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Laparo-endoscopic single-site surgery vs conventional laparoscopic surgery for endometrial cancer

A systematic review and meta-analysis

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Abstract

Objective: To systematically review and evaluate the safety, advantages and clinical application value of laparo-endoscopic single-site surgery (LESS) for endometrial cancer by comparing it with conventional laparoscopic surgery (CLS).

Methods: We conducted a systematic review of the published literature comparing LESS with CLS in the treatment of endometrial cancer. English databases including PubMed, Embase, Ovid, and the Cochrane Library and Chinese databases including Chinese National Knowledge Infrastructure, Wanfang and China Biology Medicine were searched for eligible observational studies up to July 10, 2019. We then evaluated the quality of the selected comparative studies before performing a meta-analysis using the RevMan 5.3 software. The complications, surgical time, blood loss during surgery, postoperative length of hospital stay and number of lymph nodes removed during surgery were compared between the 2 surgical approaches.

Results: Four studies with 234 patients were finally included in this meta-analysis. We found that there was no statistically significant difference in complications between the 2 surgical approaches [odds ratio (OR): 0.63, 95% confidence interval (CI): 0.18–2.21, $P = .47$, $I^2 = 0\%$]. There was no statistically significant difference in blood loss between the 2 surgical approaches [mean difference (MD): –61.81, 95% CI: –130.87 to –7.25, $P = .08$, $I^2 = 74\%$]. There was no statistically significant difference in surgical time between the 2 surgical approaches (MD: –11.51, 95% CI: –40.19 to 17.16, $P = .43$, $I^2 = 81\%$). There was also no statistically significant difference in postoperative length of hospital stay between the 2 surgical approaches (MD: –0.56, 95% CI: –1.25 to –0.13, $P = .11$, $I^2 = 72\%$). Both pelvic and paraaortic lymph nodes can be removed with either of the 2 procedures. There were no statistically significant differences in the number of paraaortic lymph nodes and total lymph nodes removed during surgery between the 2 surgical approaches [(MD: –0.11, 95% CI: –3.12 to 2.91, $P = .29$, $I^2 = 11\%$) and (MD: –0.53, 95% CI (–3.22 to 2.16), $P = .70$, $I^2 = 83\%$)]. However, patients treated with LESS had more pelvic lymph nodes removed during surgery than those treated with CLS (MD: 3.33, 95% CI: 1.05–5.62, $P = .004$, $I^2 = 32\%$).

Conclusion: Compared with CLS, LESS did not reduce the incidence of complications or shorten postoperative hospital stay. Nor did it increase surgical time or the amount of bleeding during surgery. LESS can remove lymph nodes and ease postoperative pain in the same way as CLS. However, LESS improves cosmesis by leaving a single small scar.

Abbreviations: CI = confidence interval, CLS = conventional laparoscopic surgery, ICU = intensive care unit, LESS = laparo-endoscopic single-site surgery, MD = mean difference, OR = odds ratio, RCT = randomized controlled trial.

Keywords: conventional laparoscopic surgery, endometrial cancer, laparo-endoscopic single-site surgery, meta-analysis

1. Introduction

Endometrial cancer is the most common gynecologic cancer in developed countries.[1] It is the fourth most common cancer in women after breast, lung, and colorectal cancers.[2] It is estimated that 63,230 new cases of endometrial cancer and 11,350 related deaths occurred in 2018.[3] Treatment options for endometrial cancer include surgery, chemotherapy, radiation therapy, and hormone therapy, among which surgery is the main approach for

staging and treatment.[4] Minimally invasive total hysterectomy and bilateral salpingo-oophorectomy with/without lymphadenectomy is the first-line treatment for endometrial cancer.[5–7] Laparoscopic surgery has become one of the most commonly used minimally invasive surgical techniques in gynecology. Previous studies have shown that, compared with laparotomy, laparoscopic surgery has many advantages, including a lower rate of adverse perioperative outcomes, wound complications, blood transfusion, intensive care unit (ICU) admission, and hospital readmission.[8–12]

Although conventional laparoscopic surgery (CLS) is less invasive than laparotomy, 3 to 4 surgical scars will still be left at the incision sites. In today's society, patients' satisfaction with scar appearance has become increasingly important and is an important factor affecting the choice of surgical methods, especially for young women.[13] During transumbilical single-port laparoscopy, only 1 umbilical incision is made to allow insertion of the laparoscopic instruments and provide access to the abdominopelvic cavity. As the whole surgical procedure is performed almost exclusively through a single entry point, it can maximize cosmetic benefits and minimize physical and psychological trauma to the patients, so as to improve their quality of life.

