

Feasibility and surgical outcomes of conventional and robot-assisted laparoscopy for early-stage ovarian cancer: a retrospective, multicenter analysis

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Abstract

Purpose We aimed to investigate the safety, adequacy and oncological outcomes of laparoscopic surgery (LS) and robot-assisted laparoscopic (RALS) approach for the treatment of early-stage ovarian cancer.

Methods We performed a multicentric, retrospective cohort study, enrolling patients affected by early-stage ovarian cancer who underwent laparoscopic management for early-stage ovarian cancer between 2006 and 2014. Surgical, pathologic and oncologic outcome data were analyzed to compare LS and RALS performances for early-stage ovarian cancer management.

Results 39 patients underwent laparoscopic staging for presumed stage I ovarian cancer: 23 underwent LS and 16 underwent RALS. The mean operative time was 281 ± 81 min (LS 288 ± 88 min; RALS 270 ± 72 min; $p = 0.49$). No conversion to laparotomy occurred, and one patient had intraoperative hemorrhage requiring blood transfusion. Four patients (10.2 %) experienced postoperative complications of grade 3 according to the Clavien-Dindo classification. The median hospital stay was 3 days (1–15); the differences were not statistically significant between two groups [LS = 4 (1–15); RALS = 3 (1–7); $p = 0.43$]. During a mean follow-up period of

19.4 months, tumor recurrence occurred in 3 patients: 2 (8.7 %) in the LS group and 1 (6.25 %) in the RALS group. Overall survival and disease-free survival for the entire cohort were 97.4 and 92.3 %, respectively.

Conclusions LS and RALS seem to be adequate and feasible for the treatment of early-stage ovarian cancer in terms of the surgical outcomes and oncological safety. Furthermore, in our experience, perioperative outcomes are comparable between LS and RALS making them an acceptable approach in selected patients.

Keywords Early-stage ovarian cancer · Laparoscopic surgery · Robot-assisted laparoscopy · Outcomes · Complications · Feasibility

Introduction

Ovarian cancer accounts for one-quarter of all malignancies of the female genital tract and is the most deadly of these malignancies: the estimated number of new ovarian cancer cases in Europe in 2012 was 65,538 with 42,704 deaths [1]. At diagnosis, 19 % of women have International Federation of Gynecology and Obstetrics (FIGO) stage I disease. Early diagnosis is often incidental following surgery for presumed benign adnexal mass [2, 3]. Women with FIGO stage I disease have 5-year survival rates of 90 %. However, up to 30 % of women with apparent early stage disease have microscopic metastasis; the disease is upstaged when comprehensive surgical staging is completed [4, 5]. Full staging of presumed early stage disease provides important prognostic information and influences advice regarding adjuvant chemotherapy. Surgical staging for ovarian cancer originally necessitated an exploratory laparotomy to perform the various procedures advised by

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FIGO: hysterectomy and salpingo-oophorectomy, pelvic and para-aortic lymph node dissections, omentectomy, peritoneal washings and peritoneal biopsies [6, 7]. With the advent of minimally invasive surgical techniques, surgeons are now able to perform all of the necessary procedures for comprehensive surgical staging, using conventional video-assisted or computer-enhanced telesurgery-robotics in selected patients [8]. The advantages of laparoscopic surgery (LS) over laparotomy (LT) are well established, including superior intraoperative visualization, smaller incisions, reduced blood loss, decreased postoperative complications such as wound infections and small bowel ileus, shorter hospitalization time, and faster recovery. The role of LS in ovarian cancer includes staging, primary and secondary cytoreduction in selected cases [9, 10]. Furthermore, accumulating evidence suggests an increasing role of robotic-assisted laparoscopy (RALS) in oncologic surgery for endometrial, cervical and ovarian cancer [11]. RALS has many advantages respect to LS, including (but not limited to) 3-dimensional view, increased dexterity, tremor filtration, and a more favorable learning curve [12, 13]. A LS approach for the staging of ovarian cancer was first reported in 1994 by Querleu and Leblanc [14]. Since then, many researchers have sought to demonstrate the advantages of LS for early-stage ovarian cancer. As was already showed by Nezhat et al. [15], clinical evidence indicated that laparoscopic staging of ovarian cancer appeared to be feasible and comprehensive without compromising survival, supporting the use of laparoscopy in the management of early-stage ovarian cancer. Questions still remain regarding its performance compared with a traditional laparotomy and its proper application to diverse populations of patients. In this study, we aimed to investigate feasibility, benefits, possible risks, surgical and oncological outcomes of LS and RALS in early ovarian cancer management.

