ROLE OF LAPAROSCOPIC LYMPHADENECTOMY IN THE MANAGEMENT OF CERVICAL CANCER

Kung-Liahng Wang*

Department of Obstetrics and Gynecology, Mackay Memorial Hospital, and Mackay Medicine, Nursing and Management College, Taipei, Taiwan.

SUMMARY

Cervical cancer is the most prevalent genital tract neoplasm in Taiwan. Generally speaking, surgical staging is superior to clinical staging since histologic verification of tumor extent correlates better with the biologic behavior of disease. However, a major shortcoming of surgical staging by laparotomy is not only its association with high morbidity and prolonged recovery time, but also the development of postoperative peritoneal adhesions. Adhesion formation limits the mobility of the intestinal loops and exposes them to excess irradiation. The ability to prevent postoperative peritoneal adhesions is the impetus behind the ongoing investigation into the use of laparoscopic surgery. This outstanding feature of laparoscopy is extremely significant in the management of patients with cervical cancer, who are subjected to radiotherapy after lymphadenectomy. Laparoscopic lymphadenectomy, either partial (lymph node sampling) or complete, leads to minimal postoperative peritoneal adhesions and permits accurate assessment of the extent of disease for cervical cancer patients with early or advanced disease. This paper reviews recent reports and updates available information concerning the current practice of laparoscopic pelvic and paraaortic lymphadenectomy in the management of cervical cancer. Various aspects of laparoscopic lymphadenectomy and its clinical role are addressed here, including complications and any controversial issues. [*Taiwanese J Obstet Gynecol* 2005;44(4):301–313]

Key Words: extraperitoneal, gynecologic cancer, laparoscopic lymphadenectomy, laparoscopic surgery, laparoscopy, retroperitoneal

Introduction

Laparoscopic surgery was initially developed in France and the USA. It was originally referred to as laser surgery since lasers were used for parts of the dissection. This type of surgery is associated with significantly more benefits than conventional laparotomy. It leads to little blood loss, short hospital stay, quick recovery, less need for analgesia, rapid return to normal daily activity, and better cosmetic appearance [1,2]. Laparotomy commonly paralyzes bowel function (known as ileus), which is rarely seen after laparoscopic surgery. Early experience with laparoscopic surgery in gynecology was gained mainly through female sterilization by laparoscopic tubal ligation in the 1970s [3]. Significant improvements in surgical skill and instrumentation over the last decade, including video monitoring technology in the late 1980s that evolved until abdominal content could be projected onto TV screens, have stretched the application of laparoscopy beyond a secondary diagnostic role and transformed it into a primary assisting component of gynecologic surgery. Since many gynecologic malignancies require complicated procedures, projection of a relatively small area in selected regions of the abdomen enables better management of the disease during laparoscopic surgery. It is now possible to perform increasingly complex surgical procedures using video monitor laparoscopy, avoiding major surgery. Today, laparoscopic surgery refers to a minimally invasive procedure in a very focal area of the abdomen without a large incision that results in minimal formation of scar tissue. Unlike imaging methods such as X-ray, computed

**Correspondence to:* Dr. Kung-Liahng Wang, Department of Obstetrics and Gynecology, Mackay Memorial Hospital, 92, Section 2, Chung-Shan North Road, Taipei 10449, Taiwan.
E-mail: kl421229@ms6.hinet.net
Received: August 16, 2005
Revised: August 19, 2005
Accepted: August 19, 2005

tomography (CT), magnetic resonance imaging (MRI), and ultrasound, laparoscopic surgery allows direct observation of the abdomen and pelvis. It has become a popular and widespread technique accepted by gynecologists as an appropriate alternative to conventional surgery in the management of patients with gynecologic disease [4].

Despite its many advantages over standard laparotomy, the role of laparoscopic surgery has been controversial for managing patients with gynecologic malignancies. Although laparoscopy offers better visualization during surgery, the lack of tactile feedback and loss of depth perception have frustrated many gynecological oncologists who are familiar with conventional laparotomy [2]. Many have not developed laparoscopic skills because of the lack of opportunity, the lack of standardization of the laparoscopic techniques, and increased frustration in the learning process. Different laparoscopic procedures are also associated with different degrees of learning, from a relatively simple laparoscopically assisted radical vaginal hysterectomy (LARVH) to the more difficult Schauta operation. Some gynecologic oncologists have been somewhat hesitant because the effectiveness of laparoscopic procedures compared with standard abdominal procedures has not been established by prospective randomized trials [5]. Others are concerned with the risk of port-site metastases, which have been reported in patients with early malignancies [6]. From the first documentation of laparoscopic lymphadenectomy by Dargent in 1987 [7] to the comparison of LARVH with abdominal radical hysterectomy (ARH) by Steed et al in 2004 [8], long-term follow-up and comparative studies have highlighted the use of modern laparoscopy in the field of gynecologic oncology. It is clear that, after more than 10 years of experience with laparoscopic procedures, laparoscopic surgery is appropriate for several gynecologic malignancies. This paper reviews recent reports and updates information on current practice in laparoscopic pelvic and paraaortic lymphadenectomy for the management of cervical cancer.

Laparoscopic Pelvic and Paraaortic Lymphadenectomy

Cervical cancer is the second most common gynecologic malignancy in the world, but the most prevalent genital tract neoplasm in Taiwan [9]. Although many factors have been studied and correlated with patient outcome in various staging systems and classifications, the International Federation of Gynecology and Obstetrics (FIGO) staging system is the most common classification system used by major medical centers across the world for the clinical diagnosis of patients with cervical cancer. Generally speaking, surgical staging is superior to clinical staging since histologic verification of tumor extent correlates better with the biologic behavior of the disease [10]. Lymphatic dissemination of tumor cells is one of the main metastatic routes of cervical cancer. Lymphatic metastases follow a relatively predictable ascending pattern [11], appearing first in the pelvic lymph nodes and spreading to the aortic lymph nodes. The presence of lymph node metastases (pelvic or paraaortic) is the most significant prognostic factor that determines recurrence and survival in patients with early cervical cancer [12]. Nodal metastases in gynecologic malignancies have an unfavorable impact on survival in patients with early and advanced cervical cancer. Aortic node sampling is particularly critical in the assessment of advanced cervical cancer compared with early disease. Surgical-pathologic staging is the only reliable method for evaluation of pelvic and aortic lymph nodes and can be performed as a pretreatment assessment, as part of surgical procedures, or as reassessment of inadequately staged patients. However, a major shortcoming of surgical staging by laparotomy is its association not only with high morbidity and prolonged recovery, but also with development of postoperative peritoneal adhesions. Peritoneal adhesions are responsible for the high incidence of post-irradiation enteric morbidity during radiotherapy, and are a critical concern for patients with advanced disease. Laparoscopic staging is an alternative in the surgical-pathologic staging of patients with cervical cancer. The major attribute of laparoscopic surgery is its association with fewer postoperative peritoneal adhesions, which is particularly critical for pretreatment assessment of patients with advanced disease to define the extent of disease spread. Laparoscopic lymphadenectomy, either partial (lymph node sampling) or complete lymphadenectomy, leads to minimal postoperative peritoneal adhesions and permits accurate assessment of the extent of disease in cervical patients with early or advanced disease. Laparoscopic pelvic and paraaortic lymphadenectomy have emerged as a new surgical technique that can potentially replace conventional surgical staging by laparotomy.