The first single-port laparoscopy was described in 1969 when Wheeless reported the first single-incision tubal ligation.[14] Improved flexible optical and endoscopic instrumentation has led to the further development of single-port laparoscopy, which is called laparo-endoscopic single-site surgery (LESS).[15] In 2009, Fader et al reported that 13 women underwent transumbilical single-port laparoscopic procedures for endometrial and ovarian cancer staging, lymph node dissection, adnexal cyst management, and other complex surgeries.[16] Since then, many studies have proved that minimally invasive surgery for malignant gynecologic tumors, such as early endometrial cancer, cervical cancer, and pelvic tumors, is a feasible surgical technique, and can shorten hospital stay, reduce the incidence of surgical complications, and improve patients' quality of life.[17–22]

The most obvious advantage of LESS is the minimal number of incisions made in the abdominal wall, which can reduce complications related to trocar placement, such as abdominal vascular injuries, surgical wound infection, hematoma, and internal organ puncture.[23] Other advantages of LESS include less postoperative pain, faster recovery, and shorter hospital stay.[22] Moreover, intact surgical specimens can be extracted through the umbilical incision, which can reduce the risk of implantation metastasis.

However, there is still no consensus over the feasibility of LESS for gynecologic surgery. The main problems with LESS are the lack of triangulation and the resulting "chopsticks" effect as the instruments entering in close proximity clash with one another, as well as lack of exposure.[24] These problems make it difficult for surgeons to perform this procedure and complications such as prolonged surgical time and increased blood loss due to difficulty in stopping bleeding are likely to occur. Nevertheless, most studies have been conducted on only a few cases. Therefore, to corroborate the safety and efficacy of LESS for endometrial cancer staging and compare the advantages and disadvantages between LESS and CLS, in this study we retrieved and reviewed all case–control studies that compared LESS with CLS for endometrial cancer. Cochrane systematic reviews were used to evaluate objectively the safety and effectiveness of LESS for endometrial cancer. We hope to provide more sound clinical evidence for gynecologists using LESS in clinical practice.

2. Methods

This study was written in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist.[25]

2.1. Eligibility criteria
2.1.1. Types of study. Randomized controlled trials (RCTs), cohort studies or case–control studies were selected for inclusion in this study, regardless of the use of blinding or the presence of loss to follow-up, and including meta-analyses of RCTs.

2.1.2. Types of participant. This study included patients with endometrial cancer at any age who received LESS or CLS in randomized controlled trials or nonrandomized controlled trials.

2.1.3. Types of intervention. LESS includes robotic laparoscopic surgery and laparoscopic surgery. In this study, cases received LESS for endometrial cancer, while controls underwent CLS.

2.1.4. Types of outcome. When comparing different surgical methods, patients' safety (physical and mental) is the most important criterion. In addition, the presence or severity of surgical complications is an important indicator for evaluating surgical safety. Therefore, the primary outcome measure was surgical complications and the secondary outcome measures were surgical time, loss of blood during surgery, postoperative length of hospital stay, number of lymph nodes removed during surgery, postoperative pain, and satisfaction with the appearance of the scars after surgery.

2.1.5. Exclusion criteria. Exclusion criteria included:

1. Trials with only abstracts and no full content;
2. important data were incomplete and could not be obtained;
3. repeated publications;
4. studies with unclear efficacy outcomes;
5. trials with contents that were different from this study.

2.1.6. Electronic retrieval. The trials were selected and independently reviewed by 2 reviewers (ZLPYM and MRAY). If consensus was not reached between the 2 reviewers, the decision was made by a third reviewer (LLH).

2.1.7. Sources of trials. Trials were retrieved from Chinese databases including the China National Knowledge Infrastructure (CNKI) (on July 10, 2019), the China Biology Medicine (CBM) (on July 10, 2019), and Wanfang (on July 10, 2019), and English databases including Pubmed (on July 10, 2019), EMBASE (on July 10, 2019), OVID (on July 10, 2019), and the Cochrane Library (on July 10, 2019).

2.1.8. Search strategy
2.1.8.1. Computer retrieval. For CNKI, CBM, and Wanfang, the trials were searched using the keywords in Chinese for: "(single port laparoscopy OR single site laparoscopy) AND (endometrial cancer); (conventional laparoscopy OR multiport laparoscopy) AND (endometrial cancer); (single port laparoscopy OR single site laparoscopy) AND (conventional laparoscopy OR multiport laparoscopy) AND (endometrial cancer)" using "full text," "title," and "keyword" limiters, and within the scope of the journals, conference papers, and theses. For Pubmed, EMBASE, OVID, and the Cochrane Library, trials were searched using the keywords "(single port laparoscopy) OR (single site laparoscopy)

OR (one port laparoscopy) OR (single incision laparoscopy) OR (1 site laparoscopy) OR (single port laparoscopy) OR (laparo-endoscopic single site) OR (single-port access laparoscopy); 2# (conventional laparoscopy) OR (multiport laparoscopy) OR (standard laparoscopy) OR (traditional laparoscopy); 3# (endometrial neoplasms) OR (endometrial cancer)." Trials and all relevant reference trials from the library of Xinjiang Medical University were also manually reviewed to ensure that no trial was omitted during the electronic retrieval. There was no language restriction for the search query, and cross-database searches were performed to avoid any missed or wrong trials. Search results were downloaded for further screening and management using the NoteExpress2.8 software. Trials that did not meet the inclusion criteria were deleted. Descriptive review articles, surveys, technical reports, published abstracts without full manuscripts, conference reports, trials, and edited papers were also excluded.