Materials and methods

We performed a retrospective analysis of all patients who underwent primary laparoscopic (conventional LS or RALS) management for apparent early-stage ovarian cancer between January 2006 and May 2014 at the Institute Paoli-Calmettes of Marseille (France) and Garibaldi Nesima Hospital of Catania (Italy). We collected data about characteristics of the patients, surgical procedures histological findings and follow-up. We excluded from the current analysis patients with borderline ovarian malignancy, non-epithelial ovarian cancer, FIGO stage IV. The study design is in accordance with the Helsinki Declaration, conforms the Committee on Publication Ethics (COPE) guidelines (<http://publicationethics.org/>) and was

approved by the Institutional Review Boards (IRB) of the hospitals in which it was performed. Each patient who participated in this study was well informed regarding the procedures that they would undergo and signed a consent form for data collection for research purposes. All the design, analysis, interpretation of data, drafting and revisions followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: guidelines for reporting observational studies, available through the EQUATOR (enhancing the quality and transparency of health research) network (<http://www.equator-network.org/>).

For LS, a 10-mm 0° laparoscope was introduced at the umbilical site after pneumoperitoneum was established. Under direct vision, 3 ancillary trocars were positioned: one 12-mm suprapubic trocar for extraction of the retrieved lymph nodes and two 5-mm trocars at the lower abdomen lateral to the epigastric arteries. After employing this 4-trocar system, pelvic procedures including hysterectomy, bilateral salpingo-oophorectomy, and pelvic lymphadenectomy were performed. Thus, to perform para-aortic lymphadenectomy and omentectomy, the laparoscope was moved to and placed on the 12-mm suprapubic trocar, and an additional pair of 5-mm trocars was introduced 2 cm inferior to the costal margin and immediately medial to the left and right midclavicular line.

For RALS, all patients were placed in the low lithotomy position with their arms padded and tucked to one side. The Da Vinci unit (Da Vinci; Intuitive Surgical) was positioned between the legs for all pelvic procedures. As described elsewhere [16], five ports were placed in all cases: four for the Da Vinci surgical system's arms (one camera port, three instrument ports) and the fifth as a classical laparoscopic port for the assistant (suction, specimen removal, needle application). The first port was placed after opening the abdominal cavity with a small abdominal incision to introduce the camera. The position of the camera depended on the anatomical site of the intended procedure. For pelvic surgery, the camera port was placed 1–2 cm above the umbilicus and the four additional ports were positioned in a curved line, keeping a 7–8 cm distance between the ports. After routine exploration of the peritoneal cavity, the Da Vinci unit was docked.

Operative time was collected from the surgical database. Intraoperative and post-operative complications were recorded at the end of the procedure and at discharge from hospital. The Clavien-Dindo classification of post-operative complications was used. Hospitalization was counted from the first post-operative day. All specimens were examined by histopathologists dedicated to gynecological oncology. Advice in respect to adjuvant treatment was discussed at Multi-Disciplinary Team Meeting (MDTM).

Follow-up was scheduled every 3 months in the first year, every 4 months in the second year and every 6 months thereafter. Overall survival (OS) and disease-free survival (DFS) were calculated from the date of the diagnosing surgical procedure.

Statistical analyses were performed the SPSS ver. 12.0 (SPSS Inc., Chicago, IL, USA) statistical software package. Continuous variables were compared between the 2 groups (LS and RALS) using the Student *t* test; categorical variables were compared using the two-tailed Chi-square test, as appropriate. Survival analyses were conducted using the Kaplan–Meier method, and surviving patients were censored at the date of last follow-up. A *p* value of <0.05 was considered statistically significant.

Results

A total of 39 patients underwent laparoscopic staging for presumed stage I ovarian cancer. Of these, 23 women underwent LS and 16 underwent RALS. Patients and tumor characteristics are outlined in Table 1.

32 patients underwent to comprehensive staging surgery, as stated in the FIGO guidelines and already described [17], including peritoneal cytology, total

hysterectomy, bilateral salpingo-oophorectomy, systematic pelvic and para-aortic lymph node dissection, omentectomy and multiple peritoneal biopsies; seven young patients (17.9 %), with histologically confirmed stage IA or IC, underwent fertility sparing surgery (preservation of the uterus and contralateral ovary) to maintain reproductive capability. Mean age of the patients was 48.6 ± 14.4 years and the median body mass index was 24.4 ± 5.6 for the entire cohort. Only the difference of median BMI between each LS and RALS groups was statistically significant (LS = 25.8 ± 6.5 ; RALS = 22.3 ± 2.9 ; *p* = 0.03). CA-125 level was higher than 35 U/mL in 16 patients (41.1 %). The differences in histological type, tumor stage and positive cytology between LS and RALS groups were not statistically significant. The majority of the cases (79.5 %) were serous (*n* = 19) and mucinous (*n* = 12) histotype.

