Comparative Analysis of Robotic-Assisted Surgery Versus Traditional Surgery in the Treatment of Endometriosis: A Narrative Review

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| ABSTRACT | Published Online: December 11, 2024 |

Background: Endometriosis is a prevalent gynecological condition among women that causes infertility, severe pain, and reduces quality of life. Despite the rapid growth in the use of robotic-assisted surgery (RAS) for various medical specialties, little is known about its effectiveness compared to traditional human-performed surgery for endometriosis treatment. This narrative review aims to compare the effectiveness of RAS compared to conventional surgery in improving various patient outcomes in endometriosis treatment.

Methods: Randomized controlled trials (RCTs) and quasi-experimental studies were searched on PubMed and Web of Science in November 2024. Studies were eligible if they compared the effectiveness of RAS and conventional surgical procedures for endometriosis treatment for improving various patient outcomes.

Results: Only one RCT has been conducted on this subject matter, and there is one ongoing RCT that is anticipated to be completed by 2026. The only RCT published so far reported three outcomes, namely condition-specific quality of life, operative time, and complications (and blood loss and conversion rates to laparotomy). The RCT revealed that both RAS and conventional surgery improved quality of life, but there were no significant differences between them. Observational cohort studies have not so far reported on quality of life as a clinically important outcome. Also, no significant differences were noted regarding complications, blood loss, and conversion rates to laparotomy, which is consistent with meta-analyses of observational cohort studies. However, although the RCT reported no significant differences between the two arms regarding operative time, all the meta-analyses of observational studies revealed that RAS was significantly inferior to conventional surgery in this outcome. Even so, the RCT noted that the operative time for RAS was relatively longer than conventional surgery, although not statistically significant.

Conclusion: This narrative review identified significant literature gaps, namely, no RCT reporting on pain as a clinically important outcome. Also, the currently available RCT is of moderate quality due to double-blinding concerns. Generally, RAS does not offer any outstanding advantages compared to conventional surgery, but it can be considered a safe and effective alternative.

KEYWORDS:
Endometriosis, RCT, robotic-assisted surgery, conventional surgery

INTRODUCTION

Robotic-assisted surgery (RAS) refers to the utilization of robotic systems to support and improve the accuracy and agility of human surgeons during various medical procedures (Handa et al., 2024). The use of RAS is rapidly growing in various medical specialties, such as urology, hepato-pancreato-biliary, gynecology, and colorectal (Lai et al., 2024). Thus, it is important to compare the effectiveness and safety of RAS and traditional human-performed surgery for various medical procedures and provide directions for practice and future research.

This review focuses on endometriosis treatment. According to the World Health Organization (WHO),

endometriosis refers to when tissue similar to the lining of the uterus grows outside the uterus, leading to severe pelvic pain and infertility, but sometimes it can be asymptomatic (WHO, 2023). The overall global prevalence of this condition is approximately 18%, but it affects roughly 10% of women of reproductive age (Moradi et al., 2021; WHO, 2023). In severe cases, the most common treatment of endometriosis is the surgical removal of the endometriotic lesions (Working group of ESGE, ESHRE, and WES et al., 2020). This procedure, human-performed, can lead to symptoms like pain, but a significant portion of the patients (about 11.8%) still experience no symptom improvement post-surgery, and about 22.6% require further surgery (Singh et al., 2020). Due to the increased use of RAS in laparoscopic surgical procedures for various medical conditions with superior outcomes (Sheng et al., 2018; Yao et al., 2023), it is also important to determine whether RAS, compared to conventional surgery, can improve outcomes for endometriosis treatment.

This review aims to compare patient outcomes between RAS and human-performed laparoscopic surgery for endometriosis treatment. The sources of information searched include PubMed and Web of Science. Only randomized controlled trials (RCTs) and quasi-experimental comparative studies were considered eligible. Clinical trial protocols will also be reviewed to identify outcomes of interest. Keywords like "endometriosis," "robotic-assisted surgery," and "RCT" were used in the search strategy. The objectives of the review include determining the patient outcomes reported in the studies and identifying the specific outcomes that may be superior when RAS is used compared to human-performed surgery. A narrative synthesis was performed to analyze similarities and differences between studies, laying a firm groundwork for a future systematic review and meta-analysis.

REVIEW
The Current State of Evidence

RCTs are considered the gold standard of evidence-based medicine, and their presence in an area of interest signifies the rigor of available evidence. In the context of surgical treatment of endometriosis, the availability of RCTs can help surgeons make better and more informed decisions (Ahuja, 2019). In RAS versus traditional human-performed surgery for endometriosis treatment, a systematic search on PubMed using MeSH terms and text words yielded only one relevant RCT (Soto et al., 2017). Indeed, before the publication of this RCT, a systematic review and meta-analysis relied on only four observational studies that used a comparative approach, such as comparing outcomes between two groups (RAS versus conventional surgery) without an experimental design (Chen et al., 2016). Similarly, a recent systematic review and meta-analysis found only one RCT (Soto et al., 2017) after searching PubMed, Google Scholar, and ClinicalTrial.gov for studies published between 1980 and

2023 (Pavone et al., 2024). The rest of the studies were observational with a comparative approach.

