Original Article

Robotic-assisted Versus Conventional Laparoscopic Hysterectomy for Benign Gynecological Conditions: A Systematic Review and Meta-analysis

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ABSTRACT

Background: Minimally invasive gynecologic surgery is safe and feasible procedure for benign gynaecological conditions with less morbidity. **Objective:** To determine the best approach in benign gynecology and establish superiority of robotic over conventional laparoscopic hysterectomy in terms of safety and effectiveness. **Methods:** Search strategy: Electronic databases: MEDLINE, Embase, CENTRAL (the Registry of Controlled Clinical Studies of the Cochrane Collaboration), Google scholar, Pubmed and Scopus were searched from 2010-2022. Selection criteria: All randomized controlled trials and quasi-randomised trials which compared robotic versus conventional laparoscopic hysterectomy were included to conduct this systematic review and meta-analysis to investigate compared to traditional approaches. **Results:** Only five RCTs (326 patients in total) comparing robotic and conventional laparoscopic hysterectomy were included after a comprehensive literature search. Results of our analysis showed no clear benefit in any of the two techniques in operating time, estimated blood loss, length of hospital stay and overall complications. **Conclusion:** This systematic review suggests no statistical difference in surgical and patient outcomes between robotic and conventional laparoscopic hysterectomy relating to OT, EBL, LOHS, overall complications, and survival.

Keywords: *Conventional laparoscopy, meta-analysis, robotic surgery*

Introduction

Hysterectomy is one of the most commonly performed surgical procedures in gynecological practice for various benign and malignant indications, with a prevalence as high as 6% in women aged 30–49 years in India.[1] Hysterectomy is commonly performed for benign uterine pathology, the most common indication being symptomatic uterine leiomyoma (51.4%), followed by abnormal uterine bleeding (41.7%), endometriosis (30%), and prolapse (18.2%).

There are several approaches to the surgical removal of the uterus, namely, abdominal, vaginal, laparoscopic, and most recently, robotic-assisted laparoscopic and natural-orifice transluminal endoscopic surgery. The route is determined by a number of variables, including the uterus' size and shape, mobility, pelvic adhesions, degree of extrauterine disease, cost-effectiveness, surgeon training and expertise, and the resources available. Every method of hysterectomy carries a different risk of complications and length of postoperative recovery.[2]

Open/abdominal surgery is generally associated with higher morbidity than minimally invasive approaches, including vaginal route as well as laparoscopic and robotic-assisted laparoscopic routes of hysterectomy.[3] However, minimally invasive gynecologic surgery (MIGS) has transformed the science of gynecologic treatments over the past 20 years.

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MIGS includes the newest technique of robotic surgery and also the conventional laparoscopic surgery. Small incisions are made during traditional laparoscopic surgery to surgically manipulate tissues using endoscopic cameras and long instruments. In contrast, robotic-assisted surgery enables a computer link between the doctor and the patient, allowing for the use of cutting-edge tools and three-dimensional vision that is typically operated from a distance.[4] Minimally invasive routes aim to reduce perioperative complications and improve patient and surgical outcomes.

A multicenter analysis comparing robotic-assisted hysterectomy (RH) to conventional open, laparoscopic, and vaginal approaches was done by Lim *et al*. in 2016. After performing more than 2000 robotic hysterectomies, researchers came to the conclusion that robotic-assisted benign hysterectomy produced better results than abdominal, vaginal, and laparoscopic hysterectomy (LH).[5]

Nevertheless, the superiority of robotic-assisted surgery over conventional routes is yet to be established, and a systematic review and meta-analysis like the present study would go a long way in cementing the role of robotic surgery for benign gynecological surgeries. Some studies have discovered benefits, whereas others have indicated that robotic surgery is significantly more expensive than LH. This review's main goal is to compare traditional LH with robotic surgery in terms of safety and efficacy. Although a vast majority of the literature on this topic has been published, still there is a need to review the evidence for the wider adoption of robotic hysterectomy with extensive data and recent literature.

Research question

Is RH superior to conventional laparoscopic hysterectomy (CLH) in terms of safety and effectiveness?

