

# Increasing experience in laparoscopic staging of early ovarian cancer

Henk W. R. Schreuder · Thyrza O. S. Pattij ·  
Ronald P. Zweemer · Marchien W. van Baal ·  
René H. M. Verheijen

Received: 9 May 2011 / Accepted: 23 June 2011 / Published online: 14 July 2011  
© The Author(s) 2011. This article is published with open access at Springerlink.com

**Abstract** We assessed the effect of increasing experience of a single surgeon (learning curve) in the laparoscopic staging procedure for women with early ovarian cancer and compared the results with the literature. We retrospectively analysed a total of 25 women with apparent early-stage ovarian cancer who underwent a laparoscopic staging procedure by the same surgeon. Three time periods, based on date of surgery, were compared with respect to operating time, amount of lymph nodes harvested and surgical outcome. There was no significant difference in operation time, estimated blood loss and hospital stay between the three periods. There was, however, a significant increase in the median number of pelvic and para-aortal lymph nodes harvested (group 1=6.5, group 2=8.0 and group 3=21.0;  $P<0.005$ ). For the total period, median operation time was 235 min and median estimated blood loss was 100 ml. The median length of hospital stay was 4.0 days. Two intra-operative and two postoperative complications occurred. The upstaging rate was 32%. The mean interval between initial surgery and laparoscopic staging was 51.2 days. Mean duration of follow-up was 43 months, range (1–116 months). Five (20%) patients had recurrences, and two (8%) patients died of the disease. In conclusion, there is a significant learning curve for the laparoscopic full staging procedure in ovarian cancer. In our study this is

mainly reflected in the amount of lymph nodes harvested and not in the total operating time.

**Keywords** Early ovarian cancer · Laparoscopy · Staging · Learning curve

## Background

The risk of an unexpected ovarian malignancy is estimated to be 1% or less in premenopausal women and 3.0% in postmenopausal women [1]. The majority of these adnexal cysts and masses are managed by general gynaecologists, which may lead to inadequate staging of ovarian cancer during the primary operation [2, 3]. As a consequence these patients have two options: (1) second surgery to be optimally staged since optimal staging is an independent prognostic parameter for survival or (2) chemotherapy, since non-optimal staged patients benefit from adjuvant chemotherapy [4]. In patients there are subgroups who have little or nothing to gain from adjuvant chemotherapy and it appears to be safe to withhold adjuvant chemotherapy from patients with early-stage disease who are optimally staged [5].

The traditional procedure for staging ovarian cancer is through laparotomy with a midline incision, exposing the whole peritoneal cavity [6]. Since 1994 several mainly small studies have been published by a limited group of centres on the results of a laparoscopic approach to the staging of early ovarian cancer [7–22]. Laparoscopic staging proves to be accurate and feasible in ovarian cancer patients and has the advantages of minimal invasive surgery. These advantages include less blood loss [8, 17, 18, 21], optical magnification of laparoscopic inspection [12, 14, 17], shorter hospital stay [8, 10–12, 16–18, 21], shorter time interval to adjuvant chemotherapy [10, 17] and

H. W. R. Schreuder (✉) · T. O. S. Pattij · R. P. Zweemer ·  
R. H. M. Verheijen  
Division of Woman and Baby, Department of Surgical and  
Oncological Gynecology, University Medical Centre Utrecht,  
P.O. Box 85500, Room F05-126,  
3508 GA Utrecht, The Netherlands  
e-mail: h.w.r.schreuder@umcutrecht.nl

M. W. van Baal  
Department of Obstetrics and Gynaecology, Flevo Hospital,  
Almere, The Netherlands

faster return of bowel movements [17, 18]. Laparoscopic staging provides similar complication rates as open surgery [8, 16]. Despite studies proving the feasibility, accuracy and safety of laparoscopic staging in early ovarian cancer, laparotomy is still advocated by the majority of centres. One of the reasons for a slow implementation of minimal invasive techniques in complex oncological surgery may be a long learning curve. The learning curve of the laparoscopic staging procedure in ovarian cancer has never been addressed. However Eltabbakh et al. demonstrated clearly a learning curve in the laparoscopic staging procedure for endometrial cancer [23]. Our study primarily focuses on the learning curve of a single surgeon in the laparoscopic staging procedure in women with early ovarian cancer and the surgical outcome of these patients.