History

The laparoscopic management of cervical cancer has been evolving over the last 18 years. The progression of laparoscopic technique is documented in works published by many clinicians, addressing various aspects of laparoscopic lymphadenectomy and its clinical roles. The published experience with laparoscopic lymphadenectomy for surgical staging in patients with cervical cancer is summarized in Tables 1 and 2. Laparoscopic lymphadenectomy is generally combined with radical or vaginal hysterectomy in a curative approach (Table 1); very few cases have been reported of staging alone (Table 2). The use of laparoscopy for pelvic and paraaortic lymph node dissections are the subject of considerable debate in relation to its complications. Although both pelvic and paraaortic lymph node dissections have been used in some studies, information concerning operating time and complications are not available separately for the two procedures. It is a challenging task to assess the specific role of laparoscopic lymphadenectomy in the surgical-pathologic staging of patients with cervical cancer when it is performed as part of other surgical procedures.

Early disease

Dargent reported the first use of laparoscopic lymphadenectomy in early disease in 1987 [7]. The 3-year survival rate was 95.5% in 51 patients with negative pelvic nodes. This alternative, to dissect lymph nodes laparoscopically, opened up new perspectives for gynecologic oncology. Dargent incorporated laparoscopic retroperitoneal pelvic lymphadenectomy (LRPL) in Schauta radical hysterectomy. However, laparoscopic transperitoneal pelvic lymphadenectomy (LTPL), developed subsequently by Querleu et al in 1991 as a transperitoneal counterpart [13], replaced LRPL as the standard technique in pelvic lymph node sampling. Although the transperitoneal approach is associated with a longer learning process, is less easy, and has more limitations than LRPL, it offers a better view and reduced hematoma and lymphocyst formation than LRPL [33]. The feasibility of using transperitoneal laparoscopy for paraaortic lymphadenectomy (laparoscopic transperitoneal paraaortic lymphadenectomy, LTPAL) was demonstrated by Childers et al the following year [14]. Querleu reported a series of eight patients, demonstrating less blood loss, shorter hospital stay, and decreased pain with LARVH and LTPL than with abdominal surgery [18]. Hatch et al reported their experience in 37 patients treated using LARVH and LTPL [20]. Mean blood loss was 525 mL (range, 200–1,400 mL) and average hospital stay was 3 days (range, 2–11 days). Roy et al compared postoperative complications of radical vaginal and radical abdominal hysterectomies after laparoscopic pelvic lymphadenectomy [21]. After laparoscopic pelvic lymphadenectomy in 52 patients, 25 underwent radical vaginal hysterectomy and the other 27 underwent radical abdominal hysterectomy. Blood loss, operative time, and blood transfusion were comparable in the two groups. Schneider's group has published extensively on laparoscopic nodal dissection and has maintained prospective data for 10 years, from which significant information is available [23,27,28,34]. Kohler et al compiled the largest series to date of laparoscopic pelvic and/or paraaortic nodal dissections [28]. Transperitoneal lymphadenectomy was performed in 650 patients between August 1994 and September 2003. Most cases (396/650, 61%) were related to cervical cancer: staging of advanced cervical cancer (133/396, 34%); trachelectomy for early cervical cancer (42/396, 11%); and LARVH (221/396, 56%). The authors concluded that the complication rate of both LTPL and LTPAL was low and could be minimized by standardization of the procedure. Nevertheless, this study evaluated the complication rate in all 650 patients, including more than one cancer type. A more precise understanding of the complications involved in laparoscopic lymphadenectomy for cervical cancer was provided by Hertel et al [27], who reported the largest series of LARVH, comprising 200 patients with cervical cancer (FIGO stage IA1–IV) between August 1994 and June 2002. Not only did they report both short- and long-term complications of the procedure, they also correlated the clinical pathologic data with long-term survival data. Laparoscopic pelvic and/or paraaortic nodal dissections were performed in all 200 patients. The major contribution of this publication was the proposal of selection criteria for LARVH: ideal candidates were patients with tumor size less than 4 cm, negative lymph nodes, and no angio-lymph vascular involvement. Patients with stage IIB disease or greater are typically not considered candidates for radical hysterectomy in the USA: stage IIB (45/200, 23%), stage IIIA (1/200, 0.5%), and stage IV (1/200, 0.5%). The recognized higher complication rate of radical surgery with radiation therapy and the effectiveness of chemoradiation therapy in randomized controlled trials have precluded patients with IB2 disease and above from surgery in the USA [12, 35,36]. Hertel et al's paper was the first to provide the same clinical pathologic data for LARVH comparable to the Gynecologic Oncology Group (GOG) study [35] and the study by Alvarez et al [12] for radical surgery. This study supports that the high-risk parameters for recurrence following radical hysterectomy are also important in LARVH. After a median follow-up of 40 months, the overall 5-year survival was projected to be 83%. An excellent projected 5-year survival of 98% for 110 patients can be achieved using the proposed selection criteria for ideal patients followed by indicated adjuvant therapy. However, no explanation was given as to why 29 of these 110 patients (26%) received adjuvant radiotherapy. The study by Hertel et al provides the best

Table 1. Literature concerning laparoscopic lymphadenectomy for curative treatment of cervical cancer

