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REVIEW ARTICLE

Systematic review and meta-analysis of single-port versus conventional laparoscopic hysterectomy

Lilin Yang [a], Jie Gao [b], Lei Zeng [b], Zhiwei Weng [c], Songping Luo [a,*]

[a] First School of Clinical Medicine, Guangzhou University of Chinese Medicine, Guangzhou, China
[b] Department of Gynecology, First Affiliated Hospital, Guangzhou University of Chinese Medicine, Guangzhou, China
[c] Department of Reproductive Medicine, First Affiliated Hospital, Guangzhou University of Chinese Medicine, Guangzhou, China

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ABSTRACT

Background: The choice between single-port laparoscopic hysterectomy (SPLH) and conventional laparoscopic hysterectomy (CLH) remains unclear. *Objectives:* To evaluate the feasibility, safety, and comparative effectiveness of SPLH and CLH. *Search strategy:* PubMed, Web of Science, and the Cochrane Library were searched in February 2015 using combinations of the terms “single port,” “single incision,” “single site,” “laparoscopic hysterectomy,” and “laparoendoscopic hysterectomy.” *Selection criteria:* Randomized controlled trials (RCTs) and retrospective studies comparing SPLH and CLH were included if they reported at least one quantitative outcome. *Data collection and analysis:* Study characteristics, quality, and outcomes were assessed. The primary outcomes were procedure failure and perioperative complications. Odds ratio (ORs) and 95% confidence intervals (CIs) were calculated. *Main results:* Eighteen studies (6 RCTs, 12 retrospective studies) were included. As compared with CLH, SPLH had a higher failure rate (OR 6.37, 95% CI 3.34–12.14; $P < 0.001$). The frequency of perioperative complications did not differ (OR 0.89, 95% CI 0.45–1.74; $P = 0.73$). *Conclusions:* There is no significant difference in the frequency of perioperative complications between SPLH and CLH. However, the higher rate of procedure failure in SPLH should be taken into consideration.

1. Introduction

Laparoscopy has gained worldwide acceptance since its first use for hysterectomy—one of the most common gynecologic surgeries—in 1989 [1]. Laparoscopic hysterectomy is widely practiced because of its various advantages, including reduced pain, shorter hospital stay, and enhanced cosmetic satisfaction [2].

Single-port laparoscopic hysterectomy (SPLH) has emerged as an innovation of the technique. A single incision is made, usually at the umbilicus, through which different instruments are inserted to perform surgery. Pelosi and Pelosi [3] completed the first hysterectomy by a single-trocar technique in 1991. Despite its advantages, SPLH presents surgeons with many challenges, including loss of instrumental triangulation, reduced visualization, and crowding and clashing of instruments [4,5].

Several studies have compared the techniques of SPLH and conventional laparoscopic hysterectomy (CLH). Owing to limited sample sizes, however, such studies were not sufficiently powered and yielded conflicting results. Song et al. [6] previously performed a meta-analysis comparing the two techniques in gynecologic surgery, analyzing three randomized controlled trials (RCTs) of uterine surgeries. However, their analysis did not include RCTs published after 2012 and lacked data from retrospective studies.

An updated and thorough meta-analysis comparing all available data would be helpful. The aim of the present review was therefore to systematically search all available RCTs and retrospective studies to provide a higher level of evidence to evaluate the feasibility, safety, and comparative effectiveness of SPLH and CLH.

2. Materials and methods

2.1. Literature search and selection criteria

The present systematic review and meta-analysis was conducted and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [7]. A parallel search of PubMed, Web of Science, and the Cochrane Library was performed to identify reports published between inception and February 2015, without restriction by region, publication type, or language. Different combinations of the search terms “single port,” “single incision,” “single site,” “laparoscopic hysterectomy,” and “laparoendoscopic hysterectomy” were used. The reference lists of all of the extracted articles, reviews, and conference abstracts were also screened to broaden

* Corresponding author at: First School of Clinical Medicine, Guangzhou University of Chinese Medicine, No.12 Jichang Road, Guangzhou, Guangdong 510405, China. Tel.: +86 20 36585434, +86 15918728358; fax: +86 20 36585434.
E-mail address: gynspluo@hotmail.com (S. Luo).

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the search. The initial literature research, screening, and full-text review were conducted by two researchers (J.G. and Z.W.).

For inclusion in the present meta-analysis, the studies had to be an RCT or retrospective study, compare SPLH and CLH, report at least one of the quantitative outcomes, and clearly document the study procedure.

2.2. Data extraction

Two researchers (L.Y. and L.Z.) independently extracted the following data from each study: first author, year of publication, country, study design, number of patients enrolled, baseline characteristics of study, type of intervention, operative procedure, and outcome data (procedure failure, perioperative complications, postoperative pain, operative time, estimated blood loss, time to first flatus, postoperative hospital days, uterine weight, and cosmetic satisfaction). Any disagreement was resolved by discussion between the two researchers. Corresponding authors were contacted if any data were unclear to ensure accuracy in the review.

The primary outcomes were procedure failure and perioperative complications. Procedure failure during SPLH was defined either as the addition of extra ports (including conversion to CLH) or conversion to open surgery. Procedure failure during CLH was defined as conversion to open surgery. The perioperative period covered the beginning of the operation to 30 days after surgery.

The secondary outcomes included postoperative pain, operative time, estimated blood loss, time to first flatus, postoperative hospital days, uterine weight, and cosmetic satisfaction. Postoperative pain was assessed via an 11-point visual analog scale (scores 0–10).