2.1.8.2. Manual retrieval. Related authoritative magazines and professional books, such as the Chinese Journal of Obstetrics and Gynecology, China Journal of Endoscopy, Chinese Journal of Minimally Invasive Surgery, and Chinese Journal of Laparoscopic Surgery, were consulted. The latest and relatively complete studies prevailed if the same or similar studies were manually retrieved among the included studies.

2.1.8.3. Other retrieval. Relevant data were searched for using such search engines as Google Scholar and Baidu Scholar, and important data that were unavailable were obtained by contacting the original authors.

2.2. Data collection and analyses
2.2.1. Selection of studies.
The titles and abstracts of the retrieved trials were independently evaluated by 3 reviewers (ZLPYM, MRAY, and LLH), and each trial was then classified as "absolutely excluded," "not sure," or "absolutely included." Final eligibility of all possible or certainly relevant trials was determined based on the full contents of the trials. Differences in assessment between the 2 reviewers were resolved through discussion, and all excluded studies and the reasons for exclusion were recorded (see exclusion criteria).

2.2.2. Data extraction and management. Data including primary and secondary outcomes were extracted independently by the 2 reviewers (ZLPYM and MRAY) and documented. A third reviewer (LLH) made the final decision regarding any differences that may have occurred between the 2 reviewers. Data were entered into Review Manager 5.3 software by an independent reviewer, and the entered data were reviewed by a second independent reviewer.

2.2.3. Evaluation of article quality. The number of relevant research articles is limited and no RCT was retrieved. The ROBINS-I (Risk Of Bias In Non-Randomized Studies – of Interventions) was used to evaluate the risk of bias in the results of interventions from non-randomized studies.[26,27] The response options to the signaling questions are: "Not applicable," "Yes," "Probably yes," "Probably no," "No," and "No information." Risk of bias judgments were formulated for 7 bias domains: bias due to confounding, bias in selection of participants for the study, bias in classification of interventions, bias due to deviations from intended interventions, bias due to missing data, bias in

measurement of outcomes, and bias in selection of the reported result. The judgments within each domain carry forward to an overall risk of bias judgment across bias domains for the outcome being assessed. All analyses were based on previous published studies, thus no ethical approval and patient consent are required.

2.2.4. Data extraction. Data were extracted and cross checked by 2 reviewers after reading the full article. The contents for extraction included the authors, year of publication, sample size and/or number lost to follow-up, study design, patient characteristics, intervention measures of the experimental and control groups, outcomes for measuring efficacy, measured time points and outcome assessment, and the number and type of adverse events. The overall efficacy is based on best corrected visual acuity (BCVA). It is effective to improve BCVA by 2 lines or more through the international standard visual acuity scale, and fewer than 2 actions are ineffective.

2.3. Statistical analysis

Meta-analyses were performed using the Review Manager 5.3 software. Dichotomous data were expressed as an odds ratio (OR), and continuous variables as a mean difference (MD). The 95% confidence interval (CI) was calculated for each effective size. Tests for heterogeneity between studies were assessed by the χ^2 and I^2 tests. If $P > .01$ and $I^2 < 50\%$, the studies were considered homogeneous, and the fixed effect model was used for meta-analyses. If $P < .10$ and $I^2 \geq 50\%$, studies were considered heterogeneous, and the source of heterogeneity was analyzed. If the source of heterogeneity could not be explained by clinical or methodological heterogeneity, the random effect model was used for meta-analysis, and the cause of heterogeneity was analyzed by subgroup analysis. Subgroup analysis was based on:

1. whether the study was conducted by researchers in a developed country or developing country;
2. regional classification;
3. the level of the hospital where surgeries were performed.

3. Results

3.1. Literature search

According to our searching strategy, 161 studies were retrieved, of which 149 were excluded for duplication and non-clinical research after review of the title/abstract. The full texts of the remaining 12 papers were reviewed further, and 8 papers were excluded because of the absence of control groups and key data (4 papers) and for being conference papers (4 papers). Finally, 4 studies with 234 patients met the inclusion criteria for the meta-analysis. Of all the patients included, 99 received LESS while 135 underwent CLS. Detailed information on the study selection process is illustrated in the *Guidelines Flow Diagram*.

3.2. Study characteristics

General characteristics of the 4 studies included in the meta-analysis included grouping, number of cases, and surgical sites (Table 1). The methodological quality of the included studies was assessed according to the method recommended by Cochrane. Risk of bias judgments were formulated for 7 bias domains: bias due to confounding, bias in selection of participants into the study, bias in classification of interventions, bias due to

Table 1

Main characteristics of included clinical trials.

