The potential damage of laparoscopic electrocoagulation on ovarian reserve in endometriomas reduced in benign ovarian cysts: A systematic review and meta-analysis

Tsung-Hsien Lee[1], Yu-Hsuan Lin[1], Li-Hsin Hsia[1], Yun-Yao Huang[1], and Hao-Jung Chang[1]

[1]Chung Shan Medical University Hospital

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Abstract

Background Laparoscopic cystectomy for ovarian endometriomas and benign ovarian cysts often involves the use of hemostatic methods, with electrocoagulation using bipolar energy as a common approach. This study aimed to assess the impact of electrocoagulation compared to nonthermal hemostatic methods on ovarian reserve during such surgeries. **Objectives** To evaluate the influence of electrocoagulation using bipolar energy versus nonthermal hemostatic methods on ovarian reserve in patients undergoing laparoscopic cystectomy for endometriomas and benign ovarian cysts. **Search Strategy** A systematic review with meta-analysis was conducted by searching the Cochrane Library, PubMed, EMBASE, and Web of Science databases. Entry terms associated with MeSH terms, such as "ovarian cysts," "laparoscopy," "electrocoagulation," and "anti-Müllerian hormone" or "antral follicle count" were used for articles published before October 2022. **Selection Criteria** Randomized controlled trials (RCTs) comparing the impact of nonthermal hemostatic methods with electrocoagulation on ovarian reserve during laparoscopic cystectomy were included. The Cochrane Risk of Bias Tool for Randomized Controlled Trials (ROB 2.0) was utilized to assess the quality of included studies. **Data Collection and Analysis** Thirteen RCTs involving 1043 patients were included in the meta-analysis. Postoperative serum anti-Müllerian hormone (AMH) levels and antral follicle counts (AFC) were analyzed using Review Manager ver. 5.4. **Main Results** In patients with endometriomas, the nonthermal hemostatic group exhibited significantly higher postoperative AMH levels at one, three, six, and 12 months compared to the bipolar group. Conversely, no significant differences in AMH levels were observed in patients with benign ovarian cysts. Similarly, the AFC levels showed no significant differences, except for a lower postoperative AFC in the electrocoagulation group for endometrioma cases. **Conclusions** Nonthermal hemostatic methods are associated with better preservation of ovarian reserve compared to bipolar electrocoagulation in laparoscopic cystectomy for ovarian endometriomas. However, no significant impact on ovarian reserve was observed with bipolar electrocoagulation in patients with benign ovarian cysts.

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Running title: Effects of Electrocoagulation on Ovarian Reserve

Yu-Hsuan Lin, MD[1]

Li-Hsin Hsia, MD[1]

Yun-Yao Huang, MD[1,2]

Hao-Jung Chang, MD[1]

Tsung-Hsien Lee, MD, Ph.D. [1,2,3]

[1] Department of Obstetrics and Gynecology, Chung Shan Medical University Hospital, Taichung 40203, Taiwan

[2]Institute of Medicine, Chung Shan Medical University, Taichung 40203, Taiwan

[3]Division of Infertility, Lee Women's Hospital, Taichung 40602, Taiwan

Corresponding author:

Tsung-Hsien Lee, MD, Ph.D.

Chung Shan Medical University Hospital, Department of Obstetrics and Gynecology

No. 110, Section 1, Jianguo N Rd, South District, Taichung City, 402

Tel: +886-4-2473-9595 # 801091

jackth.lee@gmail.com

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ABSTRACT

Background

Laparoscopic cystectomy for ovarian endometriomas and benign ovarian cysts often involves the use of hemostatic methods, with electrocoagulation using bipolar energy as a common approach. This study aimed to assess the impact of electrocoagulation compared to nonthermal hemostatic methods on ovarian reserve during such surgeries.

Objectives

To evaluate the influence of electrocoagulation using bipolar energy versus nonthermal hemostatic methods on ovarian reserve in patients undergoing laparoscopic cystectomy for endometriomas and benign ovarian cysts.

Search Strategy

A systematic review with meta-analysis was conducted by searching the Cochrane Library, PubMed, EMBASE, and Web of Science databases. Entry terms associated with MeSH terms, such as "ovarian cysts," "laparoscopy," "electrocoagulation," and "anti-Müllerian hormone" or "antral follicle count" were used for articles published before October 2022.