### Patients and methods

A retrospective chart review was undertaken and identified 25 cases of laparoscopic staging of apparent early-stage ovarian cancer, all operated by the same surgeon (RV) in the period from June 2001 to October 2009. To obtain clinical and pathologic information, we reviewed the patient's medical records. The following information was obtained: age, BMI, surgical procedure, pre- and postoperative FIGO stage, histopathology, days between first operation and staging laparoscopy, operation time, estimated blood loss, number of pelvic and para-aortic nodes, complications, hospital stay, nature of subsequent treatment, delay in chemotherapy, length of follow-up, recurrence and mortality. Postoperative complications were defined as occurring within 30 days after the procedure. Most ovarian carcinomas were diagnosed at final histopathology, after a first operation where a malignancy was not anticipated. After the final pathologic diagnosis, patients were scheduled for a laparoscopic staging procedure. Preoperative investigations after the diagnosis of malignancies included: CA 125 measurement, ultrasound and CT scan. All but two patients were clinically expected to have stage I disease, the other two patients were expected to have stage II disease. All histological types of ovarian cancers were included. Patient characteristics are shown in Table 1.

### Laparoscopic staging procedure

All patients were operated by the same surgeon, using the same technique. Four trocar ports were used. The first 11-mm trocar was inserted into the umbilical area, one 10-mm trocar above the symphysis, one 10-mm at the left upper quadrant and a 5-mm trocar at the right upper quadrant of the lower abdomen. A thorough exploration of all pelvic and abdominal organs and peritoneal surface was conducted. Cytological

**Table 1** Patient characteristics

Characteristics	Number
Patients	25
Mean age in years (range)	49.7 (18–79)
BMI in kg/m <sup>2</sup> (range)	24.6 (17.4–36.5)
Histological types	
Adenocarcinoma	16
Clear cell	4
Borderline	4
Other	1
FIGO stage (before staging)	
IA	12
IB	1
IC	9
IIC	2
Unknown	1
Tumour grade	
Grade 1	10
Grade 2	7
Grade 3	5
Unknown	3
Procedures at initial surgery	
Cystectomy	3
Adnectomy	11
Bilateral adnectomy	5
Hysterectomy + adnectomy	1
Hysterectomy + bilateral adnectomy	4
No initial surgery	1
Ovarian preservation procedure at secondary surgery	4
Mean age in years (range)	32.3 (18–41)
Histologic type	
Borderline	2
Adenocarcinoma	2

washings of the peritoneal cavity were taken, and any suspicious lesion was biopsied next to random biopsies from the diaphragm, left and right paracolic gutter, peritoneal reflection of the bladder and pouch of Douglas. Residual adnexal tissue and/or the residual infundibulo-pelvic ligament on the side of the originally involved ovary was removed. Comprehensive surgical staging further involved transperitoneal lymph node sampling from the pelvic and para-aortic regions up to the left renal vein, followed by an infra- or supracolic omentectomy (using a vessel-sealing technique). A hysterectomy was not routinely performed. The uninvolved ovary, when unsuspecting on visual inspection, was left in situ in fertility-sparing procedures, in which case a wedge biopsy was taken.

## Learning curve

To assess the effect of increasing experience, of the surgeon in the laparoscopic staging procedure, the patients were arranged in chronological order based on the date of their staging surgery. The patients were divided in equal groups according to three periods. Group I ( $n=9$ ) had surgery in 2001–2003, group II ( $n=8$ ) had surgery in 2004–2006 and group III ( $n=8$ ) had surgery in 2007–2009. The groups were compared for surgical outcomes: operating time, estimated blood loss, number of lymph nodes harvested, complications and hospital stay.

## Literature search

A PubMed search was performed to retrieve all articles concerning laparoscopic staging procedures in women with ovarian cancer between 1980 and January 2010. Search terms used included: ‘ovarian cancer’, ‘early ovarian cancer’, ‘early-stage ovarian cancer’, ‘ovarian carcinoma’, ‘ovarian neoplasm’s’, ‘adnexal tumor’, ‘fallopian tube neoplasm’s’, ‘fallopian tube cancer’, ‘laparoscopy’, ‘laparoscopic surgery’, ‘staging’, ‘staging surgery’ and ‘laparoscopic staging’. The relevant studies we found were compared to our series on the basis of above parameters.

## Statistical analysis

To analyse non-continuous variables we used the Kruskal–Wallis test.  $P$  values  $<0.05$  were considered significant. Statistic analysis was performed using the statistical software package SPSS 15.0 (SPSS Inc, Chicago, IL).

