Annals of Oncology 23: 903–911, 2012
doi:10.1093/annonc/mdr360
Published online 12 August 2011

Laparoscopic versus open radical hysterectomy in early-stage cervical cancer: long-term survival outcomes in a matched cohort study

J.-H. Nam†*, J.-Y. Park†, D.-Y. Kim, J.-H. Kim, Y.-M. Kim & Y.-T. Kim

Department of Obstetrics and Gynecology, University of Ulsan College of Medicine, Asan Medical Center, Seoul, Korea

Received 3 April 2011; revised 23 June 2011; revised 28 June 2011; accepted 30 June 2011

Background: To compare the long-term survival outcomes between laparoscopic radical hysterectomy (LRH) and open radical hysterectomy (ORH).

Method: We matched patients with stage IA2 to IIA cervical cancer with known risk factors for recurrence who underwent ORH and LRH.

Results: Compared with ORH (n = 263), LRH (n = 263) did not have higher risks of recurrence [hazard ratio (HR) = 1.28; 95% confidence interval (CI) 0.62–2.64] or death (HR = 1.46; 95% CI 0.62–3.43). Even in patients with tumors >2 cm in diameter, the risks of recurrence (HR = 0.82; 95% CI 0.31–2.16) or death (HR = 1.01; 95% CI 0.35–2.95) were not higher for LRH than for ORH. The LRH and ORH group had 5-year recurrence-free survival rates of 92.8% and 94.4%, respectively (P = 0.499). LRH resulted in significantly lower estimated blood loss (379.6 versus 541.1 ml, P < 0.001) and shorter postoperative hospital stay (12.5 versus 20.3 days, P < 0.001). Intraoperative complication rates were similar in the two groups (6.8% versus 5.7%, P = 0.711), but postoperative complication rate was lower in the LRH than in the ORH group (9.2% versus 21%, P < 0.001).

Conclusion: LRH is an oncologically safe alternative to ORH and was associated with fewer postoperative complication and earlier recovery.

Key words: early-stage cervical cancer, laparoscopic radical hysterectomy, open radical hysterectomy, survival outcomes, surgical outcomes

introduction

Cervical cancer is the second most common and the third leading cause of cancer fatalities among women worldwide [1]. In Korea, cervical cancer is the most common gynecologic cancer and the third most common cancer among women [2, 3]. The standard treatment of early-stage cervical cancer is open radical hysterectomy (ORH), resulting in 5-year survival rates of 75%–90% [4–6]. Intermediate risk factors for recurrence after radical hysterectomy include tumor size, lymphovascular space invasion (LVSI), and depth of cervical stromal invasion [7, 8], and high risk factors include parametrial involvement, lymph node metastasis, and resection margin involvement [9–11]. Laparoscopic radical hysterectomy (LRH) is an alternative to ORH, but its acceptance has been slower than that of other laparoscopic oncological surgical techniques, with the use of LRH limited to patients with small tumors (<2 cm) because of technical difficulties. Since LRH was first described in the early 1990s [12, 13], only a few small retrospective studies have compared the outcomes of LRH and ORH [14–20], and their long-term survival outcomes have never been compared to date in a large well-controlled study with sufficient follow-up. Using our 14-year, large-scale prospectively gathered database of patients with stage IA2 to IIA cervical cancer, we matched patients who underwent ORH and LRH for known risk factors for recurrence. The long-term survival outcomes and the immediate surgical outcomes in these two groups of patients were compared.

*Correspondence to: Prof. J.-H. Nam, Department of Obstetrics and Gynecology, College of Medicine, University of Ulsan, Asan Medical Center, No. 388-1 Poongnap-2 dong, Songpa-gu, Seoul 138-736, Korea. Tel: +82-2-3010-3633; Fax: +82-2-476-7331; E-mail: jhnam@amc.seoul.kr

†J.-H. Nam and J.-Y. Park equally contributed to this article as first authors.

materials and methods

study population

Using the cancer registry and computerized database of the Asan Medical Center (AMC; Seoul, Korea), we retrieved the records of all patients with early-stage cervical cancer who were treated and followed up between October 1997 and April 2008. With the approval of the Institutional Review Board of AMC, we retrospectively evaluated the demographic, clinicopathologic, and follow-up data of all patients. Patients were included if they had (i) previously untreated cervical cancer; (ii) International Federation of Gynecology and Obstetrics (FIGO) stage IA2 to IIA; (iii) squamous cell carcinoma, adenocarcinoma, or adenosquamous

carcinoma; (iv) had undergone LRH or ORH as primary treatment (v) had received adjuvant therapy after radical hysterectomy if they had intermediate or high risk factors; and (vi) were followed up for >2 years after radical hysterectomy. We excluded patients who received radiation or concurrent chemoradiation therapy as primary treatment, as well as those who received neoadjuvant chemotherapy, radiation, or concurrent chemoradiation therapy before radical hysterectomy. We found that 415 patients who underwent LRH and 721 who underwent ORH met the eligibility criteria and were included in the matching process (Figure 1).

Each patient in the LRH group was matched to one patient in the ORH group using the following matching criteria: lymph node metastasis, parametrial involvement, tumor size (±2 cm), depth of cervical stromal invasion (<1/2 versus >1/2), LVSI, and age (±3 years). Since all variables were matched in equal significance, the two groups, each containing 263 patients, were completely matched for all intermediate and high risk factors for recurrence after radical hysterectomy.

study treatment and follow-up

We have described the surgical procedures for LRH in a previous report [16]. After LRH, a single Jackson-Pratt drain was inserted through the lateral trocar to ensure drainage, with the retroperitoneum remaining open. The Foley catheter was usually removed 7 days after surgery.

