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Impact of hospital care volume on clinical outcomes of laparoscopic radical hysterectomy for cervical cancer
A systematic review and meta-analysis
Banghyun Lee, MD, PhD, Kidong Kim, MD, PhD, Youngmi Park, BS, Myong Cheol Lim, MD, PhD, Robert E. Bristow, MD

Abstract
Background: In cervical cancer, the impact of hospital volume of laparoscopic radical hysterectomy (LRH) has not been investigated systematically as in ovarian cancer. The aim of this study was to investigate the impact of hospital care volume of LRH on treatment outcomes of patients with cervical cancer.

Methods: The PubMed, Embase, and Cochrane Library databases were searched with the terms “cervical cancer,” “radical hysterectomy,” and “laparoscopy.” The selection criteria included studies presenting operative outcomes and/or perioperative complications of LRH from high-volume hospitals (HVHs) (≥ 15 cases/year) and low-volume hospitals (LVHs) (< 15 cases/year). Fifty-nine studies including 4367 cases were selected. Linear regression analysis weighted by the average annual case number in each study was performed to evaluate differences between the groups.

Results: In HVH, a higher number of lymph nodes (24.5 vs 21.1; \(P = .037\)) were retrieved by LRH in older women (48.4 vs 44.5 years; \(P = .010\)) with tendencies of shorter operation time (224.4 vs 256.4 minutes; \(P = .096\)) and less blood loss (253.1 vs 322.2 mL; \(P = .080\)). Compared with LVH, HVH had fewer patients with stage IA disease (13.8 vs 24.4; \(P = .003\)) and more patients with stage IIA disease (15.3 vs 7.1; \(P = .052\)) with comparable 5-year overall survival (93.1 vs 88.6; \(P = .112\)).

Conclusion: HVH is a prognostic factor for operative outcome and perioperative complications in patients with cervical cancer undergoing LRH. The exact effect of hospital volume on survival outcome needs to be evaluated.

Abbreviations: CIs = confidence intervals, DFS = disease-free survival, FIGO = International Federation of Gynecology and Obstetrics, HVH = high-volume hospitals, LARVH = laparoscopic-assisted radical vaginal hysterectomy, LNs = lymph nodes, LRH = laparoscopic radical hysterectomy, LVH = low-volume hospitals, OS = overall survival, TLRH = total laparoscopic radical hysterectomy.

Keywords: cervical cancer, high-volume hospitals, laparoscopic radical hysterectomy, survival
1. Introduction

The incidence of cervical cancer is continuously decreasing in developed countries,[11] however, the mortality rate is still high.[2] Radical hysterectomy is the standard treatment for early cervical cancer, especially for International Federation of Gynecology and Obstetrics (FIGO) stages IA2 to IIA.[3] Radical hysterectomy requires wide dissection of the bladder and lower ureter, which is inevitably associated with a higher rate of complications such as lower urinary tract injuries than that for simple hysterectomy.[4,5]

In the management of ovarian cancer, high hospital, and/or surgeon volumes, specifically, a high number of cases performed by an individual hospital and/or surgeon have been recognized as predictive factors for receiving standard treatment and as prognostic factors for overall survival (OS) outcomes.[6–7] Since the introduction of laparoscopic radical hysterectomy (LRH) in the early 1990s for surgical treatment of cervical cancer, this minimally invasive procedure has now become well established, even when any surgeon lacks experience in open radical hysterectomy.[8–10] The learning curve for LRH in cervical cancer to achieve an acceptable level of surgical proficiency has been reported to be 40 cases.[11] In cervical cancer, high surgeon volume is a predictive marker for fewer postoperative complications, shorter hospitalization, and lower rates of transfusion after open radical hysterectomy.[12,13] However, the impact of hospital volume of LRH has not been investigated systematically as in ovarian cancer. Therefore, the objective of the present systematic analysis was to investigate the effect of hospital volume of LRH on treatment outcomes of patients with cervical cancer.