Selection Criteria

Randomized controlled trials (RCTs) comparing the impact of nonthermal hemostatic methods with electrocoagulation on ovarian reserve during laparoscopic cystectomy were included. The Cochrane Risk of Bias Tool for Randomized Controlled Trials (ROB 2.0) was utilized to assess the quality of included studies.

Data Collection and Analysis

Thirteen RCTs involving 1043 patients were included in the meta-analysis. Postoperative serum anti-Müllerian hormone (AMH) levels and antral follicle counts (AFC) were analyzed using Review Manager ver. 5.4.

Main Results

In patients with endometriomas, the nonthermal hemostatic group exhibited significantly higher postoperative AMH levels at one, three, six, and 12 months compared to the bipolar group. Conversely, no significant differences in AMH levels were observed in patients with benign ovarian cysts. Similarly, the AFC levels

showed no significant differences, except for a lower postoperative AFC in the electrocoagulation group for endometrioma cases.

Conclusions

Nonthermal hemostatic methods are associated with better preservation of ovarian reserve compared to bipolar electrocoagulation in laparoscopic cystectomy for ovarian endometriomas. However, no significant impact on ovarian reserve was observed with bipolar electrocoagulation in patients with benign ovarian cysts.

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Keywords

electrocoagulation, nonthermal hemostasis, laparoscopic ovarian cystectomy, endometrioma, benign ovarian cysts, ovarian reserve, anti-Müllerian hormone (AMH), antral follicle count (AFC)

Introduction

Benign ovarian cysts are common gynecological problems in approximately 7 % of women during procreative age[1]. Laparoscopic ovarian cystectomy, rather than oophorectomy, has been considered the surgical treatment of benign ovarian cysts in patients who desire further fertility. Surgeons perform excision of ovarian cysts by stripping the cyst wall, and the subsequent bleeding may be controlled using electrocoagulation, a hemostatic agent, or suturing[2]. The ovarian reserve may be affected by mechanical injury or thermal damage during laparoscopic cystectomy. Mechanical injury is often caused by the removal of healthy ovarian tissue close to the lesion [3]. Furthermore, hemostasis achieved with electrical energy increases the risk of thermal damage to the surrounding ovarian tissue [4].

Treating benign ovarian cysts has become an issue for patients desiring fertility. Previous studies had reported reduced ovarian reserve after laparoscopic cystectomy [5, 6]. Varied types of hemostatic agents have been developed and introduced in surgical intervention to avoid using bipolar coagulation and reduce thermal damage [7]. The hemostatic matrix commonly used is comprised of a gelatin-based matrix and a human-derived thrombin component. When the gelatin granules contact the bleeding site, they swell to tamponade the bleeding. Then, they interact with thrombin and induce clot formation, achieving rapid hemostasis. Studies have been conducted to compare the preservation of ovarian reserve in laparoscopic cystectomy when using nonthermal hemostatic methods versus bipolar coagulation.

Previous studies employed the ovarian reserve to define the functional potential of the ovary and reflect the number and quality of oocytes remaining in the ovary. Several measurements, such as anti-Müllerian hormone (AMH), antral follicle count (AFC), and basal follicle-stimulating hormone (FSH) level, are used to evaluate ovarian reserve [8-10]. Among these ovarian reserve markers, AMH and AFC are the most accurate ones for representing the functional potential of the ovary[11, 12].

A meta-analysis in 2018, including three randomized controlled trials (RCTs), showed a significant adverse effect of bipolar electrocoagulation on postoperative ovarian reserve three months after laparoscopic surgery for endometrioma compared to nonthermal hemostatic methods [13]. In another meta-analysis conducted in 2022, RCTs comparing at least two hemostatic approaches in laparoscopic excision of endometrioma were included. It concluded that suturing is an effective hemostatic method for maintaining a higher ovarian reserve[14]. Naturally, endometrioma is close to the ovarian cortex, where the primordial follicles reside. Consequently, inadvertent damage of the cortex during surgical intervention can result in a more significant loss of follicles. By contrast, other benign ovarian cysts are not located beside the ovarian cortex[15]. Since the detrimental effect of mechanical or thermal injury on other benign ovarian cysts is unclear, we performed a systematic review and meta-analysis to analyze the impact of nonthermal hemostatic methods on ovarian reserve during laparoscopic cystectomy compared to electrocoagulation. We undertook a comprehensive analysis of follow-up data at postoperative 3, 6, and 12 months, providing insights into both short-term and long-term effects of thermal injury induced by electrocoagulation. In contrast to prior meta-analyses, we also conducted separate subgroup analyses on the data for endometriomas and other benign ovarian cysts.

