

## ONCOLOGY

# Does the type of surgery for early-stage endometrial cancer affect the rate of reported lymphovascular space invasion in final pathology specimens?

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**OBJECTIVE:** Laparoscopically assisted vaginal hysterectomy (LAVH), which usually involves the use of an intrauterine manipulator for optimal surgical control, has been shown to be as effective and safe as conventional total abdominal hysterectomy (TAH) for the staging of endometrial carcinoma. The purpose of this study was to determine whether the use of an intrauterine manipulator was associated with an increase in the pathologic reporting of lymphovascular space invasion (LVSI), which is an important determinant in choosing adjuvant therapy. We hypothesized that intracavitary manipulation and an increase of the intrauterine pressure could cause pseudolymphovascular invasion.

**STUDY DESIGN:** We performed a retrospective chart review of endometrial cancer patients treated at our institution from January 1996 through January 2006. Records were reviewed for patient's age, preoperative diagnosis, procedure type, final surgical staging, and final pathology report. Using the 2009 International Federation of Gynecology and Obstetrics staging, we included all patients having stage IA or IB endometrioid-type endometrial cancer who had undergone either a TAH or LAVH with or without pelvic and paraaortic lymph node dissection. The  $\chi^2$  and Fisher exact tests were used to measure the association between risk of positive lymphovascular invasion and surgical groups.

**RESULTS:** Of 568 women identified as having endometrioid-type endometrial cancer, 486 (85.6%) met criteria for stage IA-IB endometrioid histology,

grade 1, 2, or 3. LVSI was reported in 553/568 cases, with LVSI positivity in 16.9% ( $n = 96/568$ ). The mean ages of the LAVH and TAH groups were significantly different (59.4 vs 62.4 years, respectively,  $P = .0050$ ). Also, mean estimated blood loss and uterine weight significantly varied between TAH and LAVH groups ( $P = .0001$  and  $.008$ , respectively). For stage IA, 17/220 (7.7%) who had been treated with LAVH had positive LVSI compared with 20/199 (10.1%) of patients receiving TAH ( $P = .73$ ). For stage IB, 11/25 (44.0%) of patients treated with LAVH had positive LVSI compared with 10/31 (32.3%) of patients receiving TAH ( $P = .53$ ). The stage I cancer patients were further subdivided into histological grades 1, 2, and 3, and LVSI was not significantly different between TAH and LAVH groups per grade of cancer. We found no differences between TAH and LAVH in early-stage endometrial cancer (stage IA and IB), with respect to the presence of positive peritoneal washings.

**CONCLUSION:** In early-stage endometrial cancer (stage IA and IB), there were no differences between TAH and LAVH in the final pathologic report of LVSI. The use of an intrauterine manipulator for LAVH was not associated with an increased detection of LVSI.

**Key words:** cytology, endometrial carcinoma, laparoscopically assisted vaginal hysterectomy, lymphovascular space invasion, total abdominal hysterectomy

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The surgical approach to performing a hysterectomy has evolved from laparotomy to laparoscopic techniques such as laparoscopically assisted vaginal

hysterectomy (LAVH), total laparoscopic hysterectomy, and robot-assisted laparoscopic hysterectomy. These minimally invasive techniques have gained

popularity in gynecologic oncology as they result in reduced morbidity and improved cosmesis, while maintaining similar disease-free and overall survival rates particularly in the treatment of endometrial cancer.<sup>1</sup> Palomba et al<sup>2</sup> published a metaanalysis of all randomized clinical trials available to date comparing laparoscopic and open approaches for endometrial cancer, and concluded that the laparoscopic approach is as safe and as effective.

