Salpingectomy vs tubal ligation for sterilization: a systematic review and meta-analysis

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OBJECTIVE: After strong evidence and major organizations recommending salpingectomy over tubal ligation, we sought to perform a systematic review and meta-analysis comparing the intraoperative attributes and complication rates associated with these 2 procedures.

DATA SOURCES: We searched PubMed, the Cochrane Library, Embase, and clinical trials registries without time or language restrictions. The search was conducted in February 2020. Database searches revealed 74 potential studies, of which 11 were examined at the full-text level. Of these, 6 studies were included in the qualitative analysis and 5 studies were included in the meta-analysis.

STUDY ELIGIBILITY CRITERIA: We included randomized controlled trials comparing salpingectomy with tubal ligation in women seeking sterilization. We included studies that also had at least 1 outcome listed in the population/patient problem, intervention, comparison, outcome, and time. Articles were excluded if they did not meet the inclusion criteria or if data were not reported and the authors did not respond to inquiries.

STUDY APPRAISAL AND SYNTHESIS METHODS: Abstracts and full-text articles were assessed by 2 authors independently using the blinded coding assignment function or EPPI-Reviewer 4. Conflicting selections were resolved by consensus. The quality of included studies was determined using the Cochrane Collaboration tool for assessing the risk of bias in randomized trials. Two authors independently assessed the risk of bias for each study; disagreements were resolved by consensus.

RESULTS: There were few differences between the procedures, with no differences in most important clinical outcomes (antimüllerian hormone, blood loss, length of hospital stay, pre- or postoperative complications, or wound infections). A single study reported a reduced rate of pregnancies with salpingectomy (risk ratio, 0.22; 95% confidence interval, 0.05–1.02), but this did not reach statistical significance (P=.05).

CONCLUSION: We conclude from these data that salpingectomy is as safe and efficacious as tubal ligation for sterilization and may be preferred, where appropriate, to reduce the risk of ovarian cancer.

Key words: risk-reducing salpingectomy, risk-reducing surgery, salpingectomy, sterilization, surgery to reduce the risk of ovarian cancer, tubal ligation

Introduction

Many authors have documented the connection between removal of the fallopian tubes and a decreased risk of ovarian cancer, particularly serous carcinomas.[1–5] Ovarian serous carcinomas are believed to originate directly from epithelial cells within the fallopian tube secondary to a coexisting TP53 mutation.[6,7] Although clinically the idea of salpingectomies for the prevention of ovarian cancer seems promising, there is no unequivocal evidence to support this practice. However, the theoretical prevention of cancer risk that salpingectomy may confer in women seeking sterilization is worth investigating.

Before the release of the Committee Opinion Number 620 of the American College of Obstetricians and Gynecologists in January of 2015[8] (later replaced by Committee Opinion Number 774 in March of 2019),[9] salpingectomy for the purpose of sterilization was a rarely performed practice, because multiple authors had described many methods of minimally invasive interruption of the fallopian tubes without necessitating their complete removal.[10,11] Although routinely performed at the time of removal of the ovaries with hysterectomy, salpingectomy as a distinct procedure was rarely performed before this time, with the exception of oncologic procedures and definitive correction of failed tubal ligation procedures.[12,13]

After these opinions and the supporting evidence, there has been a trend toward "opportunistic" salpingectomy to decrease a patient's risk of ovarian cancer, and it is generally accepted that tubal ligation should be avoided in favor of salpingectomy in most cases.[14–16] Barriers to universal acceptance of salpingectomy for sterilization include the fact that it is a more advanced surgical procedure, potential increased operative

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AJOG at a Glance

Why was this study conducted?

After strong evidence and major organizations recommending salpingectomy over tubal ligation, we sought to perform a systematic review and meta-analysis to analyze and compare the safety and complications of these 2 procedures.

Key findings

Our limited data speak to similar safety and complication rates in these 2 procedures.

What does this add to what is known?

Our limited data contribute to the increasing body of evidence in support of performing salpingectomy over tubal ligation, when feasible, to confer the additional benefit of partial ovarian cancer protection to the patient.

time, lack of coverage of salpingectomy vs ligation with insurance providers, and the potential for greater risk of preoperative and postoperative complications.[14,17,18] Therefore, tubal ligations are still performed routinely in the United States in many areas.[19]

Salpingectomy and tubal ligation for the purpose of sterilization can be performed at any time during a woman's reproductive years, although the most common times will be in the postpartum period and directly after an uncomplicated cesarean delivery.[20] Salpingectomy performed at the time of cesarean delivery or in the first weeks after delivery could be complicated by both the increased blood supply of the gynecologic organs after pregnancy and the increased size of the uterus, which could distort the anatomy and impede safe laparoscopic entry into the abdomen.[21] The techniques for salpingectomy commonly include laparoscopy and through an open incision at the time of cesarean delivery.[22] Tubal ligation is commonly performed under the same circumstances, although tubal ligation through umbilical minilaparotomy is also very common immediately after vaginal delivery. Salpingectomy is rarely performed in this way.[23] Vaginal and hysteroscopic approaches to salpingectomy or tubal ligation are rarely used in the United States.[24]

Therefore, despite the recommendation for intensive counseling for all women, there is no clear consensus in the United States that salpingectomy should be performed in favor of tubal ligation, even in areas that have abundant resources to provide the procedure.