2. Materials and methods

2.1. Search strategy

In January 2017, PubMed, Cochrane Library, and Embase databases were searched for all pertinent studies without restriction on the year of publication. A combination of the following key words was used in the search: (“cervical cancer” AND “laparoscopy” AND “radical hysterectomy”) and (“cervical cancer” AND “LRH”) (see Appendix, Supplemental Content 1, http://links.lww.com/MD/C679, which demonstrates search strategy). Bibliographic references of selected clinical studies and review articles were also examined for additional relevant literature not covered by the database searches.

2.2. Selection criteria

The inclusion criteria for study selection were as follows: cervical cancer confirmed via permanent pathology; LRH or total laparoscopic radical hysterectomy (TLRH) or laparoscopic-assisted radical vaginal hysterectomy (LARVH); operative outcomes such as operation time, blood loss, number of lymph nodes (LN) retrieved, and postoperative hospital stay; and/or intra- and postoperative complications. Articles on studies about neoadjuvant therapy, studies involving patients with endometrial cancers as the candidates for LRH, and studies including cases accompanied by other types of cancer; articles not in English; review articles; editorials; case reports; and letters were excluded. When multiple studies reported overlapping groups of patients, only 1 study with the largest number of events was included in the meta-analysis to avoid duplication of information.

2.3. Data extraction and outcomes of interest

Data retrieved from studies included the following details: hospital volume, surgeon volume, the name of the first author, publication year, data collection year, the number of total cases, the case number per year, study design, types of LRH, country, age, stage, histology, operation time, blood loss, number of LNs retrieved, postoperative hospital stay, intra- and postoperative complications, lymphovascular space invasion, tumor size, LN metastasis, parametrial invasion, surgical margin invasion, postoperative adjuvant therapy, postoperative radiotherapy, recurrence rate, and survival rates.

The eligible studies were classified as high-volume hospitals (HVHs) (≥15 cases/year) and low-volume hospitals (LVHs) (<15 cases/year), based on the average annual case numbers of LRH performed in the hospitals. To evaluate the outcomes, each variable was compared with the hospital volumes.

The primary outcomes in the systematic analysis were operative outcomes, such as operation time, blood loss, the number of LNs retrieved, and postoperative hospital stay, and perioperative complications, such as intra- and postoperative complications. The secondary outcomes were as follows: prognostic factors such as lymphovascular space invasion, mass size, LN metastasis, parametrial invasion, and surgical margin invasion; postoperative adjuvant therapy, especially radiotherapy; and prognostic outcomes such as 5-year recurrence rate, OS, and disease-free survival (DFS). OS was defined as the length of time from surgery to death from any cause. DFS was defined as the length of time after the end of primary treatment for cancer wherein the patient survived without any signs or symptoms of cervical cancer.

2.4. Quality assessment

The quality of case–control studies was evaluated using the Newcastle–Ottawa Scale (see Table, Supplemental Content 2, http://links.lww.com/MD/C679, which demonstrates the quality of the included studies).[14,15] The risk of bias of interrupted time series studies was evaluated with the criteria suggested by the Cochrane Effective Practice and Organisation of Care (EPOC) Group (see Table, Supplemental Content 3, http://links.lww.com/MD/C679, which demonstrates the quality of the included studies).[16] The risk of bias of randomized controlled trials was evaluated with the Cochrane Collaboration tool (see Table, Supplemental Content 4, http://links.lww.com/MD/C680, which demonstrates how to evaluate the quality of the included studies).[17] The study qualities were independently evaluated by 2 authors (BL and KK) and any disagreements were resolved after discussion with all the other authors.