Materials and methods

Objectives

This systematic review and meta-analysis aims to provide a comprehensive summary of the current evidence regarding the impact on ovarian reserve when using nonthermal hemostatic methods compared to electrocoagulation with bipolar current during laparoscopic cystectomy for both endometriomas or benign ovarian cysts.

Study selection

We searched the databases PubMed/Medline, Cochrane Library, Web of Science/Knowledge, and Embase. We searched associated terms on the PubMed MeSH database for "ovarian cysts," "laparoscopy," "electrocoagulation," and "anti-Müllerian hormone," or "antral follicle count." Then, we searched for articles in the mentioned databases to find those published before October 2022. We also hand-searched the bibliographies of included studies and previous systematic reviews to identify further relevant trials. We included RCTs that evaluate the impact of bipolar coagulation on postoperative ovarian reserve in comparison to nonthermal hemostasis methods during laparoscopic surgery. The included studies measured preoperative and postoperative AMH or AFC in premenopausal women who underwent laparoscopic cystectomy. The two authors (LHH and YHL) independently screened the titles and abstracts of the studies under consideration for inclusion and eliminated the ineligible ones. The selection process did not involve the use of any automation tool. The eligible studies' entire texts were examined to determine their suitability for inclusion. Any disagreements concerning the inclusion of a study were resolved by discussing the matter or consulting with a third author (THL).

Inclusion and exclusion criteria

Inclusion criteria: Studies that met all of the following criteria were eligible for the analysis: (1) RCTs; (2) patients with a diagnosis of endometrioma or other benign ovarian cysts who underwent laparoscopic surgery; (3) compare the different impacts on the ovarian reserve between nonthermal hemostatic methods and electrocoagulation during laparoscopic surgery; (4) measurements of preoperative and postoperative AMH, or AFC levels.

Exclusion criteria: Studies that met any of the following criteria were excluded: (1) animal studies; (2) non-randomized-controlled studies; (3) patients with solid tumors, e.g. thecoma, fibroma, etc., or suspected malignancy; (4) abstracts, letters, editorials, expert opinions, reviews, and case reports (5) studies that did not evaluate ovarian function, did not specify their hemostatic method, or did not meet all the inclusion criteria (6) articles that are not written in English; (7) Studies published before 1990.

Assessment of risk of bias

We assessed the risk of bias in the RCTs with the Cochrane Risk of Bias Tool for Randomized Controlled Trials (ROB 2.0). The bias was classified into five domains, including (1) Bias arising from the randomization process; (2) Bias due to deviations from intended interventions; (3) Bias due to missing outcome data; (4) Bias in measurement of the outcome; (5) Bias in selection of the reported result. Two authors (YHL, LHH) independently evaluated bias in each RCT; a third author (THL) would be consulted if no consensus was reached.

Data extraction and assessment

After independently reviewing all the abstracts, two authors (YHL, LHH) agreed on their potential relevance. If any discrepancies could not be resolved, a third author (THL) was present to settle them. One author performed the data extraction (YYH), and a second author (HJC) verified it. Study characteristics were extracted, together with the results that were of interest.

Statistical analysis and data synthesis

The outcomes of the present meta-analysis included mean serum AMH levels (in ng/mL) and mean AFC counts, along with their respective standard deviations, both preoperatively and at postoperative 1,3,6 and 12 months. These measures were utilized to evaluate ovarian reserve. AMH decline rate was also evaluated. The datasets of comparable outcome measures were pooled for meta-analysis using standard statistical procedures in RevMan 5.4 (Review Manager (RevMan). Version 5.4. The Cochrane Collaboration, 2020. Available at revman.cochrane.org). To assess the impact of continuous outcomes represented as mean and standard deviation, we calculated the mean difference along with a 95% confidence interval. $P<0.05$ was considered statistically significant. Statistical heterogeneity was determined by examining the results of the I^2 statistics. A random-effect model was used for meta-analysis with high heterogeneity ($I^2>50$), and a fixed-effect model was used with low heterogeneity. We employed a funnel plot to assess publication bias for the primary outcome. The certainty of evidence for various outcomes was evaluated by two reviewers using the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) system. The GRADE approach categorizes the level of evidence into four grades: high, moderate, low, and very low.

Result

Study selection

Initially, we identified 318 articles. After deduplication (n=93) based on title and abstracts, we excluded 193 irrelevant papers and two studies without full articles available.