First author (year)	Number of participants		BMI (kg/m^2)		Average age (years)		Outcomes
	LESS	CLS	LESS	CLS	LESS	CLS	
Escobar 2011[15]	30	30	31.3±32.0	31.2±6.7	61.9 (43–84)	60.9 (38.9–79.7)	①②③④⑥⑦
Park 2014[34]	37	74	24.87±3.59	24.47±3.89	52.6±7.8	55.1±10.1	①②③④⑤⑥⑦
Cai 2016[35]	18	18	24.42±0.8	25.8±1.4	52.1±9.4	49.1±6.2	①②③④⑤
Moukarzel 2017[36]	14	13	24.6 (20.2–29.6)	27.2 (21–29.7)	53 (45–77)	62 (41–82)	①②③④

BMI = body mass index, CLS = conventional laparoscopic surgery, LESS = laparo-endoscopic single-site surgery. ①Total surgical complications ②Blood loss during surgery ③Surgical time ④Postoperative length of hospital stays ⑤total lymph nodes ⑥pelvic lymph nodes ⑦paraaortic lymph nodes.

deviations from intended interventions, bias due to missing data, bias in measurement of outcomes, and bias in selection of the reported result. Risk of bias judgments for the included studies are shown in the risk of bias graph and risk of bias summary (Figs. 8 and 9); all the meta-analysis results are shown in Table 2.

3.3. Meta-analysis results

3.3.1. Total surgical complications.
A total of 234 cases from the 4 studies were included in this meta-analysis. Complications were reported in 3 studies. Fixed effects meta-analysis showed that there was no statistically significant difference in total surgical complications between the LESS and CLS groups (OR: 0.63, 95% CI: 0.18–2.21). In addition, there was no heterogeneity among the studies ($P = .47, I^2 = 0\%$), suggesting that LESS did not result in fewer complications than CLS. The meta-analysis result is shown in Figure 1.

3.3.2. Blood loss during surgery.
Blood loss during surgery was evaluated in all 234 patients from the 4 studies. Random effects meta-analysis showed that there was no statistically significant difference in blood loss during surgery between the 2 groups (MD: –61.81, 95% CI: –130.87 to 7.25). The between-study heterogeneity was statically significant ($P = .08, I^2 = 74\%$). The meta-analysis result is shown in Figure 2.

3.3.3. Surgical time.
Among the 234 patients in the four studies, random effects meta-analysis showed that there was no statistically significant difference in surgical time between the 2 groups (MD: –11.51, 95% CI: –40.19 to 17.16). The between-study heterogeneity was statically significant ($P = .43, I^2 = 81\%$). The meta-analysis result is shown in Figure 3.

3.3.4. Postoperative length of hospital stay.
For the 234 patients in the 4 studies, random effects meta-analysis showed that there was no statistically significant difference in postoperative length of hospital stay between the 2 groups (MD: –0.56, 95% CI: –1.25 to –0.13). Patients in the LESS group did not have shorter hospital stays than those in the CLS group, and there was heterogeneity between the studies ($P = .11, I^2 = 72\%$). Subgroup analysis by region showed that there was no statistically significant difference in postoperative length of hospital stay between the 2 groups in Asia (MD –0.23, 95% CI 0.65–0.19) and there was no heterogeneity between the studies done in Asia ($P = .28, I^2 = 0\%$). The meta-analysis result is shown in Figure 4.

3.3.5. The number of lymph nodes removed during surgery.
The number of lymph nodes removed during surgery (i.e., the number of pelvic, paraaortic, and total lymph nodes removed) was available in 3 studies. The number of total lymph nodes removed during surgery was available in 2 studies, with 147 patients. Fixed effects meta-analysis showed that there was no statistically significant difference in the total number of lymph nodes removed during surgery between the LESS and CLS groups (MD: –0.11, 95% CI: –3.12 to 2.91), and there was no between-study heterogeneity ($P = .29, I^2 = 11\%$). The meta-analysis result is shown in Figure 5.

Random effects meta-analysis showed that there was no statistically significant difference in the number of paraaortic lymph nodes removed during surgery (available in 2 studies, with 104 patients) between the 2 groups (MD: –0.53, 95% CI –3.22 to

Table 2

Meta-analysis results.