Seven patients (17.9 %) with apparent surgical I stage were upstaged to stage III after histologic exam. Sites of occult extraovarian spread in patients restaged to IIIA disease (*n* = 2) included omentum (*n* = 1) and mesosigmoid (*n* = 1); 1 patient was restaged to IIB for metastasis to pelvic peritoneum and 4 patients were upstaged to IIIC for occult metastasis to pelvic (*n* = 1) or pelvic and paraortic nodes (*n* = 3).

Table 1 Patient and tumor characteristics

	Patient and tumor characteristic (<i>n</i> = 39)	LS (<i>n</i> = 23)	RALS (<i>n</i> = 16)	<i>p</i>
Age (years; mean \pm SD)	48.6 \pm 14.4	49.4 \pm 15.9	47.3 \pm 12.3	0.66
BMI (kg/m ² ; mean \pm SD)	24.4 \pm 5.6	25.8 \pm 6.5	22.3 \pm 2.9	0.03
Smoke	18 %	13 %	25 %	0.34
Ca-125 >35 U/mL	41 %	35 %	50 %	0.3
Histologic type (%)				0.61
Serous	19 (48.7 %)	13 (56.5 %)	6 (37.5 %)	
Endometrioid	4 (10.2 %)	2 (8.7 %)	2 (12.5 %)	
Clear cells	3 (7.7 %)	1 (2.5 %)	2 (12.5 %)	
Mucinous	12 (30.8 %)	6 (26 %)	6 (37.5 %)	
Mixed	1 (2.5 %)	1 (4.3 %)	–	
Grading				0.02
G1	18 (46.1 %)	13 (56.5 %)	5 (31.3 %)	
G2	7 (17.9 %)	4 (17.4 %)	3 (18.7 %)	
G3	14 (35.9 %)	6 (26.1 %)	8 (50 %)	
Final stage				0.66
IA	23 (59 %)	13 (56.5 %)	10 (62.5 %)	
IB	1 (2.5 %)	–	1 (6.2 %)	
IC	8 (20.5 %)	6 (26 %)	2 (12.5 %)	
IIIA	2 (5.1 %)	1 (4.3 %)	1 (6.2 %)	
IIB	1 (2.5 %)	1 (4.3 %)	–	
IIIC	4 (10.2 %)	2 (8.7 %)	2 (12.5 %)	
Positive cytology	6 (15.38 %)	5 (21.74 %)	1 (6.25 %)	0.18

Data are expressed as mean \pm standard deviation, or as *n* (%). LS laparoscopic surgery, RALS robotic-assisted laparoscopic surgery

Table 2 Intra- and post-operative data

	Intra- and post-operative details (<i>n</i> = 39)	LS (<i>n</i> = 23)	RALS (<i>n</i> = 16)	<i>p</i>
Operating time (min, mean ± SD)	281 ± 81	288 ± 88	270 ± 72	0.49
Blood transfusion, <i>n</i> (%)	3 (7.6 %)	3 (13.04 %)	–	0.13
Right pelvic nodes, median (range)	6 (2–17)	6 (2–17)	6 (3–15)	0.72
Left pelvic nodes, median (range)	6 (2–15)	6 (2–15)	6 (2–12)	0.68
Para-aortic nodes, median (range)	8 (3–26)	7 (3–26)	9 (3–21)	0.27
Intraoperative complications, <i>n</i> (%)	1 (2.5 %)	1 (4.3 %)	–	0.41
Hemorrhage, <i>n</i> (%)	1 (2.5 %)	1 (4.3 %)	–	
Postop. complications, grade 1–2, <i>n</i> (%)	7 (17.9 %)	3 (13.04 %)	4 (25 %)	0.34
Fever, <i>n</i> (%)	5 (12.8 %)	3 (13.04 %)	2 (12.5 %)	
Lymphorrhea <i>n</i> (%)	1 (2.6 %)	–	1 (6.2 %)	
Vaginal cuff partial dehiscence, <i>n</i> (%)	1 (2.6 %)	–	1 (6.2 %)	
Postop. complications, grade 3, <i>n</i> (%)	4 (10.2 %)	3 (13.04 %)	1 (6.2 %)	0.49
Hemoperitoneum, <i>n</i> (%)	1 (5.1 %)	2 (8.6 %)	–	
Incarceration of omentum, <i>n</i> (%)	1 (2.6 %)	1 (4.3 %)	–	
Lymphocyst, <i>n</i> (%)	1 (2.6 %)	–	1 (6.2 %)	
Hospital stay, days, median (range)	3 (1–15)	4 (1–15)	3 (1–7)	0.43

Data are expressed as mean ± standard deviation, or as *n* (%). LS laparoscopic surgery, RALS robotic-assisted laparoscopic surgery

Intra- and postoperative details are provided in Table 2. No conversion to laparotomy occurred. The mean operative time was 281 ± 81 min for the entire cohort with no statistically difference ($p = 0.49$) between LS (288 ± 88 min) and RALS (270 ± 72 min). Intraoperative hemorrhage from left renal vein lesion occurred during aortic lymph node dissection in one patient of the LS group, and bleeding was controlled with endoscopic vessel clip. This patient received three units of packed red blood cells intraoperatively and two units postoperatively. Postoperative transfusions were performed in two other patients of LS group; of interest, no patient in the RALS group experienced intraoperative complications or blood transfusions. The number of pelvic and para-aortic lymph nodes retrieved was similar between the LS and RALS groups (Table 2).