## Findings

A total of 25 patients underwent laparoscopic staging for presumed early-stage ovarian cancer. Most patients ( $n=24$ ) had a secondary staging (restaging) procedure after referral, one patient was primarily staged. Patient's characteristics are outlined in Table 1. The surgical outcome is outlined in Table 2. The median operation time was 235 min (range 100–285, mean 224). Intraoperative complications were two arterial bleedings. One patient lost 1,000 ml of blood, the other patient 1,500 ml and required a blood transfusion during surgery. No conversion to laparotomy was needed. Postoperative complications were two port site haematomas in different patients, which resolved spontaneously. In 19 patients pelvic lymph nodes were collected (median 8.0, mean 12.2) and in 24 patients' para-aortic lymph nodes were collected (median 6.0, mean 5.8). The median number of total lymph nodes harvested was 8.0 (range 3–31, mean 12.2).

**Table 2** Surgical outcome

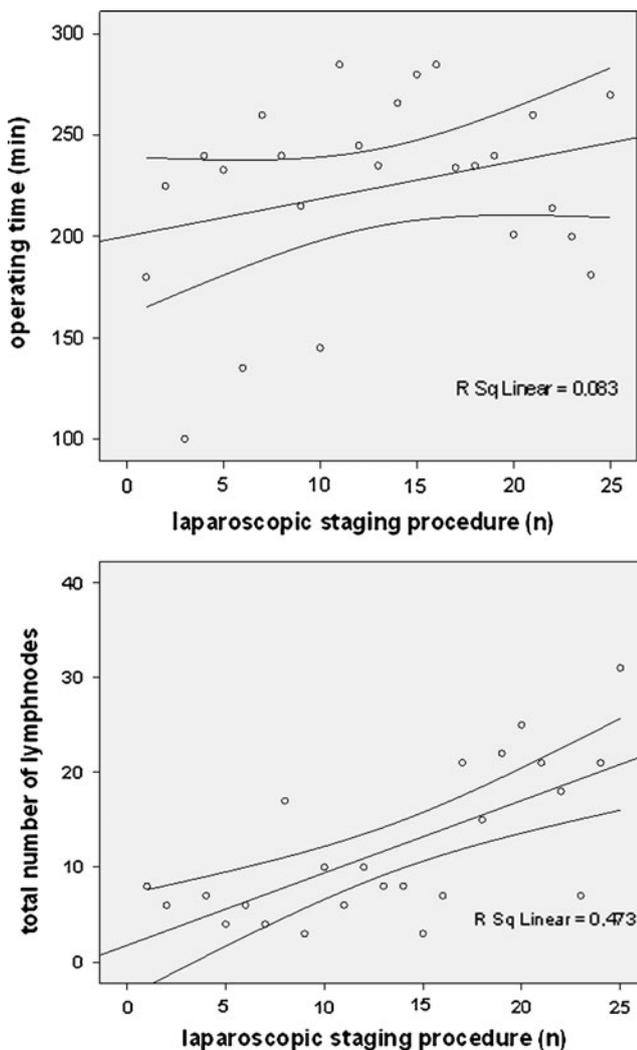
Variable	
Operation time (min)	235 (100–285)
Estimated blood loss (ml)	100 (10–1,500)
Total LNN <sup>a</sup>	
Pelvic lymph nodes ( $n=19$ )	8.0 (3–31)
Para-aortic lymph nodes ( $n=24$ )	6.0 (2–12)
Overall ( $n=24$ )	8.0 (3–31)
Time between operations (days)	54±21
Upstaging ( $n$ )	8 (32%)
Intraoperative complications ( $n$ )	2 (8%)
Postoperative complications ( $n$ )	2 (8%)
Postoperative hospital stay (days)	4.0 (2–6)
Time to adjuvant chemotherapy (days)	21 (±10.3)
Follow-up (months)	43 (±31.5)

Data are expressed as median (range), mean±standard deviation or number (in percentage)

<sup>a</sup> In those patients where a pelvic and/or para-aortic lymphadenectomy was performed

The operating time and total number of lymph nodes collected are shown in a scatter plot chronologically arranged by date of surgery (Fig. 1). The operating times are widely spread, but the total number of lymph nodes harvested show an increase during time. Based on final pathological assessment, eight patients were upstaged. From presumed stage IA, two patients were upstaged to stage IC, one to stage IIB, one to stage IIC, one to stage IIIA, two patients were upstaged from presumed stage IC to stage IIIC and one patient was upstaged from IIC to stage IIIC. Eleven patients did not need adjuvant chemotherapy; all other patients received adjuvant chemotherapy. These patients all had stage IC or higher or a grade 3 tumour. Mean duration of follow-up was 43 months. Five patients had a recurrence. One mucinous borderline tumour (2001 FIGO stage IC, no lymph node dissection) and four carcinomas recurred. In two patients recurrence appeared as carcinomatous pleuritis or peritonitis. Both these patients were completely staged and had a clear cell carcinoma (2003 FIGO IIC and 2006 FIGO stage IC); they died from the disease. The other patients are all alive without disease.

