Comparison of Robotic Versus Standard Laparoscopy for the Treatment of Endometriosis: A Systematic Review

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Abstract

Endometriosis is a serious chronic condition that causes significant morbidity in women worldwide. Laparoscopy surgery is a mainstay treatment for severe and symptomatic endometriosis. However, new techniques are emerging; one being robotic surgery. This paper aims to assess robot-assisted surgery (RAS) and conventional laparoscopic surgery (LPS) for the treatment of endometriosis in terms of operating time, blood loss, length of hospital stay, and rate of perioperative complication. PubMed, Embase, Scopus, and CINAHL databases were searched from January 2001 to September 2023. In accordance with the eligibility criteria, 3 studies and a meta-analysis were selected. A total of 1741 patients were identified. No significant differences in blood loss, hospital stay, and complications were found between RAS and LPS. However, RAS was shown to have a significantly longer mean operating time than LPS. This systematic literature review substantiates the safety and feasibility of RAS for the treatment of endometriosis and could be considered a viable alternative to LPS.

Keywords: Systematic Review, Endometriosis, Laparoscopic Surgery, Robot-assisted surgery

Introduction

Endometriosis is a chronic disease that occurs in about 10% of women of reproductive age. It occurs when endometrial-type tissue grows outside of the uterus and in other areas of the body.[1] Patients with endometriosis may be asymptomatic but can present with symptoms such as severe pain (being the most common symptom), infertility, heavy menstrual bleeding, bloating, diarrhea, as well as other urinary and intestinal symptoms depending on the location of the disease.[2]

Surgically resecting endometrial lesions (especially superficial lesions) has been shown to reduce pain and enhance quality of life. Surgical treatment usually involves excision (removal of endometrial tissue by cutting), ablation (destruction of the cells using high energy), or a combination of both through laparoscopic and minimally invasive techniques.[3]

In the past decades, laparoscopic surgery (LPS) has been the recommended treatment for endometriosis.[4] It provides long-term outcomes that are comparable to that of laparotomy, with the advantages of being a minimally invasive technique (such as better visualization, shorter hospital stays, faster recovery time, better cosmetic results, and less risk of infection).[5] However, more recently, robotic-assisted surgery (RAS) has become available and increasingly widespread. It is also a minimally invasive technique, and advocates for robotic surgery argue that increased dexterity, precision, and depth perception may offer improved outcomes for endometriosis.[6] However, there have been few studies or reviews comparing RAS to LPS for endometriosis. With robotic surgery being a rapidly evolving field, a systematic literature review would be helpful in understanding this new technique and how it compares to other surgical approaches. Therefore, this review aims to synthesize the available body of literature on RAS and LPS with a comparison of their outcomes including operating time, blood loss, length of hospital stay, and rate of intra- and post-operative conditions.

Methods

Search Strategy

A search of 4 electronic databases was conducted (PubMed, Embase, Scopus, CINAHL). All English publications comparing RAS and LPS for the treatment of endometriosis from January 2001 to September 2023 were identified. The following keywords were used in the search: “endometriosis” AND “laparoscopic surgery” AND “robotic”. This search was modified, and other search terms were used, such as “laparoscopy”, and “robotic surgery” in the place of “laparoscopic surgery” and “robotic”, respectively. However, the first search query was most commonly used. Related articles provided by the databases were also searched.
Data was extracted by one independent researcher. PRISMA guidelines were used.

Inclusion Criteria

All of the studies that were included in the review met the following criteria: directly compared LPS and RAS in patients with endometriosis, addressed one or more of the outcome measures of operating time, blood loss, complication rate, or length of hospital stay, had a sample size of more than 25, English-language sources, and had easily accessible full-text versions.

Exclusion Criteria

Sources that only reported LPS or RAS were excluded. Sources in languages other than English or those without full-text versions were also excluded. Publications that didn’t provide clear information about patients or results were excluded.