Indexes	Number		I^2 (%)	χ^2	P	OR/MD	95% CI	Model
	LESS	CLS						
Surgical complications	99	135	0	0.06	0.47	0.63	0.18–2.21	fixed effects
Blood loss during surgery	99	135	74	11.54	0.08	−52.13	−130.87–7.25	random effects
Surgical time	99	135	81	16.16	0.43	−11.51	−40.19–17.16	random effects
Postoperative length of hospital stays								
Subgroup 1	55	92	0	0.20	0.28	−0.23	0.65–0.19	random effects
Subgroup 2	44	43			0.0002	−1.3	−1.98–0.62	
Total	99	135	72	7.06	0.11	−0.56	−1.25–0.13	
Number of lymph nodes removed								
Total	55	92	11	1.12	0.94	−0.11	−3.12–2.91	fixed effects
Pelvic lymph nodes	67	104	32	1.47	0.004	3.33	1.05~5.62	random effects
Paraaortic lymph nodes	67	104	83	5.97	0.70	−0.53	−3.22–2.16	random effects

95 CI = 95% confidence interval, CLS = conventional laparoscopic surgery, LESS = laparo-endoscopic single-site surgery, MD = mean difference, OR = odds ratio.
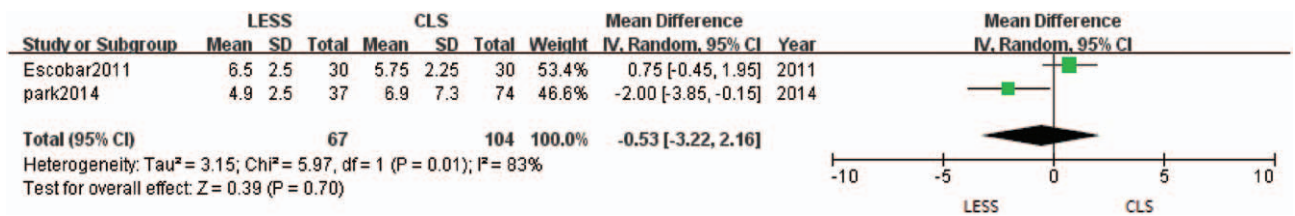
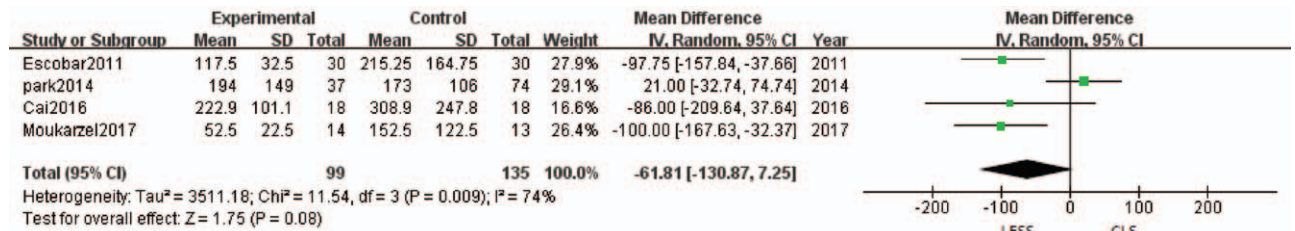Figure 1. Total surgical complications.
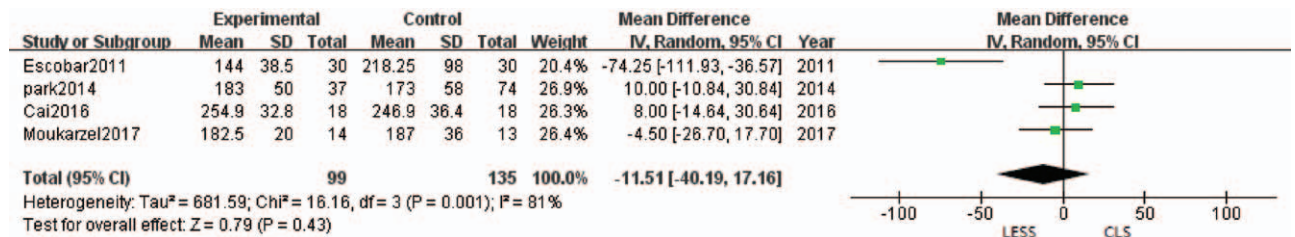

Figure 2. Blood loss during surgery.

Figure 3. Surgical time.

2.16) and the between-study heterogeneity was statistically significant ($P = .70$, $I^2 = 83\%$).

The number of pelvic lymph nodes removed during surgery was available in 2 studies, with 104 patients. Random effects