To demonstrate a possible learning curve over time, the patients were divided into three groups and compared with respect to operating time, estimated blood loss, hospital stay and number of pelvic and para-aortic lymph nodes. Median operating time, estimated blood loss and hospital stay did not show a significant difference between the three groups. But there was a significant increase in the total number of lymph nodes collected ( $P=0.003$ , Table 3). Table 4 shows an overview of the original literature



**Fig. 1** Operating time and number of lymph nodes. Surgical procedures in chronological order: operating time ( $n=25$ ) and total number of lymph nodes [pelvic + para-aortal ( $n=24$ ) (scatter plot)]

regarding the laparoscopic staging procedure in early ovarian cancer. We added the present study in this table.

## Discussion

We expected that with increase of the surgeon's experience in performing laparoscopic staging procedures, the effect would be a shorter operating time and a higher number of pelvic and para-aortal lymph nodes harvested. However we did not find a decrease in operating time as a function of the surgeon's experience in laparoscopic staging. This might be due to the relatively limited number of cases. We did find a significant increase in the amount of lymph nodes harvested. The variation in operating time may be due to differences in the extent of surgery performed during laparoscopic staging. In the relatively small group we were unable to correct for

these differences. Depending on what is done at initial surgery, the staging procedure for early ovarian cancer should be completed at the second operation (restaging). In our series all patients had an omentectomy, which was usually performed infracolicly. In nine patients a unilateral and in three patients, a bilateral salpingo-oophorectomy was performed, four patients had an ovarian excision (to preserve fertility) and in nine patients, a bilateral salpingo-oophorectomy had already been performed during the initial surgery. In six patients (four carcinomas and two borderline tumours, all before 2004), there was no pelvic lymphadenectomy performed. In the earlier years, less emphasis was laid on the role of pelvic lymphadenectomy and during the years, the guidelines changed. In one patient, with a borderline tumour, a para-aortic lymphadenectomy was not performed. In one patient a hysterectomy was performed, and two patients had an appendectomy because of a mucinous tumour. A laparoscopic procedure including a hysterectomy takes longer. Childers et al. found a mean operating time of 149 min in patients who did not undergo a hysterectomy during their laparoscopic staging, and a mean operating time of 196 min in patients who did undergo a hysterectomy [9]. We do not routinely perform a full hysterectomy in a laparoscopic staging procedure. In view of the lack of evidence that the uterus may be involved when the tumour (seemingly) does not extend beyond the ovaries, it is not justifiable to routinely include such, potentially harmful, operation [24, 25]. However in a case of endometroid ovarian carcinoma, we perform an endometrial curettage. We did not find recurrences in a retained uterus, confirming that it is safe to leave the hysterectomy. Regarding fertility-sparing surgery in early ovarian cancer, several authors reported that it seems to be safe to leave the uterus and the remaining ovary [15]. Despite the fact that we couldn't find a decrease in operating time, it is likely that the increase of lymph nodes harvested demonstrates a learning curve in the laparoscopic management of women with early-stage ovarian carcinoma. This aspect of the learning curve was also found by Eltabbakh et al. In this study, a laparoscopic assisted vaginal hysterectomy with bilateral salpingo-oophorectomy and pelvic lymph node sampling was performed in patients staged for endometrial cancer. Next to a significantly reduced operating time, the authors describe a significant increase in the amount of pelvic lymph nodes harvested with gaining experience [23].

Although there are studies proving laparoscopic staging to be accurate and feasible [8, 10–12, 14, 16–18, 21], many gynaecologic oncologists are still reluctant to adopt laparoscopic staging of ovarian cancer. Apart from inexperience with minimal invasive surgery, reluctance seems mainly based on doubts about the adequacy of the procedure. In particular to the number of lymph nodes obtained, possible risk of port site metastases, lack of tactile

**Table 3** Surgical outcome in time periods

	Group I (first period), <i>n</i> =9	Group II (second period), <i>n</i> =8	Group III (third period), <i>n</i> =8	<i>P</i> value
Operative time (min)	225.0 (100–260)	245.0 (145–285)	207.5 (181–270)	0.095
EBL (ml)	50.0 (10–1,000)	50.0 (20–200)	100.0 (20–1,500)	0.682
Total number lymph nodes <sup>a</sup>	6.5 (3–17)	8.0 (3–21)	21.0 (7–31)	0.003
Pelvic <sup>a</sup>	7.5 (1–12)	3.0 (1–13)	13.0 (4–19)	0.023
Para-aortic <sup>a</sup>	5.5 (2–7)	4.0 (2–8)	9.0 (3–12)	0.017
Hospital stay (days)	3.0 (2–5)	4.0 (3–6)	3.5 (3–6)	0.069

Data expressed as medians with range

<sup>a</sup>In those patients where a pelvic and/or para-aortic lymphadenectomy was performed

sensation and risk of intraoperative mass rupture have been questioned [8, 11, 12, 16–18, 22].