Materials and Methods

Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) standards, a standard technique was used. Search strategy was formulated on PICO format [Table 1]. A systematic review of the literature was performed by electronic search of databases such as MEDLINE, EMBASE, CENTRAL (the Registry of Controlled Clinical Studies of the Cochrane Collaboration), Google Scholar, PUBMED, and SCOPUS searched from 2010 to 2022, and all randomized controlled trials (RCTs) and quasi-randomized trials which compared robotic versus CLH were included in the study.

Table 1: Population, intervention, comparison, and outcomes flow

Acronym	Definition	Description
P	Population	All women undergoing diagnostic hysteroscopy
I	Intervention	Hysteroscopy
C	Comparison	Vaginoscopic and traditional hysteroscopy
O	Outcome	Pain and duration of procedure

Medical Subject Heading phrases and keywords were used by two of the authors (AB and RM) to fill in theme sets relating to "hysterectomy" and "robotic," and the Boolean operator "AND" was used to determine the intersection of these sets. There were no time or language constraints, and duplicate articles were removed. To optimize the outcomes, we additionally looked up other trials in the included studies' references.

PROSPERO ID: CRD42021243506.

Inclusion and exclusion criteria

All randomized and quasi-randomized controlled trials in English were included, which compared surgical outcomes of robotic-assisted LH with CLH. The characteristics of included studies are described in Table 2.

Books, documents, case series, and case reports were not included in the study. To assess final eligibility, two separate researchers (A. B. and R. M.) manually read all titles, abstracts, and complete texts. Disagreements were settled through debate and consensus.

Data collection and synthesis

The PRISMA flow diagram explains the study methodology, literature search, and trial selection, where search results are finally summed up [Figure 1].[6]

Data were collected and extracted from the included trials using ReviewManager (RevMan; The Cochrane Collaboration) software with data collection and extraction form of Cochrane Review Group.[7] Studies were not limited to: first author, year published, study population, language, country, blinding or sample size, description of the intervention (s), comparison studied, what and how the outcomes were measured, and number of patients in the intervention and the control arm. For all statistical calculations in this systematic review and meta-analysis, RevMan (version 5.4) was utilized.[8] Cochrane's Q Chi-square statistic calculator was used and further I^2 was calculated. Using both fixed-effects and random-effects models, a summary effect estimate was generated. Significant results were those with $P < 0.05$. Forest plots were used to visually represent heterogeneity, and the Chi-square test was used for statistical analysis in accordance with the Cochrane Handbook.[7]

Results

Characteristics of included studies

A total of 8234 records were identified, and 960 records were extracted through electronic databases comparing

Table 2: Characteristics of included studies

Study, year, country	Number of participants	Estimated blood loss	Total operating time	Length of hospital stay	Complication rate (intraoperative/ postoperative)	Quality of life	Conversion of procedure	Uterus weight
Deimling *et al*., 2017, USA[9]	144 (72 each arm)	EBL> or <50 mL similar	Mean/median/ IQR more in LH	Postsurgery hours similar	More in LH	Similar	1 laparoscopic adhesiolysis	More in LH
Lönnerfors *et al*., 2015, Sweden[10]	97 (61 RH and 36 LH)	Median - Hb drop more in LH	Mean, median more in LH	Median days more in LH	More in LH	Similar	2 LH to laparotomy	Not much difference
Martínez-Maestre *et al*., 2014, Spain[11]	105 (51 and 54)	Hb drop % mean±SD, HCT decrease % more in LH	Mean±SD more in LH	Mean±SD days more in LH	More in LH	Similar	None	More in LH
Paraiso *et al*., 2013, USA[12]	52 (26 each arm)	Postoperative BT more in LH	Mean±SD more in RH	Average days more in RH	More in RH	Similar	2 LH to laparotomy and RH 2 RH–LH	Not much difference
Sarlos *et al*., 2012, Switzerland[13]	100 (50 in each arm)	Mean±SD, Median more in RH	Mean±SD (median) more in RH	Mean±SD (median) days more in RH	More in RH	Better in RH	1 RH–LH	More in RH

SD: Standard deviation, LH: Laparoscopic hysterectomy, RH: Robotic-assisted hysterectomy, EBL: Estimated blood loss, Hb: Hemoglobin, HCT: hematocrit, IQR: Interquartile range, BT: Blood transfusion