meta-analysis showed that there was a statistically significant difference in the number of pelvic lymph nodes removed during surgery between the 2 groups (MD: 3.33, 95% CI: 1.05–5.62). Patients in the LESS group had more pelvic lymph nodes removed
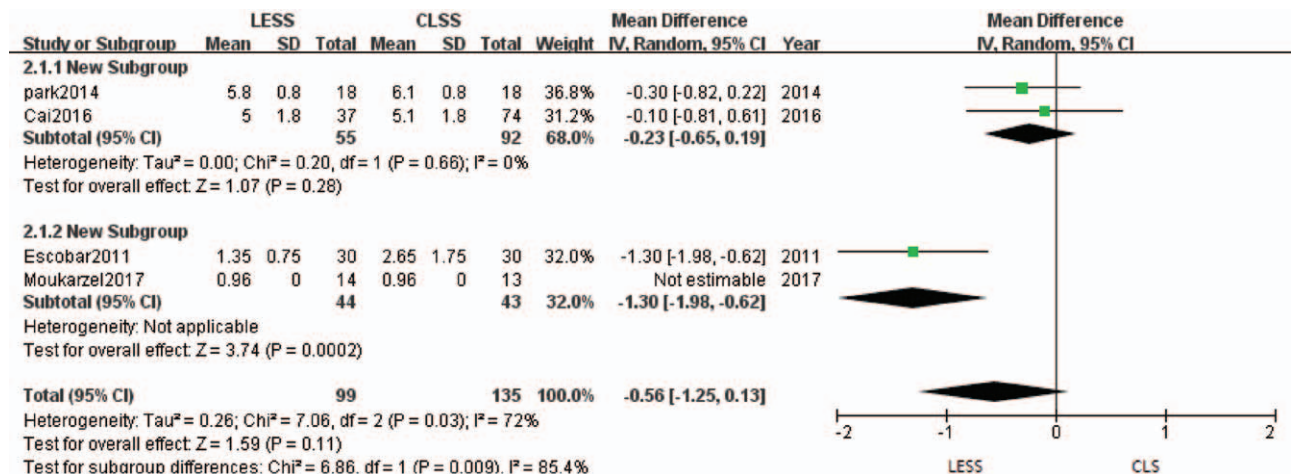

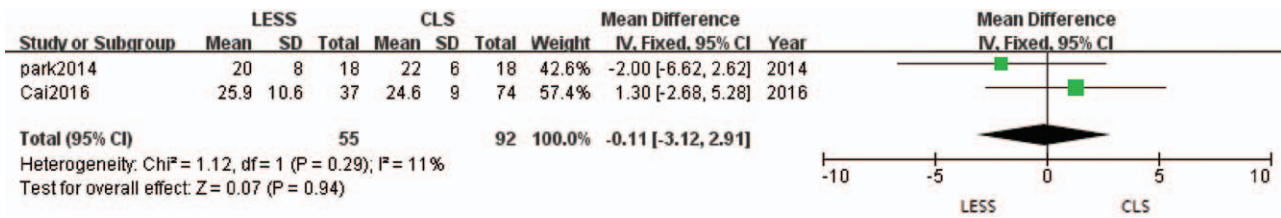Figure 4. Postoperative length of hospital stay.

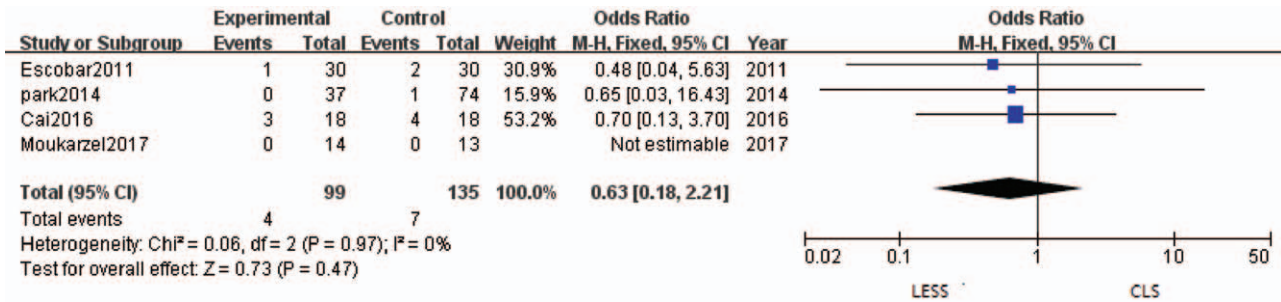**Figure 5.** Total lymph nodes removed during surgery.

Figure 6. Paraaortic lymph nodes removed during surgery.

than those in the CLS group. There was no heterogeneity between the studies ($P = .004$, $I^2 = 32\%$). The meta-analysis result are shown in Figures 6 and 7.

4. Discussion

Single-port laparoscopy was first used by gynecologists 50 years ago.[14] The single-port laparoscopic approach to surgery works well for women because they have genital organs in close proximity to the umbilicus located in the pelvic cavity, and the vagina (a natural orifice) connecting the uterus to the outside world. Many studies have confirmed the feasibility of LESS for treatment of endometrial cancer.[28–30] Preclinical research, clinical research and extension studies are needed to establish whether a new surgical method can become mainstream.[31] It is difficult to conduct RCTs on LESS for endometrial cancer owing to the complex surgical procedure, the need for expensive surgical equipment, surgeons' experience with laparoscopic skills, and the ethical considerations involved, not to mention patients' willingness to undergo standard laparoscopic surgery.