Several studies found similar numbers of lymph nodes obtained during laparoscopic and laparotomic staging [11, 21]. The overall number of lymph nodes obtained in our study is lower than in other studies. This could be due to the fact that we describe the learning curve from the first case. In other studies the surgeons are already experienced in the laparoscopic staging procedure and completed their learning curve before the series they describe. This is substantiated by the fact that the mean number of lymph nodes in the last eight patients (group 3) is indeed comparable with other authors. Besides we do not routinely perform a full lymph node dissection, but rather a sampling. In retrospect, the number of lymph nodes harvested in the first periods was too low. Future surgeons can avoid this by learning the procedure from a gynaecologic surgeon who already performed many lymph node dissections. Another concern is the risk of port site metastases due to direct wound contamination or implantation by instruments [17]. Nagarsheth et al. demonstrated that the risk of port site metastases (ranging from 0% to 2.3%) is comparable to the incidence of implantation metastases observed after conventional laparotomy [18, 26]. The risk seems to be higher in patients with recurrent ovarian cancer or primary peritoneal malignancies in the presence of ascites [16, 26]. In our study no port site metastases were seen.

Intraoperative mass rupture in the primary laparoscopic staging procedure of early-stage ovarian cancer is also been thought to be a risk [27]. However in secondary staging procedures, there is no risk of intraoperative mass rupture, since the tumour has already been removed in the first procedure. Intraoperative mass rupture leads to subsequent contamination of the peritoneal cavity with tumour cells and upstages the unexpected ovarian cancer from stage IA to stage IC. Upstaging of the tumour can create the need for adjuvant chemotherapy in patients with potentially curable disease [18]. A multivariate analysis showed that capsular rupture caused by the surgeon did not significantly affect the prognosis in stage I and II ovarian cancer [28]. In contrast to many others, Vergote et al. reported in a larger multivariate analysis that tumour rupture during surgery has

a negative effect on prognosis [29]. However, whether or not tumour rupture has a prognostic effect, it should not be considered specific to the laparoscopic procedure. The incidence of iatrogenic rupture of ovarian cancer cysts is similar in the laparoscopy and laparotomy groups [17, 19].

The rate of upstaging (having a higher stage after secondary staging procedure then presumed after the initial operation) found in this study is 32%, percentages found in other studies range between 0% (only nine patients described) [20] and 41.7% [12]. The high percentage of 41.7% found by Jung et al. is not entirely comparable to percentages found in other studies because they included a relatively high percentage of primary staging procedures. Our upstaging percentage is similar to upstaging rates in laparotomic staging ranging from 21.2% [17] to 47% [21].

The mean operation time in our series is comparable to the operating times reported by other authors, ranging from 149 to 377 min [9, 11]. The operating times found in studies with a laparotomy control group range from 218 to 290 min [18, 21]. The operation time for the laparoscopic procedures is generally longer than for a laparotomy. This should however be weighted against the patients' benefit from a less traumatic technique, quicker recovery, shorter hospitalisation and the opportunity to start chemotherapy earlier [10].

In the literature, postoperative stay for laparoscopic staging ranges from 2 to 10.6 days [12, 30]. We found a median of 4.0 days (range 2–6 days). Jung et al. found a mean postoperative stay of 10.6 days, which is substantially longer than in the most other studies. The postoperative stay in the laparotomic control groups ranges 5.8–14.5 days [8, 17].

In our series, four complications occurred. The complication rate for the laparoscopic staging procedure in early-stage ovarian cancer found in the literature ranges from 4.2% [12] to 37.5% [7]. The complication rate in laparoscopy is similar to or even less compared with laparotomy [8, 11].

