

Comparison of the short-term outcomes of reduced-port laparoscopic surgery and conventional multiport surgery in colon cancer: a propensity score matching analysis

Ji Hoon Kang^{1,2}, Soo Young Lee¹, Chang Hyun Kim¹, Hyeong Rok Kim¹, Han Deok Kwak², Jae Kyun Ju², Young Jin Kim¹

¹Department of Surgery, Chonnam National University Hwasun Hospital, Chonnam National University Medical School, Hwasun, Korea

²Department of Surgery, Chonnam National University Hospital, Chonnam National University Medical School, Gwangju, Korea

Purpose: The feasibility of reduced-port laparoscopic surgery (RPS) in colon cancer remains uncertain. This study aimed to compare the short-term outcomes of RPS and multiport surgery (MPS) in colon cancer using propensity score matching analysis.

Methods: A total of 302 patients with colon cancer who underwent laparoscopic anterior resection (AR) (n = 184) or right hemicolectomy (RHC) (n = 118) by a single surgeon between January 2011 and January 2017 were included. Short-term outcomes were compared between RPS and MPS.

Results: Seventy-three patients in the AR group and 23 in the RHC group underwent RPS. After propensity score matching, the RPS and MPS groups showed similar baseline characteristics. In the AR group, patients who underwent RPS (n = 72) showed a shorter operation time (114.4 ± 28.7 minutes vs. 126.7 ± 34.5 minutes, P = 0.021) and a longer time to gas passage (3.6 ± 1.7 days vs. 2.6 ± 1.5 days, P = 0.005) than MPS (n = 72). Similarly, in the RHC group, the operation time was shorter (112.6 ± 26.0 minutes vs. 146.5 ± 31.2 minutes, P = 0.005), and the time to first flatus was longer (2.7 ± 1.1 days vs. 3.8 ± 1.3 days, P = 0.004) in the RPS group (n = 23) than in the MPS group (n = 23). Other short-term outcomes were similar for RPS and MPS in both the AR and RHC groups.

Conclusion: The short-term outcomes of RPS were found to be acceptable compared to those of MPS in colon cancer surgery.

[Ann Surg Treat Res 2018;94(3):147-153]

Key Words: Colonic neoplasms, Laparoscopy, Minimally invasive surgical procedures, Postoperative complications

INTRODUCTION

Colorectal cancer (CRC) is one of the most common cancer-causing mortalities in the world [1,2]. The current prevailing treatment of CRC is radical surgery followed by adjuvant therapy [3]. Historically, open laparotomy was the standard surgical procedure in CRC surgery; however, with the introduction of

laparoscopy, the proportion of laparoscopic colorectal surgeries has increased [4]. Some prospective randomized studies of laparoscopic surgical treatment for colon cancer have shown superior short-term outcomes such as reduced hospital stay, better cosmetic effect, and less pain, as well as comparable long-term outcomes to those of open surgical treatment [5-8]. Consequently, laparoscopic colon cancer surgery has been

Received May 29, 2017, Revised July 18, 2017, Accepted August 17, 2017

Corresponding Author: Young Jin Kim

Department of Surgery, Chonnam National University Hwasun Hospital, Chonnam National University Medical School, 322 Seoyang-ro, Hwasun 58128, Korea

Tel: +82-61-379-7642, Fax: +82-61-379-7661

E-mail: kimyj@jnu.ac.kr

ORCID code: https://orcid.org/0000-0002-0104-8255

Copyright © 2018, the Korean Surgical Society

© Annals of Surgical Treatment and Research is an Open Access Journal. All articles are distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/4.0/>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

established as a standard surgical treatment [9-11].

Recently, along with advancements in surgical skills and devices, several surgeons have reported the feasibility of single-port laparoscopic surgery (SPS) in colon cancer [12-16]. SPS has a cosmetic benefit compared with conventional multiport surgery (MPS) [12-16]; however, single-port laparoscopic colectomy requires a longer operation time, highly experienced surgeons, and advanced surgical techniques owing to its technical challenges, including collision of laparoscopic instruments and the limitation of triangular tissue traction [12,16].

