Systematic review of laparoscopic vs open surgery for colorectal cancer in elderly patients

Shoichi Fujii, Mitsuo Tsukamoto, Yoshihisa Fukushima, Ryu Shimada, Koichi Okamoto, Takeshi Tsuchiya, Keijiro Nozawa, Keiji Matsuda, Yojiro Hashiguchi

Shoichi Fujii, Mitsuo Tsukamoto, Yoshihisa Fukushima, Ryu Shimada, Koichi Okamoto, Takeshi Tsuchiya, Keijiro Nozawa, Keiji Matsuda, Yojiro Hashiguchi, Department of Surgery, Teikyo University School of Medicine, Tokyo 173-8605, Japan

Author contributions: Fujii S wrote the paper; Tsukamoto M, Fukushima Y, Shimada R, Okamoto K, Tsuchiya T, Nozawa K and Matsuda K performed the collected the data; Hashiguchi Y generalized and guided the paper production.

Conflict-of-interest statement: Authors declare no conflict of interests for this article.

Data sharing statement: No additional data are available.

Open-Access: This article is an open-access article which was selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: http://creativecommons.org/licenses/by-nc/4.0/

Manuscript source: Invited manuscript

Correspondence to: Shoichi Fujii, MD, PhD, Department of Surgery, Teikyo University School of Medicine, 2-11-1 Kaga, Itabashi-ku, Tokyo 173-8605, Japan. sfujii631011@med.teikyo-u.ac.jp Telephone: +81-3-39641231 Fax: +81-3-53756097

Received: March 4, 2016 Peer-review started: March 7, 2016 First decision: April 15, 2016 Revised: April 15, 2016 Accepted: May 17, 2016 Article in press: May 27, 2016 Published online: July 15, 2016

Abstract

AIM: To verify the safety and validity of laparoscopic surgery for the treatment of colorectal cancer in elderly patients.

METHODS: A meta-analysis was performed of a systematic search of studies on an electronic database. Studies that compared laparoscopic colectomy (LAC) in elderly colorectal cancer patients with open colectomy (OC) were retrieved, and their short and long-term outcomes compared. Elderly people were defined as 65 years old or more. Inclusion criteria were set at: Resection of colorectal cancer, comparison between laparoscopic and OC and no significant difference in backgrounds between groups.

RESULTS: Fifteen studies were identified for analysis. LAC was performed on 1436 patients, and OC performed on 1810 patients. In analyses of short-term outcomes, operation time for LAC was longer than for OC (mean difference = 34.4162, 95%CI: 17.8473-50.9851, \( P < 0.0001 \)). The following clinical parameters were lower in LAC than in OC: Amount of estimated blood loss (mean difference = -93.3738, 95%CI: -132.3437 to -54.4039, \( P < 0.0001 \)), overall morbidity (OR = 0.5427, 95%CI: 0.4425-0.6655, \( P < 0.0001 \)), incisional surgical site infection (OR = 0.6262, 95%CI: 0.4310-0.9097, \( P = 0.0140 \)), bowel obstruction and ileus (OR = 0.6248, 95%CI: 0.4519-0.8638, \( P = 0.0044 \)) and cardiovascular complications (OR = 0.4767, 95%CI: 0.2805-0.8101, \( P = 0.0062 \)). In analyses of long-term outcomes (median follow-up period: 36.4 mo in LAC, 34.3 mo in OC), there was no significant difference in overall survival (mean difference = 0.8321, 95%CI: -93.3738, 95%CI: -132.3437 to -54.4039, \( P < 0.0001 \)), overall morbidity (OR = 0.5427, 95%CI: 0.4425-0.6655, \( P < 0.0001 \)), incisional surgical site infection (OR = 0.6262, 95%CI: 0.4310-0.9097, \( P = 0.0140 \)), bowel obstruction and ileus (OR = 0.6248, 95%CI: 0.4519-0.8638, \( P = 0.0044 \)) and cardiovascular complications (OR = 0.4767, 95%CI: 0.2805-0.8101, \( P = 0.0062 \)). In analyses of long-term outcomes (median follow-up period: 36.4 mo in LAC, 34.3 mo in OC), there was no significant difference in overall survival (mean difference = 0.8321, 95%CI: -93.3738, 95%CI: -132.3437 to -54.4039, \( P < 0.0001 \)), overall morbidity (OR = 0.5427, 95%CI: 0.4425-0.6655, \( P < 0.0001 \)), incisional surgical site infection (OR = 0.6262, 95%CI: 0.4310-0.9097, \( P = 0.0140 \)), bowel obstruction and ileus (OR = 0.6248, 95%CI: 0.4519-0.8638, \( P = 0.0044 \)) and cardiovascular complications (OR = 0.4767, 95%CI: 0.2805-0.8101, \( P = 0.0062 \)).
CONCLUSION: LAC in elderly colorectal cancer patients had benefits in short-term outcomes compared with OC except operation time. The long-term outcomes and oncological clearance of LAC were similar to that of OC. These results support the assertion that LAC is an effective procedure for elderly patients with colorectal cancer.