Study	*n*	FIGO stage	Treatment type	Operative time (min)	LA time (min)	Pelvic LN (*n*)	Paraaortic LN (*n*)	Positive LN (*n*)	Estimated blood loss (mL)	Intraoperative complications (LA only) (*n*)	Postoperative complications (clearly not associated with LA) (*n*)	Hospital stay (d)
Querleu et al (1991) [13]	39	IB–IIB	RT 5, LARVH 2, ARH 32	n.i.	90	8.7 (3–22)	Not done	5 pelvic	n.i.	1 hemorrhage, 1 anesthetic problem	1 pelvic hematoma	1 (except 1 patient)
Childers et al (1992) [14]	5	IB	ARH	n.i.	n.i.	31.4 (17–37)	Not done	1 pelvic	n.i.	None	None	8.3 (7–10)
Nezhat et al (1992) [15]	1	IA2	LRH	420	n.i.	14	5	None	30	None	None	2
Fowler et al (1993) [16]	12	IB	ARH	373 (275–545)	n.i.	23.5 (7–33)	6.5 (5–8) (2 pts)	2 pelvic	629 (250–1,200)	3 transfusions	1 patient with emphysema and wound infection	6.4 (4–8)
Nezhat et al (1993) [17]	19	IA2–IIA	LRH 7, LARVH 11, ARH 1	LRH 315 (240–480), LARVH 163 (125–214)	n.i.	21.7 (11–33)	5.5 (3–9) (11 pts)	n.i.	30–250	1 conversion to laparotomy	1 UTI, 1 hemorrhage from umbilical incision	2.1 (1–6)
Querleu (1993) [18]	8	IA2–IIB	LARVH	281	n.i.	12.6 (7–17)	Not done	3 pelvic	6 cases < 300, 2 cases > 1,000	2 transfusions	1 bladder atony	5.2
Dargent et al (1994) [19]	28	IA2–IIA	TRA	n.i.	n.i.	13.4 ± 6	Not done	None	n.i.	None	2 hematoma in the small pelvis	9.2
Hatch et al (1996) [20]	37	n.i.	LARVH (SA)	226	n.i.	35.5	11.3	4 pelvic	525 (200–1,400)	1 large bowel injury	9 fever, 1 post-op appendicitis	3 (2–11)
Spirtos et al (1996) [1]	10	IA2–IB	LARVH	253 (200–430)	n.i.	18.3 (15–26)	6.5 (4–9)	n.i.	300 (100–700)	None	None	3.2 (2–5)
Roy et al (1996) [21]	25	IA2–IIA	LARVH (SA) 10, VRH 15	270 (160–420)	n.i.	27 (8–59)	Not done	None	400 (50–1,300)	1 external iliac vein lesion, 5 transfusions	1 abdominal wall abscess, 1 hematoma, 4 fever, 1 ileus	7
Chu et al (1997) [22]	34	IA2–IB	LARVH 6, ARH 28	92 (70–138)	n.i.	26.7 (13–38)	Not done	5	n.i.	None	None	n.i.
Possover et al (1998) [23]	70	IA–IVA	LARVH	LAVRH type II 298 (194–420), LARVH type III/IV 375 (245–500)	Paraaortic right 36.4, left 24.1, pelvic 64.9	26.8 (10–56)	7.3 (0–19)	3 pelvic	Difference between pre-op and post-op hemoglobin is 5.07 mmol/L	7 vascular injuries (3 vena cava, 1 right renal vein, 1 internal iliac vein, 1 external iliac vein, 1 internal iliac artery) with 4 conversions to	4 hemorrhages, 8 fever, 2 lymphedema, 1 left plexus lumbosacralis injury, 1 obturator nerve injury, 2 bowel obstruction	11.6 (7–25)

										laparotomy, 4 transfusions		
Renaud et al (2000) [24]	91	LARVH (SA) IB2–IIA, LRVT, IA1–IB1	LARVH (SA) 57, LTRV 34	LARVH 270 (180–360), LRVT 260 (155–470)	n.i.	LARVH 27 (8–59), LT LRVT RV 26 (11–96)	LARVH 3 (1–6), LRVT 4 (2–13) (9 pts)	n.i.	VRH 300 (20–1,300), VRT 200 (75–1,200)	VRH+VRT: 2 iliac and 1 epigastric vessel injuries, 2 VRH to laparotomy, 1 VRT converted to VRH, 4 transfusions (2 VRH + 2 VRT)	LARVH (SA): 1 abscess, 1 UTI, 1 bladder atony, 2 lymphoceles; LRVT: 1 hematoma	VRH 5 (3–15), VRT 4 (2–13)
Malur et al (2001) [25]	70	IA1–IIIA	LARVH (SS)	292.9 (194–420)	n.i.	27 (10–56)	7.8 (1–19)	n.i.	300–1,000	1 ureteral injury, 2 vascular injuries (1 internal iliac artery, 1 internal iliac vein), 5 bladder injuries, 6 minor transfusions	5 UTI, 2 lymphedema, 1 obturator nerve injury, 3 bleeding, 4 fever	11.4 (7–21)
Spirtos et al (2002) [26]	78	IA2–IB	LRH 78	205 (150–430)	n.i.	23.8	10.3	9	250 (50–700)	1 ureteral injury, 2 vascular injuries, with 5 conversions to laparotomy, 1 transfusion	1 vaginal cuff abscess, 1 abdominal wall hematoma, 1 urosepsis, 1 DVT, 1 ureterovaginal fistula, 2 pelvic lymphocysts	2.9
Hertel et al (2003) [27]	200	IA1–IV	LARVH	333 (151–556)	n.i.	22 (3–57)	8 (1–27) (170 pts)	25 pelvic, 1 aortic	n.i.	7 ureteral injuries, 4 vascular, 1 bowel injury	3 diffuse bleeding, 1 bleeding of medial rectal artery + cardinal ligament, 1 bladder leakage from suprapubic catheter, 7 ureterostenosis, 2 uretero/bladder-vaginal fistula, 1 hemorrhage + coagulopathy, 14 fever	14 (5–32)
Kohler et al (2004) [28]	263	n.i.	LARVH 221, LRVT 42	LARVH 147, LRVT 173	LARVH 112, LRVT 132	LARVH 21.6 (3–52), LRVT 23.7 (7–44)	LARVH 10.1 (1–35), LRVT 13.8 (6–19)	n.i.	n.i.	n.i.	n.i.	n.i.

ARH = abdominal radical hysterectomy; DVT = deep venous thrombosis; FIGO = International Federation of Gynecology and Obstetrics; LA = lymphadenectomy; LARVH = laparoscopically assisted radical vaginal hysterectomy; LARVH (SA)/(SS) = laparoscopic assisted Schauta-Amreich and Schauta-Stokel operations; LRH = laparoscopic radical hysterectomy; LRVT = laparoscopic radical vaginal trachelectomy; LN = lymph nodes; n.i. = not indicated; pts = patients; RT = radiotherapy; TRA = trachelectomy; UTI = urinary tract infection; VRH = vaginal radical hysterectomy; VRT = vaginal radical trachelectomy.

evidence to support LARVH as being equally effective as radical abdominal hysterectomy and open lymphadenectomy in the management of cervical cancer.

Advanced disease

Patients with advanced disease (FIGO stage IIB or higher) are often clinically staged without surgical assessment. The risk of extended-field radiotherapy (EFRT) is an additional factor to consider when assessing the complication rate and accuracy of laparoscopic diagnostic procedures for patients with advanced disease. Such patients are usually treated with chemotherapy, irradiation, or a combination of both. Chemoradiation is, in general, limited to the pelvis for these patients. Since EFRT can be associated with significant gastrointestinal tract and other morbidities, it is used only if there is evidence of paraaortic lymph node involvement [37,38]. The risk of grade 3 or 4 toxicities, mainly gastrointestinal tract and urinary complications, following prophylactic paraaortic irradiation in randomized controlled trials is 4% [39, 40]. The presence and extent of metastases in the common iliac and paraaortic nodes directly influences clinical decisions [41,42]. There is a high incidence of paraaortic lymph node metastasis in advanced disease: 6% in stage IB, 12–19% in stage II, 29–33% in stage III, and 30–40% in stage IV disease [43]. Unfortunately, the evaluation of lymphatic spread with currently available noninvasive cross-sectional imaging modalities such as lymphography, CT, MRI, and guided fine-needle aspiration is associated with relatively poor sensitivity and specificity [42]. Understaging of up to 30–50% of advanced disease cases using clinical methods has been reported [44]. Conventional CT or MRI provides a sensitivity and specificity near 80% when nodes are greater than 1 cm, but this falls to 24% with smaller lymph nodes [45,46], which are found in many patients with advanced disease. Moreover, these lymph nodes often do not show signs of enlargement or distortion, which makes diagnosis even more difficult. The apparent discrepancy between clinical staging and surgical-pathologic findings clearly delineates the significance of surgical assessment for patients with advanced disease. Surgical staging by laparoscopy and negative nodes on preoperative CT in advanced cervical cancer (stage IIB or greater) were pioneered by Childers et al [14] as an appropriate alternative to avoid some of these complications. These authors found no significant short-term complications. However, other authors have reported that CT is inaccurate. Goff et al reported that it was necessary to modify the standard pelvic radiation field in 43% of patients with locally advanced disease after surgical staging [47]. Vergote et al also found no suspicious nodes on CT in 38 advanced-stage patients (stages IB2–IIIB in this study) who underwent lower paraaortic lymphadenectomy, while laparoscopic evaluation detected microscopic paraaortic metastases in 18% of patients (7/38) [48]. Possover et al reported that frozen section was an indispensable component of laparoscopic evaluation that could correctly identify all patients with involved lymph nodes [34]. The addition of frozen section to laparoscopic evaluation led to a change in primary therapy in 15.4% of cases, and the laparoscopy–frozen section combination achieved a sensitivity and specificity of 92.3%. Considering the high accuracy and specificity of the laparoscopy–frozen section combination as well as the minimal complication rate, it seems reasonable to recommend the use of laparoscopic surgery for staging of advanced patients before radiation therapy.