Further, our search on Web of Science yielded two unique studies, one RCT (Riley et al., 2019) and one protocol for an RCT (Terho et al., 2022). Terho et al. (2022) indicated that the RCT whose protocol they published (ROBEndo trial) is scheduled to be completed in 2026. No other ongoing clinical trial was identified based on our search strategy. Also, Riley et al. (2019) did not fully meet our eligibility criteria because they compared ablation versus excision in RSA instead of exclusively focusing on RSA versus human-performed surgery. Therefore, although we were interested in their outcomes, we did not rely on their findings to inform about RSA versus human-performed surgery for endometriosis treatment. We did not locate a single quasi-experimental study in our search strategy. According to the levels of evidence in evidence-based practice in medicine and nursing, if there are no RCTs, quasi-experimental studies should be considered the highest level of evidence in an area of interest (Burns et al., 2011). Hence, it can be concluded that RCT-based or quasi-experiment-based evidence in this context is very minimal, and there is a need for more future studies to be conducted for better and more informed decision-making.

Reported Outcomes in RCTs and Protocols of Ongoing RCTs

Outcomes reported in the eligible RCT included quality of life as the primary outcome and operative time and perioperative complications as the secondary outcomes (Soto et al., 2017). In the protocol for the ROBEndo trial, the primary outcome that will be reported is postoperative pain, and secondary outcomes include intraoperative measures, enhanced recovery after surgery factors, complications, cost, and long-term quality of life (Terho et al., 2022). Finally, in the ineligible RCT, the primary outcomes that were reported included preoperative and postoperative menstrual pain, non-menstrual pain, dyspareunia, and dyschezia. The secondary outcomes reported included preoperative and postoperative pelvic pain, general health-related quality of life, and sexual function (Riley et al., 2019). At this point, it is imperative to synthesize the findings of the eligible RCT, considering other studies with different designs.

How Do the Findings of the RCT Compare with Other Studies?

Soto et al. (2017) found that both groups, RAS versus conventional laparoscopic surgery, reported improvements in condition-specific quality of life at 6 weeks and 6 months postoperatively. No significant differences were observed between them. So far, it is only Soto et al. (2017) who reported quality of life, an important outcome for endometriosis, since the condition has been linked to significant reductions in the quality of life. Studies of other designs, mainly observational or cohort comparative studies,

often do not report on this important outcome as confirmed by various systematic reviews and meta-analyses that have synthesized their findings (Chen et al., 2016; Csirzó et al., 2024; Pavone et al., 2024; Restaino et al., 2020; Song et al., 2023).

Also, Soto et al. (2017) found that there were no statistically significant differences in blood loss, intraoperative and postoperative complications, and rates of conversion to laparotomy between the experimental and control groups. Their findings are consistent with the various meta-analyses that have synthesized findings from various cohort comparative studies (Chen et al., 2016; Csirzó et al., 2024; Pavone et al., 2024; Restaino et al., 2020; Song et al., 2023). Blood loss, complications, and conversion rates are the most frequently reported outcomes in cohort comparative studies whose findings are synthesized in these systematic reviews and meta-analyses. Based on these outcomes, all the meta-analyses concluded that RAS does not offer any advantages compared to conventional human-performed surgery for endometriosis treatment.

Further, Soto et al. (2017) found that operative time was relatively longer in the RAS arm (106.6 ± 48.4 mins) compared to the control arm (101.6 ± 63.2 mins). However, these differences were not statistically significant. Based on statistical significance, these findings differ from those of the cohort comparative studies synthesized in the various meta-analyses, whereby they all reported statistically significant differences between RAS and conventional surgery groups, RAS being inferior in terms of operative times (Chen et al., 2016; Csirzó et al., 2024; Pavone et al., 2024; Restaino et al., 2020; Song et al., 2023). Apart from operative times, the meta-analytic synthesis of the cohort comparative studies revealed that RAS was inferior to conventional human-performed surgery regarding the length of hospital stay and operating room times (Csirzó et al., 2024; Pavone et al., 2024; Song et al., 2023). In general, there is an agreement between the RCT and other studies that RAS does not offer any outstanding advantages compared to conventional human-performed surgery. Still, it is safe and effective and hence can be used as an alternative to conventional surgery.

Further, it is important to note that Soto et al. (2017) conducted what can be considered a moderate-quality RCT because of double-blinding concerns. For example, patients were blinded to their group assignment only until the day of surgery. Afterward, they were aware of whether they underwent robotic or conventional laparoscopic surgery, which limits blinding effectiveness. Similarly, there is no indication that investigators assessing outcomes were blinded, meaning they likely knew the group assignments when analyzing data or collecting follow-up information. The absence of full double-blinding introduces the potential for detection bias or observer bias, particularly for subjective outcomes such as quality of life. However, the study's robust randomization and use of validated questionnaires mitigate some of these concerns. Additionally, the RCT did not assess pain-related outcomes, which are very important in the context of endometriosis treatment. Hence, more high-quality RCTs are needed in the future to address this literature gap and provide better insights into clinically important outcomes like pain and quality of life, among others.

CONCLUSION

The findings of this narrative review have revealed important literature gaps regarding the effectiveness of RAS compared to conventional human-performed surgery for endometriosis treatment. They include the fact that there is currently only one moderate-quality RCT comparing the two interventions but fails to report on some clinically important outcomes like pain. The available systematic reviews and meta-analyses synthesize findings from observational cohort comparative studies. However, based on the available evidence, there is a consistent agreement between studies that RAS does not offer any outstanding advantages over conventional surgical interventions for endometriosis treatment. Still, it is a safe and effective alternative.

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