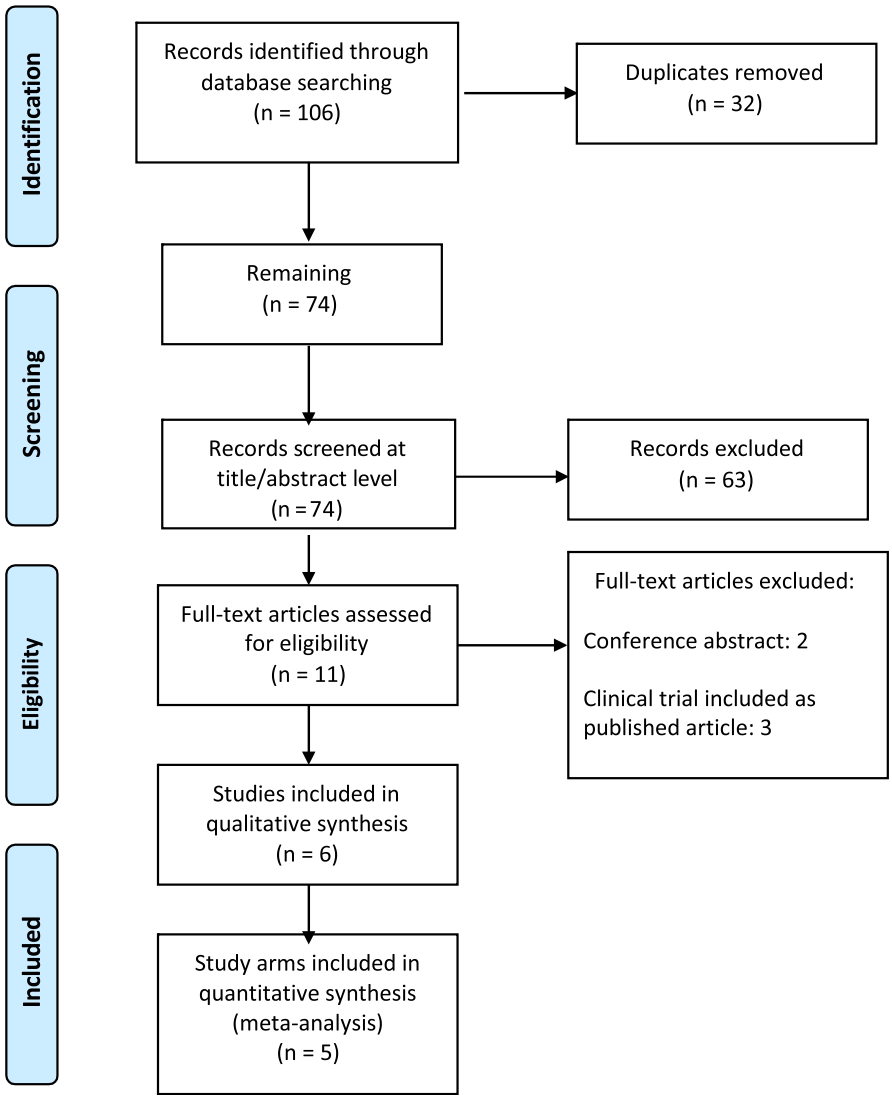
Therefore, in this review, we aimed to systematically identify, appraise, and summarize the existing data from randomized control trials that compare the attributes of the practice of salpingectomy and tubal ligation.

Materials and Methods

Review registration

This systematic review and meta-analysis was conducted in accordance

FIGURE 1
PRISMA flow diagram



PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

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TABLE
Study characteristics

Author (year)	Age of participants (y)	BMI (kg/m^2)	N intervention	N control	Intervention type	Control type	Follow-up duration	Country	Funding
Ganer Herman et al[32] (2017)	35.6	26.9	22	24	Bilateral salpingectomy	Bilateral tubal ligation	6–8 wk	Israel	None
Garcia et al[33] (2018)	32.2	37.3	19	18	Bilateral salpingectomy	Bilateral tubal ligation	Not reported	USA	None
Torbenson[34] (2017)	33.6	Not reported	18	20	Bilateral salpingectomy	Bilateral tubal ligation	24–48 h	USA	Not reported
Rodriguez et al[35] (2013)	30.1	Not reported	702	698	Partial Salpingectomy	Titanium clip	1, 6, 12, and 24 mo	Switzerland	USAID
Subramaniam et al[36] (2018)	32.7	39.1	27	38	Bilateral salpingectomy	Bilateral tubal ligation	1–6 wk	USA	Debra Kogan Lyda Memorial Ovarian Cancer Fund
Ongoing study									
Bnai Zion Medical Center[26] (2016)	30–50	No data	50?	50?	Bilateral salpingectomy	Bilateral tubal ligation	5 d; 3 mo	Israel	Bnai Zion Medical Center

BMI, body mass index; *ID*, identity; *N*, number; *USAID*, United States Agency for International Development.