## Conclusion

This study is primarily focused on the effect of increasing experience of a single surgeon ('learning curve') in the

**Table 4** Overview of literature for the laparoscopic staging procedure in early-stage ovarian cancer

Laparoscopy	Number	Restaging/primary staging	OR time (min)	Delay (weeks)	Hospital stay (days)	PLN (n)	PALN (n)	EBL (ml)	Upstaging (n, %)	Compl (n, %)	Follow-up (months)	R (n)	M (n)
Present series	25	24/1	224 (100–285)	7.3 (3.1–13.3)	4.0 (2–6)	13.8 (3–31)	5.8 (2–12)	193 (10–1,500)	8 (32%)	4 (16%)	43 (1–116)	5	2
Nezhat et al. [16]	36	9/25	229 (59–386)	NA	2.37 (1–5)	14.84 (0–45)	12.23 (0–53)	195 (25–500)	7 (19.4%)	4 (11.1%)	56	3	0
Muzii et al. [15]	27	27/0	180 (130–300)	6.8 (2–9)	3 (2–7)	NA	NA	200 (100–700)	7 (26%)	1 (3.7%)	20 (7–38)	1	0
Jung et al. [12]	24	5/19	253.7±65.7	NA	10.6±4.0	22.5±8.9	11.0±5.8	567.0±170.9	10 (41.7%)	1 (4.2%)	10 (2–39)	1	1
Park et al. [17]	19	7/12	221±83	19 (7–34)	8.9±6.1	27.2±9.7	6.6±6.2	240±228	4 (21.1%)	2 (10.5%)	17 (2–40)	0	0
Park et al. [18]	17	6 / 11	303.8±84.9	35.8	9.4±4.1	13.7±5.6	8.9±7.1	231.2±117.9	1 (5.9%)	2 (11.8%)	19 (5–56)	2	1
Colomer et al. [10]	20	7/13	223 (180–320)	4.7 (2–11.4)	3.2 (1–7)	18 (14–21)	11.3 (7–23)	NA	4 (20%)	2 (10%)	24.7 (1–61)	1	0
Ghezzi et al. [11]	15	5/10	377±47	8 (5–14)	3 (2–12)	25.2±9.3	6.5±3.9	250 (50–1,000)	4 (26.7%)	2 (6.7%)	16 (4–33)	0	0
Chi et al. [8]	20	13/7	321±64	NA	3.1±0.7	L, 5.8±2.9 R, 6.5±3.9	L, 2.9±1.7 R, 3.8±1.8	235±138	NA	0	NA	NA	NA
Spirtos et al. [21]	58	58/0	187.9±59.8	NA	3.35±5.10	L, 9.0±6.0 R, 9.6±5.2	L, 5.3±3.3 R, 5.0±3.4	171.9±128	8 (13.8%)	11 (19%)	NA	NA	0
Leblanc et al. [14]	53	42/11	238 (120–370)	8.3±4.8	3.1 (1–5)	14 (4–27)	20 (7–40)	NA	8 (19%)	4 (7.5%)	54 (8–116)	5	2
Krivak et al. [30]	19	0/19	201 (90–350)	NA	2 (1–8)	NA	NA	271 (50–1,500)	7 (36%)	4 (16%)	32	NA	NA
Tozzi et al. [22]	24	11/13	176 (102–306)	12 (4–21)	7 (5–12)	19.8 (14–29)	19.6 (5–35)	NA	NA	1 (4.1%)	46 (2–72)	2	0
Leblanc et al. [13]	28	25/3	230±67.5	8.3 (2–26)	3.3 (1–6)	13.7 (4–27)	19.7 (5–40)	NA	6 (21%)	1 (3.7%)	38 (2–89)	1	1
Amara et al. [7]	4	3/1	290 (190–335)	NA	1.75 (1–2)	NA	NA	NA	NA	0	NA	NA	NA
Pornel et al. [19]	10	10/0	313	NA	4.75 (2–8)	7.1 (3–13)	8.8 (6–12)	NA	NA	2 (20%)	NA	NA	NA
Childers et al. [9]	14	5/9	149 (120–240)	NA	1.6 (0–3)	NA	NA	NA	8 (57%)	2 (14.3%)	NA	NA	NA
Querleu and Leblanc [20]	9	9/0	227 (130–360)	NA	2.8 (1–5)	NA	8.6 (5–17)	<300	0%	0	NA	NA	NA
Laparotomy													
Park et al. [17]	33	NA	275±63	13 (9–16)	14.5±5.6	33.9±14.5	8.8±8.1	568±451	7 (21.2%)	9 (27.3%)	23 (1–44)	0	0
Park et al. [18]	19	NA	290±121	32	14.1±4.2	19.3±10.1	6.4±3.9	505.3±279.8	6 (31.6%)	7 (36.8%)	14 (5–61)	0	0
Ghezzi et al. [11]	19	NA	272±81	NA	7 (4–14)	25.1±5.8	7±4.5	400 (150–1,000)	6 (31.6%)	8 (42.1%)	60 (32–108)	4	0
Chi et al. [8]	30	NA	276±68	NA	5.8±2.6	L, 7.1±4.3 R, 7.6±3.8	L, 4.8±4.2 R, 4.4±2.8	367±208	NA	2 (7%)	NA	NA	NA
Spirtos et al. [21]	17	NA	218±73	NA	7.31±9.3	L, 8.2±5.0 R, 9.14±9.9	L, 4.6±2.6 R, 4.4±2.7	352.8±415.0	8 (47%)	NA	NA	NA	0