Postoperative peritoneal adhesions

The ability to prevent postoperative peritoneal adhesions is the impetus behind the ongoing investigation into laparoscopic surgery. Adhesion formation limits the mobility of intestinal loops and exposes them to excess irradiation. This outstanding feature of laparoscopy is extremely significant in the management of uterine cancer because patients subjected to radiotherapy after lymphadenectomy are considered at risk for recurrence. Patients with cervical cancer could benefit from less traumatic surgery, potentially enabling a faster recovery and early administration of postoperative adjuvant chemotherapy and radiotherapy. Lanvin et al provided evidence of the benefit of laparoscopic dissection and its association with significantly fewer adhesions than transperitoneal laparotomy (anterior abdominal wall, $p = 0.0006$; paraaortic area, $p = 0.0005$; right iliac area, $p = 0.015$; left iliac area, $p = 0.0324$) [49]. Querleu et al reported that pelvic adhesions were not observed in 32 patients undergoing laparotomy up to 6 weeks after LTPL [13]. An animal study by Fowler et al also showed less adhesion formation after LTPL when compared with retroperitoneal laparotomy [50]. Leblanc et al conducted a retrospective comparative study of 26 patients, and discovered six severe complications among patients irradiated after laparotomic pelvic dissection and only one complication after laparoscopic dissection [51]. These studies clearly demonstrate the absence of significant postoperative complications after laparoscopic surgery.

Approach of laparoscopic paraaortic lymph node dissection

Randomized studies have not been performed to compare the three approaches to laparoscopic paraaortic lymph node dissection (transperitoneal, bilateral retroperitoneal, and left retroperitoneal), and it is difficult to compare the results from different studies. The major technical disadvantage of the transperitoneal approach is the difficulty in exposing the left paraaortic area during nodal dissection. The retroperitoneal approach is technically easier, surgically and anatomically more logical, and creates fewer peritoneal adhesions with fewer resultant bowel complications than its transperitoneal counterpart [52]. It is generally accepted that retroperitoneal aortic dissection reduces the risk of radiation enteritis. Unlike its transperitoneal counterpart, the retroperitoneal approach provides rapid access to the paraaortic lymph node dissection area. Laparoscopic retroperitoneal paraaortic lymphadenectomy (LRPAL) allows accurate detection of micrometastases in the paraaortic nodes, allowing more precise selection of patients with advanced cervical cancer for EFRT and precluding patients from overtreatment. LRPAL can be performed through a bilateral iliac incision or through a unilateral left incision. The first available publication on LRPAL was by Vasilev and McGonigle [53], followed by papers by Dargent et al [54], Querleu et al [55], and Mehra et al [56] (Table 3). Dargent et al, in a retrospective study, extended LRPL to the retroperitoneal dissection of the common iliac and aortic nodes [54]. They reported that all three approaches to laparoscopic paraaortic lymph node dissection were able to retrieve similar numbers of nodes. Moreover, the mean duration of the total operation, complication rate, and hospital stay were also comparable. The authors confirmed the feasibility of the left retroperitoneal route for systematic paraaortic lymph node sampling for patients with cervical cancer, but recommended the bilateral approach when facing difficulties in the left side approach. Since LRPL was designed primarily for the removal of interiliac nodes, it does not allow adequate intraperitoneal exploration and aortic lymphadenectomy [13,57,58]. It has been commented that this novel technique has gained the acceptance of Querleu et al [59], the pioneers of LTPL, in 2003. The major complication of this technique is the formation of giant lymphocysts, which can be avoided by incision of the peritoneum of the paracolic gutter at the end of the procedure, allowing intraperitoneal drainage of the retroperitoneal dissection area.

Numbers of retrieved lymph nodes

The adequacy of laparoscopic pelvic and paraaortic lymphadenectomy is the subject of considerable debate. Various numbers of retrieved lymph nodes have been reported (Tables 1 and 2). Seventeen studies are summarized in Table 1 in an attempt to provide an overview of the various techniques that have been combined with laparoscopic lymphadenectomy between 1991 and 2004. Since patients with early disease are mostly curable, lymph node dissections are often combined with various other curative surgical techniques (Table 1). Conversely, only patients with advanced disease require pretreatment laparoscopic staging (Table 2). Only nine studies are available for laparoscopic staging alone within the same period, and data on retrieved lymph nodes are available for only eight studies. Paraaortic lymphadenectomies are performed to determine the extent of disease spread so that appropriate chemo/radiotherapy can be tailored for advanced disease patients. A few early studies between 1991 and 1994 reported inadequate numbers of retrieved pelvic lymph nodes (Table 1), including Querleu et al [13], Nezhat et al [15], Querleu et al [18], and Dargent et al [19], who reported an average of only 8.7, 14, 12.6, and 13.4 lymph nodes, respectively. However, many other investigators have provided sufficient evidence that laparoscopic lymphadenectomy is capable of adequately identifying all positive lymph nodes and removing sufficient lymph nodes for adequate staging. The exclusion of the four cases with inadequate retrieval from Table 1 yields an average of 25 retrieved pelvic lymph nodes (range, 18.3–35.5), which is comparable to the number recovered at laparotomy [14,16, 22,23,32,60].

Childers et al published the first description of LTPAL in patients with cervical cancer [14]. Su et al published the first series in which adequacy of LTPAL was confirmed by standard laparotomy [31]. This series comprised 36 cases of laparoscopic paraaortic lymphadenectomy and 21 comparative laparotomies. Chu et al reported 28 cases of LTPAL, 28 cases of LTPAL followed by ARH, and six cases of LARVH [22]. Lecuru et al also retrieved matching numbers of lymph nodes in their study in 33 fresh cadavers, comparing pelvic lymphadenectomy performed by unilateral laparoscopy and contralateral laparotomy [61]. Dargent et al also retrieved similar mean numbers of nodes using all three approaches to laparoscopic paraaortic lymph node dissection (transperitoneal, bilateral retroperitoneal, left retroperitoneal) [54], which were comparable or even higher than in laparotomy as reported by Buchsbaum [62] and Finan et al [63].