The rate of grade 1–2 postoperative complications was 17.9 % (7 patients) for the entire cohorts with no statistical difference between the two groups ($p = 0.34$). One patient of RALS group (6.2 %) experienced vaginal cuff partial dehiscence after 22 days from surgery, resolved with conservative management.

The rate of grade 3 postoperative complications was 10.2 % (four patients) for the entire cohort with no statistical difference between LS and RALS (13.1 and 6.2 % respectively; $p = 0.49$). Three patients of LS group required reoperation with laparoscopic approach in day 0 ($n = 2$ hemoperitoneum; $n = 1$ incarceration of omentum); furthermore, there was one case of lymphocyst in RALS group that required radiological drainage.

The average length of hospital stay was 3 days (range 1–15 days) for the entire cohort, 4 days (range 1–15) for LS group and 3 days (range 1–7) for RALS group ($p = 0.43$). The treatment method and survival outcomes are outlined in Table 3.

In total 23 of the 39 (58.9 %) women in the current study received adjuvant chemotherapy in view of tumor histological type, stage and grade, after discussion of each case at MDTM.

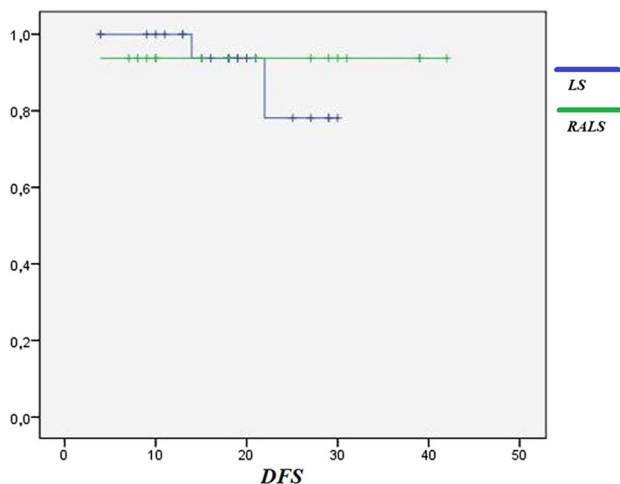
The median follow-up period was 19.4 ± 10.4 months (range 4–42 months). During the follow-up period, cancer recurred in three patients (7.7 %): two of them had been upstaged to IIIC disease after laparoscopic staging, one died 19 months after primary surgery (chest recurrence); one is alive with disease (pelvic recurrence); a contralateral ovary recurrence occurred in a 26 years old patient who had fertility sparing surgery and adjuvant chemotherapy (stage Ia disease, mucinous histology, grade 3) who is currently disease-free after surgical resection and postoperative chemotherapy. There were no cases of port-site metastasis in our study. The median time to recurrence was 18.5 (range 4–22) months. All the remaining patients are alive and clinically disease-free at the time of this report.

OS for the entire cohort was 97.4 %, with a DFS of 92.3 %. As showed in Fig. 1, in the subgroup of LS patients OS was 95.6 % with a DFS of 91.3 % months, whereas in the RALS group were 100 and 93.8 % respectively, with no statistical difference between two groups ($p = 0.15$).

Table 3 Treatment method and survival outcomes

	Treatment method and survival outcomes (<i>n</i> = 39)	LS (<i>n</i> = 23)	RALS (<i>n</i> = 16)	<i>p</i> value
Surgical procedure				0.11
Comprehensive staging surgery	32 (82.1 %)	17 (74 %)	15 (93.75 %)	
Fertility sparing surgery	7 (17.9 %)	6 (26 %)	1 (6.25 %)	
Treatment				0.34
Surgery only	16 (41.1 %)	10 (43.2 %)	6 (37.5 %)	
Surgery + adjuvant chemotherapy	23 (58.9 %)	13 (56.8 %)	10 (62.5 %)	
Follow-up period	19.4 ± 10.4	18.5 ± 8.6	21.2 ± 12.7	0.47
Tumor recurrence	3 (7.7 %)	2 (8.7 %)	1 (6.25 %)	0.48
Current status				
No evidence of disease	36	21	15	0.48
Alive with disease	2	1	1	0.79
Death for disease	1	1	–	0.41