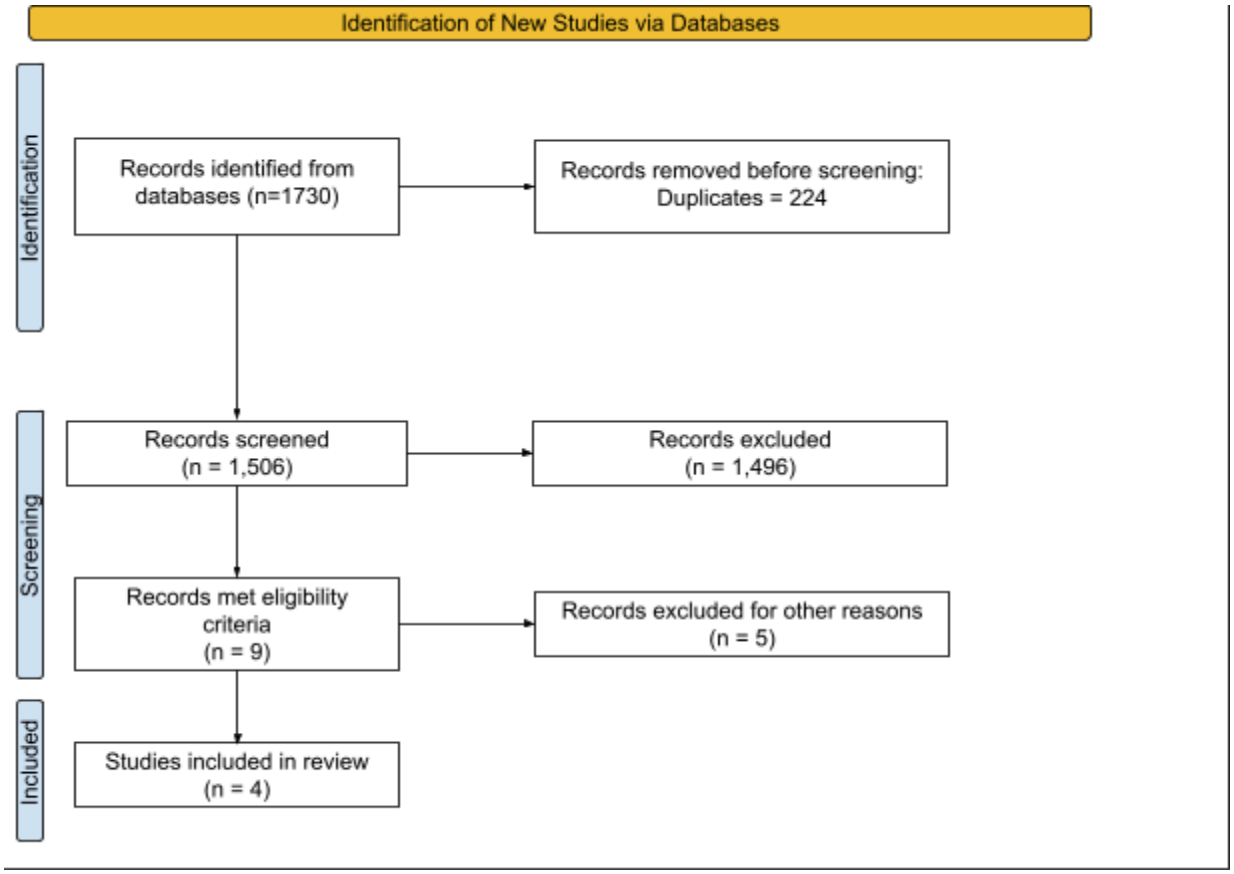
Results

Study characteristics and selection

One thousand seven hundred thirty articles were identified. 224 duplicates were moved using Endnote. 1,496 articles were excluded, mainly for the following reasons: they did not directly compare only RAS to LPS, they did not focus on endometriosis, full-text versions could not be obtained, or they were not written in English. Nine articles met the inclusion criteria, however, 5 of these were included within a meta-analysis, and

therefore three unique studies and a meta-analysis were included in the review. [7-10] (Figure 1). The three individual studies were prospective cohort studies. The meta-analysis included four retrospective studies and one randomized controlled trial (RCT). A total of 1741 patients were identified in these selected studies, 959 from the LPS group and 782 from the RAS group.