Reduced-port laparoscopic surgery (RPS), which involves the insertion of an additional port in SPS, was introduced to overcome these challenges. The additional port in RPS may provide several advantages over SPS, including the avoidance of internal and external collisions between instruments and the ability to achieve efficient traction [17]. Although several previous studies have reported the short-term outcomes of RPS for colon cancer [17-21], the feasibility of RPS for colon cancer remains unclear.

Therefore, we designed this study to evaluate the feasibility of RPS for colon cancer by comparing the short-term outcomes of RPS and MPS.

METHODS

This study was approved by the Institutional Review Board of our institution. A waiver of informed consent was requested, and approval was obtained.

Study population

We retrospectively reviewed a prospectively collected colon cancer database between January 2011 and January 2017 and included patients who underwent laparoscopic colectomy performed by a single surgeon. Since most of the transverse colectomies, left hemicolectomies, and low anterior resections (ARs) were performed via MPS, only patients who underwent AR or right hemicolectomy (RHC) were included to minimize

selection bias. The choice of surgical method, either RPS or MPS, was determined by the attending surgeon.

Data collection

All patients underwent preoperative evaluation including abdominopelvic and chest computed tomography, laboratory testing, and colonoscopy with biopsy. Clinicopathologic data such as sex, age, body mass index (BMI), American Society of Anesthesiologists (ASA) physical status classification, abdominal operation history, TNM stage, and tumor size were collected. Intraoperative and postoperative outcomes including operation time, intraoperative blood loss, total number of lymph nodes harvested, time to gas passage, hospital stay, and postoperative complications were also reviewed.

Surgical procedure

Under general anesthesia, patients were placed in the lithotomy position. MPS was performed via the conventional 5-port method, with an umbilical camera port, 2 operator ports, and 2 assistant ports. A transumbilical midline or transverse mini-laparotomy was performed to extract the specimen. For RPS, we made a 3- to 4-cm-sized transumbilical midline or transverse incision, and inserted an Octoport (Dalim Surginet, Seoul, Korea), a single port with a 4-channel system. A 5-mm additional port was inserted in the right lower quadrant in AR and in the low midline in RHC (Fig. 1). Both RPS and MPS were performed in a similar way using general oncologic surgical principles. The detailed surgical techniques have been described previously [22]. A Jackson-Pratt drain was routinely placed on the operative bed via an additional 5-mm port during surgery and was removed at postoperative day 3 or 4. Operation time and intraoperative blood loss measured by the volume of suction and the weight of gauze were recorded after surgery.

Statistical analysis

Categorical variables were compared using the chi-square

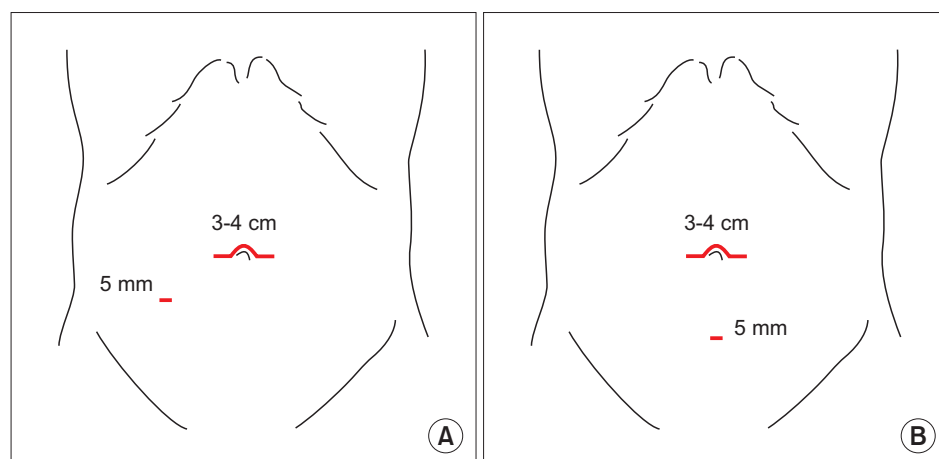


Fig. 1. Trochar insertion site of reduced-port laparoscopic surgery. (A) Anterior resection, (B) right hemicolectomy.

test or Fisher exact test, and continuous variables were compared using the Student t-test. To prevent selection bias by compensating for the differences in baseline characteristics, we conducted propensity score matching analysis. Propensity scores were derived using binary logistic regression for each patient who underwent either RPS or MPS using the covariates of age, sex, BMI, ASA physical status classification, abdominal operation history, TNM stage, and tumor size. Subsequently, patients who underwent RPS were matched to patients who underwent MPS according to their propensity scores. All results were considered significant at $P < 0.05$. Statistical analyses were conducted using IBM SPSS Statistics ver. 21.0 (IBM Co., Armonk, NY, USA).