Data are expressed as mean ± standard deviation, or as *n* (%). *LS* laparoscopic surgery, *RALS* robotic-assisted laparoscopic surgery

**Fig. 1** Kaplan-Meier analysis

Discussion

Deterrents as inadequate staging, port-site recurrence, and intraperitoneal spillage still loom over the use of laparoscopy as an approach for the management of ovarian cancer, although these fears are based more on theoretical considerations than on reliable scientific data. Our report of 39 cases of laparoscopic staging for presumed early stage ovarian cancer provides additional evidence that laparoscopic staging is feasible and safe. Moreover, this series benefits from including a multicentric sample to enhance generalizability of results. Our perioperative complication rate (12.8 %) and conversion to laparotomy rate (0 %) is similar to that published by other groups (Table 4). Two of the largest and recent studies [18, 19], with 35 and 82

patient, showed a perioperative rate of 14 and 15,8 % respectively. This is favorable when compared to restaging by laparotomy, which is associated with a 20–33 % morbidity rate [4, 20–22], including a rate of 12 % for visceral injury [23]. One of the largest retrospective, comparative report [24] showed that complete surgical staging through laparoscopy was achieved in all 26 cases with reduced blood loss, earlier diet resumption, shorter hospital stay and lower postoperative pain scores compared with staging via laparotomy among 113 patients with early-stage ovarian cancer. In addition, laparoscopic approach may improve cosmesis and the potential earlier initiation of chemotherapy [25–27]. Potential disadvantages of minimally invasive surgery for ovarian cancer include the risk of laparoscopic dissemination of ovarian cancer cells and increasing port site recurrence risk respect to laparotomy. Nevertheless, Zivanovic et al. [28] showed a port site recurrence rate of 1.96 % following laparoscopy for ovarian, fallopian tube or primary peritoneal cancer, fully comparable with classic laparotomy. Furthermore, others [29] have retrospectively examined 31 cases of abdominal wall metastasis, evidencing that abdominal wall metastasis did not have a dramatic impact on long-term survival. Finally, in several studies of early-stage ovarian cancer, no cases of port-site metastasis or recurrence were reported after laparoscopy [24, 26, 27]. Similarly, there were no cases of port-site metastasis in the present study.

Surgical staging is an essential component of the management of all women with ovarian and fallopian tube cancer; it provides prognostic information, particularly regarding the decision on whether to withhold or to recommend adjuvant treatment. After a mean follow-up of 19.4 months, we found a recurrence rate of 7.7 % in our

Table 4 Data from previous published studies about laparoscopic management of early ovarian cancer

Authors	Year	n	OT (min)	Complications	Conversion rate	Hospitalization (days)	Mean pelvic LN	Mean PA LN	Upstage (%)	FU	DFS (%)	OS (%)
Querleu et al.	1994	8	227	1 (13 %)	0	2.8	NR	8.6	26	NR	NR	NR
Childers et al.	1995	14	180	2 (14 %)	0	1.6	NR	NR	57	NR	NR	NR
Pomerl et al.	1995	10	313	2 (20 %)	1 (10 %)	4.8	6	8	10	NR	100	100
Possover et al.	1999	13	187	3 (23 %)	0	5.6	13.4	8.6	NR	NR	NR	NR
Tozzi et al.	2004	24	176	4 (16.7 %)	0	7	19.4	19.6	20.8	46.4	91.6	100
Le Blanc et al.	2004	42	238	3 (7.2 %)	0	3.1	14	20	19	54	90.5	97.6
Chi et al.	2005	20	321	2 (10 %)	0	3.1	12.3	6.7	10	NR	NR	NR
Park et al.	2008	19	220	1 (5.2 %)	1 (5.2 %)	8.9	27.2	6.6	21.1	17	100	100
Nezhat et al.	2008	36	195	2 (5.6 %)	0	2.4	14.8	12.2	19.4	55.9	83.3	100
Lee et al.	2011	26	228	2 (7.7 %)	1 (3.8 %)	6.4	23.5	9.9	3.8	12	100	100
Ghezzi et al.	2012	82	263	14 (17.1 %)	0	4	23	13	25.6	28.5	95.1	98.8
Brockbank et al.	2013	35	210	5 (14 %)	2 (6 %)	2	6	5.6	23	18	94	100
Current study		39	281	5 (12.8 %)	0	3.9	12.1	8.3	17.9	19.4	92.3	97.4

Data are expressed as n (%). NR not reported

cohort, that is similar with that reported by Ghezzi et al. [19] (28.5 months; 7.3 %) and Brockbank et al. [18] (18 months; 5.7 %). These recurrence rates appear lower, if compared to classic laparotomic surgical staging (3–18 %) [17, 19, 30, 31]. Lymph node yield and proportion of women upstaged following laparoscopic staging could potentially be used as a surrogate marker for adequacy of staging. Importantly, our rate of upstaging (17.9 %) is similar to that reported following open surgical staging [4, 5].