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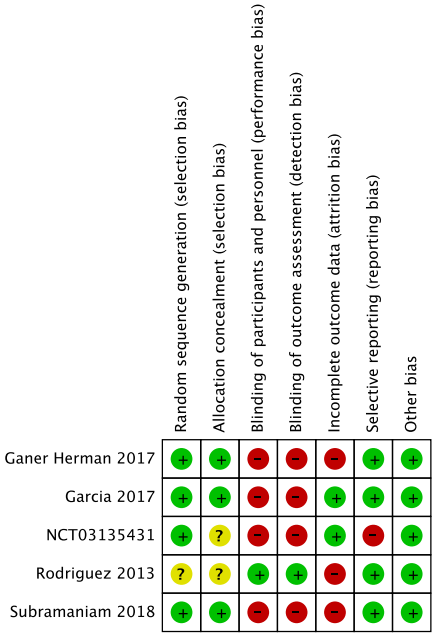
FIGURE 2
Risk of bias summary and graph



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with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare interventions.[25] The protocol for the review was registered prospectively in the International Prospective Register of Systematic Reviews (CRD42020168113).

Review question (population/patient problem, intervention, comparison, outcome, and time)

Our review question was as follows: In women seeking sterilization, does salpingectomy compared with tubal ligation result in a change in antimüllerian hormone (AMH), surgical time, length of hospitalization, blood loss, hemoglobin, hematocrit, complications, reoperation rate, and unplanned pregnancies over the perioperative period (operative outcomes) and postoperative period (complications) and in the long term (rate of pregnancies) in an inpatient, outpatient, and free-living situation?

Data sources and search strategy

We searched PubMed, the Cochrane Library, Embase, and clinical trials registries without time or language restrictions, using key words and MeSH terms, where applicable. The search was conducted in February 2020. The search strategy was: salpingectomy or "fallopian tube removal" or "fallopian tube excision" or "tubal sterilization" and "tubal ligation" or "bipolar coagulation" or fimbriectomy or "Irving procedure" or "tubal clip" or "tubal ring" and "randomized controlled trial [pt]" or "controlled clinical trial [pt]" or randomized [tiab] or placebo [tiab] or randomly [tiab] or groups [tiab]."

Inclusion/exclusion criteria

Included studies met the following criteria: randomized controlled trials comparing salpingectomy with tubal ligation in women seeking sterilization. Included studies also had at least 1 outcome listed in the population/patient problem, intervention, comparison,

outcome, and time. Articles were excluded if they did not meet the inclusion criteria or if data were not reported and the authors did not respond to inquiries (1 study only).[26]

Study selection

Abstracts and full-text articles were assessed by 2 authors independently using the blinded coding assignment function or EPPI-Reviewer 4.[27] Conflicting selections were resolved by consensus.

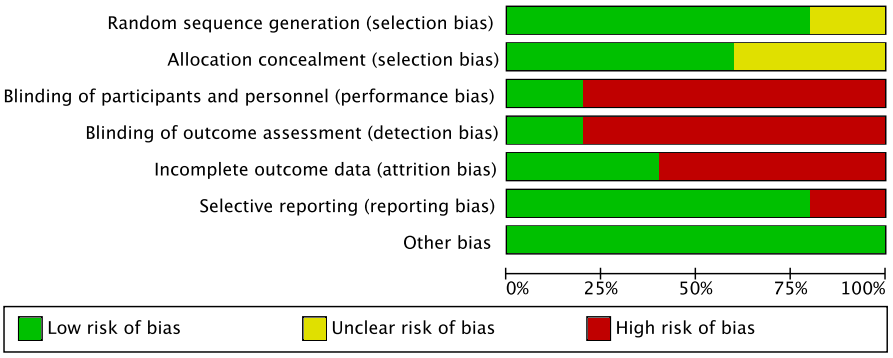
Study quality

The quality of included studies was determined using the Cochrane Collaboration tool for assessing the risk of bias in randomized trials.[28] Two authors independently assessed the risk of bias for each study; disagreements were resolved by consensus.

Data extraction

Data extraction was performed by 1 author (K.S.) and checked by a second author (S.R.). Study characteristics were extracted, along with the outcomes of interest. Standard errors were converted to standard deviations (SDs) using the following equation: SD=standard error of the mean×square root (N), where N is the number in the study arm. Where only medians and interquartile ranges were reported, these were converted to means and SDs using VassarStats[29] following the work of Hozo, Djulbegovic, and Hozo.[30] Because this is an imputation, a sensitivity analysis was undertaken removing studies for which this methodology was used.

FIGURE 3
Risk of bias graph



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Statistical analysis

The meta-analysis of data from included studies was conducted using Review Manager 5.3[31] using a random effects model. A random effects model was chosen because we anticipated that differences in effect sizes would be influenced by factors other than chance, such as the timing of the procedure (during cesarean delivery or not, age, the hospital or clinic doing the procedure, etc.). For continuous outcomes, we calculated mean differences (MDs) with 95% confidence intervals (CIs) using an inverse variance model. For dichotomous outcomes, we calculated risk ratios (RRs) with 95% CI using a Mantel-Haenszel model.