Four case–control studies with 234 patients were included in our meta-analysis. We found that LESS is a safe and feasible surgical technique for endometrial cancer. Through meta-

analysis, we found that LESS did not result in more blood loss during surgery than multiport CLS. However, there was heterogeneity among studies, which may have been caused by inconsistencies in surgeons' skill level, surgical equipment, and the surgical environment. We also found that there was no statistically significant difference in surgical time between the 2 groups but there was again significant heterogeneity between studies, which may be related to surgeons' experience in performing LESS and the surgical equipment used. Patients who received CLS did not have longer hospital stay than those who received LESS surgeries, but significant heterogeneity was found. Subgroup analysis showed that there was no such heterogeneity between studies conducted in Asia. This can be explained by the fact that different discharge criteria are used in different regions. However, data trend analysis showed that patients who received LESS had shorter hospital stays than those who underwent CLS. Large-sample studies are needed to verify this result.

Pelvic and para-aortic lymphadenectomy remains an essential part of the staging system for endometrial cancer. Lymphatic metastasis has a very close relationship with prognosis. Pieterse and other statistics found that the number of pelvic lymph nodes is 13 to 56 uncertain.[32] There is no clear conclusion about the
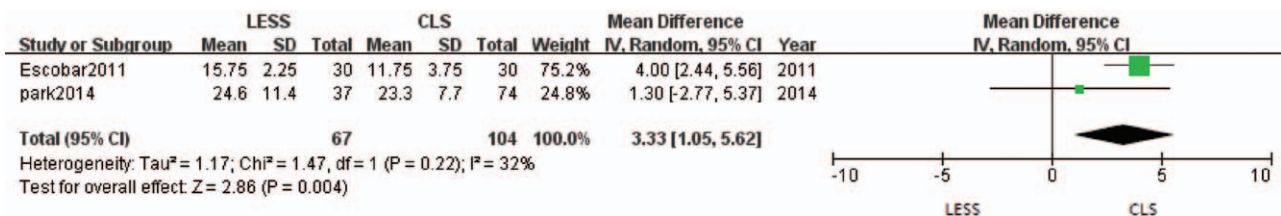

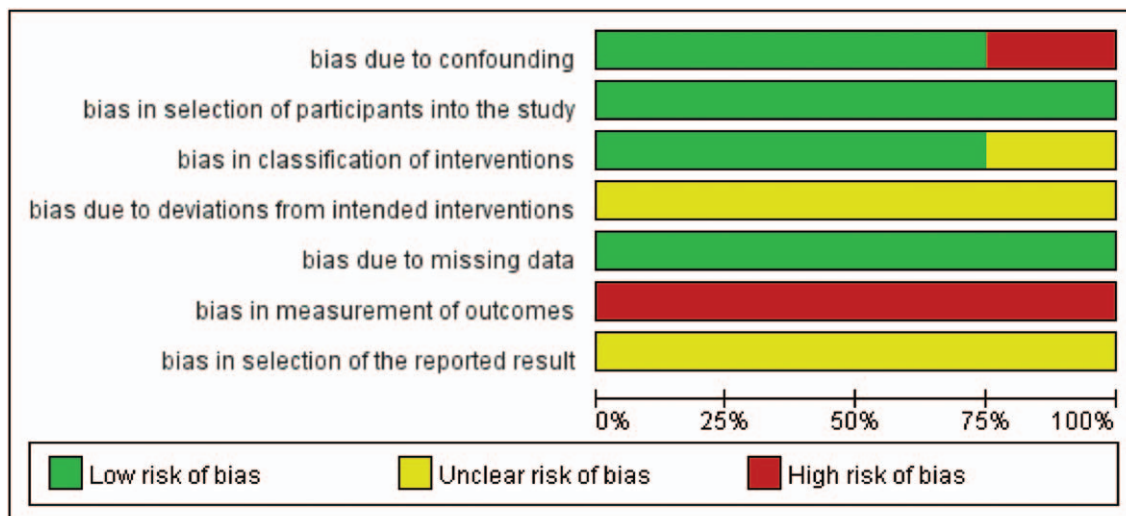**Figure 7.** Pelvic lymph nodes removed during surgery.

Figure 8. Risk of bias graph.

number of paraaortic lymph nodes, so the number of lymph nodes removed in each operation included in this article is also different. There were no statistically significant differences in the number of paraaortic lymph nodes and total lymph nodes removed between the 2 surgical approaches. However, patients treated with LESS had more pelvic lymph nodes removed during

Figure 9. Risk of bias summary.

surgery than those treated with CLS, which may be because surgeons performing LESS made a point of removing lymph nodes during surgery. This finding nonetheless proves that lymphadenectomy is also possible with LESS.