Key words: Laparoscopic surgery; Systematic review; Meta-analysis; Colorectal cancer; Elderly patient

© The Author(s) 2016. Published by Baishideng Publishing Group Inc. All rights reserved.

Core tip: Safety and effectiveness of laparoscopic surgery (LAC) in elderly has been unknown. A meta-analysis was performed of a systematic search of studies on an electronic database. Studies that compared LAC in elderly colorectal cancer patients with open colectomy (OC) were retrieved, and their short and long-term outcomes compared. Fifteen studies which had 1436 LAC and 1810 OC were identified. In short-term outcomes, blood loss, morbidity, incisional surgical site infection, bowel obstruction and cardiovascular complications were superior in LAC except operation time. There was no significant difference in long-term outcomes. LAC is an effective procedure for elderly with colorectal cancer.

Fujii S, Tsukamoto M, Fukushima Y, Shimada R, Okamoto K, Tsuchiya T, Nozawa K, Matsuda K, Hashiguchi Y. Systematic review of laparoscopic vs open surgery for colorectal cancer in elderly patients. World J Gastrointest Oncol 2016; 8(7): 573-582 Available from: URL: http://www.wjgnet.com/1948-5204/full/v8/i7/573.htm DOI: http://dx.doi.org/10.4251/wjgo.v8.i7.573

INTRODUCTION

People are living longer across the globe. According to the World Health Organization, 6.9% of the world was over the age of 65 in 2000 with an estimated increase to 10.4% in 2025 and a further rise to 16.4% in 2050[1]. This estimation is valid in all regions of the world. Average life expectancies in 2025 are estimated to be 77 years old in the Americas and Europe and 72 years old in Asia. Colorectal cancer is the third most common malignant neoplasm in the world and aging is assumed to be one of the risk factors for colorectal carcinogenesis[2]. Elderly patients have a higher American Society of Anesthesiologists score, higher cardiac and pulmonary comorbidity rate and lower preoperative nutritional conditioning than younger patients[3-5]. Therefore, there is a high risk associated with even minimally invasive surgery in elderly patients. Several studies have reported the benefits of laparoscopic colorectal surgery in elderly patients[6-10]. Most studies concluded that laparoscopic surgery had a lower postoperative morbidity rate and shorter length of hospital stay when compared to open surgery. Several large-scale systematic reviews that compare laparoscopic colorectal surgery with open surgery have been published in recent years[11,12]. They report that laparoscopic surgery has lower mortality, lower overall morbidity, lower cardiac and respiratory complications, lower wound infection and shorter length of hospital stay. However, they analyzed both colorectal cancer and benign diseases together. The surgical procedure for colorectal cancer differs from that for benign disease because optimal lymph node dissection and resection, with a securing safety margin, are vital in malignant neoplasm surgery. Therefore, a study analyzing laparoscopic surgery that targeted only colorectal cancer was required.

Moreover, the results of previous reviews reported only short-term outcomes. The evaluation of long-term outcomes is very important in the analysis of treatment efficacy for malignant neoplasia. The purpose of the present review is to clarify the benefits of laparoscopic surgery in elderly patients with colorectal cancer. We analyzed not only short-term but also long-term outcomes.

MATERIALS AND METHODS

Eligibility criteria

Elderly people were defined as 65 years old or more, as outlined by the World Health Organization[1]. All studies were limited to randomized controlled or comparative studies. The subject of each study was limited to colorectal cancer and studies that included any benign disease were excluded. Backgrounds were similar between both groups, and had at least 15 patients in one group. The results had to include a comparison between laparoscopic and open surgery.