RESULTS

A total of 184 patients who underwent AR and 118 patients who underwent RHC were included. Seventy-three patients (39.7%) in the AR group and 23 (19.5%) in the RHC group

underwent RPS. The clinicopathologic characteristics of the included patients are shown in Table 1. In general, baseline characteristics were similar between the RPS and MPS groups; however, patients who underwent RPS had earlier T stage in the AR group ($P = 0.038$), and less previous abdominal operation history in the RHC group ($P = 0.034$).

To reduce selection bias, we performed propensity score matching analysis, and the clinicopathologic characteristics of the matched cohorts are shown in Table 2. After matching, no significant differences between RPS and MPS in both the AR and RHC groups were found.

Table 3 presents the short-term outcomes according to surgical procedures after propensity score matching. In both the AR and RHC groups, there was no difference between the number of harvested lymph nodes (AR: 33.3 ± 14.5 vs. 31.1 ± 17.0 , $P = 0.409$; RHC: 50.8 ± 11.9 vs. 48.7 ± 17.5 , $P = 0.638$) between RPS and MPS. However, the operation time of RPS was shorter than that of MPS in both the AR (114.4 ± 28.7 minutes vs. 126.7 ± 34.5 minutes, $P = 0.021$) and RHC (112.61 ± 26.0 minutes vs. $146.52 \pm$

Table 1. Clinicopathologic characteristics

Variable	Anterior resection			Right hemicolectomy		
	RPS (n = 73)	MPS (n = 111)	P-value	RPS (n = 23)	MPS (n = 95)	P-value
Sex			0.660			0.806
Male	49 (67.1)	71 (64.0)		10 (43.5)	44 (46.3)	
Female	24 (32.9)	40 (36.0)		13 (56.5)	51 (53.7)	
Age (yr)	65.3 ± 10.0	67.3 ± 10.2	0.197	70.0 ± 8.0	67.9 ± 11.3	0.395
BMI (kg/m ²)	24.3 ± 2.9	23.8 ± 3.3	0.219	23.2 ± 3.4	25.0 ± 6.8	0.214
ASA PS classification			0.090			0.556
I	20/72 (27.8)	22 (19.8)		6 (26.1)	16 (16.8)	
II	51/72 (70.8)	80 (72.1)		15 (65.2)	72 (75.8)	
III	1/72 (1.4)	9 (8.1)		2 (8.7)	7 (7.4)	
Abdominal operation history			0.376			0.034
Yes	9 (12.3)	19 (17.1)		1 (4.3)	23 (24.2)	
No	64 (87.7)	92 (82.9)		22 (95.7)	72 (75.8)	
T stage			0.038			0.587
1	24 (32.9)	18 (16.2)		5 (21.7)	11 (11.6)	
2	6 (8.2)	15 (13.5)		1 (4.3)	7 (7.4)	
3	35 (47.9)	69 (62.2)		14 (60.9)	60 (63.2)	
4	8 (11.0)	9 (8.1)		3 (13.0)	17 (17.9)	
N stage			0.574			0.732
0	42 (57.5)	66 (59.5)		14 (60.9)	65 (68.4)	
1	24 (32.9)	30 (27.0)		6 (26.1)	18 (18.9)	
2	7 (9.6)	15 (13.5)		3 (13.0)	12 (12.6)	
M stage			0.386			0.388
0	70 (95.9)	103 (92.8)		23 (100)	92 (96.8)	
1	3 (4.1)	8 (7.2)		0 (0)	3 (3.2)	
Tumor size (mm)	40.7 ± 21.1	41.9 ± 19.9	0.704	48.1 ± 21.6	52.9 ± 26.5	0.428

Values are presented as number (%) or mean \pm standard deviation.