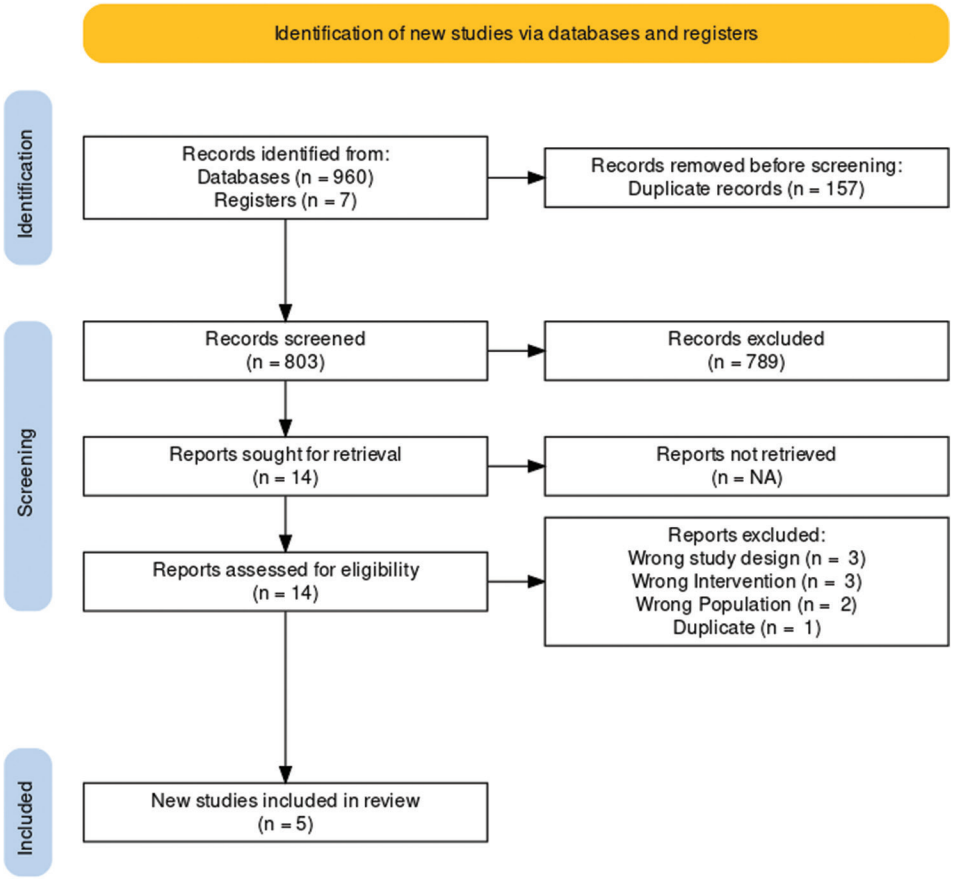

Figure 1: The Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram

treatment outcome between robotic and LH. Out of them, 803 records were extracted, examined, and screened for eligibility after reviewing the title and abstracts and removing the duplicated. Finally, five full-text articles met our eligibility criteria and were included in the qualitative review.

All the included studies[9-13] were single-center studies except Paraiso *et al.*'s,[12] in 2013, which was carried out at two different centers in the USA. Martinez's,[11] in 2014, was a quasi-randomized trial, whereas the rest were RCTs.

Baseline patient characteristics were similar in terms of participant age, body mass index (BMI), parity, and history of previous abdominal surgery. The surgeon was blinded to the technique only in a study by Paraiso *et al.*[12] As a result, descriptions of allocation concealment were often lacking. In addition, Martínez-Maestre *et al.*[11] conducted a quasi-randomization trial that depended on the availability of a robot and an operating room but excluded the possibility of patient preference or operator choice influencing the selected surgical strategy.[11]

Total operating time

Skin-to-skin operation times, including robot docking times, were reported in mean ± standard deviation (SD) or median across all five studies. Despite significant variation between trials, patients undergoing robotic hysterectomy saw a slight, nonsignificant increase in the mean skin-to-skin operating times (OTs) [Figure 2] (weighted mean difference = 4.13 min, 95% confidence interval [CI] −21.03–29.28, I^2 = 95%). Reviewing the results of the contributing studies, three studies (studies 9, 10, and 11) revealed statistically significant results in favor of robotic surgery, whereas the other two studies (studies 12 and 13) produced results in favor of laparoscopic surgery.

