)	<0.001
Consumables costs ($)	575 (217–642)	1441 (724–1788)	<0.001

Data are expressed as median values with interquartile ranges (1st–3rd quartile)
OS, open surgery; LAP, laparoscopic surgery; OR, operating room; $, US dollar

Table 4. Comparison of operating room (OR) hospital-profits

	OS (range)	LAP (range)	P value
Hospital-profit in OR ($)	–154 (–421 to –12)	–564 (–920 to –398)	<0.001
Subtracted OR costs ($)	881 (694–1180)	1254 (1115–1483)	<0.001
OR charges ($)	760 (465–1138)	697 (465–969)	NS

Data are expressed as median values with interquartile ranges (1st–3rd quartile)
Hospital-profit in operating room = OR charges–Subtracted OR costs
Subtracted OR costs = Labor costs + Supply costs
Negative hospital-profit means hospital-deficit
OS, open surgery; LAP, laparoscopic surgery; OR, operating room; $, US dollar; NS, not significant

ileus in the OS group, versus one case of wound infection, one case of late ileus, and one case of anastomotic stricture in the LAP group (P = 0.323).

Operating room costs were significantly higher in the LAP group than in the OS group ($1347 versus $2709; $P < 0.001$) (Table 3). Labor costs, supply costs, and consumables costs were also higher in the LAP patients, with no exceptions (P = 0.001). Operating room hospital-profit differed significantly between the groups (OS –$154 vs LAP –$564; $P < 0.001$) (Table 4). Both groups induced hospital-deficits in the OR, which was attributed to the generally low OR charges in Korea. The LAP group was associated with significantly greater hospital-deficits than the OS group with regard to hospital balance.

The total hospital charges, consisting of benefit services, and nonbenefit-service charges were also significantly higher in the LAP group than in the OS group

Table 5. Comparisons of total charges categorized into benefit and nonbenefit services

		OS (range)	LAP (range)	*P* value
Benefit-service charges ($)	Operation	760 (620–853)	697 (620–853)	NS
	Anesthesia	180 (146–225)	253 (209–295)	<0.001
	Laboratory	390 (313–557)	369 (277–523)	NS
	Radiology	219 (201–231)	217 (209–241)	NS
	Nursing	437 (380–608)	399 (334–503)	NS
	Medical therapy	469 (408–530)	424 (359–504)	NS
	Consumables	203 (77–458)	153 (51–241)	NS
	Total ($)	2892 (2508–3229)	2670 (2251–3000)	NS
Nonbenefit-service charges ($)	Operation	0	0	NS
	Anesthesia	19 (16–51)	20 (15–75)	NS
	Laboratory	163 (40–190)	94 (29–185)	NS
	Radiology	8 (0–568)	0 (0–107)	NS
	Nursing	89 (71–145)	81 (62–99)	NS
	Medical therapy	466 (193–1206)	195 (113–589)	NS
	Consumables	234 (194–472)	1292 (604–1734)	<0.001
	Total ($)	1322 (891–1791)	2068 (1737–3439)	<0.001
Total charges ($)		4093 (3514–4885)	5017 (4325–6007)	<0.01

Data are expressed as median values with interquartile ranges (1st–3rd quartile)
Benefit service means services for which 80% was reimbursed by the National Health Insurance Corporation
Nonbenefit service means what was paid entirely by the patients
OS, open surgery; LAP, laparoscopic surgery; $, US dollar; NS, not significant

Table 6. Comparison of payments according to payers

Payer	OS (range)	LAP (range)	*P* value
NHI corporation ($)	2305 (2006–2583)	2136 (1801–2400)	NS
Patient ($)	1856 (1397–2491)	2653 (2286–3960)	<0.001

Data are expressed as median values with interquartile ranges (1st–3rd quartile)
OS, open surgery; LAP, laparoscopic surgery; NHI, national health insurance; $, US dollar; NS, not significant

(OS $4093 vs LAP $5017; $P < 0.001$) (Table 5). In terms of the benefit-service charges associated with the NHI Corporation, we found no differences in any of the other categories, with the exception of anesthesia charges. The consumables charges in the nonbenefit services were significantly higher in the LAP group than in the OS group (OS $234 vs LAP $1292; $P < 0.001$).