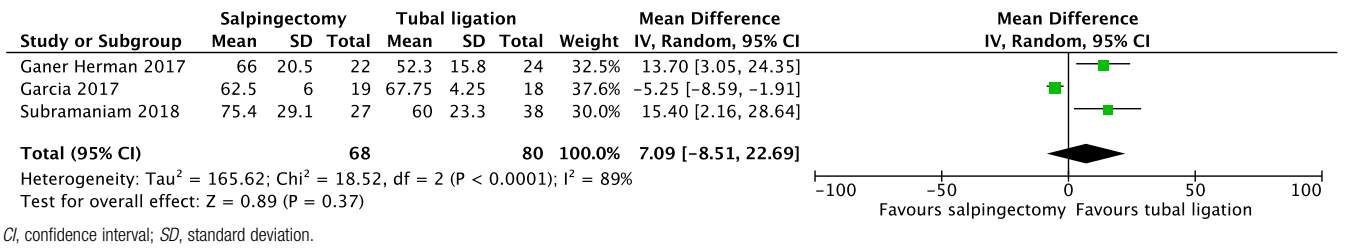
Heterogeneity was determined using Tau^2, chi-square, and I^2 tests. Heterogeneity as defined by I^2 was considered to be minor if 0% to 40%, moderate if 30% to 60%, substantial if 50% to 90%, and considerable if 75% to 100%. The percentage heterogeneity was interpreted in the context of the magnitude of the effect size and the strength of evidence surrounding the heterogeneity.

Results

Search results

We identified 106 citations through database searching. Of these, 32 were duplicates. The remaining 74 studies were subjected to title and abstract screening. Of these 63 abstracts were excluded. The 11 remaining abstracts were screened at the full-text level. Of these, 5 were excluded because the data (in conference abstracts or published on a clinical trials registry) were already published in peer-reviewed journals and included in our analysis. Of the 6 included studies, 5 were included in the meta-

FIGURE 4
Length of surgical time



CI, confidence interval; *SD*, standard deviation.

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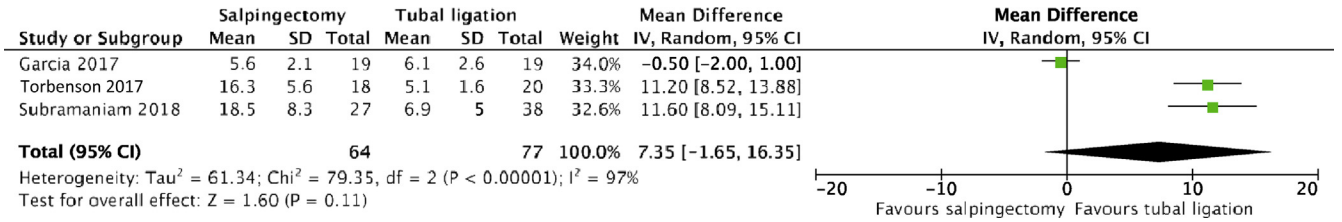
FIGURE 5
Length of procedure time



CI, confidence interval; *SD*, standard deviation.

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analysis[32–36] and 1 study is ongoing[26] (Figure 1). We contacted the authors of the ongoing clinical trial but received no response.

Study characteristics

The characteristics of the included studies are given in the Table. The studies included 4 published peer-reviewed clinical trials along with 1 registered clinical trial that has not yet been published. The mean age of the patients was between 30.1 and 35.6 years, with the average body mass index of the 3 studies that reported this measure being 34.4 kg/m^2. The studies ranged in size from 37 to 1400 participants and compared partial or bilateral salpingectomy with bilateral tubal ligation or titanium clip. Three studies took place in the United States, with 1 in Israel and 1 in Switzerland.

Study quality

The quality of the included studies was mostly good, with most articles displaying low risk of bias from randomization, allocation concealment, selective reporting, or other (Figures 2 and 3). None of the studies was blinded to the personnel or participants, but 1 study (Rodriguez et al,[35] 2013) reported only on rates of pregnancy—an outcome hardly influenced by the knowledge of which procedure the woman had undergone.

Length of surgery

The length of surgical time was reported by 3 studies (Figure 4). There were no significant differences in the length of surgical time between those undergoing salpingectomy and those undergoing tubal ligation (MD, 7.09 m; 95% CI, −8.51 to 22.69) (P=.37). I^2 was again considerable and driven entirely by Garcia et al.[33] Removal of this study resulted in a significant increase in surgical time for salpingectomy compared with tubal ligation (MD, 14.37 m; 95% CI, 6.07−22.6) (P=.0007).

Length of procedure

The length of the procedure during the surgery was reported by 3 studies (Figure 5). There were no significant differences in the procedural length between those undergoing salpingectomy and those undergoing tubal ligation (MD, 7.09 m; 95% CI, −8.51 to 22.69) (P=.37). I^2=97%, again driven entirely by Garcia et al.[33] Removal of this study resulted in a significant increase in procedure time for salpingectomy compared with tubal ligation (MD, 11.35 m; 95% CI, 9.22−13.48) (P<.00001).