Estimated blood loss

In five studies, the amount of blood lost during surgery was quantified [Figure 3]; three studies reported estimated blood loss (EBL) (mL) at the conclusion of the procedure,[9,12,13] and two studies reported a percent change in hemoglobin from pre- to postoperative blood draws.[10,11] The results of our primary analysis were identical for patients having robotic hysterectomy compared to LH (standard mean difference = −11.92, 95% CI − 37.08-13.24), but this finding demonstrated significant heterogeneity (I^2 = 73). When the analysis was restricted to the three trials that reported EBL in mL (excluding 9 and 10) and the weighted mean difference was computed, the results were comparable. When it came to problems involving bleeding (hematomas, blood transfusions, and postoperative bleeding), we observed that rates were comparable for patients receiving robotic (8/162) and laparoscopic (9/164) procedures.

Length of hospital stay

Patients receiving robotic versus LH showed a slight, nonsignificant reduction in duration of stay (weighted mean difference = −0.13 days, 95% CI −0.74-0.49). Martinez-Maestre *et al.*'s[11] technique, which was deemed to have a high risk of bias in multiple domains, was determined to be substantially responsible for the great heterogeneity among contributing findings (I^2 = 91%). The three more homogeneous and high-quality studies were pooled, and the outcome was not statistically significant (Z = 0.40, P = 0.69) [Figure 4].

Intraoperative complications

Patients undergoing robotic surgery (12.3%) experienced perioperative problems at rates that were almost equal to those of patients receiving laparoscopic surgery (12.8%). Vaginal cuff hematoma or bleeding (n = 12), robotic issues requiring conversion to laparoscopy or vaginal cuff closure (n = 8), and

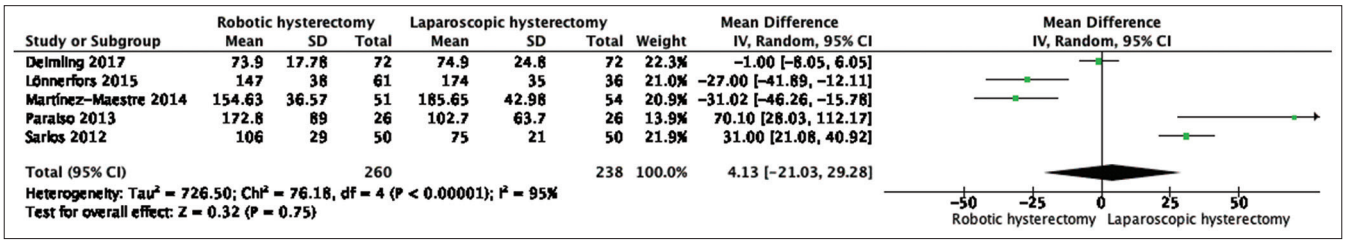

Figure 2: Comparing operating times. SD: Standard deviation, CI: Confidence interval

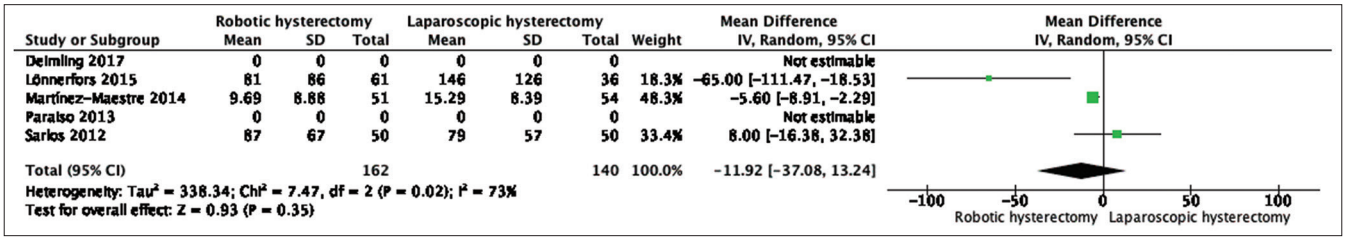

Figure 3: Comparison of estimated blood loss. SD: Standard deviation, CI: Confidence interval

blood transfusion (n = 4) were the most frequent postoperative problems. Vaginal vault hematomas, postoperative hemorrhage, and intraoperative surgical conversions all needed consensus assignment when grading complications according to severity. There were no discernible changes in the rate of intraoperative complications between robotic and laparoscopic hysterectomies, according to a pooled analysis [Figure 5] (respiratory rate [RR] =1.29, 95% CI 0.61–2.72, I^2 = 0%). There were no major issues that might have caused organ failure or death. Results from sensitivity analyses excluding surgical conversions and excluding quasi-randomised study,[11] did not substantially differ from the primary analysis.