A GOG study in multiple centers evaluated laparoscopic retroperitoneal lymphadenectomy in women with early cervical cancer (Table 2) [32]. The surgical sites were inspected at laparotomy (radical hysterectomy) immediately after LRPL and LRPAL. The objectives of the study were to examine the adequacy of lymph node removal, and the adverse effects and difficulties associated with laparoscopic lymph node dissection.

Table 2. Literature concerning laparoscopic lymphadenectomy for staging of cervical cancer

Study	*n*	FIGO stage	Operative time (min)	LA time (min)	Pelvic LN (*n*)	Paraaortic LN (*n*)	Positive LN (*n*)	Estimated blood loss (mL)	Intraoperative complications (LA only) (*n*)	Postoperative complications (clearly not associated with LA) (*n*)	Hospital stay (d)
Childers et al (1992) [14]	13	IIB–IVA	75–175	n.i.	n.i.	n.i.	1 paraaortic, 1 pelvic	50–100	None	None	1
Kadar (1993) [29]	11	IIB–IIIB	n.i.	97, 106	Not done	6 (1 +ve), 10 (4 +ve)	1, 4	n.i.	None	None	1, 1
Querleu (1993) [30]	2	I	165, 405	125, 65	14, 13	7, 6	0, 0	n.i.	No major	n.i.	1, 3
Su et al (1995) [31]	36	IB–IIIB	n.i.	77 (27–180)	Not done	15 (3–33)	7	116 (10–2,000)	1 vena cava lesion, 1 ureteral injury	n.i.	n.i.
Chu et al (1997) [22]	28	IIB–IIIB	n.i.	95 (55–138)	Not done	8.6 (3–19)	10	n.i.	1 vena cava lesion	None	1.9 (1–4)
Possover et al (1998) [23]	26	IIB–IIIB	162.1 (70–335)	Paraaortic 45 (27–71), pelvic 131 (91–164)	15.3 (6–35)	6.8 (1–14)	3 pelvic, 2 paraaortic	Difference between pre-op and post-op hemoglobin is 5.03 mmol/L	1 vena cava lesion	1 fever, 1 UTI	3.2 (2–7)
Renaud et al (2000) [24]	11	IB1–IIA	n.i.	200 (130–310)	23 (16–34)	9 (1–19) (6 pts)	11 pelvic, 6 paraaortic	60 (10–600)	None	None	2 (1–8)
Schlaerth et al (GOG Study) (2002) [32]	67	IA2–IIA	n.i.	209 (90–465) (40 pts)	Pelvic (40 pts), right 16.6 (4–41), left 15.5 (4–32)	Paraaortic (40 pts), right 6.2 (0–17), left 5.9 (1–21)	7 pelvic, 0 paraaortic	n.i.	1 ureteral injury + 7 major vessel injuries (2 vena cava, 1 common iliac artery, 1 common iliac vein, 1 external iliac artery, 1 inferior mesenteric artery, 1 inferior mesenteric vein) with 3 conversions to laparotomy, 7 transfusions, 1 fragmentation of dissected LN, 1 fracture of a metastatic LN during removal, and 1 missing LN metastasis outside the protocol surgery boundaries	4 fever, 1 pelvic abscess, 2 hematomas, 1 delirium tremens, 1 heart failure, 1 anterior compartment syndrome in lower leg after injury and repair to common iliac arteriotomy, 1 post-op appendicitis, 2 lymphocysts	6.3 (3–21) (40 pts)

Kohler et al (2004) [28]	133	n.i.	157	114	14.5 (1–43)	13.6 (1–52)	n.i.	n.i.	n.i.	n.i.	n.i.

FIGO = International Federation of Gynecology and Obstetrics; LA = lymphadenectomy; LN = lymph nodes; n.i. = not indicated; pts = patients; UTI = urinary tract infection; +ve = positive.

Table 3. Literature concerning laparoscopic retroperitoneal paraaortic lymphadenectomy for staging of cervical cancer

Study	*n*	FIGO stage	Operative time (min)	LA time (min)	Paraaortic LN (*n*)	Positive LN (*n*)	Estimated blood loss (mL)	Intraoperative complications (LA only) (*n*)	Postoperative complications (clearly not associated with LA) (*n*)	Hospital stay (d)
Vasilev & McGonigle (1996) [53]	5	n.i.	120–140	n.i.	5 (1–9)	n.i.	< 50	None	None	n.i.
Dargent et al (2000) [54]	35	IB1–IV	Bilat (6 pts): 153 (130–180), Left (12 pts): 119 (100–150)	n.i.	Bilat (6 pts): 16 (14–19), Bilat, right node: 7.7 (6–10), Left (12 pts): 15 (10–19), Left, right nodes (9 pts): 2.4 (0–5)	n.i.	n.i.	Bilat: 3 peritoneal tear with conversion to transperitoneal approach, Left: 2 peritoneal tear with conversion to transperitoneal approach, 1 transfusion	Bilat: 1 fever, 1 phlebitis, Left: 1 lymphocele	2.5
Querleu et al (2000) [55]	42	IB1–IVA	125.9 (45–185)	n.i.	20.7 (10–44)	17	n.i.	1 ureteral injury	1 hematoma, 2 incisional hernias, 1 lymphocyst	2.5
Vergote et al (2002) [48]	16	IB2–III	n.i.	64 (20–115)	6 (1–15)	0	78 (10–300)	None	1 hematoma	2

Bilat = bilateral retroperitoneal approach; FIGO = International Federation of Gynecology and Obstetrics; LA = lymphadenectomy; Left = left retroperitoneal approach; LN = lymph nodes; n.i. = not indicated; pts = patients.

Although 67 patients underwent laparoscopy, only 40 (60%) conformed to all study parameters. These 40 patients constituted the core of the study. Mean operating time was 209 minutes (range, 90–465 minutes). The mean number of retrieved pelvic nodes was 32.1 (16.6 on the left and 15.5 on the right) and that of aortic nodes was 12.1 (5.9 on the left and 6.2 on the right). The results of LRPL were judged inadequate in six of the 40 patients (15%), but the residual nodes, mainly in the lateral common iliac area, did not contain metastases. Laparoscopic complications were evaluated in all 67 patients. There were seven major vessel injuries (10.4%) and one ureteral vessel injury (1.5%). Three of the major vessel injuries required conversion to laparotomy for bleeding control, a conversion rate of 4.5%. Since laparotomy was subsequently performed in all cases, there was no way to evaluate the benefits or detriments of laparoscopic lymph node removal in relation to hospital stay, blood loss, or postoperative complications. This study demonstrated that LRPAL is a safe and feasible procedure by all methods of evaluation (i.e. blinded review of video prints or video tape and surgeon opinion at laparotomy). The authors judged that the complication rate associated with LRPL could probably be improved. Although more radical aortic lymphadenectomy has been advocated by some centers to achieve a higher node count, there is no evidence that increased radicalism translates into higher cure rates [64]. Even in obese patients, approximately equal numbers of pelvic and paraaortic nodes were obtained by LTPL and LTPAL as at laparotomy. Laparoscopic lymphadenectomy has been regarded as contraindicated in obese patients, especially those requiring LTPAL [65]. Since obese patients can make LTPL and LTPAL more difficult, most studies have limited their patients to either the weight range of 180–210 pounds or a body mass index (BMI) of less than 30 [22,23,31, 65]. Although obesity is regarded as the most limiting factor in successful paraaortic lymphadenectomy, the number of nodes yielded is comparable to that obtained at laparotomy. The largest reported series of obese patients showed an overall success rate of 82.1% in patients with a BMI of less than 35, and 44.4% success rate in patients with a BMI above 35 [66]. Kohler et al, in their retrospective study of 650 patients, confirmed that LTPL and LTPAL were independent of BMI, with an adequate number of lymph nodes removed in an adequate time [28].