The presence or absence of lymphovascular space invasion (LVSI) has been identified as one of the most important predictors of nodal involvement: progression-free as well as overall survival of

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**TABLE 1**  
**Patients' characteristics**

| Characteristic       | All patients |
|----------------------|--------------|
| Mean age, y (SD)     | 61.1 (11.6)  |
| Histologic type      | Endometrioid |
| LVSI negative        | 457 (80.5%)  |
| LVSI positive        | 96 (16.9%)   |
| LVSI unknown         | 8 (1.4%)     |
| LVSI suspicious      | 7 (1.2%)     |
| Grading unspecified  | 2 (0.4%)     |
| Grade 1              | 202 (35.6%)  |
| Grade 2              | 258 (45.4%)  |
| Grade 3              | 106 (18.7%)  |
| Stage IA             | 429 (75.5%)  |
| Stage IB             | 57 (10.0%)   |
| Stage II             | 33 (5.8%)    |
| Stage III            | 44 (7.7%)    |
| Stage IV             | 5 (0.9%)     |
| Washing negative     | 449 (79.0%)  |
| Washing positive     | 20 (3.5%)    |
| Washing suspicious   | 36 (6.3%)    |
| Washing not reported | 63 (11.1%)   |

LVSI, lymphovascular space invasion.

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patients with endometrial cancer.<sup>3-5</sup> The presence of LVSI in endometrial cancer has been incorporated into clinical decision making in combination with other clinicopathological factors, such as stage, tumor grade, histological type, and depth of myometrial invasion. These factors formed the basis for Gynecologic Oncology Group 99 findings that identified the so-called "high intermediate risk" group for disease recurrence and are used to recommend adjuvant therapy in the form of radiation. While lymphadenectomy provides important information, in unstaged patients, LVSI may be used as a surrogate for future treatment planning.

It has been postulated that tumor cells could be artificially introduced into the lymphatics and blood vasculature at the time of the laparoscopic surgical staging procedure. Therefore, our study sought to confirm these findings and determine

**TABLE 2**  
**Patients' characteristics for laparoscopically assisted vaginal hysterectomy and total abdominal hysterectomy groups**

| Characteristic            | LAVH (n = 270) | TAH (n = 287) | P value |
|---------------------------|----------------|---------------|---------|
| Mean age, y (SD)          | 59.4 (10.6)    | 62.4 (12.3)   | .002    |
| Histologic type           | Endometrioid   | Endometrioid  |         |
| LVSI                      |                |               |         |
| Negative                  | 228 (84.4%)    | 219 (76.3%)   |         |
| Positive                  | 36 (13.3%)     | 59 (20.6%)    |         |
| Suspicious                | 2 (0.7%)       | 5 (1.7%)      |         |
| Unknown                   | 4 (1.5%)       | 4 (1.4%)      |         |
| Grade                     |                |               |         |
| Unspecified               | 1 (0.4%)       | 1 (0.3%)      |         |
| 1                         | 113 (41.9%)    | 85 (29.6%)    |         |
| 2                         | 126 (46.7%)    | 126 (43.9%)   |         |
| 3                         | 30 (11.1%)     | 75 (26.1%)    |         |
| Stage                     |                |               |         |
| IA                        | 220 (81.5%)    | 199 (69.3%)   |         |
| IB                        | 25 (9.3%)      | 31 (10.8%)    |         |
| II                        | 7 (2.6%)       | 26 (9.1%)     |         |
| III                       | 17 (6.3%)      | 27 (9.4%)     |         |
| IV                        | 1 (0.4%)       | 4 (1.4%)      |         |
| Washing                   |                |               |         |
| Negative                  | 215 (79.6%)    | 230 (80.1%)   |         |
| Positive                  | 13 (4.8%)      | 7 (2.4%)      |         |
| Suspicious                | 22 (8.1%)      | 14 (4.9%)     |         |
| Not reported              | 20 (7.4%)      | 36 (12.5%)    |         |
| Uterine weight, g (SD)    | 140.5 (96.0)   | 181.8 (234.5) | .008    |
| Minimum uterine weight, g | 42             | 21            |         |
| Maximum uterine weight, g | 918            | 2750          |         |
| EBL, mL (SD)              | 155.2 (127.9)  | 309.2 (304.7) | < .001  |
| Minimum EBL, mL           | 10             | 50            |         |
| Maximum EBL, mL           | 1200           | 1800          |         |

EBL, estimated blood loss; LAVH, laparoscopically assisted vaginal hysterectomy; LVSI, lymphovascular space invasion; TAH, total abdominal hysterectomy.