Delay between initial OR and staging, PLN pelvic lymph nodes, PALN para-aortic lymph nodes, EBL estimated blood loss, Compl complications, R Recurrence, M Mortality (depending on what authors describe NA not available, – range, ± standard deviation)

laparoscopic staging of women with early ovarian cancer. We demonstrated a significant learning curve for the laparoscopic full staging procedure in early ovarian cancer. In our study the effect of the increased experience of the surgeon is mainly reflected in the increased number of lymph nodes harvested and not by the total operating time. Minimal invasive surgery requires a high level of skill and delicate dissection, and many gynaecologic oncologists have not yet been trained in this procedure. The laparoscopic staging procedure is a complex procedure and should best be learned under direct supervision of a skilled gynaecologic laparoscopic surgeon. If more gynaecologic oncologists would develop their experience with laparoscopic staging, this could have a great impact on applying laparoscopic surgery on a wider scale among women with early-stage ovarian cancer.

**Declaration of interest** The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

**Open Access** This article is distributed under the terms of the Creative Commons Attribution Noncommercial License which permits any noncommercial use, distribution, and reproduction in any medium, provided the original author(s) and source are credited.

## Reference

- Muzii L, Angioli R, Zullo M, Panici PB (2005) The unexpected ovarian malignancy found during operative laparoscopy: incidence, management, and implications for prognosis. *J Minim Invasive Gynecol* 12(1):81–89
- Engelen MJ, van der Zee AG, de Vries EG, Willemse PH (2006) Debulking surgery for ovarian epithelial cancer performed by a gynaecological oncologist improved survival compared with less specialised surgeons. *Cancer Treat Rev* 32(4):320–323
- Mayer AR, Chambers SK, Graves E, Holm C, Tseng PC, Nelson BE, Schwartz PE (1992) Ovarian cancer staging: does it require a gynecologic oncologist? *Gynecol Oncol* 47(2):223–227
- Trimbos JB, Vergote I, Bolis G, Vermorken JB, Mangioni C, Madronal C, Franchi M, Tateo S, Zanetta G, Scarfone G, Giurgea L, Timmers P, Coens C, Pecorelli S (2003) Impact of adjuvant chemotherapy and surgical staging in early-stage ovarian carcinoma: European Organisation for Research and Treatment of Cancer-Adjuvant ChemoTherapy in Ovarian Neoplasm trial. *J Natl Cancer Inst* 95(2):113–125
- Winter-Roach BA, Kitchener HC, Dickinson HO (2009) Adjuvant (post-surgery) chemotherapy for early stage epithelial ovarian cancer. *Cochrane Database Syst Rev* 3:CD004706
- Benedet JL, Bender H, Jones H III, Ngan HY, Pecorelli S (2000) FIGO staging classifications and clinical practice guidelines in the management of gynecologic cancers. FIGO Committee on Gynecologic Oncology. *Int J Gynaecol Obstet* 70(2):209–262
- Amara DP, Nezhat C, Teng NN, Nezhat F, Nezhat C, Rosati M (1996) Operative laparoscopy in the management of ovarian cancer. *Surg Laparosc Endosc* 6(1):38–45
- Chi DS, Bu-Rustum NR, Sonoda Y, Ivy J, Rhee E, Moore K, Levine DA, Barakat RR (2005) The safety and efficacy of laparoscopic surgical staging of apparent stage I ovarian and fallopian tube cancers. *Am J Obstet Gynecol* 192(5):1614–1619
- Childers JM, Lang J, Surwit EA, Hatch KD (1995) Laparoscopic surgical staging of ovarian cancer. *Gynecol Oncol* 59(1):25–33
- Colomer AT, Jimenez AM, Bover Barcelo MI (2008) Laparoscopic treatment and staging of early ovarian cancer. *J Minim Invasive Gynecol* 15(4):414–419
- Ghezzi F, Cromi A, Uccella S, Bergamini V, Tomera S, Franchi M, Bolis P (2007) Laparoscopy versus laparotomy for the surgical management of apparent early stage ovarian cancer. *Gynecol Oncol* 105(2):409–413