Laparoscopic staging may offer reproductive benefits to premenopausal women who desire fertility preservation in case of unilateral ovarian malignancy. In this regard, Muzii and Colleagues [32] performed a prospective study of 27 unexpected patients affected by ovarian cancer who underwent fertility-saving laparoscopic surgical staging. They reported two term pregnancies and two instances of spontaneous abortion after 20-months follow-up. Laparoscopic staging has been indicated as preferable to laparotomy for fertility-sparing surgeries due to the smaller number of adhesions caused by laparoscopy and avoidance of laparotomy, known to decrease fecundity [32, 33]. However, several studies have reported recurrence in patients who underwent a more conservative, fertility-sparing laparoscopic staging [15, 33].

According to our experience, one of seven women (14.3 %) who underwent fertility-sparing surgery developed recurrence in the contralateral ovary at 22 months post diagnosis. Nezhat et al. [15] showed that 28 % of patients who underwent fertility-sparing staging experienced a recurrence of cancer in the remaining ovary. It is unclear if this high recurrence rate can be attributed to the initial technique used or the inherent limitations of fertility-sparing staging. More research is needed to determine whether laparoscopy affects the reproductive outcome and the oncologic safety of this deliberately incomplete staging in this specialized population [21]. Disease recurrence and OS present a serious concern associated with laparoscopic staging. In our study, we had a DFS and OS of 92.3 and 97.4 %, respectively. Nezhat and Colleagues [15] reported a series of 20 ovarian and fallopian tube cancer patients who underwent laparoscopic staging and observed a 100 % survival rate with no evidence of disease after close to 5 years of follow-up. Moreover, Ghezzi et al. [19] showed OS and DFS of 98.8 and 95.1 %, respectively. Tozzi et al. [34] observed two disease recurrences (8.3 %) among a cohort of 24 patients staged by laparoscopy at a median follow-up of 46.4 months, but reported no deaths from disease.

In our study, we also compared the different surgical outcome between patients treated with conventional LS and those treated with RALS approach. In the LS group, complications rate and length of hospitalization were

slightly greater than RALS group, but without statistical difference. RALS is superior to LS with respect to visualization, dexterity, ergonomics, and surgeon's learning curve. Although robotic-assisted surgery is a well-accepted treatment for endometrial and cervical cancers, despite its steady increase in utilization, such success is yet to be achieved in the treatment for ovarian cancer [35, 36]. In a recent cases series [37] complications rates were equivalent between RALS and LS ($p = 0.89$).

This study is not without limitations: one of these is the current relatively short follow-up period; in addition, this study includes no direct comparison to staging by laparotomy. Given the rarity of early stage adnexal tumors and that long follow up is required, it is likely to be difficult to recruit a sufficient number of patients into randomized controlled trial. Therefore clinical decisions will need to be concluded starting from case series reports, of which this current series adds to the available literature.

In conclusion, our study can demonstrate that perioperative and gynecologic-oncologic outcomes (including complication rates, lymph node sampling and OS and DFS) are comparable between LS and RALS in early disease, making LS and RALS an acceptable approach in selected patients. Nevertheless, prospective randomized studies are required to confirm the safety of laparoscopic surgery and to determine the proper indication for laparoscopy as a treatment for ovarian cancer.

Compliance with ethical standards

Funding This study was not supported by any grant/fund.

Conflict of interest The authors have no proprietary, financial, professional or other personal interest of any nature in any product, service or company.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

References

1. Ferlay J, Steliarova-Foucher E, Lortet-Tieulent J et al (2013) Cancer incidence and mortality patterns in Europe: Estimates for 40 countries in 2012. *Eur J Cancer* 49:1374–1403. doi:10.1016/j.ejca.2012.12.027
2. Laganà AS, Colonese F, Colonese E et al (2015) Cytogenetic analysis of epithelial ovarian cancer's stem cells: an overview on new diagnostic and therapeutic perspectives. *Eur J Gynaecol Oncol* 36:495–505
3. Jemal A, Siegel R, Xu J, Ward E (2009) Cancer Statistics, 2010. *CA Cancer J Clin* 59:1–25. doi:10.1002/caac.20073. Available