RPS, reduced-port surgery; MPS, multiport surgery; BMI, body mass index; ASA PS, American Society of Anesthesiologists physical status.

Table 2. Clinicopathologic characteristics after propensity score matching

Variable	Anterior resection			Right hemicolectomy		
	RPS (n = 72)	MPS (n = 72)	P-value	RPS (n = 23)	MPS (n = 23)	P-value
Sex						
Male	49 (68.1)	48 (66.7)	0.859	10 (43.5)	11 (47.8)	0.767
Female	23 (31.9)	24 (33.3)		13 (56.5)	12 (52.2)	
Age (yr)	65.2 ± 9.9	66.1 ± 10.6	0.593	70.0 ± 8.0	71.9 ± 10.7	0.495
BMI (kg/m ²)	24.4 ± 3.0	24.3 ± 3.3	0.888	23.1 ± 3.4	23.5 ± 3.7	0.727
ASA PS classification						
I	20 (27.8)	18 (25.0)	0.551	6 (26.1)	5 (21.7)	0.760
II	51 (70.8)	54 (75.0)		15 (65.2)	17 (73.9)	
III	1 (1.4)	0 (0)		2 (8.7)	1 (4.3)	
Abdominal operation history						
Yes	9 (12.5)	10 (13.9)	0.806	22 (95.7)	22 (95.7)	0.999
No	63 (87.5)	62 (86.1)		1 (4.3)	1 (4.3)	
T stage						
1	24 (33.3)	16 (22.2)	0.490	5 (21.7)	4 (17.4)	0.659
2	5 (6.9)	5 (6.9)		1 (4.3)	0 (0)	
3	35 (48.6)	43 (59.7)		14 (60.9)	17 (73.9)	
4	8 (11.1)	8 (11.1)		3 (13.0)	2 (8.7)	
N stage						
0	41 (56.9)	43 (59.7)	0.574	14 (60.9)	13 (56.5)	0.914
1	24 (33.3)	20 (27.8)		6 (26.1)	6 (26.1)	
2	7 (9.7)	9 (12.5)		3 (13.0)	4 (17.4)	
M stage						
0	69 (95.8)	68 (94.4)	0.698	23 (100)	23 (100)	0.999
1	3 (4.2)	4 (5.6)		0 (0)	0 (0)	
Tumor size (mm)	40.7 ± 21.3	43.1 ± 20.5	0.499	48.1 ± 21.6	49.9 ± 20.7	0.782

Values are presented as number (%) or mean ± standard deviation.

RPS, reduced-port surgery; MPS, multiport surgery; BMI, body mass index; ASA PS, American Society of Anesthesiologists physical status.

Table 3. Short-term outcomes according to surgical procedures

Variable	Anterior resection			Right hemicolectomy		
	RPS (n = 72)	MPS (n = 72)	P-value	RPS (n = 23)	MPS (n = 23)	P-value
Intraoperative						
Operation time (min)	114.4 ± 28.7	126.7 ± 34.5	0.021	112.61 ± 26.0	146.52 ± 31.2	<0.001
Blood loss (mL)	47.2 ± 57.2	69.4 ± 102.8	0.133	60.0 ± 75.5	103.65 ± 81.7	0.066
Number of harvested LN	33.3 ± 14.5	31.1 ± 17.0	0.409	50.8 ± 11.9	48.7 ± 17.5	0.638
Postoperative						
Time to gas passage (day)	3.6 ± 1.7	2.6 ± 1.5	<0.001	3.8 ± 1.3	2.7 ± 1.1	0.004
Hospital stay (day)	7.3 ± 1.5	7.3 ± 1.7	0.958	7.9 ± 3.1	7.6 ± 2.5	0.755
Complications*	7 (9.7)	7 (9.7)	0.999	4 (17.4)	4 (17.4)	0.999
I	7 (9.7)	3 (4.2)		3 (13.0)	0 (0)	
II	0 (0)	2 (2.8)		1 (4.3)	4 (17.4)	
III	0 (0)	2 (2.8)		0 (0)	0 (0)	

Values are presented as mean ± standard deviation or number (%).

RPS, reduced-port surgery; MPS, multiport surgery; LN, lymph node.