Surgical procedures and the extent of resection of ORH were generally identical to those for LRH, except that, in ORH, a midline abdominal incision was made from the pubic symphysis to the supraumbilical area.

If a positive pelvic or para-aortic lymph node was identified during surgery, our policy was to complete the radical hysterectomy, although it has not yet been determined whether the surgeon should complete the radical hysterectomy or stop the procedure and administer concurrent chemoradiation therapy.

After surgery, patients with two or more intermediate risk factors (LVSI, tumor >4 cm, and/or deep cervical stromal invasion) were recommended to receive adjuvant radiation therapy, whereas patients with one or more high risk factors (resection margin involvement, parametrial involvement, or lymph node involvement) were recommended to receive adjuvant concurrent chemoradiation therapy. Some patients, however, received adjuvant chemotherapy depending on the preferences of the patient and physician.

Following completion of treatment, patients were examined every 3 months for the first 2 years, every 6 months during the next 3 years and yearly thereafter.

definitions

Febrile morbidity after surgery was defined as the documentation of body temperature ≥38°C on two occasions at least 4 h apart during the postoperative period, excluding the first 24 h after surgery. Bladder dysfunction after surgery was defined as voiding difficulty requiring re-indwelling of a Foley catheter or clean intermittent catheterization. Postoperative mortality was defined as death from any cause within 30 days after surgery. Intermediate risk factors for recurrence after surgery included tumor size, depth of cervical stromal invasion, and LVSI. High risk factors

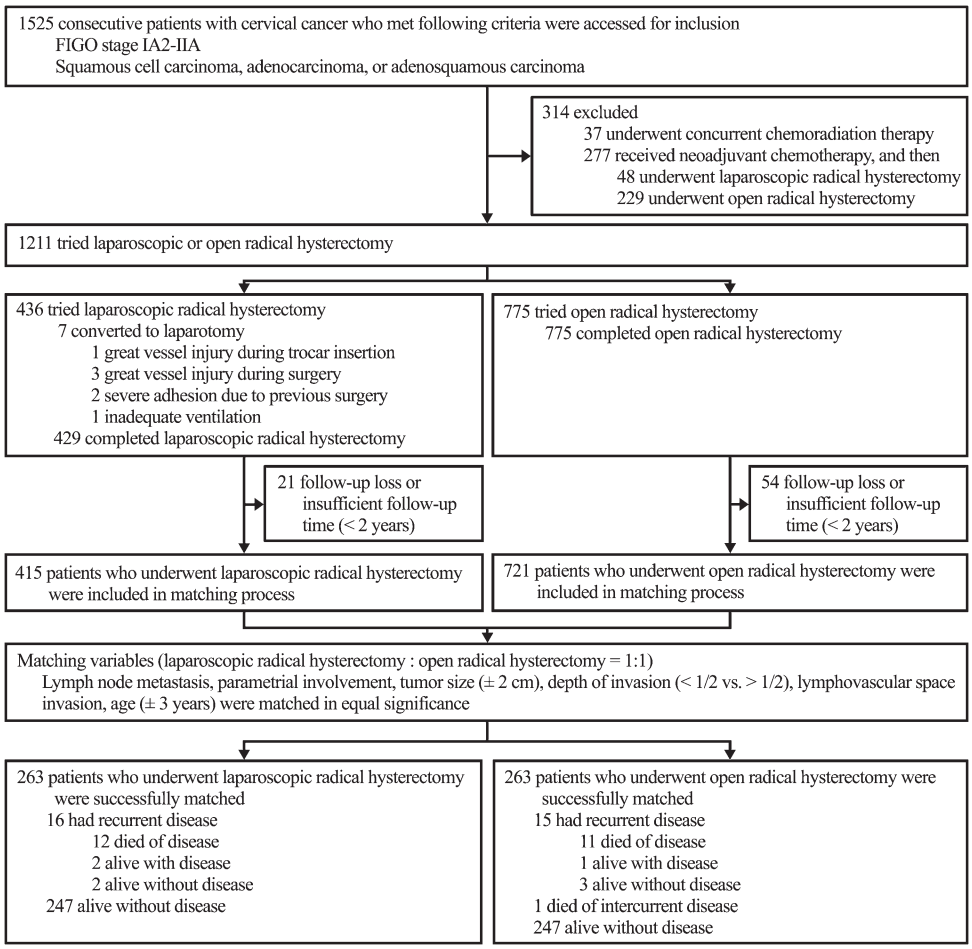

Figure 1. Study design. FIGO, International Federation of Gynecology and Obstetrics.

for recurrence after surgery included parametrial involvement, lymph node metastasis, and resection margin involvement. For subgroup analysis, patients with no intermediate or high risk factors for recurrence were designated the low-risk group, those with at least one intermediate risk factor were designated the intermediate-risk group, and those with at least one high risk factor were designated the high-risk group.