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whether the laparoscopic approach increases the rate of artificial introduction of neoplastic epithelium into the lymphovascular space by intracavitary manipulation during the surgical staging of early endometrial cancer.

## MATERIALS AND METHODS

Approval of the study proposal was obtained from the respective institutional

review boards, and a retrospective chart review of endometrial cancer patients treated at our institution from January 1996 through January 2006 was performed. We characterized all patients using the 2009 International Federation of Gynecology and Obstetrics (FIGO) with stage IA and IB endometrioid-type endometrial cancer, who underwent either a total abdomi-

nal hysterectomy (TAH) or LAVH with or without pelvic and paraaortic lymph node dissection.

**Data collection**

Details of surgical procedures were obtained from the electronic medical records. Records were reviewed for patient’s age, preoperative diagnosis, procedure type, final surgical staging, histological grade, depth of invasion, lymphovascular involvement, and peritoneal cytology status.

**Statistical analysis**

Parametric data were analyzed using the Student *t* test. The  $\chi^2$  and Fisher exact tests were used to measure the association between risk of positive lymphovascular invasion and surgical groups. The level of significance for all comparisons was defined at  $P < .05$ .

**RESULTS**

Based on our review, 568 patients had endometrioid-type endometrial cancer during the study period. In all, 486 of 586 (85.6%) had stage IA-IB endometrioid endometrial cancer, grade 1, 2, or 3. In all, 475 of 486 had either LAVH or TAH as part of their treatment. Of these 475 patients, 230 had TAH and 245 had LAVH (Tables 1 and 2). LVSI was evaluated in 553/568 cases. In all, 96 patients were noted to have positive LVSI (16.9%).

Mean patient age, estimated blood loss, and uterine weight between the groups were found to be significantly different (Table 2).

In patients with stage IA, 17/220 (7.7%) who underwent LAVH and 20/199 (10.1%) of patients treated with TAH had positive LVSI ( $P = .73$ ) (Table 3). In patients with stage IB, 11/25 (44.0%) treated with a LAVH and 10/31 (32.3%) of TAH patients had positive LVSI ( $P = .53$ ) (Table 3).

Of the patients with stage I, 102/245 (41.6%) who underwent LAVH and 118/230 (51.3%) of patients treated with TAH had pelvic lymph node dissection. The number of pelvic lymph nodes was not significantly different (13.61 vs 13.13,  $P = .48$ ). However the number of paraaortic nodes was significantly different between LAVH and TAH groups (7.55 vs 4.2,  $P < .01$ ) (Table 4).

**TABLE 3**

**Comparison of surgical modality in stage IA and stage IB cancers showing lymphovascular space invasion**

| Variable        | LVSI     |          |         |            |
|-----------------|----------|----------|---------|------------|
|                 | Negative | Positive | Unknown | Suspicious |
| <b>Stage IA</b> |          |          |         |            |
| Surgery         |          |          |         |            |
| LAVH            |          |          |         |            |
| Count           | 199      | 17       | 2       | 2          |
| Within surgery  | 90.5%    | 7.7%     | .9%     | .9%        |
| TAH             |          |          |         |            |
| Count           | 175      | 20       | 1       | 3          |
| Within surgery  | 87.9%    | 10.1%    | .5%     | 1.5%       |
| <b>Stage IB</b> |          |          |         |            |
| Surgery         |          |          |         |            |
| LAVH            |          |          |         |            |
| Count           | 14       | 11       | 0       | 0          |
| Within surgery  | 56.0%    | 44.0%    | .0%     | .0%        |
| TAH             |          |          |         |            |
| Count           | 19       | 10       | 1       | 1          |
| Within surgery  | 61.3%    | 32.3%    | 3.2%    | 3.2%       |

LAVH, laparoscopically assisted vaginal hysterectomy; LVSI, lymphovascular space invasion; TAH, total abdominal hysterectomy. Momeni. *Affect of surgery for early-stage endometrial cancer and the rate of LVSI. Am J Obstet Gynecol* 2013.