*Grade by Clavien-Dindo classification.

31.2 minutes, $P < 0.001$) groups. In addition, less intraoperative blood loss occurred during RPS than during MPS in both the AR (47.2 ± 57.2 mL vs. 69.4 ± 102.8 mL, $P = 0.133$) and RHC (60.0 ± 75.5 mL vs. 103.65 ± 81.7 mL, $P = 0.066$) groups, though it was not statistically significant. None of the patients experienced conversion to open surgery in either RPS or MPS, and no case in the RPS group was converted to MPS.

Regarding postoperative outcomes, length of hospital stay (AR: 7.3 ± 1.5 days vs. 7.3 ± 1.7 days, $P = 0.958$; RHC: 7.9 ± 3.1 days vs. 7.6 ± 2.5 days, $P = 0.755$) was similar between RPS and MPS (Table 3). No differences in postoperative complications such as pneumonia, urinary retention, prolonged postoperative ileus, or wound infection were observed between the 2 groups (AR: 9.7% vs. 9.7%, $P = 0.999$; RHC: 17.4% vs. 17.4%, $P = 0.999$) (Table 3). Most complications were grade I or II by the Clavien-Dindo classification, and only 2 patients (2.8%) who underwent AR by MPS experienced grade III complication (Table 3). However, time to gas passage was longer in RPS in both the AR (3.6 ± 1.7 days vs. 2.6 ± 1.5 days, $P < 0.001$) and RHC (3.8 ± 1.3 days vs. 2.7 ± 1.1 days, $P = 0.004$) groups (Table 3). No 30-day mortality occurred in either group.

DISCUSSION

In this study, we compared the short-term outcomes of RPS and MPS in colon cancer after propensity score matching. RPS was associated with a shorter operation time and a longer time to gas passage compared with MPS in both the AR and RHC groups. Intraoperative blood loss tended to be less in the RPS group than in the MPS group. In general, the short-term outcomes of RPS in colon cancer were acceptable to those of MPS.

In light of the trend toward minimally invasive surgery, single-port laparoscopic colectomy in colon cancer has become increasingly popular worldwide, and many previous studies have reported the feasibility of SPS in colon cancer [12-16]. However, SPS has the inherent weakness of technical difficulties owing to the potential collision of laparoscopic instruments and the limitation of triangular tissue traction [12,16]; consequently, SPS is an infrequently utilized colectomy procedure worldwide [17]. In contrast, enhanced by the addition of another small-size working port, RPS may partially overcome these drawbacks [17], which may increase the generalizability of the procedure. Moreover, RPS has other advantages, such as the convenience of an intracorporeal suture and stable drain placement via the additional port [17]. While several previous studies have demonstrated the feasibility of RPS in colon cancer [17-21], these studies had certain limitations such as the absence of a control group [18,19], the use of 4 ports [20], and a small number of patients who underwent RPS [17,18,20,21]. Furthermore, due to their retrospective study

design, these studies had a high risk of selection bias [17-21]. In the present study based on a relatively large prospective cohort, we performed propensity score matching analysis to reduce selection bias and confounding effect and confirmed that the short-term outcomes of RPS were comparable to those of MPS.

Interestingly, the operation time was shorter in the RPS group than in the MPS group (Table 3), which is similar to the results of previous studies [17,21]. It seems paradoxical that RPS, which could be considered more technically difficult than MPS, resulted in a shorter operation time. In previous studies, selection bias was identified as a possible explanation for this observation, suggesting that a greater number of less-complicated cases were included in the RPS group, thereby leading to shorter operation times [17,21]. However, after compensating for potential confounders such as abdominal operation history, TNM stage, and tumor size by propensity score matching, the results of our study also demonstrated decreased operation times in RPS. Another proposed explanation was that the shorter operation time of RPS could be attributed to the surgeon's high level of expertise [21]. In the present study cohort, RPS was generally performed more recently during the study period; therefore, the surgeon's advanced surgical techniques might have enabled shorter operation times in RPS. Lastly, the time of wound closure may also be a factor in the paradoxical difference. In our institution, all of the incision wounds were generally closed using a layer-by-layer method and knot-bearing skin suture by less-skilled junior residents, the timing of which might have been prolonged. Therefore, the fewer number and smaller size of the wounds might have led to decreased time of wound closure, resulting in shorter overall operation times in RPS.