2.5. Statistics

Data expressed as a median were converted into mean by Hozo formula.[18] Linear regression analysis weighted by the average annual case number in each study was performed to overcome significant heterogeneity based on extracting data from the included studies with different study designs and to evaluate the differences between the groups using Stata/SE 14 (StataCorp LP, TX). All results were provided with 95% confidence intervals (95% CIs) and 2-sided P values. P < .05 was considered statistically significant. A P value between .05 and .1 was considered as having a tendency toward statistical significance. The open-source statistical software R version 3.3.2 (http://www.R-project.org) was used to illustrate differences in care between the HVHs and LVHs.
3.2 Comparisons between the high-volume and low-volume hospital care

Studies in the HVH group included patients older than those in the LVH group (age 48.4 vs 44.5 years; \( P = 0.037 \)). However, the length of postoperative hospital stay (24.4 vs 21.1 days; \( P = 0.010 \)) showed no difference between the HVH and LVH groups. The frequency of surgical margin invasion was lower in the HVH than in the LVH groups (age 48.4 vs 44.5 years; \( P = 0.123 \)). Mean mass size ranged from 0 to 3.2 cm in the LVH group (data not shown). Postoperative complications, lymphovascular space invasion, LN metastasis, and DFS rates were not different according to hospital surgical volumes. Although not statistically significant, the 5-year survival of patients in the HVH group was higher than in the LVH cases (age 48.4 vs 44.5 years; \( P = 0.112 \)) (Figs. 1 and 2, Table 1).