The stage I cancer patients were further analyzed based on histological grade 1, 2, and 3. LVSI presence was significantly higher in grade 2 and 3 compared to grade 1 patients ( $P = .0001$ ). Of the patients with grade 3, stage I endometrioid-type endometrial cancer, 41.6% had LVSI in their surgical specimen; in contrast, only 1.0% of women with grade 1, stage I endometrioid-type endometrial cancer had LVSI. Within the groups of

patients with different histological grades, presence or absence of LVSI did not differ based on the type of the procedure used ( $P = .32, .49, \text{ and } .70$ , respectively) (Table 5).

For stage IA, 16/220 (7.3%) of patients treated with LAVH and 9/199 (4.5%) of patients treated with TAH had positive cytology findings based on peritoneal washings ( $P = .14$ ) (Table 6). For stage IB, 3/25 (12.0%) of patients treated with

**TABLE 4**

**Lymphadenectomy data in laparoscopically assisted vaginal hysterectomy and total abdominal hysterectomy groups**

| Variable                                | Both groups       | LAVH              | TAH               |
|---|-------------------|-------------------|-------------------|
| n                                       | 475               | 245               | 230               |
| Pelvic node done                        | 220 (46.3%)       | 102 (41.6%)       | 118 (51.3%)       |
| No. of pelvic nodes (mean $\pm$ SD)     | 13.35 $\pm$ 11.36 | 13.61 $\pm$ 11.32 | 13.13 $\pm$ 11.43 |
| Paraaortic node done                    | 100 (21.1%)       | 44 (17.9%)        | 56 (24.3%)        |
| No. of paraaortic nodes (mean $\pm$ SD) | 5.67 $\pm$ 5.70   | 7.55 $\pm$ 7.12   | 4.2 $\pm$ 3.72    |

LAVH, laparoscopically assisted vaginal hysterectomy; TAH, total abdominal hysterectomy. Momeni. *Affect of surgery for early-stage endometrial cancer and the rate of LVSI. Am J Obstet Gynecol* 2013.

**TABLE 5**  
**Comparison of surgical modality rate in stage I cancers subdivided per histology grade**

| Stage I        | LVSI     |          |         |            |
|----------------|----------|----------|---------|------------|
|                | Negative | Positive | Unknown | Suspicious |
| <b>Grade 1</b> |          |          |         |            |
| LAVH           |          |          |         |            |
| Count          | 106      | 2        | 1       | 0          |
| Within surgery | 97.2%    | 1.8%     | 0.9%    | .0%        |
| TAH            |          |          |         |            |
| Count          | 82       | 0        | 0       | 0          |
| Within surgery | 100.0%   | .0%      | .0%     | .0%        |
| <b>Grade 2</b> |          |          |         |            |
| LAVH           |          |          |         |            |
| Count          | 95       | 13       | 0       | 1          |
| Within surgery | 87.2%    | 11.9%    | .0%     | .9%        |
| TAH            |          |          |         |            |
| Count          | 82       | 11       | 1       | 3          |
| Within surgery | 84.5%    | 11.3%    | 1.0%    | 3.1%       |
| <b>Grade 3</b> |          |          |         |            |
| LAVH           |          |          |         |            |
| Count          | 12       | 13       | 1       | 1          |
| Within surgery | 44.4%    | 48.1%    | 3.7%    | 3.7%       |
| TAH            |          |          |         |            |
| Count          | 29       | 19       | 1       | 1          |
| Within surgery | 58.0%    | 38.0%    | 2.0%    | 2.0%       |

LAVH, laparoscopically assisted vaginal hysterectomy; LVSI, lymphovascular space invasion; TAH, total abdominal hysterectomy.