Outcomes

Short-term outcomes analyzed in the present study were as follows: Operative time, amount of estimated blood loss, mortality, overall morbidity, incisional surgical site infection, deep surgical site infection, anastomotic leakage, bowel obstruction and ileus, pneumonia, cardiovascular complication, time of normal bowel function and length of postoperative hospital stay. Duration of short-term was defined after the operation within 30 d. The overall and disease specific survival rates were measured as long-term outcomes.

The number of dissected lymph nodes was used as an indicator of oncological clearance.

Study selection

The literature search was performed electronically using PubMed (MEDLINE). The search terms were as follows: Elderly or old, colorectal cancer or colon cancer, and laparoscopic surgery or laparoscopic colectomy (LAC) in combination with Boolean operators AND or OR. The language was limited to English. Studies were selected from those published after 2000 because they included the long-term results of several randomized...
controlled studies that compared laparoscopic and open surgery\textsuperscript{13-18}. Moreover, developments in laparoscopic surgery instrumentation might influence short-term results in studies conducted in more recent years.

**Assessment of study quality**

The number of randomized controlled study was only one in this meta-analysis\textsuperscript{19}. The randomized controlled study was assessed for methodological quality using the Cochrane Handbook\textsuperscript{20}. Five of six items were at low risk of bias. Blinding of the study was not possible.

The comparative studies were assessed by the Newcastle-Ottawa Quality Assessment Scale (NOS)\textsuperscript{21}. Twelve of 14 studies had 6 or more star points on the NOS scale.

**Statistical analysis**

The odds ratios (ORs) for each study and 95% CIs were calculated from event numbers of categorical variables of short-term results. Pooled ORs were calculated using a random effect model. The mean value difference between continuous variables of short-term results and the number of dissected lymph nodes was also calculated using a random effect model. In the analysis of long-term results, 95% CIs of survival comparison and the number of patients in each study were synthesized using a random effect model. Synthesis of data was performed using the DerSimonian-Laird method\textsuperscript{22}. Study heterogeneity was checked by means of Cochran’s Q statistic. If the $P$ value of the heterogeneity test was less than 0.05 in significance level, a null hypothesis of homogeneity was dismissed and study heterogeneity was proved. Publication bias among the studies was checked using the Egger test or Begg test accordingly. If the $P$ value for publication bias was less than 0.10 a null hypothesis of no bias was dismissed and publication bias was confirmed.

**RESULTS**

**Study profile**

Thirty seven studies were identified by the first screening of MEDLINE. The reviews and studies that included benign disease cases or no data comparison between laparoscopic and open surgery were excluded. Finally, 15 studies were selected for analysis (Figure 1)\textsuperscript{19,23-36}.

The types of studies were as follows: 1 randomized controlled, 2 case-matched, 1 prospective comparative and 11 retrospective comparative studies. In total, 1436 laparoscopic surgeries and 1810 open surgeries were analyzed. Conversion to open surgery was described in 9 studies. The range of conversion rate was between 0% and 13.9%, and the incidence of total patients was 4.5%. A summary of study characteristics is shown in Table 1.

**Short-term outcomes**

**Operation time:** Five studies reported operative time as the mean value with standard deviation. The operation time of LAC was significantly longer than OC (mean difference = 34.4162, 95% CI: 17.8473-50.9851, $P <$
The heterogeneity was statistically significant (Cochrane’s Q = 156.2123, P < 0.0001). Publication bias was not evident (Egger = 0.3993, P = 0.9409) (Figure 2).

**Amount of estimated blood loss:** Six studies reported the amount of estimated blood loss as a mean value with standard deviation. The operation time of LAC was significantly less than OC (mean difference = -93.373, 95%CI: -132.3437 to -54.4039, P < 0.0001). Heterogeneity was statistically evident (Cochrane’s Q = 74.1364, P < 0.0001). Publication bias was not evident (Egger = 0.9129, P = 0.7776) (Figure 3).

**Mortality:** Four studies reported mortality. There was no significant difference between LAC and OC in mortality (OR = 0.5052, 95%CI: 0.2438-1.0467, P = 0.0662). Heterogeneity and publication bias were not evident (Cochrane’s Q = 2.0911, P = 0.5537, Egger = -0.6646, P = 0.5883).