Table 1

<table>
<thead>
<tr>
<th>Study</th>
<th>Publication year</th>
<th>Data collection year</th>
<th>No. of cases</th>
<th>No. of cases/ year</th>
<th>Study design</th>
<th>Types of LRH</th>
<th>Country</th>
<th>Age, y (mean)</th>
<th>IIA</th>
<th>IIA2</th>
<th>IB1</th>
<th>IB2</th>
<th>IIA or more</th>
<th>Squamous cell (%)</th>
<th>Adenocarcinoma (%)</th>
<th>Adenosquamous (%)</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yang et al[25]</td>
<td>2015</td>
<td>9/2008 - 8/2013</td>
<td>403</td>
<td>75.6</td>
<td>Retrospective LRH</td>
<td>China</td>
<td>44</td>
<td>IA: 29 (2.2)</td>
<td>304 (75.4)</td>
<td>24 (6.5)</td>
<td>45 (11.2)</td>
<td>IIA: 1 (0.2)</td>
<td>23 (3.0)</td>
<td>36 (4.3)</td>
<td>12 (2.9)</td>
<td>12 (2.9)</td>
<td></td>
</tr>
<tr>
<td>Park and Nam[26]</td>
<td>2014</td>
<td>1/2007 - 11/2011</td>
<td>260</td>
<td>52.9</td>
<td>Retrospective LRH</td>
<td>Korea</td>
<td>44</td>
<td>IA: 32 (13.8)</td>
<td>165 (63.5)</td>
<td>48 (18.1)</td>
<td>31 (11.8)</td>
<td>1 (0.3)</td>
<td>188 (2,3)</td>
<td>64 (24.6)</td>
<td>8 (0.1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Xu et al[27]</td>
<td>2017</td>
<td>2000 - 2015</td>
<td>317</td>
<td>52.5</td>
<td>Prospective LRH</td>
<td>China</td>
<td>55</td>
<td>IA: 82 (25.9)</td>
<td>73 (23.0)</td>
<td>52 (16.4)</td>
<td>65 (20.5)</td>
<td>58 (18.3)</td>
<td>64 (21.2)</td>
<td>44 (14.9)</td>
<td>10 (3.4)</td>
<td></td>
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<tr>
<td>Spirtos et al[28]</td>
<td>2012</td>
<td>7/1994 - 12/1995</td>
<td>76</td>
<td>31.2</td>
<td>Retrospective LRH</td>
<td>USA</td>
<td>41.5</td>
<td>IA: 26 (35.3)</td>
<td>42 (55.6)</td>
<td>18 (24.4)</td>
<td>8 (10.7)</td>
<td>43 (56.9)</td>
<td>22 (29.1)</td>
<td>12 (15.4)</td>
<td>0 (0.0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hou et al[29]</td>
<td>2011</td>
<td>5/2009 - 7/2010</td>
<td>33</td>
<td>26.4</td>
<td>Prospective LRH</td>
<td>China</td>
<td>47.6</td>
<td>IA: 4 (12)</td>
<td>10 (30.3)</td>
<td>15 (45.5)</td>
<td>IB: 4 (12)</td>
<td>22 (66.7)</td>
<td>25 (75.8)</td>
<td>8 (24.2)</td>
<td>1 (3.8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pellegrino et al[30]</td>
<td>2012</td>
<td>12/2008 - 1/2013</td>
<td>90</td>
<td>26.1</td>
<td>Retrospective LRH</td>
<td>Italy</td>
<td>44.5</td>
<td>IA2: 36 (40)</td>
<td>94 (103)</td>
<td>15 (17)</td>
<td>1 (1.1)</td>
<td>50 (55.6)</td>
<td>15 (17)</td>
<td>3 (3.3)</td>
<td>0 (0.0)</td>
<td></td>
<td></td>
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<tr>
<td>Lanowska et al[31]</td>
<td>2014</td>
<td>8/1994 - 4/2002</td>
<td>200</td>
<td>25.8</td>
<td>Prospective LRH</td>
<td>Germany</td>
<td>44</td>
<td>IA: 6 (3)</td>
<td>89 (44.5)</td>
<td>36 (18)</td>
<td>11 (5.5)</td>
<td>38 (20.5)</td>
<td>25 (12.5)</td>
<td>15 (7.5)</td>
<td>10 (5.0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nam et al[32]</td>
<td>2012</td>
<td>10/1997 - 11/1998</td>
<td>263</td>
<td>24.9</td>
<td>Retrospective LRH</td>
<td>Korea</td>
<td>46.4</td>
<td>IA: 36 (13.7)</td>
<td>197 (74.0)</td>
<td>25 (9.5)</td>
<td>5 (1.9)</td>
<td>2 (0.1)</td>
<td>214 (81.4)</td>
<td>41 (15.6)</td>
<td>8 (0.3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wang et al[33]</td>
<td>2016</td>
<td>2002 - 2006</td>
<td>263</td>
<td>20.3</td>
<td>Retrospective LRH</td>
<td>China</td>
<td>45.2</td>
<td>IA: 13 (6.4)</td>
<td>109 (63.7)</td>
<td>38 (23.1)</td>
<td>53 (31.6)</td>
<td>2 (1.2)</td>
<td>172 (84.7)</td>
<td>24 (11.8)</td>
<td>7 (3.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pellegrino et al[34]</td>
<td>2019</td>
<td>12/2003 - 12/2005</td>
<td>16</td>
<td>19.2</td>
<td>Prospective LRH</td>
<td>Italy</td>
<td>45</td>
<td>IA: 4 (7)</td>
<td>44 (70)</td>
<td>2 (4)</td>
<td>2 (2)</td>
<td>113 (73)</td>
<td>14 (20.5)</td>
<td>6 (3.8)</td>
<td>0 (0.0)</td>
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<td></td>
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<tr>
<td>Tan et al[35]</td>
<td>1999</td>
<td>1998</td>
<td>15</td>
<td>15</td>
<td>Retrospective LRH</td>
<td>New Zealand</td>
<td>44.5</td>
<td>IA: 1 (6.7)</td>
<td>16 (103)</td>
<td>8 (53.3)</td>
<td>2 (13.3)</td>
<td>1 (6.7)</td>
<td>130 (87.6)</td>
<td>17 (11.5)</td>
<td>0 (0.0)</td>
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</tr>
<tr>
<td>Yan et al[36]</td>
<td>2012</td>
<td>12/2000 - 3/2011</td>
<td>148</td>
<td>14.4</td>
<td>Prospective LRH</td>
<td>China</td>
<td>42</td>
<td>IA: 48 (51)</td>
<td>14 (14.5)</td>
<td>8 (8.5)</td>
<td>1 (1.4)</td>
<td>53 (73.5)</td>
<td>16 (22.9)</td>
<td>1 (1.4)</td>
<td>4 (2.7)</td>
<td></td>
<td></td>
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<tr>
<td>Mavler et al[37]</td>
<td>2001</td>
<td>4/1994 - 5/1999</td>
<td>70</td>
<td>13.5</td>
<td>Retrospective LRH</td>
<td>Germany</td>
<td>47.5</td>
<td>IA: 3 (48)</td>
<td>13 (18.6)</td>
<td>10 (13.9)</td>
<td>1 (1.4)</td>
<td>38 (53.6)</td>
<td>16 (22.9)</td>
<td>1 (1.4)</td>
<td>4 (5.7)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lim et al[38]</td>
<td>2013</td>
<td>11/2003 - 12/2011</td>
<td>19</td>
<td>13.5</td>
<td>Prospective LRH</td>
<td>Singapore</td>
<td>47.8</td>
<td>IA: 2 (11.1)</td>
<td>13 (72.2)</td>
<td>1 (5.3)</td>
<td>3 (15.8)</td>
<td>6 (31.6)</td>
<td>9 (50.0)</td>
<td>2 (11.1)</td>
<td>1 (6.6)</td>
<td></td>
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</tr>
</tbody>
</table>