statistical analysis

Individual patient matching was carried out to reduce the effects of selection bias and potential confounding and to make the risk factors for recurrence equal in the two groups. A greedy algorithm was used to obtain pairs of subjects by randomly selecting a case patient from the LRH group and matching it to a control patient in the ORH group. The cases (LRH group) are ordered and sequentially matched to the nearest unmatched control (ORH group), which exactly matches to each case in terms of tumor size (±2 cm), depth of cervical stromal invasion (<1/2 versus >1/2), LVSI (present versus absent), parametrial involvement (present versus absent), lymph node metastasis (present versus absent), and patient age (±3 years). If a case has more than one 'matched' control, one control is selected by the randomization method provided by the greedy algorithm. If there is no control that matches the six aforementioned factors, the case is excluded from the analysis. As a result of the use of such an algorithm, each case has a corresponding control that is matched by all the six stratification factors (tumor size, depth of cervical stromal invasion, LVSI, parametrial involvement, lymph node metastasis, and age). In addition, these six factors, which were used to match patients, were available for all patients who were included in the matching process. Therefore, there is no evidence of a selection bias suggested by the matching procedure used in this article. After performing all the matches, we compared the baseline covariates of the two groups. Continuous variables were compared using paired *t*-tests or Wilcoxon signed rank tests, as appropriate, and categorical variables were compared using McNemar's tests or marginal homogeneity tests. Recurrence-free survival time was calculated as the number of months from the date of radical hysterectomy to the date of recurrence or the date of censoring. Disease-specific survival time was calculated as the number of months from the date of radical hysterectomy to the date of death or the date of censoring. Survival curves and rates were calculated using the Kaplan–Meier method. Statistical significance and differences in survival were assessed using Cox regression models, with robust standard errors that accounted for the clustering of matched pairs. A two-sided P-value < 0.05 indicated statistical significance. SAS software (version 9.1; SAS institute Inc., Cary, NC), SPSS software (version 11.0; SPSS Inc., Chicago, IL), and the R programming language were used for statistical analyses.

results

Supplemental Table S1 (available at *Annals of Oncology* online) shows the clinical characteristics of patients in the LRH and ORH groups. Mean ages were similar (46.4 versus 46.5 years, $P = 0.326$). Mean parity (2.6 versus 2.2, $P < 0.001$) and mean body mass index (23.9 versus 23.2 kg/m^2, $P = 0.015$) were significantly higher in the ORH than in the LRH group;

Table 1. Tumor characteristics of patients with cervical cancer

	Laparoscopic radical hysterectomy ($n = 263$)	Open radical hysterectomy ($n = 263$)	*P*-value
FIGO stage, *n* (%)			
IA2	36 (13.7)	40 (15.2)	0.607
IB1	197 (74.9)	194 (73.8)	
IB2	25 (9.5)	21 (8)	
IIA	5 (1.9)	8 (3)	
Histology, *n* (%)			
Squamous cell carcinoma	214 (81.4)	207 (78.7)	0.741
Adenocarcinoma	41(15.6)	46 (17.5)	
Adenosquamous carcinoma	8 (3)	10 (3.8)	
Tumor size (cm), mean (range)	1.8 (3.8–6)	1.8 (3–6)	0.625
≤2	162 (61.6)	173 (65.8)	0.007
>2	101 (38.4)	90 (34.2)	
Depth of cervical stromal invasion, *n* (%)			
Less than half	158 (60.1)	158 (60.1)	1.000
More than half	105 (39.9)	105 (39.9)	
Lymphovascular space invasion, *n* (%)			
Absent	234 (89)	234 (89)	1.000
Present	29 (11)	29 (11)	
Parametrial involvement, *n* (%)			
Absent	258 (98.1)	258 (98.1)	1.000
Present	5 (1.9)	5 (1.9)	
Lymph node metastasis, *n* (%)			
Absent	252 (95.8)	252 (95.8)	1.000
Present	11 (4.2)	11 (4.2)	
Resection margin involvement, *n* (%)			
Absent	262 (99.6)	261 (99.2)	1.000
Present	1 (0.4)	2 (0.8)	

FIGO, International Federation of Gynecology and Obstetrics.

Table 2. Operative details and postoperative recovery

	Laparoscopic radical hysterectomy (n = 263)	Open radical hysterectomy (n = 263)	P-value
Operating time (min), mean (range)	246.8 (145 to 484)	247.2 (140 to 485)	0.982
Estimated blood loss (ml), mean (range)	379.6 (100 to 1500)	541.1 (80 to 3000)	<0.001
Transfusion required, n (%)	76 (28.9%)	106 (40.3%)	0.009
Transfusion amount (pints), mean (range)	2.4 (0.5 to 7)	2.7 (1 to 13)	0.377
Hemoglobin level (gm/dl), mean (range)			
Preoperative	12.3 (7.9 to 15.5)	12.3 (8.4 to 14.6)	0.664
Postoperative	10.2 (6.1 to 13.6)	9.9 (6.2 to 14.6)	0.017
Perioperative change	2.1 (−2.5 to 6.3)	2.3 (−4.8 to 5.5)	0.110
Return of bowel movement (days), mean (range)	2.1 (1 to 5)	3.2 (2 to 7)	<0.001
Removal of Foley catheter (days), mean (range)	7.2 (6 to 12)	7.5 (6 to 23)	0.002
Postoperative hospital stay (days), mean (range)	12.5 (4 to 48)	20.3 (5 to 77)	<0.001

Table 3. Intra- and postoperative complications within 60 days after surgery

	Laparoscopic radical hysterectomy (n = 263)	Open radical hysterectomy (n = 263)	P-value
Intraoperative complications, n (%)	18 (6.8)	15 (5.7)	0.711
Bladder injury	9 (3.4)	11 (4.2)	0.815
Ureter injury	6 (2.3)	3 (1.1)	0.508
Rectal injury	2 (0.8)	0 (0)	0.500
Great vessel injury	2 (0.8)	0 (0)	1.000
Obturator nerve injury	0 (0)	1 (0.4)	1.000
Postoperative complications excluding bladder dysfunction, n (%)	24 (9.2)	55 (21)	<0.001
Febrile morbidity	5 (1.9)	14 (5.3)	0.064
Pelvic abscess including infected lymphocele	7 (2.7)	17 (6.5)	0.052
Wound dehiscence	1 (0.4)	4 (1.5)	0.375
Incisional hernia	3 (1.1)	1 (0.4)	0.625
Bowel perforation	1 (0.4)	0 (0)	1.000
Postoperative bleeding	0 (0)	1 (0.4)	1.000
Urinary tract fistula formation	2 (0.8)	4 (1.5)	0.687
Ileus	2 (0.8)	7 (2.7)	0.180
Acute renal failure	0 (0)	1 (0.4)	1.000
Ischemic heart disease	1 (0.4)	0 (0)	1.000
Pseudomembranous colitis	1 (0.4)	1 (0.4)	1.000
Deep vein thrombosis	0 (0)	3 (1.1)	0.250
Brachial plexopathy	1 (0.4)	0 (0)	1.000
Obturator neuropathy	1 (0.4)	0 (0)	1.000
Ureteral stricture	1 (0.4)	5 (1.9)	0.219
Postoperative bladder dysfunction, n (%)	54 (20.5)	52 (19.8)	0.911
Reoperation, n (%)	2 (0.8)	3 (1.1)	1.000