**Overall morbidity:** Thirteen studies reported incidence of overall morbidity. The overall morbidity of LAC was significantly less than for OC (OR = 0.5427, 95%CI: 0.4425-0.6655, P < 0.0001). Heterogeneity was not evident (Cochrane’s Q = 14.7867, P = 0.2533). Publication bias was not evident (Egger = -0.6646, P = 0.5883).
Incisional surgical site infection: Twenty studies reported the incidence of incisional surgical site infection. The incisional surgical site infection of LAC was significantly less than for OC (OR = 0.6262, 95%CI: 0.4310-0.9097, P = 0.0140). Heterogeneity and publication bias were not evident (Cochrane’s Q = 15.2636, P = 0.1707, Egger = -0.3638, P = 0.6557) (Figure 5).

Deep surgical site infection: Four studies reported the incidence of deep surgical site infection. There was no significant difference between LAC and OC in deep surgical site infection (OR = 0.8234, 95%CI: 0.3298-2.0556, P = 0.6771). Heterogeneity and publication bias were not evident (Cochrane’s Q = 6.3512, P = 0.0957, Egger = -3.0524, P = 0.1922).

Anastomotic leakage: Twenty studies reported the incidence of anastomotic leakage. There was no significant difference between LAC and OC in anastomotic leakage (OR = 0.9138, 95%CI: 0.5667-1.4735, P = 0.7115). Heterogeneity and publication bias were not evident (Cochrane’s Q = 8.0075, P = 0.7126, Egger = 0.0396, P = 0.9632) (Figure 6).

Bowel obstruction and ileus: Ten studies reported the incidence of bowel obstruction and ileus. Bowel obstruction and ileus of LAC was significantly less than for OC (OR = 0.6248, 95%CI: 0.4519-0.8638, P = 0.0044). Heterogeneity and publication bias were not evident (Cochrane’s Q = 8.7612, P = 0.4596, Egger = -1.1383, P = 0.1602) (Figure 7).

Pneumonia: Three studies reported the incidence of pneumonia. There was no significant difference between LAC and OC in the incidence of pneumonia (OR = 0.4526, 95%CI: 0.2805-0.8101, P = 0.0062). Heterogeneity was not evident (Cochrane’s Q = 2.3251, P = 0.1327, Egger = -0.1846, P = 0.9743).

Cardiovascular complication: Eight studies reported the incidence of cardiovascular complication. Cardiovascular complications of LAC was significantly less than for OC (OR = 0.4767, 95%CI: 0.2805-0.8101, P = 0.0062). Heterogeneity was not evident (Cochrane’s Q = 0.4519-0.8638, P = 0.0044).
Fujii S et al. Laparoscopic surgery in elderly cancer

Recovery time of normal bowel function: Five studies reported the recovery time of normal bowel function as the mean value with standard deviation. There was no significant difference in the recovery time to normal bowel function between LAC and OC (mean difference = -0.8573, 95%CI: -1.8778 to 0.1632, \( P = 0.0997 \)). Heterogeneity was statistically evident (Cochrane’s \( Q = 379.9427, P < 0.0001 \)). Publication bias was not evident (Egger = -0.3638, \( P = 0.6557 \)).

Length of postoperative hospital stay: Three studies reported the length of postoperative hospital stay as the mean value with standard deviation. There was no significant difference in the length of postoperative hospital stay between LAC and OC (mean difference = -1.3336, 95%CI: -3.3995 to 0.7322, \( P = 0.2058 \)). Heterogeneity was not evident (Cochrane’s \( Q = 8.0075, P = 0.7126 \)). Publication bias was statistically evident (Egger = 0.0396, \( P = 0.9632 \)).
significant difference in the disease specific survival between LAC and OC (mean difference = 1.0254, 95%CI: 0.6707 to 1.5675, P = 0.9209). Heterogeneity and publication bias were not evident (Cochrane's Q = 0.1648, P = 0.9209, Egger = -0.4921, P = 0.1559) (Figure 10).

Oncological clearance

The number of dissected lymph nodes: Two studies reported the number of dissected lymph nodes as the mean value with standard deviation. There was no significant difference in the number of dissected lymph nodes between LAC and OC (mean difference = -0.1360, 95%CI: -4.0553 to 3.7833, P = 0.9458). Heterogeneity and publication bias were not evident (Cochrane's Q = 8.7612, P = 0.4596, Publication bias: Egger = -1.1383, P = 0.1602).

Figure 7  Forest plot of the odds ratio for bowel obstruction and ileus. LAC: Laparoscopic surgery; OC: Open surgery.