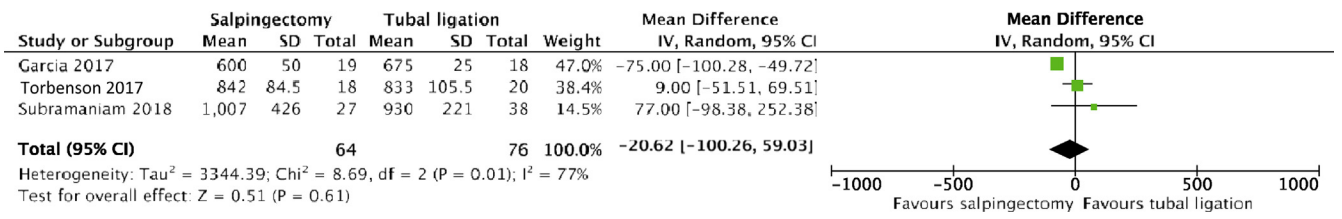
Length of hospitalization

The length of hospitalization was reported by 3 studies (Supplemental Figure 1). Hospitalization time was not significantly different between salpingectomy and tubal ligation (MD, −0.01 days; 95% CI, −0.54 to 0.53; P=.98). I^2 was considerable, but no single study was responsible for most of the heterogeneity.

Hematological changes

Blood loss. Blood loss during the operation was reported by 3 studies (Figure 6). There were no significant differences in blood loss between those undergoing salpingectomy and those undergoing tubal ligation (MD, −25.20 mL; 95%

FIGURE 6
Intraoperative blood loss



CI, confidence interval; *SD*, standard deviation.

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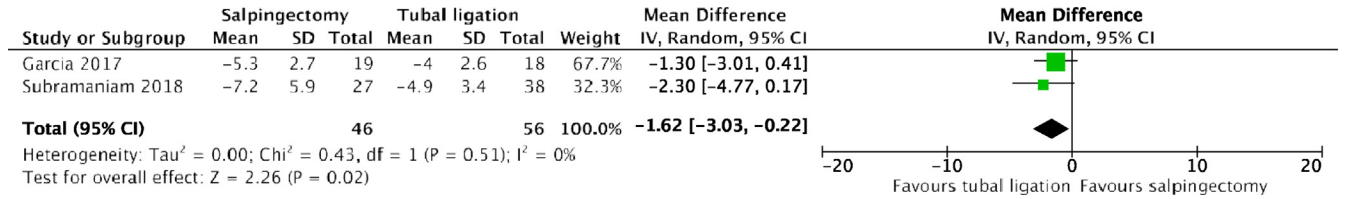
FIGURE 7
Percentage decrease in hematocrit



CI, confidence interval; *SD*, standard deviation.

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CI, −125.32 to 74.93) (*P*=.62). Heterogeneity as measured by I^2 was considerable; this was driven entirely by Garcia et al.[33] Removal of this study slightly changed the effect size (MD, 16.23; 95% CI, −40.97 to 73.44) (*P*=.58), but did not change the conclusions.

Percentage decrease in hematocrit. The percentage change in hematocrit was reported by 2 studies (Figure 7). There was a small but significantly higher decrease in hematocrit after salpingectomy than after tubal ligation (MD, −1.62%; 95 % CI, −3.03 to −0.22) (*P*=.02). There was no heterogeneity in the analysis.

Change in hemoglobin. The decrease in hemoglobin was reported by 2 studies (Figure 8). There were no significant differences in hemoglobin between salpingectomy and tubal ligation (MD, 0.33 mg/dL; 95% CI, −0.07 to 0.74) (*P*=.11).

Perioperative complications

Risk of intraoperative complications. The risk of intraoperative complications was reported by 2 studies (Supplemental Figure 2). One study reported no complications, whereas Subramaniam et al,[36] reported a single complication in the tubal ligation group.

Risk of postoperative complications. The risk of postoperative complications was reported by 2 studies (Supplemental Figure 3). There were no significant differences between salpingectomy and tubal ligation in the rate of postoperative complications (RR, 1.41; 95% CI, 0.31−6.37) (*P*=.66). There was no heterogeneity in the analysis.

Risk of wound infections. The risk of wound infections was reported by 2 studies (Supplemental Figure 4). There were no significant differences between salpingectomy and tubal ligation in the rate of wound infections (RR, 1.77; 95% CI, 0.23−13.76) (*P*=.59).

Reoperation and rehospitalization rates

Risk of rehospitalization. The risk of 90-day rehospitalization was reported by 2 studies (Supplemental Figure 5). One study reported no rehospitalizations, whereas Subramaniam et al,[36] reported a single rehospitalization in each group.

Risk of reoperation. The risk of 90-day reoperation was reported by a single study (Garcia et al[33]) (Supplemental Figure 6). There were no reoperations in either group.