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LAVH and 1/31 (3.2%) of patients treated with TAH had positive washing ( $P = .40$ ) (Table 6).

Multivariable model was used to evaluate predictors of LVSI. Variables included in the analysis were depth of invasion, type of surgery washing status, and grade and stage of disease. Only depth of invasion, and the grade and stage of disease were predictors of LVSI.

## COMMENT

LAVH was introduced as an alternative to TAH, after several studies demonstrated the safety and comparable efficacy of the technique. Recommendations on adjuvant treatment that traditionally involve radiation therapy, chemotherapy, or a combination thereof are based on clinical characteristics, including patient age

and pathological findings such as tumor grade, depth of invasion, and LVSI. Recently, reports of pathologic artifacts associated with the laparoscopic technique have been published.<sup>6-8</sup>

LVSI has been reported as a strong independent prognostic variable in endometrial carcinoma with respect to disease recurrence and survival, based on both univariate and multivariate analyses in multiple studies.<sup>5,9-14</sup> Institutional differences exist in adjuvant treatment recommendations for the subgroup of patients with early-stage endometrial carcinoma with LVSI. Cohn et al<sup>15</sup> presented data supporting adjuvant therapy after hysterectomy for unstaged endometrial carcinoma solely based on LVSI status. In some institutions, patients with grade 1 tumors that show either

deep (outer third) myometrial invasion or vascular invasion are offered pelvic radiation.<sup>7</sup> Therefore, it is critical to properly identify the true status of lymphovascular involvement by a tumor and whether uterine manipulation can cause a mechanical transportation artifact of cancerous cells into the lymphovascular spaces. Misinterpretation of vascular space involvement may lead to unnecessary or inadequate adjuvant treatment.<sup>16</sup> Due to the prognostic significance of lymphovascular invasion, most pathology reports include this information and treatment decisions are made on a case-by-case basis.

With the introduction of new surgical procedures, the effects of new tools and technologies on the pathologic assessment of specimens are not well known. LAVH may require the use of a colpotomy assembly, which consists of a uterine manipulator, vaginal expander, and a pneumo-occluder. Recently, there have been reports that these devices can alter the morphologic appearance of tissue with the introduction of artifacts and even cause iatrogenic spread of disease.<sup>6-8,17,18</sup> The intravascular deposits of neoplastic tissue may be introduced by manipulation-induced positive intracavitary pressure. These studies have described vascular pseudoinvasion secondary to positive intracavitary pressure.<sup>6,7,19</sup> Pathologists are well acquainted with the artifacts produced by the "pushing in" of tumors during dissection of a specimen and the "picking up" of stray tumor fragments during processing, but artifacts created prior to receiving the specimen may be more difficult to identify, especially if pathologists use strict criteria for assessing vascular space invasion. Intimate understanding of surgical procedures by the pathologist is required for proper assessment of the specimen and rendering of the diagnosis.

Vascular pseudoinvasion or mechanical transportation of benign or malignant tissue has been documented in other types of tumors. McLachlin et al<sup>20</sup> reported a pseudoinvasion of vascular spaces secondary to cervical lidocaine injection prior to loop electrosurgical excision procedure. Mechanical displacement of breast carcinoma cells into lymphatic channels and the subcapsular

sinus of lymph nodes has been described by Carter et al.<sup>21</sup> Banks et al<sup>22</sup> reported on the presence of menstrual endometrium in parametrial blood vessels in a hysterectomy specimen. In the uterus, Logani et al<sup>7</sup> reported the mechanical transportation of tumor into vascular spaces associated with the technique of total laparoscopic hysterectomy; however, in their limited follow-up (average 19 months), no adverse outcomes were reported.