Figure 8  Forest plot of the odds ratio for cardiovascular complication. LAC: Laparoscopic surgery; OC: Open surgery.

Figure 9  Forest plot of the odds ratio for overall survival. LAC: Laparoscopic surgery; OC: Open surgery.
bowl function. These outcomes were synthesized with studies which had 6 or more star points. Results were similar to the primary analyzed results and there was no conversion of interpretation.

**DISCUSSION**

Two systematic reviews that compare LAC with OC report benefits in short-term outcome. Grailey et al[11] report that LAC reduces the length of hospital stay, intraoperative blood loss, pneumonia, time to normal bowel function, cardiac complication and wound infection. Antoniou et al[12] report that LAC had a decreased risk for mortality, overall morbidity, plus cardiac and respiratory complications. Their results are similar to those reported in this review. However, they included analyses for both colorectal cancer and benign disease. Large scale, randomized studies and reviews that compare long-term results between LAC and OC in all generations report no difference in colon cancer patients[37]. However, long-term results of randomized studies and reviews with elderly patient have not yet been reported. This meta-analysis, which compared LAC and OC in elderly colorectal cancer patients, demonstrates advantages in short-term and equivalency with respect to long-term outcomes and oncological clearance. These results will be useful in informing the selection of operative approach in elderly patients.

In analyses of the amount of estimated blood loss, overall morbidity, incisional site infection and cardiovascular complication were all reduced in LAC. These results are similar to previous reports[11,12]. It has been suggested that decreases in blood loss and postoperative pain reduce the stress of surgery, and thereby reduce overall morbidity. The reduction in cardiovascular complications might also be due to decrease in blood loss. Bowel obstruction and ileus were also reduced in LAC. Bowel obstruction and ileus were not distinguished in this analysis, because the definition was not clear in some studies and data was assigned to both conditions. This was not shown in previous reviews and it is supposed that the incidence of ileus increase is due to the extent of lymph node dissection in colorectal cancer. The exposure of intestines and major trauma to the abdominal wall might explain the increase in incidence of bowel paralysis and adhesion in OC.

The operative time of LAC was longer than OC. This result was consistent with past reports, too. However, pneumonia was not increased and overall morbidity was decreased in LAC. Mean difference in operative time was about 34 min. The increase in operative time and pneumoperitoneum may not cause adverse effects on postoperative morbidity.

In this meta-analysis, there were no significant differences in mortality, incidence of pneumonia and recovery time of normal bowel function, which is not consistent with past reports. However, all LAC results tended to be lower than OC and p-values were close to being significantly different (mortality; OR = 0.5052, 95%CI: 0.2438-1.0467, P = 0.0662, pneumonia; OR = 0.4526, 95%CI: 0.1976-1.0365, P = 0.0608, recovery time of normal bowel function; mean difference = -0.8573, 95%CI: -1.8778 to 0.1632, P = 0.0997). These inconsistent results may be due to the fact that patients who underwent elective colorectal surgery could be considered to be at relatively low risk. The reason for there being no significant difference in recovery time of normal bowel function is unknown. There might have been a significant difference if the time period of the data collection was a number of days not hours.

The incidences of deep surgical site infection and anastomotic leakage were similar between LAC and OC (deep surgical site infection; OR = 0.8234, 95%CI: 0.3298-2.0556, P = 0.6771). It was suggested that surgical invasiveness of the retroperitoneal dissection and anastomotic procedure are similar between LAC and OC in colorectal cancer surgery.

There was no significant difference in length of postoperative hospital stay.

This may be due to differences in the standard for hospital discharge in each study and may also be related to differences in the insurance systems in each country. Thus there might be a large bias in social factors between studies.

In analyses of long-term outcomes, both overall and disease specific survival rates were similar. There was also no significant difference in the number of dissected lymph nodes. This reveals the fact that LAC had similar treatment success to OC. The results of randomized studies and Cochrane review were also supported by this meta-analysis in elderly colorectal cancer surgery.
Laparoscopic surgery for colorectal cancer is increasing rapidly, particularly among elderly patients. However, neither the safety nor the effectiveness of laparoscopic surgery in this demographic has yet been determined.

Some systematic reviews that compare laparoscopic colectomy (LAC) with open colectomy for elderly had reported benefits in short-term outcome. However, past reports included benign diseases, and no report about long-term results. The authors analyzed for elderly colorectal cancer only and long-term outcomes were limited to three data sets from two studies. The analysis of more long-term results, that include details on the specific form of relapse, may thus be required.