The characteristics of the studies, including the name of the first author, year published, average age and BMI, and the study design, are shown in Table 1.



(Figure 1)

Author	Year	Study Type	Group	Sample size	Age (years ± SD)	BMI (kg/m2), mean (±SD)
Restaino, Stefano	2020	Meta-analysis	LPS	851	N/A	N/A
			RAS	676	N/A	N/A
Ferrier, Clement	2022	Prospective Cohort Study	LPS	61	35 ± 7	26 ± 8
			RAS	61	36 ± 7	25 ± 5
Raimondo Diego	2021	Prospective Cohort Study	LPS	22	36 ± 5	22.5 (21-24)
			RAS	22	38 ± 7	24.5 (21-27)
Le Gac, Marjolaine	2020	Prospective Cohort Study	LPS	25	37 ± 8	25 ± 4
			RAS	23	36 ± 7	25 ± 3

(Table 1)

Synthesis of the Results

All of the studies and the meta-analysis assessed the operating time of the procedures. The meta-analysis by Restaino, et al., reported a weighted mean difference of 0.54 min (95% CI, 0.37 to 0.70; p<0.0001) for operating time, with RAS requiring more time. The three prospective cohort studies (Ferrier et al., Raimondo et al., Le Gac et al.) reported similar results. Ferrier, et al. observed a mean operating time of 208 ± 90 mins for RAS, compared to 169 ± 81 mins for LPS (p = 0.01). Raimondo et al. reported a mean operating time of 207 ± 79 mins for RAS and 184 ± 214 mins for LPS (p = 0.171). Le Gac et al. showed a mean operating time of 221 ± 94 mins for RAS and 163 ± 83 mins for LPS (p=0.03). All of these results were reported with statistical significance. Hence, the operating time for RAS is longer than for LPS with statistical significance (p <0.05).

All studies also assessed the length of hospital stay (LOS) in both RAS and LPS. In the meta-analysis, the pooled estimate showed a weighted mean difference of 0.12 days but this was not significant. There was a considerable amount of variation within the prospective cohort studies, with no consistent trend and without significance. Raimondo et al. and Le Gac et al. showed that LOS was longer with RAS than LPS: 8 ± 4.4 days for RAS and 6.5 ± 2.6 days for LPS (Le Gac, et al.) and 8 ± 7 days for RAS and 6 ± 2 days for LPS (Raimondo, et al.). Contrastingly, Ferrier et al. showed that the LOS with LPS is slightly longer than RAS with 7.5 days ± 3.9 days for RAS and 7.8 ± 4.6 days for

LPS. Overall, the results for the LOS for RAS compared to LPS are inconsistent, and no definitive conclusion can be drawn.

For blood loss, the meta-analysis reported no significant difference between RAS and LPS, with a WMD of 0.09mL. The individual cohort studies also had inconclusive results. Raimondo et al. and Le Gac et al. reported that blood loss (mL) with RAS is slightly higher than with LPS. For Raimondo et al., blood loss for RAS was 184 ± 214 mL compared to 144 ± 101 mL for LPS. Le Gac et al. had similar results; 130 ± 86 mL for RAS and 108 ± 99 mL for LPS. Ferrier et al., on the other hand, reported more blood loss with LPS than RAS, with 161 ± 141 mL for RAS and 188 ± 266 mL for LPS. None of these results had significance. Therefore, for blood loss, there is no clear trend, and the results are inconclusive.

Finally, operative complications were assessed as two sub-categories: intraoperative and postoperative complications. The meta-analysis reported a relative risk ratio (RR) of 1.27 for intraoperative complications in RAS compared to LPS; this was not significant. The prospective cohort studies reported mixed results with no significance. Raimondo et al. and Le Gac et al. both described a higher incidence of intraoperative complications in the RAS group compared to the LPS group. Raimondo et al. reported 1 patient (5% of patients) with intraoperative complication in the RAS group and 0 in the LPS group. Le Gac et al. reported 2 patients with intra-operative complications (9% of patients) in the RAS group and 1 in the LPS group (4% of patients). Contrary to these two studies, Ferrier et al. reported more intraoperative complications in the LPS group, with 2 cases in the RAS group (3.3% of patients) and 6 cases in the RAS group (9.8%).