Comparing postoperative outcomes, there was no significant difference in hospital stay and postoperative complications between the 2 groups. However, time to first flatus in the RPS group was longer than that in the MPS group (Table 3). This may be related to bowel manipulation during the surgical procedure. It is more difficult to establish the operative field in RPS than in MPS; therefore, increased manipulation of the bowels is inevitable in RPS, which may result in delayed gas passage. However, in the present study, no difference in the incidence of prolonged postoperative ileus and hospital stay between the 2 groups was found. Thus, delayed gas passage did not compromise the short-term outcomes of RPS in colon cancer.

In the present study, we were unable to compare long-term outcomes, due to the short follow-up period. Instead, we compared the total number of harvested lymph nodes, which has a reported association with prognosis in colon cancer [23-25]. No difference in the number of harvested lymph nodes was found between RPS and MPS (Table 3). Since both RPS and MPS were performed by a single surgeon in a similar fashion, similar

numbers of harvested lymph nodes might represent the overall oncologic safety of RPS. Further studies are needed to evaluate the long-term outcome of RPS in colon cancer.

The present study has several limitations. First, although we utilized propensity score matching analysis, hidden confounders and bias may still exist due to the retrospective nature of the study. To overcome this limitation, a large-scale randomized controlled trial is necessary. Second, the number of patients who underwent RHC by RPS is relatively small ($n = 23$). Last, although RPS has been reported to have cosmetic benefits compared with MPS [18,21], we could not show the total incision length or the satisfaction of patients due to the retrospective study design. Nevertheless, this study is one of the few to investigate the

feasibility of RPS in colon cancer, and the minimization of bias by propensity score matching is a definite strength.

In conclusion, RPS is a feasible procedure in colon cancer surgery in light of the comparable short-term outcomes of RPS and MPS after adjusting for confounding factors via propensity score matching. The long-term oncologic outcomes of RPS should be evaluated in further studies.