LAC in elderly colorectal cancer patients had benefits in short-term outcomes such as amount of estimated blood loss, overall morbidity, incidences of incisional surgical site infection, bowel obstruction and ileus and cardiovascular complications. The only area where LAC did not show a benefit over OC was for operative time. The long-term outcomes and oncological clearance of LAC were similar to that of OC. These results support the view that LAC is an effective and safe procedure for elderly patients with colorectal cancer.

**COMMENTS**

**Background**
Laparoscopic surgery for colorectal cancer is increasing rapidly, particularly among elderly patients. However, neither the safety nor the effectiveness of laparoscopic surgery in this demographic has yet been determined.

**Research frontiers**
Some systematic reviews that compare laparoscopic colectomy (LAC) with open colectomy for elderly had reported benefits in short-term outcome.

**Innovations and breakthroughs**
However, past reports included benign diseases, and no report about long-term results. The authors analyzed for elderly colorectal cancer only and long-term outcomes.

**Applications**
Some short-term outcomes were superior in LAC except operation time. There was no significant difference in long-term outcomes. LAC is an effective procedure for elderly with colorectal cancer.

**Terminology**
LAC: Laparoscopic colectomy.

**Peer-review**
Good review article, scientific and rigorous analysis.

**REFERENCES**
1 World Health Organization. Men, ageing and health: Achieving health across the life span. [World Health Organization web site]. Available from: URL: http://whqlibdoc.who.int/hq/2001/WHO_NM_H_NPH_01.2.pdf?ua=1
2 Rasool S, Kadla SA, Rasool V, Ganai BA. A comparative overview of general risk factors associated with the incidence of colorectal cancer. Tumour Biol 2013; 34: 2469-2476 [PMID: 23832537 DOI: 10.1007/s13277-013-0876-y]
3 Frasson M, Braga M, Vignali A, Zuliani W, Di Carlo V. Benefits of laparoscopic colorectal resection are more pronounced in elderly patients. Dis Colon Rectum 2008; 51: 296-300 [PMID: 18197453 DOI: 10.1007/s10350-007-9124-0]
4 Senagore AJ, Madbouly KM, Fazio VW, Duepree HJ, Brady KM, Delaney CP. Advantages of laparoscopic colectomy in older patients. Arch Surg 2003; 138: 252-256 [PMID: 12611568 DOI: 10.1001/archsurg.138.3.252]
5 Manceau G, Karouli M, Werner A, Mortensen NJ, Hannoun L. Comparative outcomes of rectal cancer surgery between elderly and non-elderly patients: a systematic review. Lancet Oncol 2012; 13: e525-e536 [PMID: 23182913 DOI: 10.1016/s1470-2045(12)70378-9]
6 Tuch JH, Pessaux P, Rouge C, Regnet N, Bergamaschi R, Arnau JP. Laparoscopic vs open colectomy for sigmoid diverticularis: a prospective comparative study in the elderly. Surg Endosc 2000; 14: 1031-1033 [PMID: 11116412 DOI: 10.1007/s004640000267]
7 Stochci L, Nelson H, Young-Fadok TM, Larson DR, Istrup DM. Safety and advantages of laparoscopic vs. open colectomy in the elderly: matched-control study. Dis Colon Rectum 2000; 43: 326-332 [PMID: 10733113 DOI: 10.1007/BF02258297]
8 Stewart BT, Sitz RW, Lumley JW. Laparoscopically assisted colorectal surgery in the elderly. Br J Surg 1999; 86: 938-941 [PMID: 10417569 DOI: 10.1046/j.1365-2168.1999.01160.x]
9 Lian L, Kalady M, Geisler D, Kiran RP. Laparoscopic colectomy is safe and leads to a significantly shorter hospital stay for octogenarians. Surg Endosc 2010; 24: 2039-2043 [PMID: 20174947 DOI: 10.1007/s00464-010-0900-x]