4. Young RC, Decker DG, Wharton JT et al (1983) Staging laparotomy in early ovarian cancer. *JAMA* 250:3072–3076. doi:[10.1001/jama.1983.03340220040030](https://doi.org/10.1001/jama.1983.03340220040030)
5. Soper JT, Johnson P, Johnson V et al (1992) Comprehensive restaging laparotomy in women with apparent early ovarian carcinoma. *Obstet Gynecol* 80:949–953
6. Benedet JL, Bender H, Jones H III et al (2000) Staging classifications and clinical practice guidelines of gynaecologic cancers. *Int J Gynecol Obstet* 70:207–312
7. Lewin SN (2011) Revised FIGO staging system for endometrial cancer. *Clin Obstet Gynecol* 54:215–218. doi:[10.1097/GRF.0b013e3182185baa](https://doi.org/10.1097/GRF.0b013e3182185baa)
8. Nezhat FR, DeNoble SM, Liu CS et al (2010) The safety and efficacy of laparoscopic surgical staging and debulking of apparent advanced stage ovarian, fallopian tube, and primary peritoneal cancers. *JLSLS* 14:155–168. doi:[10.4293/108680810X12785289143990](https://doi.org/10.4293/108680810X12785289143990)
9. Liu CS, Nagarsheth NP, Nezhat FR (2009) Laparoscopy and ovarian cancer: a paradigm change in the management of ovarian cancer? *J Minim Invasive Gynecol* 16:250–262. doi:[10.1016/j.jmig.2009.01.007](https://doi.org/10.1016/j.jmig.2009.01.007)
10. Nezhat FR, Pejovic T, Finger TN, Khalil SS (2013) Role of minimally invasive surgery in ovarian cancer. *J Minim Invasive Gynecol* 20:754–765. doi:[10.1016/j.jmig.2013.04.027](https://doi.org/10.1016/j.jmig.2013.04.027)
11. Nezhat FR, Datta MS, Liu C et al (2008) Robotic radical hysterectomy versus total laparoscopic radical hysterectomy with pelvic lymphadenectomy for treatment of early cervical cancer. *JLSLS* 12:227–237
12. Weinberg L, Rao S, Escobar PF (2011) Robotic surgery in gynecology: an updated systematic review. *Obs Gynecol Int* 2011:852061. doi:[10.1155/2011/852061](https://doi.org/10.1155/2011/852061)
13. Cho JE, Nezhat FR (2009) Robotics and gynecologic oncology: review of the literature. *J Minim Invasive Gynecol* 16:669–681. doi:[10.1016/j.jmig.2009.06.024](https://doi.org/10.1016/j.jmig.2009.06.024)
14. Querleu D, LeBlanc E (1994) Laparoscopic infrarenal paraaortic lymph node dissection for restaging of carcinoma of the ovary or fallopian tube. *Cancer* 73:1467–1471
15. Nezhat FR, Ezzati M, Chuang L et al (2009) Laparoscopic management of early ovarian and fallopian tube cancers: surgical and survival outcome. *Am J Obstet Gynecol* 200:83.e1–83.e6. doi:[10.1016/j.ajog.2008.08.013](https://doi.org/10.1016/j.ajog.2008.08.013)
16. Lambaudie E, Narducci F, Leblanc E et al (2012) Robotically assisted laparoscopy for paraaortic lymphadenectomy: technical description and results of an initial experience. *Surg Endosc* 26:2430–2435. doi:[10.1007/s00464-012-2205-8](https://doi.org/10.1007/s00464-012-2205-8)
17. Le T, Adolph A, Krepart GV et al (2002) The benefits of comprehensive surgical staging in the management of early-stage epithelial ovarian carcinoma. *Gynecol Oncol* 85:351–355. doi:[10.1006/gyno.2002.6636](https://doi.org/10.1006/gyno.2002.6636)
18. Brockbank EC, Harry V, Kolomainen D et al (2013) Laparoscopic staging for apparent early stage ovarian or fallopian tube cancer. First case series from a UK cancer centre and systematic literature review. *Eur J Surg Oncol* 39:912–917. doi:[10.1016/j.ejso.2013.05.007](https://doi.org/10.1016/j.ejso.2013.05.007)
19. Ghezzi F, Malzoni M, Vizza E et al (2012) Laparoscopic staging of early ovarian cancer: results of a multi-institutional cohort study. *Ann Surg Oncol* 19:1589–1594. doi:[10.1245/s10434-011-2138-9](https://doi.org/10.1245/s10434-011-2138-9)
20. Park HJ, Kim DW, Yim GW et al (2013) Staging laparoscopy for the management of early-stage ovarian cancer: a metaanalysis. *Am J Obstet Gynecol* 209(58):e1–e8. doi:[10.1016/j.ajog.2013.04.013](https://doi.org/10.1016/j.ajog.2013.04.013)
21. Weber S, McCann CK, Boruta DM et al (2011) Laparoscopic surgical staging of early ovarian cancer. *Rev Obs Gynecol* 4:117–122. doi:[10.3909/riog0166](https://doi.org/10.3909/riog0166)