however, the clinical significance of this small difference was likely minimal. There were no significant between-group differences in intercurrent medical disease and American Society of Anesthesiologist physical status score. Patients with previous history of abdominal surgery were more in ORH group (P = 0.037).

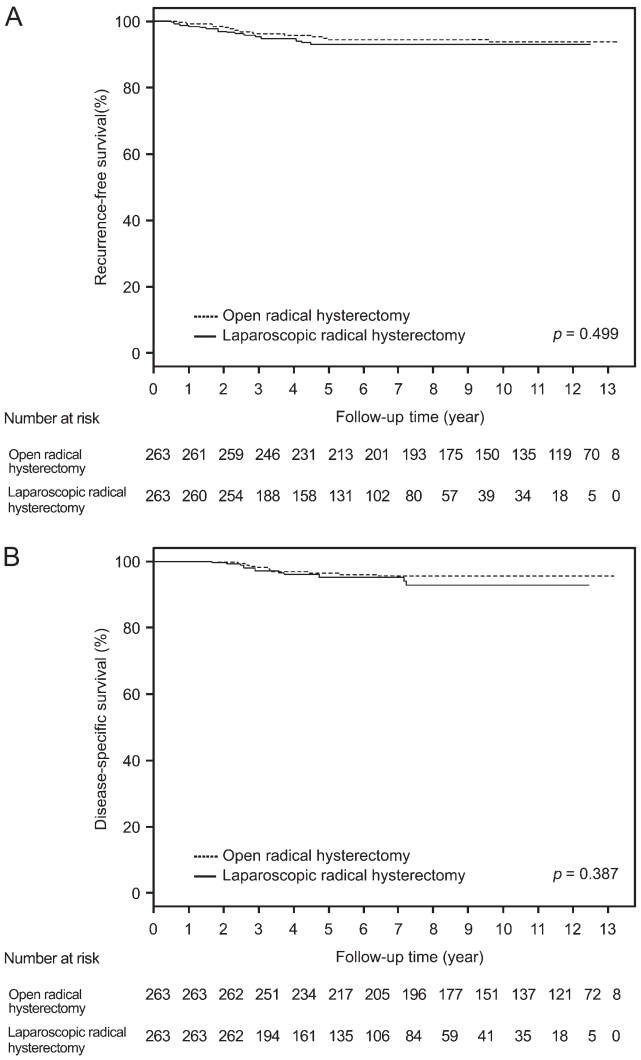

Figure 2. Kaplan—Meier analysis of (A) recurrence-free survival and (B) disease-specific survival in patients with stage IA2 to IIA cervical cancer who underwent laparoscopic radical hysterectomy or open radical hysterectomy.

Table 1 shows the tumor characteristics in the two groups. FIGO stage distribution and histological type did not differ. Mean tumor sizes were identical (1.8 versus 1.8 cm, $P = 0.625$), but a higher percentage of patients in the LRH group had tumors >2 cm (38.4% versus 34.2%, $P = 0.007$). There were no other between-group differences in intermediate (LVSI and cervical stromal invasion) and high (parametrial involvement, lymph node metastasis, and resection margin involvement) risk factors.

Surgical and adjuvant treatments in the two groups are summarized in Supplemental Table S2 (available at *Annals of Oncology* online). The proportion of patients who underwent para-aortic lymph node sampling was similar in the LRH and ORH groups (35.0% versus 38.4%, $P = 0.402$). The mean number of total lymph nodes retrieved was significantly higher in the LRH group (34.3 versus 30.6, $P = 0.001$), but the mean number of metastatic lymph nodes did not differ (2.3 versus 3.8, $P = 0.263$). After surgery, 19% of patients in the LRH group and 17.1% of patients in the ORH group received adjuvant therapy, but there were no differences in type of adjuvant therapy ($P = 0.780$). In the LRH group, 14 patients received adjuvant chemotherapy, consisting of 5-fluorouracil/cisplatin in 4 patients, paclitaxel/cisplatin in 7, and paclitaxel/carboplatin in 3. The mean number of chemotherapy cycles was 3.3 (range, 1–6). In the ORH group, 11 patients received adjuvant chemotherapy, consisting of 5-fluorouracil/cisplatin in 6 patients, paclitaxel/cisplatin in 4, and paclitaxel/carboplatin in 1. The mean number of chemotherapy cycles was 2.7 (range, 1–6).

The mean operating time was similar for the two groups (246.8 versus 247.2 min, $P = 0.982$), but estimated blood loss (541.1 versus 379.6 ml, $P < 0.001$) and transfusion requirement (40.3% versus 28.9%, $P = 0.009$) were significantly higher in the ORH group (Table 2). Return of bowel movement (2.1 versus 3.2 days, $P < 0.001$) was significantly faster and postoperative hospital stay (12.5 versus 20.3 days, $P < 0.001$) was significantly shorter in the LRH group.