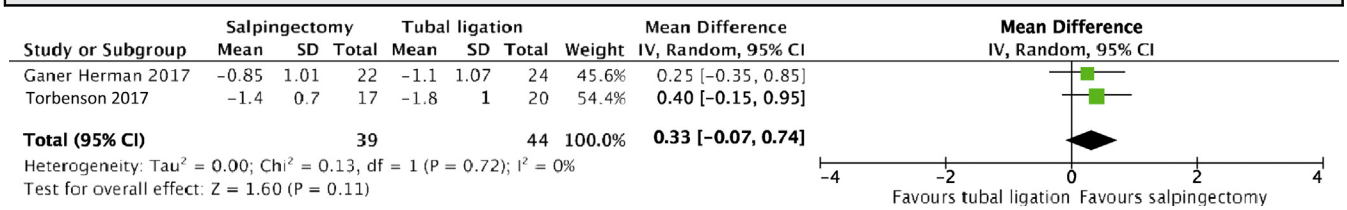
Risk of postoperative pregnancies

The risk of pregnancies after sterilization with salpingectomy or tubal ligation was reported in a single study (Rodriguez et al[35]) (Figure 9). The risk of pregnancy was lower with salpingectomy but did not reach statistical significance (RR, 0.22; 95% CI, 0.05−1.02) (*P*=.05).

Antimüllerian hormone

One study reported on the change in AMH[32] (Supplemental Figure 7). There was no statistically significant difference between salpingectomy and tubal ligation for this outcome (MD, 0.19; 95% CI −0.33 to 0.71) (*P*=.47).

FIGURE 8
Change in hemoglobin



CI, confidence interval; *SD*, standard deviation.

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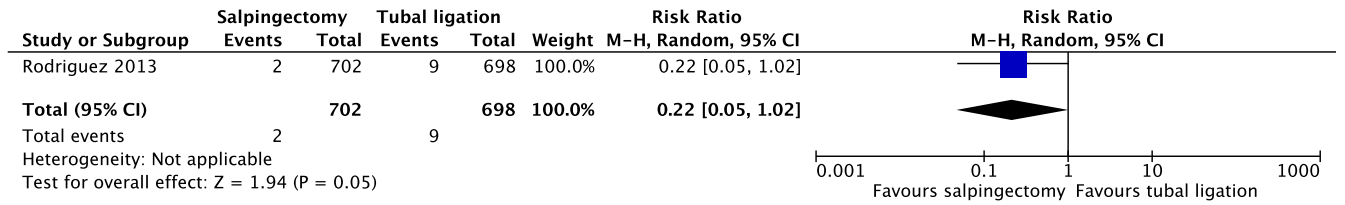
FIGURE 9
Risk of postoperative pregnancy



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Discussion

Principal findings

There were few differences between the procedures, with no differences in the most important clinical outcomes (AMH, blood loss, length of hospital stay, pre- or postoperative complications, or wound infections). A single study reported a reduced rate of pregnancies with salpingectomy (RR, 0.22; 95% CI, 0.05−1.02), but this did not reach statistical significance (P=.05).

Results

In our systematic review and meta-analysis, we compared the efficacy and safety of salpingectomy with tubal ligation for voluntary sterilization. Salpingectomy was generally associated with statistically significant increases in procedure and surgical length, especially after sensitivity analysis (Figures 4 and 5). However, this increased time was modest, being approximately 11 and 14 minutes, respectively.

Furthermore, there were no significant differences in blood loss, hemoglobin, perioperative complications, or rehospitalizations (Figures 6 and 8 and Supplemental Figures 2, 3, 4, 5, and 6). There was a small but significant percentage reduction in hematocrit associated with salpingectomy, but again this effect was modest (Figure 7).

Given that the aim of the procedure is voluntary sterilization, it was notable that the rate of pregnancy after salpingectomy was starkly reduced. Although this did not reach statistical significance (P=.05), it indicates that salpingectomy may be markedly more effective at achieving its primary aim—preventing unwanted pregnancies. This finding is in line with evidence that tubal recanalization can occur and result in pregnancy.[12]

Clinical implications

It is believed that salpingectomy results in a decrease in the lifetime risk of epithelial cell ovarian cancer, particularly serous carcinoma. However, evidentiary research is lacking in this topic and requires additional attention. If a woman is seeking a permanent and effective method of contraception, salpingectomy can be considered, especially if the goal is to theoretically reduce the risk of ovarian cancer in the future. This is particularly true, given the absence of serious adverse events associated with salpingectomy. An in-depth discussion should take place between the physician and the patient to discuss possible benefits and risks of fallopian tube removal.

Although no single study can effectively replace the decision-making process that enters into a physician's decision to proceed with salpingectomy or tubal ligation, our review of the available data supports the choice of salpingectomy over tubal ligation in most circumstances.

However, tubal ligation is not always a poor choice. If a surgeon performing a cesarean delivery combined with sterilization did not have training or experience in salpingectomy, the patient would likely be better served by tubal ligation at the time of cesarean delivery than to forego sterilization and thereby require the patient to undergo a second surgical procedure in the future.