22. Stier EA, Barakat RR, Curtin JP et al (1996) Laparotomy to complete staging of presumed early ovarian cancer. *Obstet Gynecol* 87:737–740
23. Buchsbaum HJ, Brady MF, Delgado G et al (1989) Surgical staging of carcinoma of the ovaries. *Surg Gynecol Obstet* 169:226–232
24. Lee M, Kim SW, Paek J et al (2011) Comparisons of surgical outcomes, complications, and costs between laparotomy and laparoscopy in early-stage ovarian cancer. *Int J Gynecol Cancer* 21:251–256. doi:[10.1097/IGC.0b013e318208c71c](https://doi.org/10.1097/IGC.0b013e318208c71c)
25. Chi DS, Abu-Rustum NR, Sonoda Y et al (2005) The safety and efficacy of laparoscopic surgical staging of apparent stage I ovarian and fallopian tube cancers. *Am J Obstet Gynecol* 192:1614–1619. doi:[10.1016/j.ajog.2004.11.018](https://doi.org/10.1016/j.ajog.2004.11.018)
26. Park J-Y, Bae J, Lim MC, et al. Laparoscopic and laparotomic staging in stage I epithelial ovarian cancer: a comparison of feasibility and safety. *Int J Gynecol Cancer* 18:1202–1209. doi:[10.1111/j.1525-1438.2008.01190.x](https://doi.org/10.1111/j.1525-1438.2008.01190.x)
27. Ghezzi F, Cromi A, Siesto G et al (2009) Laparoscopy staging of early ovarian cancer: our experience and review of the literature. *Int J Gynecol Cancer* 19(Suppl 2):S7–S13. doi:[10.1111/IGC.0b013e3181bf82f3](https://doi.org/10.1111/IGC.0b013e3181bf82f3)
28. Zivanovic O, Sonoda Y, Diaz JP et al (2008) The rate of port-site metastases after 2251 laparoscopic procedures in women with underlying malignant disease. *Gynecol Oncol* 111:431–437. doi:[10.1016/j.ygyno.2008.08.024](https://doi.org/10.1016/j.ygyno.2008.08.024)
29. Heitz F, Ognjenovic D, Harter P et al (2010) Abdominal wall metastases in patients with ovarian cancer after laparoscopic surgery: incidence, risk factors, and complications. *Int J Gynecol Cancer* 20:41–46. doi:[10.1111/IGC.0b013e3181c443ba](https://doi.org/10.1111/IGC.0b013e3181c443ba)
30. Zanetta G, Rota S, Chiari S et al (1998) The accuracy of staging: an important prognostic determinant in stage I ovarian carcinoma, a multivariate analysis. *Ann Oncol* 9:1097–1101
31. Faught W, Lotocki RJ, Heywood M, Krepart GV (1996) Early ovarian cancer: value of a negative staging laparotomy. *Eur J Gynaecol Oncol* 17:200–203
32. Muzii L, Palaia I, Sansone M et al (2009) Laparoscopic fertility-sparing staging in unexpected early stage ovarian malignancies. *Fertil Steril* 91:2632–2637. doi:[10.1016/j.fertnstert.2008.03.058](https://doi.org/10.1016/j.fertnstert.2008.03.058)
33. Colomer AT, Jiménez AM, Bover Barceló MI (1994) Laparoscopic treatment and staging of early ovarian cancer. *J Minim Invasive Gynecol* 15:414–419. doi:[10.1016/j.jmig.2008.04.002](https://doi.org/10.1016/j.jmig.2008.04.002)
34. Tozzi R, Kohler C, Ferrara A, Schneider A (2004) Laparoscopic treatment of early ovarian cancer: surgical and survival outcomes. *Gynecol Oncol* 93:199–203. doi:[10.1016/j.ygyno.2004.01.004](https://doi.org/10.1016/j.ygyno.2004.01.004)
35. Farache C, Alonso S, Ferrer Marsollier C et al (2012) Robotic surgery in gynecologic oncology: retrospective and comparative study with laparotomy and laparoscopy. *J gynecologie, Obs Biol la Reprod* 41:353–362. doi:[10.1016/j.jgyn.2012.03.004](https://doi.org/10.1016/j.jgyn.2012.03.004)
36. Lambaudie E, Houvenaeghel G, Walz J et al (2008) Robot-assisted laparoscopy in gynecologic oncology. *Surg Endosc* 22:2743–2747. doi:[10.1007/s00464-008-0116-5](https://doi.org/10.1007/s00464-008-0116-5)
37. Nezhat FR, Finger TN, Vetere P et al (2014) Comparison of perioperative outcomes and complication rates between conventional versus robotic-assisted laparoscopy in the evaluation and management of early, advanced, and recurrent stage ovarian, fallopian tube, and primary peritoneal cancer. *Int J Gynecol Cancer* 24:600–607. doi:[10.1097/IGC.0000000000000096](https://doi.org/10.1097/IGC.0000000000000096)