Although the two groups had similar rates of intraoperative complications (6.8% versus 5.7%, $P = 0.711$), the rate of postoperative complications within 60 days after surgery was significantly higher in the ORH than in the LRH group (21% versus 9.2%, $P < 0.001$; Table 3). Rates of febrile morbidity (5.3% versus 1.9%, $P = 0.064$), abscess formation (6.5% versus 2.7%, $P = 0.052$), wound dehiscence (1.5% versus 0.4%, $P = 0.375$), ileus (2.7% versus 0.8%, $P = 0.180$), and deep vein thrombosis (1.1% versus 0%, $P = 0.250$) were higher in the ORH group, although rates of postoperative bladder dysfunction (20.5% versus 19.8%, $P = 0.911$) and reoperation (0.8% versus 1.1%, $P = 1.000$) did not differ. There were no postoperative deaths within 30 days after surgery in either group.

The mean and median follow-up times were 91 and 92 months (range, 25–159 months), respectively, for all patients; 69 and 63 months (range, 25–150 months), respectively, for the LRH group; and 113 and 127 months (range, 26–159 months), respectively, for the ORH group (LRH versus ORH group, $P < 0.001$). About 53% of survivors in the LRH group and 85.3% of survivors in the ORH group were followed up for >60 months ($P < 0.001$). At the time of analysis, 16 patients in the LRH group and 15 in the ORH group had recurrent disease ($P = 1.000$), and 12 and 11, respectively, had died of disease ($P = 1.000$). One patient in the ORH group died of intercurrent disease (Figure 1). The mean and median times to recurrence were 26 and 24 months (range, 6–54 months), respectively, in the LRH group and 38 and 29 months (range, 5–115 months), respectively, in the ORH group (LRH versus ORH group, $P = 0.157$). In the LRH group, the anatomical location of the first recurrence included the vaginal stump in two patients, the pelvic cavity in five, regional lymph nodes in five, and distant organs in four. In the ORH group, the anatomical location of the first recurrence included the vaginal stump in one patient, the pelvic cavity in five, the abdominal cavity in one, a regional lymph node in one, and distant organs in seven. When we divided the anatomic location of the recurrent tumor into two categories (pelvis versus outside the pelvis), we found that 56.3% of recurrences in the LRH group and 60% in the ORH group were outside the pelvis ($P = 0.833$).

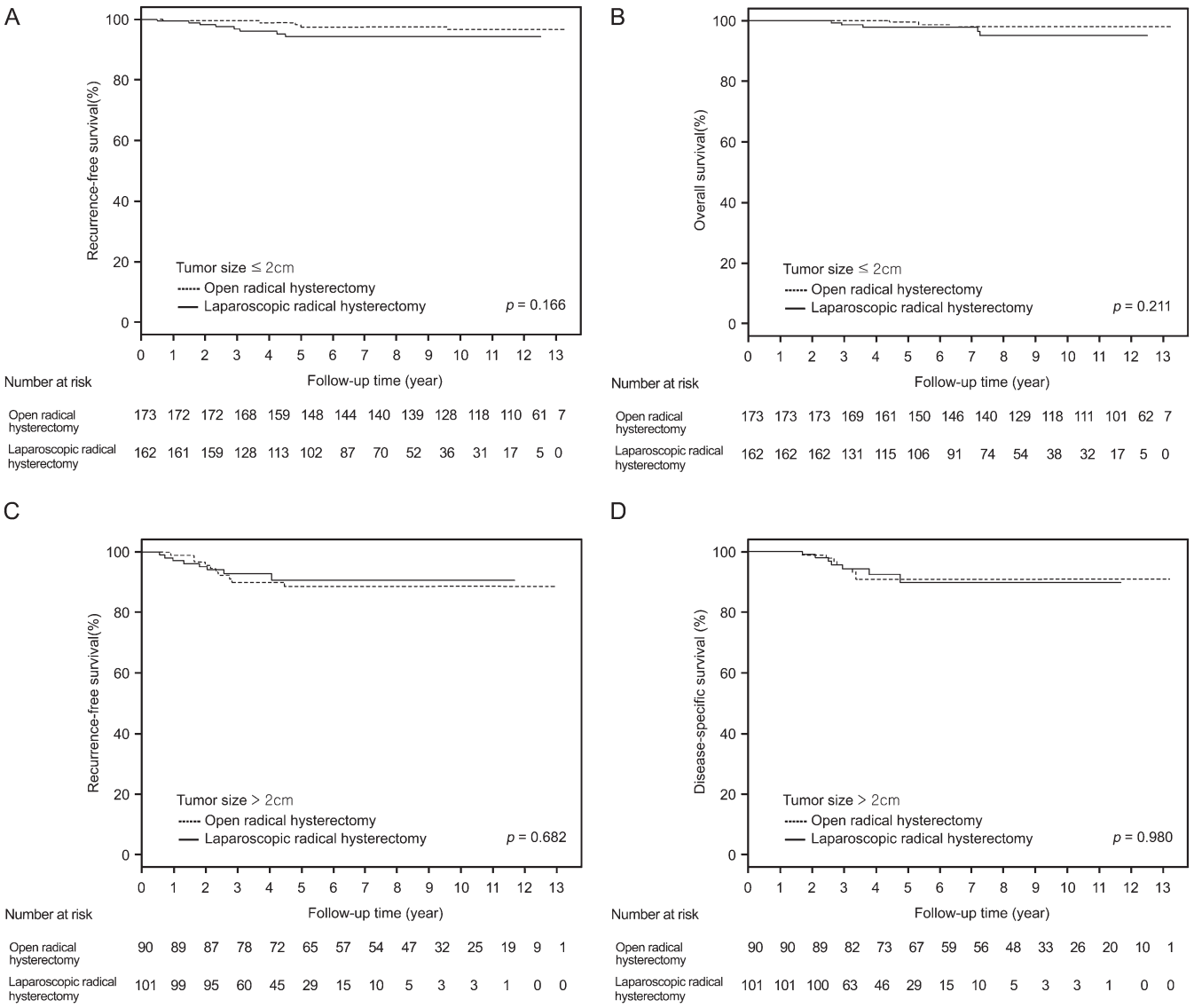

Figure 3. Kaplan–Meier analysis of recurrence-free and disease-specific survival in patients with stage IA2 to IIA cervical cancers <2 cm (A, B) and >2 cm (C, D) in patients who underwent open radical hysterectomy (A, C) or laparoscopic radical hysterectomy (B, D).