2.3. Quality assessment and statistical analysis

The risk of bias among RCTs was assessed by the Cochrane Collaboration's tool [8]. The modified Newcastle–Ottawa Scale was adopted to evaluate methodologic quality [9,10]. The weighted mean difference and odds ratio (OR) were used to compare continuous and dichotomous variables, respectively. ORs and weighted mean differences were reported with 95% confidence intervals (CIs). $P < 0.05$ was considered to be statistically significant. In studies that reported continuous data as median (range), the mean was either approximated to the median (sample size [n] >25) or excluded ($n < 25$). Standard deviation was approximated to range/4 ($15 < n < 70$), range/6 ($n > 70$), or excluded ($n < 15$) [11]. Studies with interquartile range (IQR) were excluded if the standard deviation was not reported.

All analyses were carried out with Review Manager version 5.3 (The Cochrane Collaboration, London, UK) and Stata version 12.0 (StataCorp, College Station, TX, USA). Statistical heterogeneity between studies was assessed by the χ^2 test. Heterogeneity was deemed significant if $P < 0.1$. The proportion of total variation was quantified using the I^2 statistic. The random-effect model was used if there was heterogeneity ($I^2 > 50\%$) between studies. Otherwise, the fixed-effected model was used.

Subgroup analyses of RCTs were conducted to compare the procedure failure by type of intervention (laparoscopy-assisted vaginal hysterectomy, total laparoscopic hysterectomy, or mixed hysterectomy) or by operative procedure (hysterectomy, or hysterectomy and adnexal surgery). Funnel plots were used to screen for potential publication bias. Begg and Egger tests were also used to assess publication bias.

3. Results

3.1. Identified studies

A total of 185 articles were extracted from the initial database search (Fig. 1). After excluding studies with overlapping data and irrelevant topics, and editorial and non-comparative reports, the remaining 33 studies were examined by full-text review and a further 15 were excluded. Ultimately, 18 studies were selected for systematic review and meta-analysis. All except one [12] were full-text articles.

The characteristics of the studies included in the review are presented in Table 1. All studies were published between 2010 and 2014. The sample sizes ranged from 20 to 1046 (total 3725; 1680 cases of SPLH and 2045 cases of CLH). There were six RCTs [12–17] and 12 retrospective studies [18–29], of which nine compared a contemporary series of patients [18,19,21,22,24,26–29], and three used a historic series as controls [20,23,25]. One retrospective study reported prospective data collection [23]. Among the 18 studies, one was done in Europe [19] and 17 in Asia [12–18,20–29]. Except for one study reported in Korean [26], all studies were published in English.

In the six RCTs, the type of interventions varied as follows: three were laparoscopy-assisted vaginal hysterectomy [13,14,17], two were total laparoscopic hysterectomy [15,16], and one was mixed hysterectomy [12]. In terms of the operative procedure, three studies evaluated hysterectomy [12,13,16], and three evaluated combined hysterectomy and adnexal surgery [14,15,17].

3.2. Quality assessment

The Cochrane Collaboration's tool was used to assess the risk of bias of the six RCTs (Supplementary Material S1). Three RCTs used appropriate methods to generate the randomization sequence [13,15,17]. Concealment of allocation was performed by using appropriately sealed envelopes in two studies [13,17]. Only one study was blinded [13]. In the study of Jung et al. [15], it was unclear whether there was incomplete outcome data due to attrition.

The methodologic quality of the 12 retrospective studies was evaluated by the modified Newcastle–Ottawa Scale (Supplementary Material S2). Seven achieved a score of 6 or more [18,19,22,23,26–28], and five were rated as having a total score of 5 or less [20,21,24,25,29].

3.3. Primary outcomes

To evaluate the efficacy of SPLH versus CLH, procedure failure and perioperative complications were examined as primary outcomes because they were the most essential criteria used by surgeons to weigh up the different procedures.

All except one study [29] reported procedure failure. The study by Ichikwa et al. [20] was excluded because it used a historic control series for which the procedure failure of the CLH group was not reported. Pooling the data from the remaining 16 studies involving 3540 participants [12–19,21–28] showed that procedure failure was significantly higher for SPLH than for CLH (OR 6.37, 95% CI 3.34–12.14; $P < 0.001$; $I^2 = 0\%$) (Fig. 2, Table 2). The failure rate was 3.59% (58/1617) for SPLH and 0.36% (7/1923) for CLH.

The percentage of each type of procedure failure was examined in the SPLH group. Of the 58 failures, more than two-thirds were due to the need for additional extra ports (40/58 [69%]), and only 31% (18/58) were due to conversion to open surgery.

Procedure failure was also more likely with SPLH than with CLH in the analyses of RCTs only (OR 3.95, 95% CI 1.29–12.05; $P = 0.02$) [12–17] and the 10 retrospective studies (OR 7.81, 95% CI 3.52–17.35; $P < 0.001$) [18,19,21–28] (Table 2). There was no statistical heterogeneity among the studies ($I^2 = 0\%$).

Among the six RCTs, two subgroup analyses based on the type of intervention and operative procedure were undertaken (Figs. 3, 4, Table 2). No significant differences in frequency of procedure failure were found in these subgroup analyses.

Fourteen of the studies contained data on perioperative complications [13,15–22,24,25,27–29]. There was no significant difference between the two approaches (OR 0.89, 95% CI 0.45–1.74; $P = 0.73$), but the I^2 was 59%, suggesting a moderate amount of heterogeneity among the pooled studies (Table 2). No significant differences were found in analyses of four RCTs (OR 1.76, 95% CI 0.27–11.43; $P = 0.56$;