Postoperative Complications

Infectious complications reported postoperatively varied among all studies in the form of vaginal cuff bleeding, hematoma, cuff dehiscence, port-site infection, vaginal abscess, blood transfusion, urinary tract infections, or readmission. In the pooled analysis, we found no significant differences in the rate of postoperative complications between robotic or LH in all five studies (RR 0.66, 95% CI 0.35–1.24, I-100%) as shown in Figure 6.

Quality of life

In two of the four studies that were considered, results pertaining to pain, quality of life, or return to activities were presented.[12,13] Formal pooling was, however, impossible due to the measurements' substantial variability. Sarlos *et al*.[13] concluded that the robotic procedure significantly improved quality of life when compared to laparoscopic surgery, but no statistically significant changes were identified in any other research analyses of patient experience outcomes[13] [Figure 7].

Risk-of-bias assessment

The Cochrane risk-of-bias tool[14] was used to evaluate the quality of the studies. It uses predefined criteria to categorize studies as having a low, moderate, or high risk of bias for each of the seven included domains, which are randomization method, allocation concealment, blinding of participants and staff, blinding of outcome assessment, attrition/commpleteness of data, selective reporting, and other biases, shown as risk of bias assesment graph and summary in Figure 8.

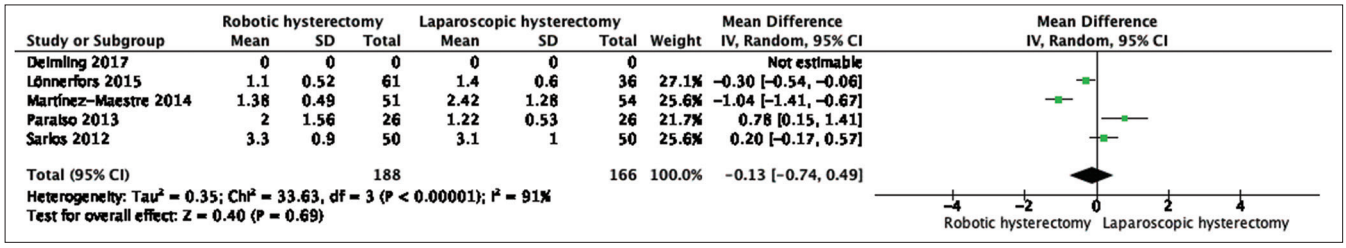

Figure 4: Comparing length of hospital stay. SD: Standard deviation, CI: Confidence interval

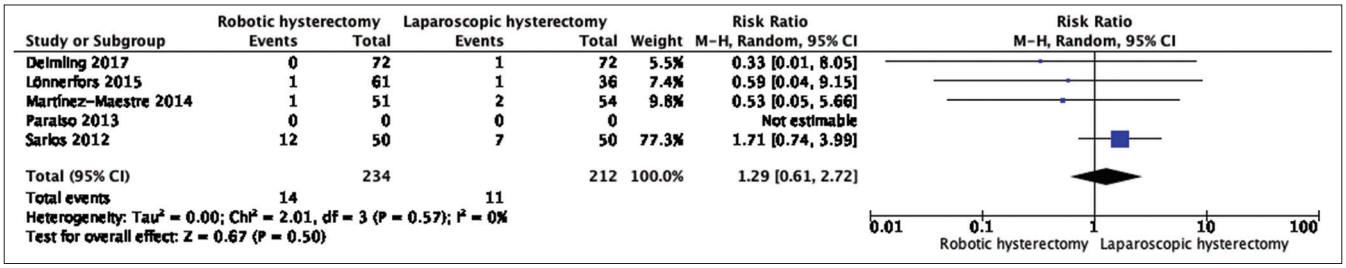

Figure 5: Intraoperative complications. SD: Standard deviation, CI: Confidence interval