When we divided the total hospital charges, we classified them into NHI Corporation payments and patient payments. The LAP group patients paid significantly higher charges than the OS patients ($2653 vs $1856; $P < 0.001$), whereas the NHI Corporation payments did not differ significantly according to the operative approach (OS $2305 vs LAP $2136; $P = 0.161$) (Table 6). In the LAP group, the higher patient payments were primarily the result of the higher consumables charges in the nonbenefit services.

Discussion

In agreement with several previous studies, we found that OR costs were significantly higher for LAP than for OS in the treatment of colorectal cancer (Table 7).[9–13,20] The OR costs were increased in the LAP group as a result of higher consumables costs (LAP $1441 versus OS $575; $P < 0.001$), and longer operating times (LAP 215 min, OS 155 min; $P < 0.001$). To increase the validity of our data, we excluded from this study, patients with a history of major abdominal surgery, adjacent organ invasion, or distant metastasis, as well as those in whom LAP was converted to OS, in consideration of operating times and costs. Most other studies have also reported significantly longer operating times for LAP than for OS.[11,13,14,20] The substantial learning curve of the surgeon appears to be a necessary factor for reducing the operating time as LAP for colorectal cancer is technically difficult.[10] The high OR costs associated with this technique could probably be lowered by reducing the operating time, which would be a natural result of increased experience in performing LAP on the part of the surgeon, as well as the necessary maintenance of the laparoscopic instruments. Operating time constitutes one of the most important factors in determining the cost-effectiveness of the LAP technique.

In some economic evaluations, the authors have confused or conflated the definitions of *cost* and *charge*

Table 7. Studies on costs and related clinical outcomes for laparoscopic versus open surgery for cancer of the colon or rectum

First author (year)[Ref.]	Country	LAP	OS	Operating time	Hospital stay	OR cost	Total cost
Saba (1995)[20a]	USA	20	25	Similar	Lower	Higher ($4337 vs $1839)	
Pfeifer (1995)[15b]	USA	53	53		Similar	Similar ($12351 vs $9723)	Similar ($29626 vs $26903)
Philipson (1997)	Australia	28	33	Higher	Similar	Higher	Higher (A$9064 vs A$7881)
Khalili (1998)[13b]	USA	80	90	Similar	Similar	Higher ($2100 vs $1200)	Similar ($14800 vs $14200)
Janson (2004)[12c]	Sweden	98	112	Higher	Similar	Higher (¥3493 vs ¥2322)	Similar (€11660 vs €9814)
Delaney (2003)[11]	USA	150	150	Lower	Lower	Higher ($1784 vs $1021)	Lower ($3209 vs $3655)
Leung (2004)[9b]	Hong Kong	203	200	Higher	Lower	Higher	Higher ($9297 vs $7148)
Senagore (2005)[16d]	USA	100	100		Lower		Lower ($3971 vs $5997)
Present study[e]	Korea	26	41	Higher	Lower	Higher ($2709 vs $1347)	Higher ($5019 vs $4093)

LAP, laparoscopic surgery; OS, open surgery; OR, operating room; $, US dollar; A$, Australian dollar; €, Euro
[a] It is unclear if *charge* or *cost* was used in the analysis
[b] *Charge* was used
[c] Total cost including productivity loss was compared
[d] Diagnosis-related groups (colorectal resection with complications) were compared
[e] *Cost* for OR cost and *charge* for total cost were used