Extent of paraaortic dissection

LRPAL to sample common iliac and aortic nodes is the principal technique for patients with advanced cervical cancer [33]. However, the extent of aortic dissection is still extensively debated. There is no doubt that extending the upper limit of dissection increases dissection time. Querleu et al reported that the aortic field can be precluded from treatment if common iliac and aortic nodes are negative by the retroperitoneal approach [59]. Positive nodes were suggested to be an important prognostic factor for high-risk patients and a critical indicator of distant metastases and death. The authors suggested that further staging is essential for patients with positive aortic nodes, including positron emission tomography and scalene node biopsy. Patients with positive nodes and no identified distant metastases were suggested to be candidates for EFRT with concurrent chemotherapy. Few published studies have indicated the feasibility of surgical-pathologic staging by laparoscopy in advanced cervical cancer, so prospective clinical trials and long-term follow-up are required to justify the safety of pre-irradiation laparoscopic staging in patients with advanced cervical carcinoma. Marchiole and Dargent believe that aortic dissection is not required if the pelvic lymph nodes are not involved (risk of aortic involvement < 1%) [67]. Inframesenteric dissection alone is adequate in 75% of all cases of aortic metastases. Vergote et al reduced the operating time from 120–150 minutes to 70 minutes by omitting the supramesenteric portion of the procedure [48]. They reported an 18% (7/38) positive rate for lymph node dissection limited to the inferior mesenteric artery. When aortic dissection must be performed, Marchiole and Dargent [67] and Querleu et al [33,59] suggest that the dissection must be performed up to the level of the left renal vein. Michel et al provided evidence of patients with positive lymph nodes in the left infrarenal area [68]. Querleu et al found a 23% positive rate in a series of 133 patients when dissection was extended to the renal vessels [33,59].

Training in laparoscopic lymphadenectomy

The ability to perform laparoscopic lymphadenectomy with minimal complications depends primarily on the surgeon. Querleu et al performed 542 pelvic lymph node dissections via LTPL without a single conversion to laparotomy as a result of complications [33]. Marchiole and Dargent advised that visceral and vascular injuries would be less frequent with pelvic lymph node dissection using LTPL from their series of 25 cases [67]. The recent study by Frumovitz et al demonstrated the difficulty of training physicians in advanced laparoscopic surgical skills [5]. They recruited 393 subjects to determine the proportion of Society of Gynecologic Oncologists (SGO) members who were able to perform laparoscopic procedures, and to determine their opinions regarding indications for, and the adequacy of training in, laparoscopy. The recruited subjects included 336 SGO members (85%) and 57 fellows (15%). They had limited laparoscopic training during their fellowships, where 39% received no training and 46% received limited training (< 5 procedures/month). Nevertheless, 78% of the SGO members (262) and 25% of the fellows (14) rated their laparoscopic skills as being either very good or good. Most SGO members (269, 80%) considered at least six procedures per month as being necessary for adequate training, but only a minority of fellows (19, 33%) performed that many procedures. As a whole, most fellows perceived their laparoscopic training to be inadequate.

Conclusion

More than 10 years of experience with laparoscopic procedures have allowed gynecologic oncologists to devise therapeutic methods for the management of cervical cancer. Although the feasibility, safety, and adequacy of laparoscopic surgery are not entirely clear, cumulative evidence demonstrates the clinical role of laparoscopic lymphadenectomy in the management of patients with cervical cancer. Many patients with early and advanced cervical cancer may benefit from laparoscopic staging, evaluation, treatment, or a combination. The mean number of pelvic and paraaortic nodes retrieved laparoscopically is similar to that obtained at laparotomy, even in obese patients. The intraoperative benefits of the laparoscopic technique include minimal blood loss, less adhesion formation, and better visual perspective. The risk of recurrence and overall survival are equivalent to those achieved with laparotomy. Intraoperative injuries are recognized and repaired laparoscopically during surgery. Only a small percentage of cases require conversion to laparotomy, and significant long-term postoperative complications are infrequent. The multicenter GOG study shows promising results with laparoscopic retroperitoneal lymphadenectomy in staging and treatment in women with early cervical cancer. These benefits include minimal discomfort, shorter hospitalization, and quicker recovery, which have a positive impact on a patient's quality of life. Moreover, the ability to prevent postoperative peritoneal adhesion marks the superiority of surgical staging by laparoscopy over laparotomy. Adhesion formation can often lead to higher radiation risks for patients during postoperative adjuvant radiotherapy. Surgical staging by laparoscopy is certainly attractive to patients with advanced disease in that they can avoid a laparotomy before initiating definitive chemotherapy and irradiation. There is no question that the complication rate of laparoscopic lymphadenectomy using both transperitoneal and retroperitoneal approaches is extremely low in the hands of experienced gynecologic oncologists. Laparoscopic surgery should be performed by experts and surgeons accredited in these fields until further results from prospective clinical trials such as GOG become available.

This literature review should convince readers that the wide spread of laparoscopic pelvic and paraaortic lymphadenectomy in the management of cervical cancer is to be expected in the near future. A major limitation is the difficulty of training physicians in advanced laparoscopic surgical skills. The lack of tactile feedback and loss of depth perception have frustrated many gynecologic oncologists who are familiar with conventional laparotomy. Since laparoscopic lymphadenectomy in the surgical-pathologic staging of patients with cervical cancer is often performed as part of other surgical procedures, the lack of new protocols for the different operations in use is a challenge. Nonetheless, it is the author's belief that laparoscopic lymphadenectomy will soon be an alternative for surgical staging of gynecologic cancers.