For post-operative complications, the meta-analysis indicated an RR of 0.88 in RAS compared to LPS.; again, this was not significant. Raimondo et al. and Le Gac et al., contrary to the meta-analysis reported that RAS had a higher complication rate than LPS. Raimondo et al. reported 4 patients (18%) in the RAS group and 1 patient (5%) in the LPS group who experienced postoperative complications. For Le Gac et al., 6 patients (27%) in the RAS group experienced postoperative complications, while 4 patients (15%) in the LPS group experienced postoperative complications. Ferrier et al. had results similar to that of the meta-analysis, with LPS having a slightly larger incidence of postoperative complication in the LPS group with 21 reported cases (34.4%) compared to 20 reported cases (32.8%) in the RAS group. None of the results were statistically significant. Therefore, there is no clear or consistent correlation between the surgical technique used and the rate of perioperative complication.

Overall, the meta-analysis and related studies investigated key outcomes of robotic-assisted surgery (RAS) and laparoscopic surgery (LPS). Operating time was consistently longer for RAS (with statistical significance), while length of hospital stay (LOS), blood loss, and perioperative complication rates had inconclusive results between the two techniques.

Quality Assessment of Included Studies

The quality of the studies and the meta-analysis included was assessed using the National Institutes of Health (NIH) quality assessment tool for observational cohort and cross-sectional studies and the National Institutes of Health (NIH) quality assessment tool of Systematic Reviews and Meta-Analyses. The assessment was done by one independent researcher. The overall rating for the prospective cohort study conducted by Raimondo and the meta-analysis conducted by Restaino was Good. The overall rating for the prospective cohort study conducted by Ferrier and the prospective cohort study conducted by Le Gac was Fair.

Discussion

Recently, the advent of robotic surgery has caught the attention of researchers, healthcare professionals, and patients. It has been professed to have the advantages of increased precision, dexterity, reduced blood loss, shorter hospital stays, less scarring, etc. However, our paper has demonstrated that RAS and LPS have similar outcomes in terms of blood loss, length of hospital stay, and rate of perioperative complications. In fact, the only statistically significant outcome was in favour of LPS, as LPS was reported to have a shorter operating time compared to RAS. Therefore, while RAS has been shown to have similar outcomes in safety (ie. blood loss and perioperative complications) and some measures of efficiency (ie. length of hospital stay) as LPS, it is not necessarily superior to LPS.

This review is one of few articles that examine the results of multiple studies and a meta-analysis to determine overall trends between RAS and LPS. We have summarized and synthesized the results of 3 prospective cohort studies, as well as a meta-analysis (which synthesized 3 retrospective studies and RCT). We have included both primary sources (the prospective studies) and a secondary source (the meta-analysis). However, there are weaknesses that need to be taken into account. One is the quality of the studies included. The individual studies were almost all prospective cohorts. The studies included in the meta-analysis were also of lower quality as they were retrospective, with only one RCT. Except for the RCT, these studies cannot make cause-and-effect claims and are not as controlled. In addition, no studies examined the long-term impacts of each surgical approach, such as pain relief or fertility outcomes. In addition, many of the studies, including those in the meta-analysis, primarily focused on deep infiltrating endometriosis involving the colon or rectosigmoid, which makes it more difficult to draw conclusions for the treatment of other forms and stages of endometriosis.

Clinically, both robotic and standard laparoscopic surgery are acceptable techniques for the treatment of endometriosis in terms of blood loss, hospital stay, and complication rate. Robotic surgery, however, does have a longer operating time and that may be a factor in the decision between the use of robotic and standard laparoscopy.

In terms of future directions in this field, more well-designed RCTs are needed to examine the benefits and risks of RAS vs LPS. Additional studies with adequate follow-up would be extremely useful, allowing for a better understanding of the long-term effects of RAS compared to LPS. In addition, studies assessing other outcomes, such as patient satisfaction, fertility outcomes, and pain relief, would allow for a more holistic comparison between RAS and LPS.

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