Survival outcomes did not differ between the two groups. The LRH and ORH groups had 5-year recurrence-free survival rates of 92.8% and 94.4%, respectively ($P = 0.499$), 5-year overall survival rates of 95.2% and 96.4%, respectively ($P = 0.451$), and 5-year disease-specific survival rates of 95.2% and 96.4%, respectively ($P = 0.387$) (Figure 2).

Patients with tumors ≤2 cm in diameter who underwent LRH and ORH had similar 5-year recurrence-free survival (94.2% versus 97.4%, $P = 0.166$) and disease-specific survival (97.8% versus 99.3%. P = 0.211) rates (Figure 3). Patients with tumors >2 cm in diameter who were treated with LRH and ORH also had similar 5-year recurrence-free survival (90.6% versus 88.5%, $P = 0.682$) and disease-specific survival (89.6% versus 90.7%, $P = 0.980$) rates (Figure 3).

We further analyzed the between-group differences in recurrence-free survival and disease-specific survival in subgroups divided by mean age (age ≤ 46 years and age > 46 years), histological type of tumor (squamous cell carcinoma and adenocarcinoma or adenosquamous carcinoma group), and risk for recurrence (low-, intermediate-, and high-risk groups). There were no significant differences between LRH and ORH in recurrence-free survival and disease-specific survival in any of these subgroups (Figures 4 and 5).

discussion

We have shown here that, in patients with FIGO stage IA2 to IIA cervical cancer and similar risk factors for recurrence, LRH resulted in comparable recurrence-free survival and disease-specific survival, as in ORH. The two methods yielded similar recurrence-free survival and disease-specific survival rates even in patients with tumors >2 cm. LRH had significant short-term advantages over ORH, including lower estimated blood loss, reduced requirement for transfusions, shorter postoperative hospital stay, and fewer postoperative

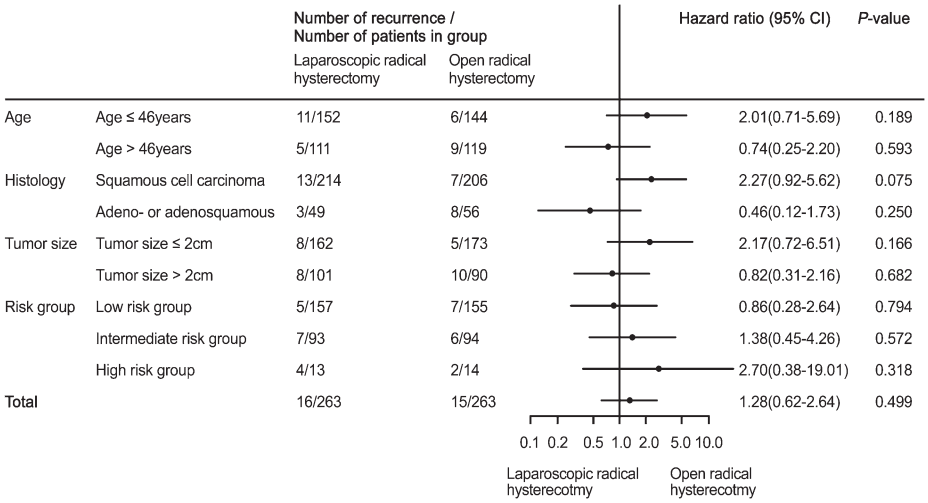

Figure 4. Cox regression analysis of recurrence-free survival in subgroups of patients assorted by mean age (≤46 and >46 years), histological type of tumor (squamous cell carcinoma, adenocarcinoma, and adenosquamous carcinoma), and risk of recurrence (low, intermediate, and high risk). CI, confidence interval.

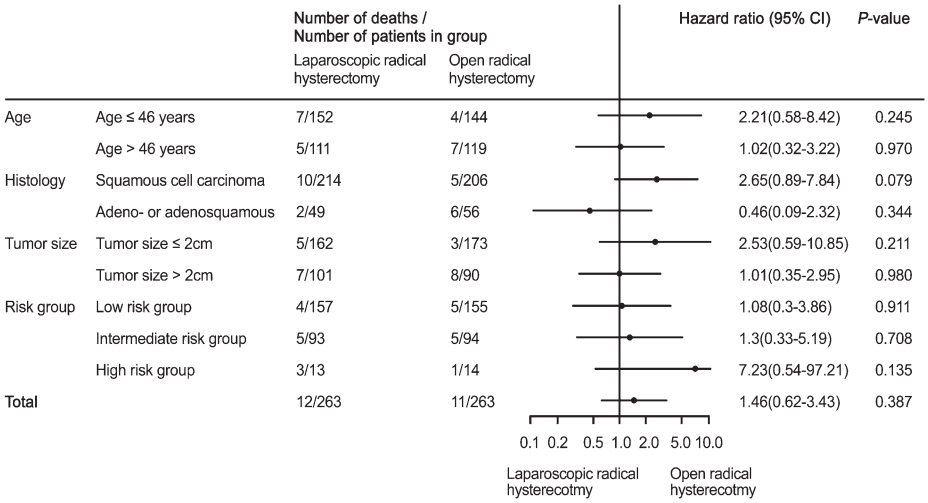

Figure 5. Cox regression analysis of disease-specific survival in subgroups of patients assorted by mean age (≤46 and >46 years), histological type of tumor (squamous cell carcinoma, adenocarcinoma, and adenosquamous carcinoma), and risk of recurrence (low, intermediate, and high risk). CI, confidence interval.

complications. These findings indicate that LRH is not only an oncologically safe alternative to ORH but is a preferred method of surgical management, as determined by short-term outcomes, in patients with FIGO stage IA2 to IIA cervical cancer.