Overall, 516 studies were identified and only 299 studies met the inclusion criteria (Fig. 1). Supplemental Content 5, 299 included studies. As a result, 213 studies were identified as HVH, and 86 as LVH.

Table 1 (continued)
| Study | Publication year | Data collection year | No. of cases | No. of cases/year | Study design | Types of LRH | Country | Age (mean) | Stage, n (%) | Histology, n (%) |
|-------|-----------------|----------------------|--------------|------------------|-------------|-------------|---------|-----------|-------------|----------------|----------------|
| Lee et al. [50] | 2012 | 12/2003-12/2007 | 119 | 13.4 | Retrospective LRH Korea | 43 | 6 (6) | 66 (55.3), 41 (40.7), 5 (4.4) | Squamous cell, 68 (75) | Adeno-carcinoma, 27 (29.2), 3 (3.2) |
| Kim et al. [51] | 2014 | 1/2010-6/2013 | 69 | 12.7 | Retrospective LRH Korea | 42 | 66 (65.3), 34 (33.3) | Squamous cell, 43 (43.4) | Adeno-carcinoma, 18 (28) |
| Li et al. [52] | 2007 | 8/1998-12/2003 | 90 | 12.1 | Retrospective LRH China | 42 | 75 (54.0), 17 (7.7) | Squamous cell, 32 (22.8) | Adeno-carcinoma, 18 (23.8) |
| Lee et al. [53] | 2010 | 6/1994-12/2007 | 139 | 12.0 | Prospective LRH Taiwan | 46.1 | IA 60 (43.2), IB 75 (54.0), IB2 5 (7.7) | Squamous cell, 19 (26.0) | Adeno-carcinoma, 20 (27.1) |
| Frumovitz et al. [54] | 2007 | 1/2004-12/2006 | 35 | 11.7 | Retrospective LRH USA | 41.8 | 5 (1.1), 20 (54.0) | Squamous cell, 28 (77.4) | Adeno-carcinoma, 15 (26.0) |
| Sardi et al. [55] | 1999 | 6/1993-12/1997 | 47 | 10.3 | Retrospective LRH Italy | 44.9 | IA 6 (7.9), U51 (-) | Squamous cell, 5 (10.3) | Adeno-carcinoma, 4 (8.4) |
| Luttrell et al. [56] | 2016 | 1997-2004 | 69 | 12.7 | Retrospective LRH Korea | 42 | 30 (65.6), 3 (6.5) | Squamous cell, 23 (40.1) | Adeno-carcinoma, 2 (3.3) |
| Trinh et al. [57] | 2010 | 1/2005-6/2010 | 76 | 10.3 | Retrospective LRH Italy | 41.9 | IA 19 (27.1) | Squamous cell, 47 (69.0) | Adeno-carcinoma, 2 (2.9) |
| Hwang et al. [58] | 2012 | 2/2004-12/2008 | 70 | 10.1 | Retrospective LRH Taiwan | 46.6 | IB 20 (37.0), IB2 10 (20.0) | Squamous cell, 53 (91.8) | Adeno-carcinoma, 3 (5.8) |
| Shen et al. [59] | 2004 | 1/1998-12/2003 | 71 | 10.1 | Retrospective LRH Canada | 43.1 | IA 14 (19.3), IB 10 (14.1) | Squamous cell, 46 (68.4) | Adeno-carcinoma, 1 (1.4) |
| Mendall et al. [60] | 2016 | 1/2004-12/2013 | 98 | 9.8 | Retrospective LRH Taiwan | 47.8 | IA 18 (36.7), IB 9 (18.4) | Squamous cell, 65 (85.5) | Adeno-carcinoma, 15 (26.0) |
| Ahn et al. [61] | 2002 | 3/2000-12/2006 | 19 | 9.1 | Retrospective LRH USA | 42.6 | IB 20 (10.5), IB2 10 (5.2) | Squamous cell, 11 (58.9) | Adeno-carcinoma, 1 (5.2) |
| Remond et al. [62] | 2010 | 6/2003-12/2007 | 57 | 8.9 | Retrospective LRH Canada | 47.1 | IA 14 (25.0), IA2 10 (18.4) | Squamous cell, 38 (68.4) | Adeno-carcinoma, 36 (65.5) |
| Simsek et al. [63] | 2011 | 7/2003-12/2007 | 35 | 8.8 | Prospective LRH Turkey | 49.2 | IA 14 (28.0), IA2 10 (20.0) | Squamous cell, 82 (68.4) | Adeno-carcinoma, 26 (74.2) |
| Kim and Moon [64] | 1998 | 2/1994-12/2003 | 139 | 8.1 | Prospective LRH France | 47 | IA 8 (16.0), IB 6 (12.0) | Squamous cell, 102 (73.4) | Adeno-carcinoma, 15 (10.3) |