References

1. Spirtos NM, Schlaerth JB, Gross GM, Spirtos TW, Schlaerth AC, Ballon S. Cost and quality-of-life analyses of surgery for early endometrial cancer: laparotomy versus laparoscopy. *Am J Obstet Gynecol* 1996;174:1795–9.
2. Jacobson TZ, Davis CJ. Safe laparoscopy: is it possible? *Curr Opin Obstet Gynecol* 2004;16:283–8.
3. Gordon AG, Magos AL. The development of laparoscopic surgery. *Bailliere's Clin Obstet Gynaecol* 1989;3:429–49.
4. Chapron C, Querleu D, Bruhat MA, Madelenat P, Fernandez H, Pierre F, Dubuisson JB. Surgical complications of diagnostic and operative gynaecological laparoscopy: a series of 29,966 cases. *Hum Reprod* 1998;13:867–72.
5. Frumovitz M, Ramirez PT, Greer M, Gregurich MA, Wolf J, Bodurka DC, Levenback C. Laparoscopic training and practice in gynecologic oncology among Society of Gynecologic Oncologists members and fellows-in-training. *Gynecol Oncol* 2004;94:746–53.
6. Ramirez PT, Frumovitz M, Wolf JK, Levenback C. Laparoscopic port-site metastases in patients with gynecological malignancies. *Int J Gynecol Cancer* 2004;14:1070–7.
7. Dargent D. A new future for Schauta's operation through pre-surgical retroperitoneal pelviscopy. *Eur J Gynecol Oncol* 1987;8:292–6.
8. Steed H, Rosen B, Murphy J, Laframboise S, De Petrillo D, Covens A. A comparison of laparoscopic-assisted radical vaginal hysterectomy and radical abdominal hysterectomy in the treatment of cervical cancer. *Gynecol Oncol* 2004;93: 588–93.
9. Parkin DM, Bray F, Ferlay J, Pisani P. Estimating the world

cancer burden: Globocan 2000. *Int J Cancer* 2001;94:153–6.
10. Heaps JM, Berek JS. Surgical staging of cervical cancer. *Clin Obstet Gynecol* 1990;33:852–62.
11. Lagasse LD, Creasman WT, Shingleton HM, Ford JH, Blessing HA. Results and complications of operative staging in cervical cancer: experience of the Gynecologic Oncology Group. *Gynecol Oncol* 1980;9:90–8.
12. Alvarez RD, Soong SJ, Kinney WK, et al. Identification of prognostic factors and risk groups in patients found to have nodal metastasis at the time of radical hysterectomy for early-stage squamous carcinoma of the cervix. *Gynecol Oncol* 1989;35:130–5.
13. Querleu D, Leblanc E, Castelain B. Laparoscopic pelvic lymphadenectomy in the staging of early carcinoma of the cervix. *Am J Obstet Gynecol* 1991;164:579–81.
14. Childers JM, Hatch K, Surwit EA. The role of laparoscopic lymphadenectomy in the management of cervical carcinoma. *Gynecol Oncol* 1992;47:38–43.
15. Nezhat CR, Burrell MO, Nezhat FR, Benigno BB, Welander CE. Laparoscopic radical hysterectomy with paraaortic and pelvic node dissection. *Am J Obstet Gynecol* 1992;166:864–5.
16. Fowler JM, Carter JR, Carlson JW, Maslonkowski R, Byers LJ, Carson LF, Twiggs LB. Lymph node yield from laparoscopic lymphadenectomy in cervical cancer: a comparative study. *Gynecol Oncol* 1993;51:187–92.
17. Nezhat CR, Nezhat FR, Burrell MO, Ramirez CE, Welander C, Carrodeguas J, Nezhat CH. Laparoscopic radical hysterectomy and laparoscopically assisted vaginal radical hysterectomy with pelvic and paraaortic node dissection. *J Gynecol Surg* 1993;9:105–20.
18. Querleu D. Laparoscopically assisted radical vaginal hysterectomy. *Gynecol Oncol* 1993:51;248–54.
19. Dargent D, Brun JL, Roy M, Mathevet P, Remy I. La trachélectomie élargie (T. E.) une alternative à l'hystérevtomie radicale dans le traitment des cancers infiltrants développés sur la face externe du col utérin. *Job Gyn* 1994;2:285–92.
20. Hatch KD, Hallum AV, Nour M. New surgical approaches to treatment of cervical cancer. *J Natl Cancer Inst* 1996;21:71–5.
21. Roy M, Plante M, Renaud MC, Tetu B. Vaginal radical hysterectomy versus abdominal radical hysterectomy in the treatment of early-stage cervical cancer. *Gynecol Oncol* 1996: 62;336–9.
22. Chu KK, Chang SD, Chen FP, Soong YK. Laparoscopic surgical staging in cervical cancer—preliminary experience among Chinese. *Gynecol Oncol* 1997;64:49–53.
23. Possover M, Krause N, Plaul K, Kühne-Heid R, Schneider A. Laparoscopic para-aortic and pelvic lymphadenectomy: experience with 150 patients and review of the literature. *Gynecol Oncol* 1998;71:19–28.
24. Renaud MC, Plante M, Roy M. Combined laparoscopic and vaginal radical surgery in cervical cancer. *Gynecol Oncol* 2000; 79:59–63.
25. Malur S, Possover M, Schneider A. Laparoscopically assisted radical vaginal versus radical abdominal hysterectomy type II in patients with cervical cancer. *Surg Endosc* 2001:15;289–92.
26. Spirtos NM, Eisenlop 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;187:340–8.
27. Hertel H, Kohler C, Michels W, Possover M, Tozzi R, Schneider A. Laparoscopic-assisted radical vaginal hysterectomy (LARVH): prospective evaluation of 200 patients with cervical cancer. *Gynecol Oncol* 2003;90:505–11.
28. Kohler C, Klemm P, Schau A, Possover M, Krause N, Tozzi R, Schneider A. Introduction of transperitoneal lymphadenectomy in a gynecologic oncology center: analysis of 650 laparoscopic pelvic and/or paraaortic transperitoneal lymphadenectomies. *Gynecol Oncol* 2004;95:52–61.
29. Kadar N. Laparoscopic resection of fixed and enlarged lymph nodes in patients with advanced cervical cancer. *Gynecol Endosc* 1993;2:217–21.
30. Querleu D. Laparoscopic paraaortic node sampling in gynecologic oncology: a preliminary experience. *Gynecol Oncol* 1993; 49:24–9.
31. Su TH, Wang KG, Yang YC, Hong BK, Huang SH. Laparoscopic para-aortic lymph node sampling in the staging of invasive cervical carcinoma: including a comparative study of 21 laparotomy cases. *Int J Gynaecol Obstet* 1995;49:311–8.
32. Schlaerth JB, Spirtos NM, Carson LF, Boike G, Adamec T, Stonebraker B. Laparoscopic retroperitoneal lymphadenectomy followed by immediate laparotomy in women with cervical cancer: a Gynecologic Oncology Group study. *Gynecol Oncol* 2002;85:81–8.
33. Querleu D, Leblanc E. Laparoscopic surgery for gynecologic oncology. *Curr Opin Obstet Gynecol* 2003;15:309–14.
34. Possover M, Krause N, Kühne-Heid R, Schneider A. Value of laparoscopic evaluation of paraaortic and pelvic lymph nodes for treatment of cervical cancer. *Am J Obstet Gynecol* 1998; 178:806–10.
35. Delgado G, Bundy B, Zaino R, Sevin B, Creasman WT, Major F. Prospective surgical-pathological study of disease-free interval in patients with stage 1b squamous cell carcinoma of the cervix: a Gynecologic Oncology Group study. *Gynecol Oncol* 1990;38:352–7.
36. Peters WA 3rd, Liu PY, Barrett RJ 2nd, 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;18:1606–13.
37. Fine BA, Hempling RE, Piver MS, Baker TR, McAuley M, Driscoll D. Severe radiation morbidity in carcinoma of the cervix: impact of pretherapy surgical staging and previous surgery. *Int J Radiat Oncol Biol Phys* 1995;31:717–23.
38. Wharton JT, Jones HW III, Day TG, Rutledge FN, Fletcher GH. Preirradiation celiotomy and extended field irradiation for invasive carcinoma of the cervix. *Obstet Gynecol* 1977;49: 333–8.
39. Rotman M, Pajak TF, Choi K, et al. Prophylactic extended-field irradiation of para-aortic lymph nodes in stages IIB and bulky IB and IIA cervical carcinomas. Ten-year treatment results of RTOG 79-20. *JAMA* 1995;274:387–93.
40. Haie C, Pejovic MH, Gerbaulet A, et al. Is prophylactic para-aortic irradiation worthwhile in the treatment of advanced cervical carcinoma? Results of a controlled clinical trial of the EORTC radiotherapy group. *Radiother Oncol* 1988;11: 101–12.
41. Averette HE, Donato DM, Lovecchio JL, Sevin BU. Surgical staging of gynecologic malignancies. *Cancer* 1987;60:2010–20.