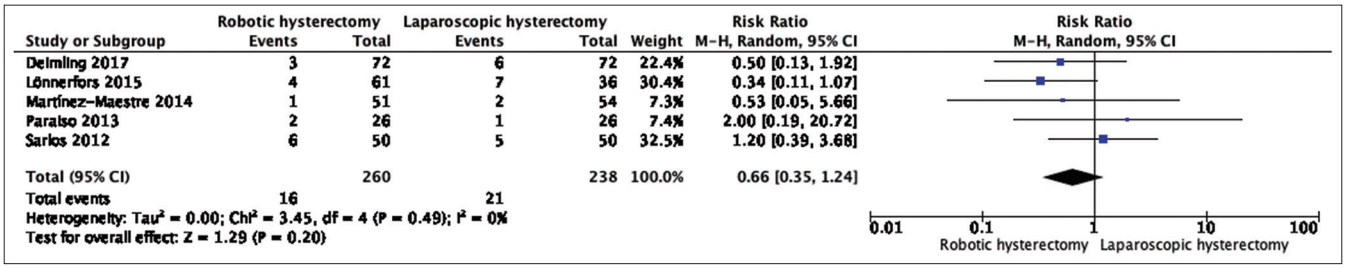

Figure 6: Postoperative complications. SD: Standard deviation, CI: Confidence interval

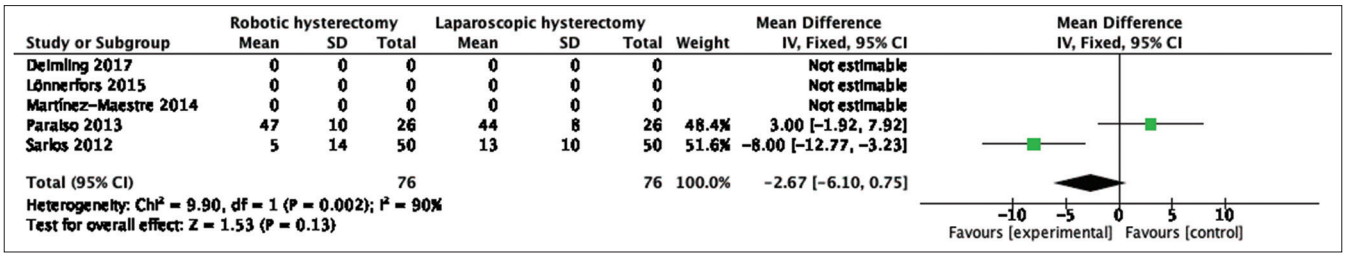

Figure 7: Quality of life. SD: Standard deviation, CI: Confidence interval

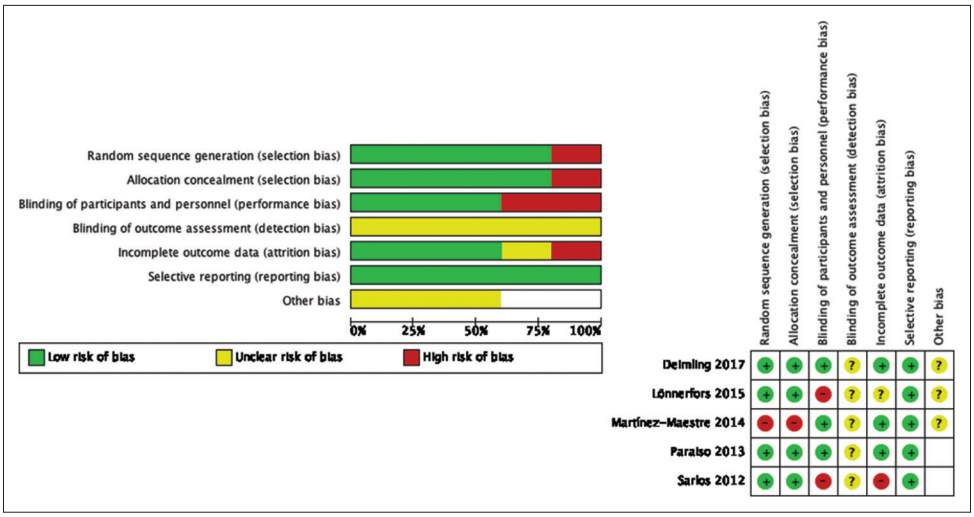

Figure 8: Risk of bias assessment graph and summary

Discussion

Gynecologic procedures like hysterectomy are frequently done for both benign and malignant reasons.[15] The widespread use of MIGS has recently expanded due to the development and validation of robotic surgery, which has improved patient and surgical results.[16] Since its launch a decade ago, robotic surgery has attracted a tremendous amount of public interest and great commercial penetration.