A second scenario where tubal ligation may be preferred is in the case of severe adhesive disease in the pelvis, which obliterates much of the normal anatomy. In this case, the authors agree that the decision to either convert to laparotomy from laparoscopy or engage in an extensive dissection of the pelvic retroperitoneum solely for the purpose of removing the entire fallopian tube was likely not in the patient's best interests. Therefore, the authors agree that in these cases simply performing a tubal ligation on the recognizable portions of the fallopian tube is likely more in the patient's best interest. However, with the exception of these situations, our study provides evidence that salpingectomy is safe and effective.

Research implications

We intended to perform a subgroup meta-analysis by the method of sterilization. Differences in outcomes may have been evident between intrapartum cesarean, laparoscopic, and robot-assisted laparoscopic salpingectomy and tubal ligation. We were unable to perform these analyses given the lack of studies available to us. As more data become available from high-quality, randomized controlled trials, these analyses can be performed. These data will add critical significance to the available literature regarding the decision between these 2 procedures.

Strengths and limitations

As stated, the quantity and quality of data comparing these 2 procedures limited our analysis. This resulted in the relatively small sample size of the included studies and the limited number of outcomes reported. Furthermore, although our study did not show many significant differences in the reported

complications, one cannot rule out the possibility that a larger study may bring to light other adverse events that were not reported in the available literature. We feel the main strength of our analysis is the novelty of the approach, because to the best of our knowledge, no previous authors had set out to compare these procedures with a formal analysis.

Conclusion

Salpingectomy seems to be as safe as tubal ligation and may be substantially more effective at achieving permanent sterilization. Given its possible benefits in preventing ovarian cancer, salpingectomy may well become the preferred method for voluntary sterilization in the future. The evidence from our systematic review and meta-analysis supports this view, but further high-quality studies are urgently required. ■

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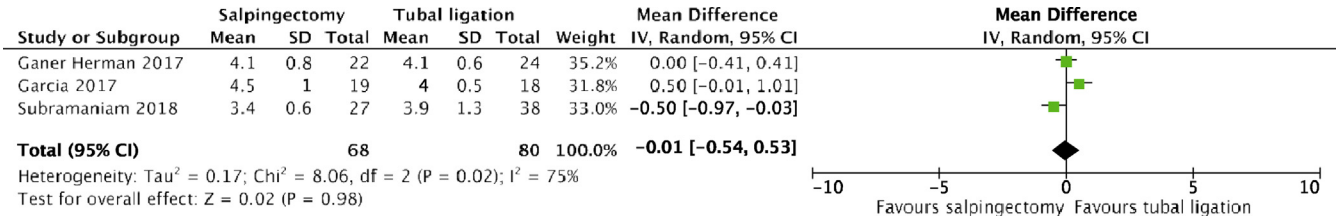
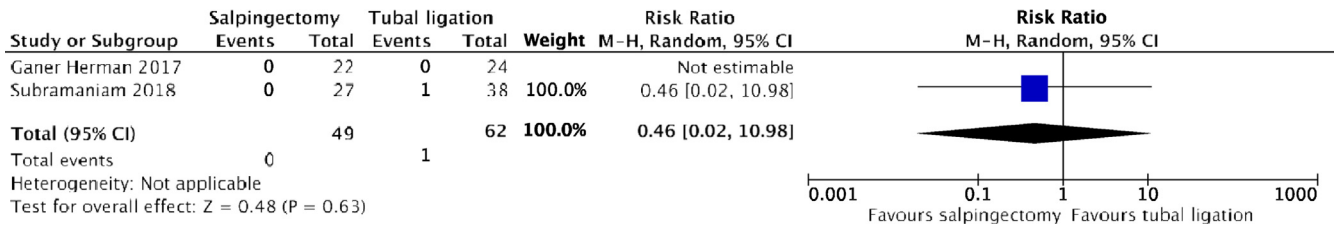
SUPPLEMENTAL FIGURE 1
Length of hospitalization



CI, confidence interval; *SD*, standard deviation.

Mills. Salpingectomy vs tubal ligation: a systematic review and meta-analysis. Am J Obstet Gynecol 2021.

SUPPLEMENTAL FIGURE 2
Risk of intraoperative complications



CI, confidence interval; *SD*, standard deviation.

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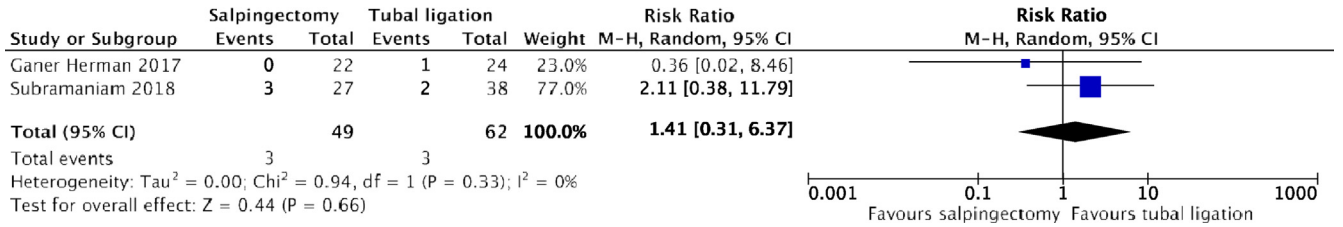
SUPPLEMENTAL FIGURE 3
Risk of postoperative complications



CI, confidence interval; *SD*, standard deviation.