CONFLICTS OF INTEREST

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

REFERENCES

1. Siegel RL, Miller KD, Jemal A. Cancer statistics, 2017. *CA Cancer J Clin* 2017;67:7-30.
2. Jung KW, Won YJ, Oh CM, Kong HJ, Lee DH, Lee KH, et al. Cancer statistics in Korea: incidence, mortality, survival, and prevalence in 2014. *Cancer Res Treat* 2017;49:292-305.
3. Law WL, Chu KW, Tung PH. Laparoscopic colorectal resection: a safe option for elderly patients. *J Am Coll Surg* 2002;195:768-73.
4. Kang SB, Park JW, Jeong SY, Nam BH, Choi HS, Kim DW, et al. Open versus laparoscopic surgery for mid or low rectal cancer after neoadjuvant chemoradiotherapy (COREAN trial): short-term outcomes of an open-label randomised controlled trial. *Lancet Oncol* 2010;11:637-45.
5. Lacy AM, García-Valdecasas JC, Delgado S, Castells A, Taurá P, Piqué JM, et al. Laparoscopy-assisted colectomy versus open colectomy for treatment of non-metastatic colon cancer: a randomised trial. *Lancet* 2002;359:2224-9.
6. Clinical Outcomes of Surgical Therapy Study Group, Nelson H, Sargent DJ, Wieand HS, Fleshman J, Anvari M, et al. A comparison of laparoscopically assisted and open colectomy for colon cancer. *N Engl J Med* 2004;350:2050-9.
7. Jayne DG, Guillou PJ, Thorpe H, Quirke P, Copeland J, Smith AM, et al. Randomized trial of laparoscopic-assisted resection of colorectal carcinoma: 3-year results of the UK MRC CLASICC Trial Group. *J Clin Oncol* 2007;25:3061-8.
8. Green BL, Marshall HC, Collinson F, Quirke P, Guillou P, Jayne DG, et al. Long-term follow-up of the Medical Research Council CLASICC trial of conventional versus laparoscopically assisted resection in colorectal cancer. *Br J Surg* 2013;100:75-82.
9. Lorenzon L, La Torre M, Ziparo V, Montebelli F, Mercantini P, Balducci G, et al. Evidence based medicine and surgical approaches for colon cancer: evidences, benefits and limitations of the laparoscopic vs open resection. *World J Gastroenterol* 2014;20:3680-92.
10. Sammour T, Jones IT, Gibbs P, Chandra R, Steel MC, Shedd SM, et al. Comparing oncological outcomes of laparoscopic versus open surgery for colon cancer: analysis of a large prospective clinical database. *J Surg Oncol* 2015;111:891-8.
11. Scarpa M, Erroi F, Ruffolo C, Mollica E, Polese L, Pozza G, et al. Minimally invasive surgery for colorectal cancer: quality of life, body image, cosmesis, and functional results. *Surg Endosc* 2009;23:577-82.
12. Choi SI, Lee KY, Park SJ, Lee SH. Single port laparoscopic right hemicolectomy with D3 dissection for advanced colon cancer. *World J Gastroenterol* 2010;16:275-8.
13. Hamzaoglu I, Karahasanoglu T, Baca B, Karatas A, Aytac E, Kahya AS. Single-port laparoscopic sphincter-saving mesorectal excision for rectal cancer: report of the first 4 human cases. *Arch Surg* 2011;146:75-81.
14. Merchant AM, Lin E. Single-incision laparoscopic right hemicolectomy for a colon mass. *Dis Colon Rectum* 2009;52:1021-4.
15. Ramos-Valadez DI, Patel CB, Ragupathi M, Bartley Pickron T, Haas EM. Single-incision laparoscopic right hemicolectomy: safety and feasibility in a series of consecutive cases. *Surg Endosc* 2010;24:2613-6.
16. Poon JT, Cheung CW, Fan JK, Lo OS, Law WL. Single-incision versus conventional laparoscopic colectomy for colonic neoplasm: a randomized, controlled trial. *Surg Endosc* 2012;26:2729-34.
17. Yu H, Shin JY. Short-term outcomes following reduced-port, single-port, and multi-port laparoscopic surgery for colon cancer: tailored laparoscopic approaches based on tumor size and nodal status. *Int J Colorectal Dis* 2016;31:115-22.
18. Bae SU, Baek SJ, Min BS, Baik SH, Kim NK, Hur H. Reduced-port laparoscopic surgery for a tumor-specific mesorectal excision

- in patients with colorectal cancer: initial experience with 20 consecutive cases. *Ann Coloproctol* 2015;31:16-22.
19. Tsutsumi S, Morita H, Fujii T, Suto T, Yajima R, Takada T, et al. Feasibility of reduced port laparoscopic colectomy for colon cancer. *Hepatogastroenterology* 2015;62:873-5.
 20. Nakanishi M, Kuriu Y, Murayama Y, Arita T, Ito H, Kosuga T, et al. Usefulness of reduced port surgery for left colon cancer. *Anticancer Res* 2016;36:4749-52.
 21. Song JM, Kim JH, Lee YS, Kim HY, Lee IK, Oh ST, et al. Reduced port laparoscopic surgery for colon cancer is safe and feasible in terms of short-term outcomes: comparative study with conventional multi-port laparoscopic surgery. *Ann Surg Treat Res* 2016;91:195-201.
 22. Huh JW, Kim CH, Kim HR, Kim YJ. Factors predicting oncologic outcomes in patients with fewer than 12 lymph nodes retrieved after curative resection for colon cancer. *J Surg Oncol* 2012;105:125-9.
 23. Le Voyer TE, Sigurdson ER, Hanlon AL, Mayer RJ, Macdonald JS, Catalano PJ, et al. Colon cancer survival is associated with increasing number of lymph nodes analyzed: a secondary survey of intergroup trial INT-0089. *J Clin Oncol* 2003; 21:2912-9.
 24. Swanson RS, Compton CC, Stewart AK, Bland KI. The prognosis of T3N0 colon cancer is dependent on the number of lymph nodes examined. *Ann Surg Oncol* 2003;10:65-71.
 25. Sarli L, Bader G, Iusco D, Salvemini C, Mauro DD, Mazzeo A, et al. Number of lymph nodes examined and prognosis of TNM stage II colorectal cancer. *Eur J Cancer* 2005;41:272-9.