10 Law WL, Chu KW, Tung PH. Laparoscopic colorectal resection: a safe option for elderly patients. J Am Coll Surg 2002; 195: 768-773 [PMID: 12495308 DOI: 10.1016/S1072-7515(02)01483-7]
11 Grailey K, Markar SR, Karthikesalingam A, Aboud R, Ziprin P, Faiz O. Laparoscopic versus open colorectal resection in the elderly population. Surg Endosc 2013; 27: 19-30 [PMID: 22752280 DOI: 10.1007/s00464-012-2414-1]
12 Antoniou SA, Antoniou GA, Koch OO, Pointner R, Grandrath FA. Laparoscopic colorectal surgery confers lower mortality in the elderly: a systematic review and meta-analysis of 66,483 patients. Surg Endosc 2015; 29: 322-333 [PMID: 24986017 DOI: 10.1007/s00464-014-3672-x]
13 Green BL, Marshall HC, Collinson F, Quirke P, Gilloulo P, Jayne DG, Brown JM. 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 [PMID: 23132548 DOI: 10.1002/bjs.8945]
14 Lacy AM, Delgado S, Castells A, Prins HA, Arroyo V, Ibarzabal A, Pique JM. The long-term results of a randomized clinical trial of laparoscopy-assisted versus open surgery for colon cancer. Ann Surg 2008; 248: 1-7 [PMID: 18589199 DOI: 10.1097/SLA.0b013e3181694d65]
15 Fleshaman J, Sargent DJ, Green E, Anvari M, Stryker SJ, Beart RW, Hellinger M, Flanagan R, Peters W, Nelson H. Laparoscopic colectomy for cancer is not inferior to open surgery based on 5-year data from the COST Study Group trial. Ann Surg 2007; 246: 655-662; discussion 662-664 [PMID: 17893502 DOI: 10.1097/SLA.0b013e31815f7e62]
16 Bannen M, Veldkamp R, Hop WC, Kuhry E, Jeevel J, Haglind E, Pählmann L, Cuesta MA, Miska S, Morino M, Lacy A, Bonjer HJ. Survival after laparoscopic surgery versus open surgery for colon cancer: long-term outcome of a randomized clinical trial. Lancet Oncol 2009; 10: 44-52 [PMID: 19071061 DOI: 10.1016/S1470-2045(08)70310-3]
17 Ng SS, Leung KL, Lee JF, Yiu RY, Li JC, Hon SS. Long-term morbidity and oncologic outcomes of laparoscopic-assisted anterior resection for upper rectal cancer: ten-year results of a prospective, randomized trial. Dis Colon Rectum 2009; 52: 556-566 [PMID: 19404053 DOI: 10.1007/s10350-007-9180-1]
18 Morris EJ, Jordan C, Thomas JD, Cooper M, Brown JM, Thorpe H, Cameron D, Forman D, Jayne D, Quirke P. Comparison of treatment and outcome information between a clinical trial and the National Cancer Data Repository. Br J Surg 2011; 98: 299-307 [DOI: 10.1002/bjs.7295]
19 Fujii S, Ishibe A, Ota M, Yamagishi S, Watanabe K, Watanabe J, Fujii S et al. Laparoscopic surgery in elderly cancer patients. Dis Colon Rectum 2008; 51: 296-300 [PMID: 18197453 DOI: 10.1007/s10350-007-9124-0]
Fujii S et al. Laparoscopic surgery in elderly cancer

Kanzawa A, Ichikawa Y, Oba M, Morita S, Hashiguchi Y, Kunisaki C, Endo I. Short-term results of a randomized study between laparoscopic and open surgery in elderly colorectal cancer patients. Surg Endosc 2014; 28: 466-476 [PMID: 24122242 DOI: 10.1007/s00464-013-3223-x]

Higgins JPT, Green S. Assessing risk of bias in included studies Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 [updated March 2011] The Cochrane Collaboration, 2011. [accessed 2015 May 12]. Available from: URL: http://handbook.cochrane.org

Wells GA, Shea B, O’Connell D, Peterson J, Welch V, Losos M, Tugwell P. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses. Ottawa Hospital/Research Institute web site, 2003. [accessed 2015 May 12]. Available from: URL: http://www.ohri.ca/programs/clinical_epidemiology/oxford.asp

DerSimonian R, Laird N. Meta-analysis in clinical trials. Control Clin Trials 1986; 7: 177-188 [PMID: 3802833 DOI: 10.1016/0197-2456(86)90046-2]

SLE.0b013e3181bd9562

Percutan Tech

of open and laparoscopic surgical procedures. 