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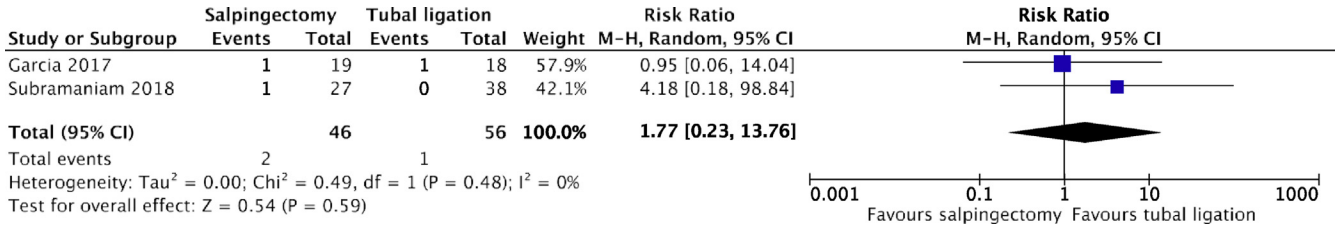
SUPPLEMENTAL FIGURE 4
Risk of wound infections



CI, confidence interval; *SD*, standard deviation.

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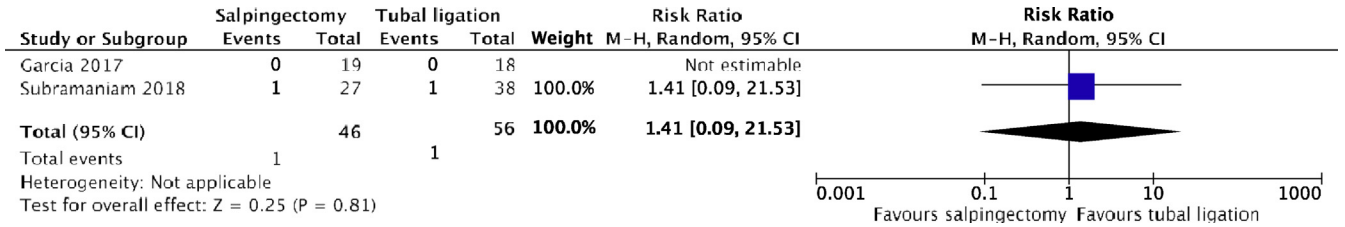
SUPPLEMENTAL FIGURE 5
Risk of rehospitalization



CI, confidence interval; *SD*, standard deviation.

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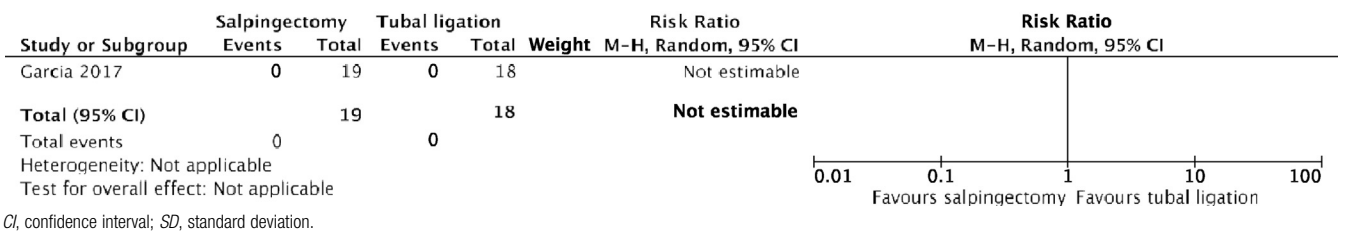
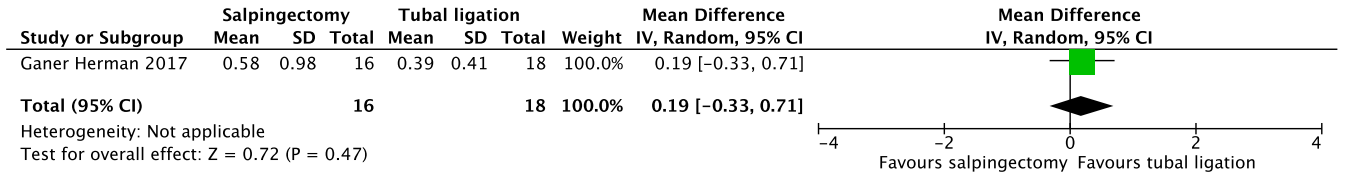
SUPPLEMENTAL FIGURE 6
Risk of reoperation



CI, confidence interval; *SD*, standard deviation.

Mills. Salpingectomy vs tubal ligation: a systematic review and meta-analysis. Am J Obstet Gynecol 2021.

SUPPLEMENTAL FIGURE 7
Antimüllerian hormone



Mills. Salpingectomy vs tubal ligation: a systematic review and meta-analysis. Am J Obstet Gynecol 2021.