In our study, we reviewed 486 women with endometrial cancer stage IA-IB, endometrioid histology, grades 1, 2, and 3. We compared the rate of LVSI in hysterectomies performed using TAH and LAVH. We found that in early-stage endometrial cancer (stage IA and IB), there were no differences between TAH and LAVH with regard to the presence of LVSI. These findings contrast those of others.<sup>8</sup> Logani et al<sup>7</sup> reported vascular pseudoinvasion in 71% (5/7) of cases associated with manipulated hysterectomies performed for a malignant condition and in 13% of cases performed for premalignant disease. They attributed such findings to the creation of a closed positive pressure within the uterine cavity while using a uterine manipulator.<sup>7</sup> In their study, preferential involvement of vascular over lymphatic channels was attributed to the collapse of the thin-walled lymphatics secondary to positive pressure.<sup>7</sup> Kitahara et al<sup>6</sup> showed a significantly higher rate of vascular pseudoinvasion in laparoscopically performed hysterectomies compared to TAH (33% of 21 cases compared to 0% of 28 cases, respectively). It was proposed that this was a result of postoperative grossing artifact, postulating that the manipulator disrupts the tumor but that mechanical displacement occurs at the time of grossing, resulting in intravascular epithelial displacement. They observed that vascular pseudoinvasion exclusively involved large, thick-walled vessels in the outer myometrium, suggesting that intraoperative displacement would affect both small and large vessels throughout the myometrium. These changes occurred only in polypoid tumors, which are being more susceptible to disruption by the uterine manipulator, and the low rate of

TABLE 6

### Comparison of surgical modality in stage IA and IB cancers based on cytology

| Variable       | Wash     |            |              |
|----------------|----------|------------|--------------|
|                | Negative | Suspicious | Not reported |
| Stage IA       |          |            |              |
| Surgery        |          |            |              |
| LAVH           |          |            |              |
| Count          | 187      | 16         | 17           |
| Within surgery | 85.0%    | 7.3%       | 7.7%         |
| TAH            |          |            |              |
| Count          | 165      | 9          | 25           |
| Within surgery | 82.9%    | 4.5%       | 12.6%        |
| Stage IB       |          |            |              |
| Surgery        |          |            |              |
| LAVH           |          |            |              |
| Count          | 20       | 3          | 2            |
| Within surgery | 80.0%    | 12.0%      | 8.0%         |
| TAH            |          |            |              |
| Count          | 26       | 1          | 4            |
| Within surgery | 83.9%    | 3.2%       | 12.9%        |

LAVH, laparoscopically assisted vaginal hysterectomy; TAH, total abdominal hysterectomy.

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lymph node positivity in these cases. To avoid these artifacts, Kitahara et al<sup>6</sup> recommended a grossing technique that requires gentle rinsing of the bivalved uterus to dislodge the disrupted tissue, followed by overnight fixation. Folkins et al<sup>23</sup> have also noted that laparoscopic procedures have a higher index of vascular involvement, associated with lower stage, fewer nodal involvements, and less myometrial invasion compared to TAH. Two of 10 cases reported as lymphovascular involvement in the original report were interpreted at the consensus review as artifactual.<sup>23</sup>