ORH is the standard surgical treatment of patients with FIGO stage IA2 to IIA cervical cancer. The laparoscopic counterpart of ORH is LRH, in which the entire ureter dissection and parametrial excision are carried out laparoscopically [12, 13, 16]. Since the first description of LRH in the 1990s [12, 13], several retrospective studies have compared the outcomes of LRH and ORH in patients with early cervical cancer [14–20]. However, most of these studies were limited in their ability to analyze oncological outcomes because they only included patients with small tumors (usually <2 cm), the follow-up time was short, the number of patients was small, and each group was heterogeneous with respect to postoperative risk factors for recurrence. Especially, little had been known about the oncological safety of LRH in patients with large tumors (usually >2 cm). Using our large prospectively gathered database, we matched patients with intermediate and high risk factors for recurrence who underwent LRH and ORH. Our study included more patients, overall and with large tumors, and had a longer follow-up time than any previous study. We found that recurrence-free survival, disease-specific survival, and pattern of recurrence were similar in the LRH and ORH groups, even in patients with tumors >2 cm, indicating that LRH is an oncologically safe alternative to ORH in patients with FIGO stage IA2 to IIA cervical cancer.

Although the median follow-up time was significantly longer for our ORH (127 months) than for our LRH group (63

months), the follow-up time in the latter was sufficient to assess patient survival outcomes. Indeed, we found that the mean time to recurrence in our ORH and LRH groups were 29 and 24 months, respectively, and all of our patients were followed up for longer than 24 months.

Consistent with previous reports [14–20], we found that patients who underwent LRH had significantly lower estimated blood loss, lower transfusion requirement, faster recovery of bowel function, and shorter postoperative hospital stay than those who underwent ORH. However, the length of postoperative hospital stay in our LRH group was longer than that in Western countries. Usually, however, the length of hospital stay after laparoscopic surgery is longer in Korea than in Western countries, because of different insurance policies. We recommend discharge if the patients eat, void, and defecate well and document no specific symptoms associated with postoperative complications, which require inpatient-based treatment. If a patient has a voiding difficulty, we educate the patient regarding clean intermittent self-catheterization and recommend discharge. We believe that our discharge criteria do not differ from those used in Western countries. However, because the charge for hospital admission is very low in Korea and Korean cancer patients have comprehensive insurance coverage, most of our patients who undergo surgery prefer to remain in the hospital postoperatively for a considerable period of time, despite our usual medical advice regarding earlier discharge. In short, the relatively long postoperative hospital stay of the patients in our study is common in the Korean medical environment and was not specific to our hospital or our series. Nevertheless, the length of the hospital stay for our patients undergoing laparoscopy was significantly shorter than for patients undergoing laparotomy. Nevertheless, the length of hospital stay was significantly shorter in our LRH than in our ORH group. Moreover, although the estimated blood loss and perioperative hemoglobin changes we observed were not high compared with previous studies, the transfusion rate was relatively high because the anesthesiologists made a decision on transfusion arbitrarily without any objective criteria [14–20]. Other studies, however, reporting outcomes after radical hysterectomy reported transfusion rates as high as 49%–81% [21–23].

Although LRH has been associated with increased operating time compared with ORH [14–20], we found that they were similar. This may have been due to our greater experience with LRH, in that we have carried out over 400 of these procedures. Accumulated experience has been associated with shorter operating times in other studies [18, 24]. Because most previous studies comparing outcomes of LRH and ORH have included small numbers of patients, most of those surgeons may be at the early phase of the learning curve. In addition, cutting the vagina and repairing the vaginal stump via a transvaginal rather than a laparoscopic route may have shortened the operating time.

Consistent with previous reports [14–20], we found that the rates of intraoperative complications were similarly low in the two groups. The most frequent intraoperative complications in the LRH group included injuries to the bladder, ureter, rectum, and great vessels, with the latter frequently requiring conversion to laparotomy for repair of injured vessels (Figure 1). In most patients with injuries to the bladder, rectum, and ureter, even with perforation of the hollow viscus, repairs were successfully carried out via a laparoscopic or transvaginal route. The rates of postoperative complications were significantly lower in the LRH than in the ORH group. This was especially true for infectious complications, wound complications, and ileus, all of which have been attributed by laparotomy itself. The rate of bladder dysfunction was similar in the two groups. Taken together, our results indicate that due to its superior immediate surgical outcomes, LRH is the preferred surgical management for patients with FIGO stage IA2 to IIA cervical cancer.