Full texts of 30 articles were selected for detailed evaluation, of which 17 randomized trials were eligible for analysis. Three studies were excluded because we could not obtain sufficient information for comparison, and two had an overlap population. Thirteen papers that met the inclusion criteria were left [2-4, 16-25]. The flow diagram illustrating the information extracted from a review of potentially relevant articles can be observed in Figure 1.

Study characteristics

The characteristics of the included studies are given in Table 1. The age of patients was between 18 and 45 years old, and the sizes of ovarian cysts in the selected studies were similar, mainly at a diameter of 3-10 cm. Five of the selected studies included patients with various kinds of ovarian cysts[2, 4, 19, 22, 23], while the others included patients with only endometriomas[3, 16-18, 20, 21, 24, 25]. As for intervention, we defined nonthermal hemostatic method as the experimental group. Six studies used suturing as the nonthermal hemostatic method[4, 16-19, 22], another six used hemostatic matrix or sealants[2, 3, 20, 21, 23, 24], and one study combined suturing with hemostatic matrix[25]. The control group received electrocoagulation using bipolar current. The bipolar current used in all included studies had a power range of 20 to 40 watts. The basal serum AMH level before surgery did not differ significantly between the two groups.

Risk of bias of included studies

The risk of bias in the 13 studies was generally low (Figure 2). Two studies did not use computerized random group allocation[4, 22], leading to some concerns in bias arising from the randomization process.

Synthesis of results

The postoperative serum AMH levels (Figure 3) of the endometrioma patients in the electrocoagulation group were significantly lower than those of the nonthermal hemostatic method group at postoperative one month (mean difference [MD] 0.72, 95% confidence interval (CI) [0.42, 1.03]), three months ([MD]0.68, 95% CI [0.27, 1.09]), six months ([MD] 0.65, 95% CI [0.27, 1.03]), and 12 months ([MD] 0.86, 95% CI [0.69, 1.04]). These findings suggest a more pronounced negative impact of electrocoaguation on the ovarian reserve of endometrioma patients [3, 16, 17, 20, 24, 25]. However, when analyzing patients with benign ovarian cysts, no significant difference was found between the two groups at postoperative three months ([MD] -0.13, 95%CI [-1.61, 1.35]), six months ([MD] 0.3, 95% CI [0.02, 0.59]), and 12 months ([MD] 0.39, 95% CI [-1.13, 1.91]). The funnel plot indicated the absence of significant publication bias for the outcome of postoperative 3-month serum AMH.

When comparing the two groups with regard to AFC [4, 17, 19, 22, 24](Figure 4.), a statistically significant decrease was observed in the endometrioma subgroup at postoperative months 1, 3, and 12. Nevertheless, the AFC difference was insignificant in the studies including various types of benign ovarian cysts [4, 19].

Discussion

Laparoscopic cystectomy is the gold standard for managing benign ovarian cystic tumors[26]. Electrocoagulation using bipolar current is commonly employed for achieving ovarian hemostasis during surgery. The potential impact of various hemostatic techniques on ovarian reserves has become topic of concern. Previous systematic reviews [13, 27]discovered a significant reduction in postoperative ovarian reserve when comparing electrocoagulation with nonthermal hemostatic methods three months after laparoscopic surgery for endometrioma. In our meta-analysis, we included studies on not only endometriomas but also other benign ovary cysts undergoing laparoscopic cystectomy. We also searched for the latest relevant studies until 2022.

Principal findings

As demonstrated in the Results section, our study found no significant difference in long-term follow-up of postoperative AMH and AFC levels between the two groups when focusing on benign ovarian cysts. In contrast, the significant difference in postoperative AMH and AFC between the two groups is consistent with previous systemic reviews[13, 28] for patients with endometrioma. Such findings favor using nonthermal hemostatic methods over electrocoagulation using bipolar current when considering ovarian reserve for patients with endometrioma. However, this benefit is reduced for other benign ovarian cysts. The findings might prove that nonthermal hemostatic methods are less destructive in maintaining the cortical blood supply in the residual ovaries and retaining the ovarian function during laparoscopic ovarian cystectomy for endometrioma.