(Table 7).[10,15,21] They expressed *charge* as *cost* in their articles, after conducting analyses of *charge*. Whereas *cost* is a difficult quantity to measure as it represents the actual value inherent to the resources required to the deliverer or provider, *charge* refers simply to billed costs and is therefore much easier to determine precisely than *cost*.[18] Thus, we used *cost* to compare OR costs, and *charge* to compare total hospital charges, an evaluation which encompassed anesthesia, laboratory, radiology, pharmacy, nursing, medical therapy, and consumables charges. In the present study, the total hospital charges were significantly higher for LAP than for OS, in agreement with previous studies.[9,10] The benefit-service charge associated with the NHI Corporation did not differ between LAP and OS; however, the non-benefit-service charges were significantly higher in the LAP patients. In accordance with many reports from other countries,[5,7–9,11,14,16,20] we found that the hospital stay associated with LAP was about 2 days shorter than that associated with OS, which is a direct result of earlier recovery after LAP and a faster return to normal activity. The length of a patient's hospital stay also depends on whether the hospital is operating at its maximal hospital bed turnover rate. Length of stay is often longer when a hospital is experiencing a low bed turnover rate This study had a minimal level of bias with regard to our comparison of lengths of hospital stay, as our working hospital is continuously operating at its maximal hospital bed turnover rate. We found that the higher OR costs incurred by the LAP patients were not compensated for by the lower costs of postoperative care saved over 2 days, due to the generally low charges associated with hospitalization in Korea. Thus, the impact of hospital stay on hospital charges clearly depends on the status of each nation's medical service system. In the present study, the increased hospital charges associated with LAP were determined to result primarily from the use of consumables, including stapling devices and laparoscopic instruments. Our analysis did not include indirect costs (such as productivity loss), or intangible costs (such as pain), both of which might have had an effect on the equation if taken into account. Societal perspectives, which would impact on direct, indirect, and intangible costs, constitute a broader perspective than those of hospitals or governments.[18] Thus, total health care costs might ultimately be lower for LAP if examined from the standpoint of societal perspectives. In a study conducted as a subset of the Swedish contributions to the Colon Cancer Laparoscopic or Open Resection (COLOR) trials, total health costs, when factors such as productivity losses were taken into account, did not differ between the LAP and OS groups.[12]

The present study found that the OR profit of a hospital, as the provider of a medical service, remained negative for both procedures, although LAP was associ-

ated with greater hospital deficits than OS. In Korea, much of the laparoscopic equipment used for LAP is regulated under the category of "unchargeable materials." Operation charges associated with LAP in the treatment of colorectal cancer are identical to those of OS in Korea. The present study determined that the NHI Corporation of Korea did not pay additional expenses for LAP. The higher expenses related to disposable instruments were excluded from the reimbursements made by the NHI Corporation, and devolved to the patients. Therefore, hospitals endure a greater economic deficit for LAP than for OS, which is principally the result of low operation charges, as well as the classification by the national government of some of the equipment used in LAP as "unchargeable."

The costs and benefits of new treatments in health interventions tend to vary over time, as a result of technological advances, market competition, staff training, and overall changes in economic conditions.[22] The initial costs are often high, but downstream costs tend to be lower.[23] Unfortunately, LAP generates a net health increase, characterized by earlier recovery and minimal incision, with an increase in net costs and charges. This study clearly showed that the operating time and equipment usage associated with LAP must be controlled for the procedure to become financially advantageous from the provider's perspective, as reported in several previous studies.[16] The cost issues associated with LAP from a direct-costs perspective have already been resolved in some centers,[11–17] but not in Korea. Laparoscopic surgery is not as cost-effective as OS for colorectal cancer in Korea. However, most colorectal surgeons are reluctant to stop performing LAP because of this. Many colorectal surgeons treat colorectal cancer by LAP at the request of the patients, who are aware of its short-term benefits, including faster recovery and minimal incisions, and also because LAP is not associated with additional oncological risks.[7–9]

In conclusion, we investigated for the first time the cost-effectiveness of LAP in comparison with OS, in Korea. We also compared the payments and OR hospital-profits between LAP and OS for colorectal cancer. A future randomized study, which includes both direct and indirect costs, will be necessary to prove that LAP can be cost-effective in the treatment of colorectal cancer.

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