In conclusion, we found that long-term survival outcomes after LRH were comparable to those after ORH in patients with FIGO stage IA2 to IIA cervical cancer and similar risk factors for recurrence, regardless of tumor size. Compared with ORH, LRH resulted in favorable surgical outcomes, including reduced blood loss, shorter length of hospital stay, and lower rates of perioperative complications. These findings indicate that LRH is not only an oncologically safe alternative to ORH, but preferred for surgical management, as shown by superior short-term outcomes, in patients with FIGO stage IA2 to IIA cervical cancer.

acknowledgements

The authors thank Seon-Ok Kim, M.S., Seunghee Baek, Ph.D., Department of Clinical Epidemiology and Biostatistics, University of Ulsan College of Medicine, Asan Medical Center, Seoul, Korea for their assistance with the statistical analysis.

funding

This study received no financial support.

disclosure

The authors declare no conflict of interest.

references

1. Parkin DM, Bray F, Ferlay J, Pisani P. Estimating the world cancer burden: Globocan 2000. Int J Cancer 2001; 94: 153–156.
2. Kim YT. Current status of cervical cancer and HPV infection in Korea. J Gynecol Oncol 2009; 20: 1–7.
3. Han CH, Cho HJ, Lee SJ et al. The increasing frequency of cervical cancer in Korean women under 35. Cancer Res Treat 2008; 40: 1–5.
4. Waggoner SE. Cervical cancer. Lancet 2003; 361: 2217–2225.
5. Landoni F, Maneo A, Colombo A et al. Randomised study of radical surgery versus radiotherapy for stage Ib-IIa cervical cancer. Lancet 1997; 350: 535–540.
6. Park JY, Kim DY, Kim JH et al. Outcomes after radical hysterectomy according to tumor size divided by 2-cm interval in patients with early cervical cancer. Ann Oncol 2011; 22: 59–67.
7. Delgado G, Bundy B, Zaino R et al. Prospective surgical-pathological study of disease-free interval in patients with stage IB squamous cell carcinoma of the cervix: a Gynecologic Oncology Group study. Gynecol Oncol 1990; 38: 352–357.
8. Sedlis A, Bundy BN, Rotman MZ et al. A randomized trial of pelvic radiation therapy versus no further therapy in selected patients with stage IB carcinoma of

the cervix after radical hysterectomy and pelvic lymphadenectomy: a Gynecologic Oncology Group Study. Gynecol Oncol 1999; 73: 177–183.
9. Sevin BU, Lu Y, Bloch DA et al. Surgically defined prognostic parameters in patients with early cervical carcinoma. A multivariate survival tree analysis. Cancer 1996; 78: 1438–1446.
10. Zreik TG, Chambers JT, Chambers SK. Parametrial involvement, regardless of nodal status: a poor prognostic factor for cervical cancer. Obstet Gynecol 1996; 87: 741–746.
11. Peters WA III, Liu PY, Barrett RJ II et al. Concurrent chemotherapy and pelvic radiation therapy compared with pelvic radiation therapy alone as adjuvant therapy after radical surgery in high-risk early-stage cancer of the cervix. J Clin Oncol 2000; 18: 1606–1613.
12. Nezhat CR, Nezhat FR, Burrell MO et al. Laparoscopic radical hysterectomy and laparoscopically assisted vaginal radical hysterectomy with pelvic and paraaortic node dissection. J Gynecol Surg 1993; 9: 105–120.
13. Spirtos NM, Schlaerth JB, Spirtos TW et al. Laparoscopic bilateral pelvic and paraaortic lymph node sampling: an evolving technique. Am J Obstet Gynecol 1995; 173: 105–111.
14. Lee CL, Huang KG, Jain S et al. Comparison of laparoscopic and conventional surgery in the treatment of early cervical cancer. J Am Assoc Gynecol Laparosc 2002; 9: 481–487.
15. Abu-Rustum NR, Gemignani ML, Moore K et al. Total laparoscopic radical hysterectomy with pelvic lymphadenectomy using the argon-beam coagulator: pilot data and comparison to laparotomy. Gynecol Oncol 2003; 91: 402–409.
16. Nam JH, Kim JH, Kim DY et al. Comparative study of laparoscopico-vaginal radical hysterectomy and abdominal radical hysterectomy in patients with early cervical cancer. Gynecol Oncol 2004; 92: 277–283.
17. Zakashansky K, Chuang L, Gretz H et al. A case-controlled study of total laparoscopic radical hysterectomy with pelvic lymphadenectomy versus radical abdominal hysterectomy in a fellowship training program. Int J Gynecol Cancer 2007; 17: 1075–1082.
18. Li G, Yan X, Shang H et al. A comparison of laparoscopic radical hysterectomy and pelvic lymphadenectomy and laparotomy in the treatment of Ib-IIa cervical cancer. Gynecol Oncol 2007; 105: 176–180.
19. Frumovitz M, dos Reis R, Sun CC et al. Comparison of total laparoscopic and abdominal radical hysterectomy for patients with early-stage cervical cancer. Obstet Gynecol 2007; 110: 96–102.
20. Malzoni M, Tinelli R, Cosentino F et al. Total laparoscopic radical hysterectomy versus abdominal radical hysterectomy with lymphadenectomy in patients with early cervical cancer: our experience. Ann Surg Oncol 2009; 16: 1316–1323.
21. Monk BJ, Tewari K, Gamboa-Vujicic G et al. Does perioperative blood transfusion affect survival in patients with cervical cancer treated with radical hysterectomy? Obstet Gynecol 1995; 85: 343–348.
22. Lentz SS, Shelton BJ, Toy NJ. Effects of perioperative blood transfusion on prognosis in early-stage cervical cancer. Ann Surg Oncol 1998; 5: 216–219.
23. Spirtos NM, Westby CM, Averette HE, Soper JT. Blood transfusion and the risk of recurrence in squamous cell carcinoma of the cervix: a gynecologic oncology group study. Am J Clin Oncol 2002; 25: 398–403.
24. Spirtos NM, Eisenkop SM, Schlaerth JB, Ballon SC. Laparoscopic radical hysterectomy (type III) with aortic and pelvic lymphadenectomy in patients with stage I cervical cancer: surgical morbidity and intermediate follow-up. Am J Obstet Gynecol 2002; 187: 340–348.