The difference between the findings of our study and others' can be attributed to the types of uterine manipulator used as well as the significantly higher number of cases analyzed. For example, in the study by Logani et al,<sup>7</sup> only 7 patients had endometrial carcinoma and all cases used a RUMI (CooperSurgical, Inc, Trumbull, CT) uterine manipulator. Kitahara et al<sup>6</sup> had only 21 early-stage endometrial cancer cases, and the type of

uterine manipulator used was not mentioned. In our study, several different types of uterine manipulators were utilized. The Hulka (Integra, Inc., York, PA) manipulator will probably have minimal effect on intrauterine pressure as it has no inflatable intrauterine balloon. On the other hand, part of the RUMI-type device includes a disposable uterine manipulator with an inflatable intrauterine balloon attached to a handle. Once in position, the inflation of the intrauterine balloon may create positive pressure inside the uterine cavity. The intrauterine pressure may be even higher in cases where fallopian tubes were occluded prior to intrauterine manipulator placement. One of the limitations of our study was in fact the use of different types of manipulators by different surgeons; also we were not able to categorize different types of uterine manipulator in our database. The strengths of our study include the large number of patients as well as the performance of the pathologic review by a single team of pathologists in our institution.

It has also been debated as to whether laparoscopic hysterectomy results in a higher incidence of positive peritoneal cytology, with a number of studies presenting conflicting results.<sup>17,24,25</sup> Although the new FIGO staging system for endometrial cancer no longer incorporates peritoneal cytology, it does state that the results must be reported. Thus, resolution of this issue is important. Lim et al<sup>25</sup> and Sonoda et al<sup>17</sup> suggest that the uterine manipulator may lead to disruption of the tumor, resulting in displacement of malignant epithelium into the peritoneal cavity through the fallopian tubes. Krizova et al<sup>8</sup> found a significantly higher rate of positive peritoneal washing in patients undergoing manipulated compared with nonmanipulated hysterectomies (12.5% vs 2.5%). However, another study by Eltabbakh et al<sup>24</sup> showed conflicting results. We also looked into our data with regard to the status of peritoneal cytology. In our cohort, we found no differences between TAH and LAVH in early-stage endometrial cancer (stage IA and IB), with respect to the presence of positive washings. Whether or not positive peritoneal washings secondary to epithelial displacement will have clinical significance can only be determined by adequately powered multivariate analysis with long-term clinical follow-up.

In summary, in early-stage endometrial cancer (stage IA and IB), there were no differences between TAH and LAVH in the final pathologic report of LVSI and the use of an intrauterine manipulator for LAVH was not associated with an increased detection of LVSI. ■