- Jung US, Lee JH, Kyung MS, Choi JS (2009) Feasibility and efficacy of laparoscopic management of ovarian cancer. *J Obstet Gynaecol Res* 35(1):113–118
- Leblanc E, Querleu D, Narducci F, Chauvet MP, Chevalier A, Lesoin A, Vennin P, Taieb S (2000) Surgical staging of early invasive epithelial ovarian tumors. *Semin Surg Oncol* 19(1):36–41
- Leblanc E, Querleu D, Narducci F, Occelli B, Papageorgiou T, Sonoda Y (2004) Laparoscopic restaging of early stage invasive adnexal tumors: a 10-year experience. *Gynecol Oncol* 94(3):624–629
- Muzii L, Palaia I, Sansone M, Calcagno M, Plotti F, Angioli R, Panici PB (2009) Laparoscopic fertility-sparing staging in unexpected early stage ovarian malignancies. *Fertil Steril* 91(6):2632–2637
- Nezhat FR, Ezzati M, Chuang L, Shamshirsaz AA, Rahaman J, Gretz H (2009) Laparoscopic management of early ovarian and fallopian tube cancers: surgical and survival outcome. *Am J Obstet Gynecol* 200(1):83–86
- Park JY, Kim DY, Suh DS, Kim JH, Kim YM, Kim YT, Nam JH (2008) Comparison of laparoscopy and laparotomy in surgical staging of early-stage ovarian and fallopian tubal cancer. *Ann Surg Oncol* 15(7):2012–2019
- Park JY, Bae J, Lim MC, Lim SY, Seo SS, Kang S, Park SY (2008) Laparoscopic and laparotomic staging in stage I epithelial ovarian cancer: a comparison of feasibility and safety. *Int J Gynecol Cancer* 18(6):1202–1209
- Pomel C, Provencher D, Dauplat J, Gauthier P, Le BG, Drouin P, Udet-Lapointe P, Dubuc-Lissoir J (1995) Laparoscopic staging of early ovarian cancer. *Gynecol Oncol* 58(3):301–306
- Querleu D, Leblanc E (1994) Laparoscopic infrarenal paraaortic lymph node dissection for restaging of carcinoma of the ovary or fallopian tube. *Cancer* 73(5):1467–1471
- Spirtos NM, Eisekop SM, Boike G, Schlaerth JB, Cappellari JO (2005) Laparoscopic staging in patients with incompletely staged cancers of the uterus, ovary, fallopian tube, and primary peritoneum: a Gynecologic Oncology Group (GOG) study. *Am J Obstet Gynecol* 193(5):1645–1649
- Tozzi R, Kohler C, Ferrara A, Schneider A (2004) Laparoscopic treatment of early ovarian cancer: surgical and survival outcomes. *Gynecol Oncol* 93(1):199–203
- Eltabbakh GH (2000) Effect of surgeon's experience on the surgical outcome of laparoscopic surgery for women with endometrial cancer. *Gynecol Oncol* 78(1):58–61
- Schlaerth AC, Chi DS, Poyner EA, Barakat RR, Brown CL (2009) Long-term survival after fertility-sparing surgery for epithelial ovarian cancer. *Int J Gynecol Cancer* 19(7):1199–1204
- Zanetta G, Chiari S, Rota S, Bratina G, Maneo A, Torri V, Mangioni C (1997) Conservative surgery for stage I ovarian carcinoma in women of childbearing age. *Br J Obstet Gynaecol* 104(9):1030–1035

26. Nagarsheth NP, Rahaman J, Cohen CJ, Gretz H, Nezhat F (2004) The incidence of port-site metastases in gynecologic cancers. *JSLs* 8(2):133–139
27. Tozzi R, Schneider A (2005) Laparoscopic treatment of early ovarian cancer. *Curr Opin Obstet Gynecol* 17(4):354–358
28. Kodama S, Tanaka K, Tokunaga A, Sudo N, Takahashi T, Matsui K (1997) Multivariate analysis of prognostic factors in patients with ovarian cancer stage I and II. *Int J Gynaecol Obstet* 56(2):147–153
29. Vergote I, De BJ, Fyles A, Bertelsen K, Einhorn N, Sevelde P, Gore ME, Kaern J, Verrelst H, Sjøvall K, Timmerman D, Vandewalle J, Van GM, Trope CG (2001) Prognostic importance of degree of differentiation and cyst rupture in stage I invasive epithelial ovarian carcinoma. *Lancet* 357(9251):176–182
30. Krivak TC, Elkas JC, Rose GS, Sundborg M, Winter WE, Carlson J, MacKoul PJ (2005) The utility of hand-assisted laparoscopy in ovarian cancer. *Gynecol Oncol* 96(1):72–76