Three of the 4 studies included in our meta-analysis showed that LESS is associated with reduced postoperative pain. One study specifically analyzed the postoperative pain scores and the dosage of analgesic drugs used after surgery and it was found that LESS can reduce pain in the early stage of postoperative rehabilitation, and significantly decrease the demand for analgesics when compared with CLS. Two studies demonstrated that LESS had better cosmetic effects because of the reduced number of incisions and the hidden scar within the umbilicus, especially for patients with scar diathesis. In addition, intact surgical specimens can be extracted through a single umbilical incision, which reduces surgical trauma and the risk of implantation metastasis.[33,34]

However, our meta-analysis has some limitations. First, the quality of the studies included was generally not high. No randomized controlled trials were available, which could be the result of the nature of radical hysterectomy for endometrial cancer. Radical resection for endometrial cancer is complicated, and the patients' ability to choose procedures during blinded randomized controlled trials is affected by ethical issues, so that it is difficult to perform these trials and the original literature was of low quality. Only 4 studies were included and there were small sample sizes. As a result, inadequate randomness of allocation and blinding increased the risk of bias. Second, the high heterogeneity in the present meta-analysis may have been caused by different factors such as the age of the patients, operating ability of the surgeons, and indications for discharge. Different methods were adopted in the present meta-analysis, so a certain degree of heterogeneity is acceptable.

Kommu et al suggest that surgeons who have performed more LESS procedures require less time to complete the procedure.[35,36] During the procedure, a single-port multichannel cannula is fixed at a single site, within the 2 cm umbilical incision, and surgical devices are so close among multiple channels that a "chopstick" effect occurs.[24] Given the narrow space, the optical

lens and surgical instruments bump each other, the surgical field is not clear, and operational images have poor stereoscopic sense and stability. Moreover, the coaxial arrangement of surgical devices limits their movement range, thereby affecting the operator's accurate judgment of pelvic depth and focal distance to a certain extent, and therefore the accuracy and efficiency of surgery.[37] The "chopstick" effect influences operations and prolongs surgical time. There has been a literature report that the learning of single-port laparoscopy can be represented by a curve. To learn the operation of LESS, training in the theory and practical operations and observations for a certain time are first required. Subsequently, surgeries need to be carried out in 10 to 15 cases to change the habits associated with performing CLS. The operation of LESS cannot be stabilized until training has been conducted on about 40 cases.[38]

Additionally, the application of a conventional laparoscope makes suturing and knotting difficult during LESS, prevents prompt hemostasis and extends surgical time. As a result, the duration of anesthesia is prolonged, thereby extending postoperative recovery time and postoperative rehabilitation. Therefore, LESS requires special devices, such as "S" or "L"-shaped pre-bent instruments with fixed arcs, and wrist-rotatable, joint-flexible, and single-port endoscopic instruments. The distance between the navel and the pelvic cavity is a little longer, and instruments have limited length, so devices are lengthened to keep the operating handle away from the approaching platform and reduce surgical difficulty. Straight and curved instruments work together during LESS, and a surgical triangle can be reconstructed by use of different horizontal positions or altering the vertical depth of surgical instruments to reduce the difficulty in surgery, thereby decreasing blood loss during surgery and shortening surgical time. It can be inferred that shorter surgical time decreases the dosage of intraoperative anesthetics, reduces postoperative adverse reactions such as nausea and vomiting, helps with postoperative recovery, shortens postoperative length of hospital stay, and decreases the risk of postoperative complications. However, the above conclusions remain to be corroborated by large-sample controlled trials with strict designs.

The single-port laparoscopic technique represents the ideal of minimal invasiveness and reduced scarring, because the standing objective of surgery is minimal trauma and the most precise treatment for mitigating the pain of patients, no matter how medical and scientific technologies change. LESS enables the perfect combination of aesthetics and medicine and greatly conforms to the patient-based concept of medicine, therefore the advantages of LESS will be increasingly recognized and it will be extensively applied. It is believed that a new era of minimal invasiveness will be ushered in soon with the development of scientific technologies, improvement of surgical instruments, accumulation of surgical experience, consistently increased proficiency in operating ability of surgeons and increasingly mature LESS techniques.

Surgeons perform minimally invasive surgeries to better serve their patients and offer them maximum convenience. Our meta-analysis showed that LESS did not increase the incidence of surgery-related complications or the amount of bleeding during surgery, and that it can reduce postoperative pain. Our study explored the clinical effects and potential benefits of LESS in the treatment of endometrial cancer from the standpoint of evidence-based medicine.

However, the efficacy of surgery is affected by the surgeon's experience with LESS and differences in patients' characteristics.

Surgical time can be significantly reduced with improved technology and surgeons' increased experience. Lastly, postoperative hospital stay can be shortened, with less time needed to performed the surgery (when surgeons become more experienced in performing LESS), lower dosage of anesthetics, reduced incidence of postoperative adverse reactions (e.g., nausea and vomiting), and faster postoperative recovery. Therefore, rigorous large-sample randomized controlled trials are needed to verify our conclusion.

We believe that the LESS technique will gradually mature with advanced science and technology, improved surgical instruments, and surgeons' experience with laparoscopic skills. A new era of minimally invasive surgeries will begin in the near future.

Author contributions

Conceptualization: Lili Han.
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Writing – review & editing: Zulipiyamu Tuoheti.

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