HVH = high-volume hospitals, LARVH = laparoscopic assisted radical vaginal hysterectomy, LRH = laparoscopic radical hysterectomy, LVS = lymphovascular space invasion, RCT = randomized controlled trials, TLRH = total laparoscopic radical hysterectomy.
4. Discussion

4.1. Main findings

In the present study, hospital volume was a prognostic factor for operative outcomes in patients with cervical cancer undergoing LRH. A higher number of retrieved LNs, shorter operation time, less blood loss, and comparable perioperative complications and survival outcomes were observed in the HVH group consisting of fewer stage IA and more stage IIA cases.

4.2. Interpretation

4.2.1. Operative outcomes. The impact of hospital volume has not been evaluated for LRH as in open radical hysterectomy and cytoreductive surgery for ovarian cancer.\(^{6,7,12,13}\) The effect of

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Patient selection.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HVH (n=13)</td>
</tr>
<tr>
<td>No. of studies</td>
<td>Mean</td>
</tr>
<tr>
<td>Age, y (mean)</td>
<td>13  48.4</td>
</tr>
<tr>
<td>Stage IA (%)</td>
<td>11  13.8</td>
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<td>Stage IB1 (%)</td>
<td>9  65.2</td>
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<td>Stage IB2 (%)</td>
<td>7  11.6</td>
</tr>
<tr>
<td>Stage IIA (%)</td>
<td>8  15.3</td>
</tr>
</tbody>
</table>

Weighted linear regression analysis evaluating differences in care between the high-volume and low-volume hospitals. HVH=high-volume hospitals, LVH=low-volume hospitals.
hospital volume on outcomes of cancer operation is related to a surgeon’s skill and experience defined by surgical volumes, as well as hospital infrastructure and the supporting team dedicated to surgical care. Therefore, a measure of hospital volumes of surgical procedures is the most comprehensive factor affecting the outcome of surgery for cancer patients.\[12,13\] However, there have been few studies evaluating the influence of hospital volume on operative outcomes or morbidity after radical hysterectomy.\[12,13,77,78\] In retrospective analyses of 903 esophageal resections for esophageal carcinoma patients and 1894 primary ovarian cancer operations, HVH was associated with a shorter length of hospital stay.\[77,78\] In the present meta-analysis in which LRH was performed in cervical cancer patients, HVH showed higher LN retrieval rates with a tendency for a shorter operation time, less blood loss, and similar lengths of postoperative hospital stay. These findings support the results of 2 previous retrospective studies analyzing radical hysterectomy performed in 407 and 1536 cervical cancer patients, respectively, which showed favorable or comparable operative outcomes in HVH.\[12,13\] In addition, operative outcomes of HVH performing LRH are comparable to those of HVH performing radical hysterectomies despite the technical differences with regard to the use of laparoscopy.\[12,13\]