Comparison with Existing Literature

Since the type of ovarian cyst may also impact the ovarian reserve[29, 30], we categorized the studies into subgroups: those focused exclusively on endometriomas and those that examined various types of benign ovary cysts. Eight of the RCTs exclusively included only endometriomas [3, 16, 17, 20, 21, 24, 25]. And the remaining five RCTs investigated patients with various types of benign ovary cysts [2, 4, 19, 22, 23]. Previous studies indicated that endometriosis is also a risk factor for infertility, which might decrease ovarian reserve since the endometriotic cyst wall is formed by the invagination of the ovarian cortex[31]. A previous study found that the morphology pattern of the ovarian tissue adjacent to the endometrioma wall did not display standard follicular patterns. In contrast, the ovarian cortex surrounding other benign ovarian cysts is usually normal[32].

Furthermore, Park et al. presumed that the ovarian reserve is more affected in patients with endometriomas, who tend to have pelvic adhesion. The vascular system within the ovarian cortex or surrounding the ovary could be injured during adhesiolysis [23]. This might explain why the decline in serum AMH levels was more significant in the electrocoagulation group when comparing patients with endometriomas.

On the other hand, we found that the patients with benign ovarian cysts had a smaller decline in AMH and AFC after surgery, with no significant difference between the electrocoagulation group and nonthermal hemostasis group. We could surmise that if we exclude patients with endometrioma from overall patients with non-specific benign ovarian cysts, the result of the forest plot will show a shift to the left side, indicating a decreased effect size in favor of the nonthermal group, signifying no significant difference in AMH and AFC between the two groups, even in the long-term follow-up extending to 12 months. Since endometriomas inherently have an adverse impact on ovarian reserve, coupled with the significant detrimental effect of electrocoaguation during surgery in women with endometriomas, it is advisable to refrain from employing electrocoagulation using bipolar current. Additionally, surgeons should exercise caution to prevent injury to the ovarian cortex injury during surgeries for endometriomas.

AMH production initiates with the growth of primordial follicles into small antral follicles, a process that takes at least three months[33]. Thus, most studies [2-4, 16-20, 23, 24] measured AMH levels at the 3-month follow-up. We also compared outcomes at 1, 6, 12 months [3, 16, 17, 19, 21, 22, 24, 25], since the longer follow-up time allows for a more comprehensive understanding of the sustained change of AMH and AFC and addresses any immediate postoperative concerns. Some studies [3]presumed that more primordial follicles might have started to grow to compensate for the acute ovarian damage after surgery. Therefore, the secretion of AMH from those newly developed follicles might lead to similar results in both treatment groups. Nonetheless, we didn't find the decline of AMH and AFC by electrocoagulation in endometrioma patients to become normal after a long-term follow-up of 12 months. The results of this present study found no significant difference in the postoperative AMH and AFC between the two treatment groups at long-term follow-up to postoperative 12 months for patients with benign ovarian cysts [2, 4, 19, 23]. However, the results showed the beneficial effect of nonthermal hemostatic agents on preserving ovarian reserve after surgery in endometrioma patients.

In order to investigate the long-term influence of the surgical hemostatic method on the ovarian reserve, we also analyzed the outcomes of postoperative 1, 3, 6, and 12 months. The impact on ovarian reserve would change over time. The AMH levels might decrease transiently or consistently after surgery [34]. Previous papers have found a significant reduction in AMH levels in patients at 1- and 3-months post-surgery [35]. However, the AMH levels in some of the patients might subsequently recover after a year[36]. Some studies[3] presumed that more primordial follicles might have started to grow to compensate for the acute ovarian damage after surgery. The recovery of AMH is presumed to be associated with reperfusion of treated ovaries [37]and folliculogenesis from primordial follicles to preovulatory follicles, which takes about 180 days [36]. In Zhang's[17] and Chung's[24] studies, the mean AMH level of the two groups in endometrioma patients had not decreased during 3-12 months. However, the AMH level in the electrocoagulation group is still significantly lower than that of the nonthermal group at 12 months post-operation. Thus, we consider that electrocoagulation using bipolar current might have a sustained effect on the ovarian reserve in patients with endometrioma, which may act directly on destroying a substantial portion of primordial follicles.