H, Yamamoto H, Sekimoto M, Doki Y, Mori M. Postoperative

Tei M, Ikeda M, Haraguchi N, Takemasa I, Mizushima T, Ishii H, Yamamoto H, Sekimoto M, Doki Y, Mori M. Postoperative complications in elderly patients with colorectal cancer: comparison of open and laparoscopic surgical procedures. Surg Laparosc Endosc Percutan Tech 2009; 19: 488-492 [PMID: 20027093 DOI: 10.1097/SLE.0b013e3181bd9562]

Akiyoshi T, Kurayangi H, Oya M, Konishi T, Fukuda M, Fujimoto Y, Ueno M, Yamaguchi T. Short-term outcomes of laparoscopic rectal surgery for primary rectal cancer in elderly patients: is it safe and beneficial? J Gastrointest Surg 2009; 13: 1614-1618 [PMID: 19582517 DOI: 10.1007/s11605-009-0961-0]

Tomimaru Y, Ide Y, Murata K. Outcome of laparoscopic surgery for colon cancer in elderly patients. Asian J Endosc Surg 2011; 4: 1-6 [PMID: 22776166 DOI: 10.1111/j.1758-5910.2010.00061.x]

Robinson CN, Balentine CJ, Marshall CL, Wilks JA, Anaya D, Artinyan A, Berger DH, Albo D. Minimally invasive surgery improves short-term outcomes in elderly colorectal cancer patients. J Surg Res 2011; 166: 182-188 [PMID: 21276980 DOI: 10.1016/j.jss.2010.05.053]

She WH, Poon JT, Fan JK, Lo OS, Law WL. Outcome of laparoscopic colectomy for cancer in elderly patients. Surg Endosc 2013; 27: 308-312 [PMID: 22820704 DOI: 10.1007/s00464-012-2466-2]

Scarpa M, Di Cristofaro L, Cortinovis M, Pinto E, Masa M, Allieri R, Cagol M, Sandeh L, Costa A, Castoro C, Bassi N, Ruffolo C. Minimally invasive surgery for colorectal cancer: quality of life and satisfaction with care in elderly patients. Surg Endosc 2013; 27: 2911-2920 [PMID: 23468328 DOI: 10.1007/s00464-013-2854-2]

Hinoi T, Kawaguchi Y, Hattori M, Okajima M, Ohdan H, Yamamoto S, Hasegawa H, Horie H, Murata K, Yamaguchi S, Sugihara K, Watanabe M. Laparoscopic versus open surgery for colorectal cancer in elderly patients: a multicenter matched case-control study. Ann Surg Oncol 2015; 22: 2040-2050 [PMID: 25331007 DOI: 10.1245/s10434-014-4172-x]

Miyasaka Y, Mochidome N, Kobayashi K, Ryu S, Akashi Y, Miyoshi A. Efficacy of laparoscopic resection in elderly patients with colorectal cancer. Surg Today 2014; 44: 1834-1840 [PMID: 24121951 DOI: 10.1007/s00595-013-0753-8]

Valderríbera Valls F, Landi F, Euen Basany E, Sánchez García JL, Jiménez Gómez LM, Martí Gallostra M, Salgado Cruz L, Armengol Carrasco M. Laparoscopy-assisted versus open colectomy for treatment of colon cancer in the elderly: morbidity and mortality outcomes in 545 patients. Surg Endosc 2014; 28: 3373-3378 [PMID: 24928231 DOI: 10.1007/s00464-014-3597-4]

Zeng WG, Zhou ZX, Hou HR, Liang JW, Zhou Z, Zhang XM, Hu JJ. Outcome of laparoscopic versus open resection for rectal cancer in elderly patients. J Surg Res 2015; 193: 613-618 [PMID: 25214259 DOI: 10.1016/j.jss.2014.08.012]

Shigeta K, Baba H, Yamafuji K, Asami A, Takeshima K, Nagasaki K, Okamoto N, Murata T, Arai S, Kubochi K, Kitagawa Y. Effects of laparoscopic surgery on the patterns of death in elderly colorectal cancer patients: competing risk analysis compared with open surgery. Surg Today 2016; 46: 422-429 [PMID: 25904559 DOI: 10.1007/s00595-015-1171-x]

Kuhry E, Schwenk WF, Gaupset R, Romild U, Bonjer HJ. Long-term results of laparoscopic colorectal cancer resection. Cochrane Database Syst Rev 2008; (2): CD003432 [PMID: 18425886 DOI: 10.1002/14651858]