42. Heller PB, Maletano JH, Bundy BN, Barnhill DR, Okagaki T. Clinical-pathologic study of stage IIB, III and IVA carcinoma of the cervix: extended diagnostic evaluation for paraaortic node metastasis—a Gynecologic Oncology Group study. *Gynecol Oncol* 1990;38:425–30.
43. Hoskins WJ, Perez C, Young R. Gynecologic tumors. In: De Vita VJ, Hellman S, Rosenberd SA, eds. *Cancer Principles and Practise of Oncology*, 3rd edition. Philadelphia: Lippincott, 1989: 1099–161.
44. Morrow CP, Curtin JP. Tumors of the cervix. In: *Synopsis of Gynecologic Oncology.* New York: Churchill Livingstone, 1998.
45. Vercamer R, Janssens J, Usewils R, Baert A, Lawerijns J, Bonte J. Computed tomography and lymphography in presurgical staging of early carcinoma of the uterine cervix. *Cancer* 1987; 60:1745–50.
46. Togashi K, Nishimura K, Minami S. Carcinoma of the cervix. Staging with MR imaging. *Radiology* 1989;171:245–51.
47. Goff BA, Muntz HG, Paley PJ, Tamimi HK, Koh WJ, Greer BE. Impact of surgical staging of women with locally advanced cervical cancer. *Gynecol Oncol* 1999;74:436–42.
48. Vergote I, Amant F, Berteloot P, Van Gramberen M. Laparoscopic lower para-aortic staging lymphadenectomy in stage IB2, II, and III cervical cancer. *Int J Gynecol Cancer* 2002;12: 22–6.
49. Lanvin D, Elhage A, Henry B, Leblanc E, Querleu D, Delobelle-Deroide A. Accuracy and safety of laparoscopic lymphadenectomy: an experimental prospective randomized study. *Gynecol Oncol* 1997;67:83–7.
50. Fowler JM, Hartenbach EM, Reynolds HT, et al. Pelvic adhesion formation after pelvic lymphadenectomy: comparison between transperitoneal laparoscopy and extraperitoneal laparotomy in a porcine model. *Gynecol Oncol* 1994;55:25–8.
51. Leblanc E, Castelain B, Lanvin D, Querleu D. Treatment of pelvic lymph node involvement in early stage cervical cancer. *Gynecol Obstet Fertil* 2000;28:526–36.
52. Occelli B, Narducci F, Lanvin D, Leblanc E, Querleu D. Learning curves for transperitoneal laparoscopic and extraperitoneal endoscopic paraaortic lymphadenectomy. *J Am Assoc Gynecol Laparoscop* 2000;7:51–3.
53. Vasilev SA, McGonigle KF. Extraperitoneal laparoscopic paraaortic lymph node dissection. *Gynecol Oncol* 1996;61: 315–20.
54. Dargent D, Ansquer Y, Mathevet P. Technical development and results of left extraperitoneal laparoscopic paraaortic lymphadenectomy for cervical cancer. *Gynecol Oncol* 2000; 77:87–92.
55. Querleu D, Dargent D, Ansquer Y, Leblanc E, Narducci F. Extraperitoneal endosurgical aortic and common iliac dissection in the staging of bulky or advanced cervical carcinomas. *Cancer* 2000;88:1883–91.
56. Mehra G, Weekes ARL, Jacobs IJ, Visvanathan D, Menon U, Jeyarajah AR. Laparoscopic extraperitoneal paraaortic lymphadenectomy: a study of its applications in gynecological malignancies. *Gynecol Oncol* 2004;93:189–93.
57. Dargent D, Mathevet P. Schauta's vaginal hysterectomy combined with laparoscopic lymphadenectomy. *Baillieres Clin Obstet Gynaecol* 1995;9:691–705.
58. Dargent D, Arnould P. Percutaneous pelvic lymphadenectomy under laparoscopic guidance. In: Nichols DH, ed. *Gynecologic and Obstetric Surgery.* St. Louis: Mosby-Year Book, Inc, 1993: 602.
59. Querleu D, Leblanc E, Sonoda Y, et al. Laparoscopic staging of locally advanced cervical carcinomas IB2-IVA. *Int J Gynecol Cancer* 2003;13(Suppl 1):6. [Abstract]
60. Kadar N. Laparoscopic pelvic lymphadenectomy for the treatment of gynecological malignancies: description of technique. *Gynecol Endosc* 1992:179–83.
61. Lecuru F, Robin F, Neji K, Darles C, De Bievres P, Vilde F, Taurelle R. Laparoscopic pelvic lymphadenectomy in an anatomical model: results of an experimental comparative trial. *Eur J Obstet Gynecol Reprod Biol* 1997;72:51–5.
62. Buchsbaum HJ. Extrapelvic lymph node metastases in cervical carcinoma. *Am J Obstet Gynecol* 1979;133:814–24.
63. Finan MA, DeCesare S, Fiorica JV, et al. Radical hysterectomy for stage IB1 vs IB2 carcinoma of the cervix: does the new staging system predict morbidity and survival? *Gynecol Oncol* 1996;62:139–47.
64. Panici PB, Scambia G, Baiocchi G, et al. Technique and feasibility of radical para-aortic and pelvic lymphadenectomy for gynecologic malignancies. *J Gynecol Cancer* 1991;1:133–40.
65. Childers J, Hatch K, Tran A, Surwit E. Laparoscopic paraaortic lymphadenectomy in gynecologic malignancies. *Obstet Gynecol* 1993;82:741–7.
66. Scribner DR, Walker JL, Johnson GA, McMeekin DS, Gold MA, Mannel RS. Laparoscopic pelvic and paraaortic lymph node dissection in the obese. *Gynecol Oncol* 2002;84:426–30.
67. Marchiole P, Dargent D. Laparoscopic lymphadenectomy and sentinel node biopsy in uterine cancer. *Obstet Gynecol Clin North Am* 2004;31:505–21.
68. Michel G, Morice P, Castaigne D, Leblanc M, Rey A, Duvillard P. Lymphatic spread in stage IB and II cervical carcinoma: anatomy and surgical implications. *Obstet Gynecol* 1998;91: 360–3.