## REFERENCES

- Walker JL, Piedmonte MR, Spirtos NM, et al. Laparoscopy compared with laparotomy for comprehensive surgical staging of uterine cancer: gynecologic oncology group study LAP2. *J Clin Oncol* 2009;27:5331-6.
- Palomba S, Falbo A, Russo T, Zullo F. Updating of a recent meta-analysis of randomized controlled trials to assess the safety and the efficacy of the laparoscopic surgery for treating early stage endometrial cancer. *Gynecol Oncol* 2009;114:135-6.
- Briët JM, Hollema H, Reesink N, et al. Lymphovascular space involvement: an independent prognostic factor in endometrial cancer. *Gynecol Oncol* 2005;96:799-804.
- O'Brien DJ, Flannelly G, Mooney EE, Foley M. Lymphovascular space involvement in early stage well-differentiated endometrial cancer is associated with increased mortality. *BJOG* 2009;116:991-4.
- Guntupalli SR, Zigelboim I, Kizer NT, et al. Lymphovascular space invasion is an independent risk factor for nodal disease and poor outcomes in endometrioid endometrial cancer. *Gynecol Oncol* 2012;124:31-5.
- Kitahara S, Walsh C, Frumovitz M, Malpica A, Silva EG. Vascular pseudo-invasion in laparoscopic hysterectomy specimens for endometrial carcinoma: a grossing artifact? *Am J Surg Pathol* 2009;33:298-303.
- Logani S, Herdman AV, Little JV, Moller KA. Vascular "pseudo invasion" in laparoscopic hysterectomy specimens: a diagnostic pitfall. *Am J Surg Pathol* 2008;32:560-5.
- Krizova A, Clarke BA, Bernardini MQ, et al. Histologic artifacts in abdominal, vaginal, laparoscopic, and robotic hysterectomy specimens: a blinded, retrospective review. *Am J Surg Pathol* 2011;35:115-26.
- Honoré LH, Hanson J. Statistical analysis of pathologic risk factors for intramyometrial lymphovascular space involvement in myoinvasive endometrial carcinoma. *Int J Gynecol Cancer* 2006;16:1330-5.
- Nomura H, Aoki D, Suzuki N, et al. Analysis of clinicopathologic factors predicting para-aortic lymph node metastasis in endometrial cancer. *Int J Gynecol Cancer* 2006;16:799-804.
- Prat J. Prognostic parameters of endometrial carcinoma. *Hum Pathol* 2004;35:649-62.
- Sivridis E, Buckley CH, Fox H. The prognostic significance of lymphatic vascular space invasion in endometrial adenocarcinoma. *Br J Obstet Gynaecol* 1987;94:991-4.
- Zaino RJ. Lymph-vascular space invasion in endometrial adenocarcinoma: confusion, confessions, and conclusions. *Gynecol Oncol* 2002;87:240-2.
- Stefansson IM, Salvesen HB, Immervoll H, Akslen LA. Prognostic impact of histological grade and vascular invasion compared with tumor cell proliferation in endometrial carcinoma of endometrioid type. *Histopathology* 2004;44:472-9.
- Cohn DE, Horowitz NS, Mutch DG, Kim SM, Manolitsas T, Fowler JM. Should the presence of lymphovascular space involvement be used to assign patients to adjuvant therapy following hysterectomy for unstaged endometrial cancer? *Gynecol Oncol* 2002;87:243-6.
- Nofech-Mozes S, Ackerman I, Ghorab Z, et al. Lymphovascular invasion is a significant predictor for distant recurrence in patients with early-stage endometrial endometrioid adenocarcinoma. *Am J Clin Pathol* 2008;129:912-7.
- Sonoda Y, Zerbe M, Smith A, Lin O, Barakat RR, Hoskins WJ. High incidence of positive peritoneal cytology in low-risk endometrial cancer treated by laparoscopically assisted vaginal hysterectomy. *Gynecol Oncol* 2001;80:378-82.
- Wang PH, Yen MS, Yuan CC, et al. Port site metastasis after laparoscopic-assisted vaginal hysterectomy for endometrial cancer: possible mechanisms and prevention. *Gynecol Oncol* 1997;66:151-5.
- Clarke B, McCluggage WG. Iatrogenic lesions and artifacts in gynecological pathology. *J Clin Pathol* 2009;62:104-12.
- McLachlin CM, Devine P, Muto M, Genest DR. Pseudo-invasion of vascular spaces: report of an artifact caused by cervical lidocaine injection prior to loop diathermy. *Hum Pathol* 1994;25:208-11.
- Carter BA, Jensen RA, Simpson JF, Page DL. Benign transport of breast epithelium into axillary lymph nodes after biopsy. *Am J Clin Pathol* 2000;113:259-65.
- Banks ER, Mills SE, Frierson HF Jr. Uterine intravascular menstrual endometrium simulating malignancy. *Am J Surg Pathol* 1991;15:407-12.
- Folkens AK, Nevadunsky NS, Saleemuddin A, et al. Evaluation of vascular space involvement in endometrial adenocarcinomas: laparoscopic versus abdominal hysterectomies. *Mod Pathol* 2010;23:1073-9.
- Eltabbakh GH, Mount SL. Laparoscopic surgery does not increase the positive peritoneal cytology among women with endometrial carcinoma. *Gynecol Oncol* 2006;100:361-4.
- Lim S, Kim HS, Lee KB, Yoo CW, Park SY, Seo SS. Does the use of a uterine manipulator with an intrauterine balloon in total laparoscopic hysterectomy facilitate tumor cell spillage into the peritoneal cavity in patients with endometrial cancer? *Int J Gynecol Cancer* 2008;18:1145-9.