A previous retrospective study reported that HVH is associated with a higher cytoreduction rate in primary ovarian cancer operations.\[79\] Accordingly, the present study also showed a higher surgical adequacy with LRH in HVH based on the higher LN retrieval rate and lower surgical margin invasion rate.

### 4.2.2. Perioperative complications

Radical hysterectomy necessitates an en bloc resection of the parametria and upper vagina in addition to extensive radical hysterectomy, which is surgically associated with dissection of the ureter and bladder, resulting in a higher rate of lower urinary tract injury than conventional hysterectomy for benign disease.\[13\] Therefore, perioperative complications may potentially reflect the skill of the surgeon performing LRH. Moreover, hospital volumes may more accurately reflect the impact of perioperative complications associated with radical hysterectomy because it includes assessment of the capacity of the individual surgeon and of support systems of the institution.\[76\] A previous retrospective study reported that HVH was associated with lower perioperative complications in esophageal carcinoma surgery, which is considered one of the most complex surgical procedures.\[77\] In 2 retrospective studies in which cervical cancer patients underwent radical hysterectomy, hospital volume had no influence on perioperative complications.\[12,13\] In the present analysis, perioperative complications did not depend on hospital case volumes of LRH performed, which was in accordance with previous studies on radical hysterectomy.\[12,13\] In the present study, the HVH group, because of the inclusion of cases with a higher FIGO stage, might involve a higher incidence of more extensive radical hysterectomies than the LVH group. This may induce a higher number of LN retrievals and a lower rate of positive surgical margin as pathological outcomes. However, HVH showed comparable intraoperative and postoperative complication rates to those of LVH.

### 4.2.3. Survival: prognostic factors and outcomes

Hospital volume has been reported to be a prognostic factor in the oncologic management of esophageal and ovarian cancer.\[6,7,77,78\] Common cancers including ovarian cancers showed a positive hospital and/or surgeon volume relationship with survival outcome in initial cancer treatment for particularly complex surgical procedures.\[6,79,80\] The current study in which HVH included cases with relatively more advanced stages, survival outcome was favorable in HVH, although the difference did not reach statistical significance.

### 4.2.4. Patients selection

Given the greater radicality of traditional radical hysterectomy, greater skill is required by surgeons when compared with the modified radical hysterectomy performed currently.\[3\] In the present meta-analysis, the HVH group included fewer stage IA cases and more stage IIA and advanced stage cases than the LVH group suggesting that more radical hysterectomies than modified radical hysterectomies might be performed in HVH. On the basis of the stage information between the 2 groups, poor survival outcomes might be expected in HVH because LVH (13.8 vs 24.4%; \(P = .003\)) included more stage IA1 cases and especially more cases without lymphovascular space invasion. In patients with more advanced stage disease and older age (48.4 vs 44.5 years; \(P = .010\)), the survival outcome was comparable between the 2 groups.

### 4.3. Strengths and limitations

The present meta-analysis has the following limitations. First, a relatively small number of studies from HVH were included although their patient numbers were similar to those included in LVH. Recurrence rate and survival rates might be influenced by different follow-up strategies in terms of follow-up intervals and surveillance modalities. Furthermore, comparable data from the different studies were not extracted consistently because numerous studies provided only limited information. Despite these limitations, the effect of the hospital volume on treatment outcomes has been thoroughly investigated.

### 5. Conclusion

On the basis of the present systematic review and meta-analysis, HVH may be considered one of favorable prognostic factors for operative outcome and perioperative complication rates in patients with cervical cancer undergoing LRH. Although there are comparable survival outcomes in LVH and HVH, with a
higher number of patients with poorer prognosis in the latter, the real benefit of hospital volume should be investigated in a well-designed study.

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