Despite the fact that there has been strong evidence suggesting increased surgical and patient outcomes in MIGS compared to open approaches, debate continues on the advantages and disadvantages of RH versus CLH. Therefore, based on RCT studies, this review offers a thorough comparison of robotic hysterectomy and traditional LH to look at the trajectory of treatment results for the contentious features of these methods.

Overall, we did not discover any clinically relevant or statistically significant differences between the robotic and laparoscopic techniques to hysterectomy for benign illness in this systematic review and meta-analysis of five randomized or quasi-randomized studies with a total of 498 individuals. We did not include observational studies in our meta-analysis and restricted our study to randomized and quasi-randomized trials. For the purpose of assessing a novel surgical technique for an ultimately elective surgical treatment that is indicated, the rigorousness of RCTs is critically important.

Operating time

In addition to patient-related issues, including obesity, advanced age, increased uterine weight, and significant adhesions, other factors that affect the OT include surgeon skill, surgical technique, docking time, and approach. The OT of CLH in this systematic study was equivalent to RH due to numerous factors affecting OT.

Estimated blood loss

The EBL may be impacted by the two techniques' employment of various instruments. Moreover, individuals with a high BMI may show considerable variations in the EBL between RH and CLH.[17] Studies in this review showed no statistically significant difference between the two groups.

Length of hospital stay

The length of stay was found to be slightly, nonsignificantly shorter for patients receiving RH compared to LH. The likelihood of nosocomial and surgical site infections, readmission rates, and a decline

in the short-term quality of life are all increased by longer length of hospital stay, which elevates morbidity.[18]

Overall complication rate

In a pooled research comparing the rates of intraoperative complications between robotic and LH, we observed no discernible differences. Sarlos *et al*.[13] discovered that the robotic approach significantly improved quality of life when compared to laparoscopic surgery, however, no other research identified any statistically significant improvements in postcomplication rates. Long-term surgical problems included lymphatic drainage issues, but immediate postoperative difficulties were primarily wound and urinary tract infections.[19] In addition, complication risks arise with more complex surgery, student engagement, patient age, and obesity.

Strengths and limitations

The goal of this article is to advance the meta-analysis of robotic surgery by outlining its limitations and making some initial recommendations. Our study's strict inclusion criteria (randomized and quasi-randomized studies) and thorough analysis of complications according to severity levels are its main strengths. Only high-quality studies were included in the bias risk assessment used to evaluate the included articles. We only included individuals in our research who had benign, as opposed to malignant cases undergoing hysterectomy.

Limitations of this systematic review include: first, several research failed to state clearly if the docking time for robotic assisted hysterectomy (RLS) was accounted for in the operative time. Different terminologies make it more difficult to determine the real OT. Second, because patients with a variety of reasons and gynecologic diagnoses were included in this research, surgeon bias and clinical heterogeneity could not be ruled out. The level of surgeon expertise between RLS and CLH in the presence of cutting-edge technology like robotics and an established technology like laparoscopy was not compared in any of the investigations. Last but not least, imputations of SDs were done wherever they were not accessible. Despite the fact that "imputing missing SDs in meta-analyses can provide accurate results,"[20] it is important to be aware of this constraint. To evaluate the representativeness and generalizability of the study sample to the entire population, a large sample size is necessary.

Conclusion

This systematic review found no statistical difference between robotic and CLH relating to OT, EBL, length of hospital stay, overall complications, and survival. However, compared to CLH, the expense of a robotic hysterectomy continues to be much greater. A safe and similar alternative to CLH is a robotic hysterectomy, which may be more advantageous in patients with big uteri and obesity. It is essential to interpret these analyses with precaution as robotic hysterectomy is a relatively new technology and is in its evolution. To remove bias and offer enough proof to prove the superiority of the robotic method in benign gynecology and clearly outline the benefits of this technology in the well-selected patient group, larger multi-centered RCTs and more focused studies are necessary.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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