Strengths and Limitations

There are some limitations of our study. First, ovarian reserve may also be affected by the mechanical nature of performing cystectomy in an endometrioma versus a dermoid cyst or cystadenoma or by whether unilateral or bilateral cystectomy was performed [38]. Some RCTs included patients with both unilateral and bilateral ovarian cysts undergoing surgery [2, 4, 16-18, 20, 21, 24], we could not analyze the data separately. However, our results suggest that the detrimental effect of electrocoagulation compared to the nonthermal method remains consistent, regardless of whether cystectomy was performed unilaterally or bilaterally. Furthermore, some patients underwent repeated laparoscopic cystectomy, although the studies did not provide specific data on these cases. It's also worth noting that the inflammatory factors associated with endometriosis can impact ovarian reserve. Moreover, it's important to acknowledge that blinding surgeons in these studies is challenging, potentially introducing performance and detection biases. However, it's noteworthy that in the majority of the included RCTs, surgical procedures were carried out by either a single surgeon or a limited number of surgeons, effectively mitigating performance bias. Ultimately, it's essential to acknowledge the presence of substantial heterogeneity, potentially stemming from variations in nonthermal hemostatic methods, the sizes and histologic types of ovarian cysts across the studies. We performed a comprehensive, broad, and systematic search for the present report, with hand-searching of some references of included studies and previous systematic reviews. Further studies with double-blinded RCTs and long-term follow-up may be needed to define better the impact of different hemostatic techniques on ovarian reserve.

Conclusions and Implications

Our study demonstrated that there is no significant difference in the preservation of ovarian reserve when employing nonthermal hemostatic methods compared to electrocoagulation using bipolar current during laparoscopic surgery for benign ovarian cysts, except in cases of endometrioma. Therefore, we suggest that when performing laparoscopic surgery for benign ovarian cysts, electrocoagulation with bipolar current can still be used if necessary.

Author's roles

YHL: Study design, screening, data extraction, data analysis, quality assessment, and writing. LHH: Conception of the idea, screening, data extraction, quality assessment, and writing. YYH: Data extraction, and writing. HJC: Data extraction, and writing. THL: Quality assessment, screening, data extraction, and writing.

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Conflicts of interest

The authors have no conflicts of interest.

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36. Sugita A, Iwase A, Goto M, Nakahara T, Nakamura T, Kondo M, et al. One-year follow-up of serum antimüllerian hormone levels in patients with cystectomy: are different sequential changes due to different mechanisms causing damage to the ovarian reserve? Fertil Steril. 2013 Aug;100(2):516-22.e3.

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38. Younis JS, Shapso N, Fleming R, Ben-Shlomo I, Izhaki I. Impact of unilateral versus bilateral ovarian endometriotic cystectomy on ovarian reserve: a systematic review and meta-analysis. Hum Reprod Update. 2019 May 1;25(3):375-91.

Table 1. documents the main findings of the included papers.

Study and year	**Age (ys)**	**Study design**	**Method of randomization**	**He**
Sönmezer et al., 2013	19-35	Prospective randomized study	Simple randomization	hem
Tanprasertkul et al., 2014	18-45	randomized controlled trial	Simple randomization	sutu
Song et al., 2014	18-45	randomized controlled trial	Block randomization	hem
Zhang et al., 2016	18-45	randomized controlled trial	Simple randomization	sutu
Asgari et al., 2016	18–42	randomized controlled trial	Block randomization	sutu
Sahin et al., 2017	18–40	randomized controlled trial	Simple randomization	sutu
Choi et al., 2018	19–45	randomized controlled trial	Simple randomization	hem
Owczarek et al., 2018	20-35	randomized controlled trial	Simple randomization	sutu
Shaltout et al., 2019	20-35	randomized controlled trial	Simple randomization	Sur
Xiao et al., 2019	21-36	randomized controlled trial	Simple randomization	sutu
Park et al., 2021		randomized controlled trial	Simple randomization	hem
Chung et al., 2021	18-40	randomized controlled trial	Simple randomization	FloS
Araujo et al., 2022	18-menopaused	open-label, randomized controlled trial	Simple randomization	sutu

Abbreviation: BE, bipolar electrocoagulation; AMH, anti-Müllerian hormone; AFC, antral follicle count; FSH, Follicle-stimulating hormone;

Table 2. summarized inclusion and exclusion criteria of studies

	Sönmezer 2013
Inclusion criteria	regular menstrual cycles infertility and/or severe dysmenorrhea/dyspareunia appropriate medical condition for laparoscopic surgery
Exclusion criteria	previous adnexa surgery/ excision or hysterectomy and adnexa Pregnancy/ lactation other endocrine disorders such as diabetes mellitus, thyroid dysfunction, hyperprolactinemia, congenital suspicion or history of malignancy the use of medication that affect ovarian function within the last 6 months (oral contraceptive, GnRH a

Abbreviation: PCOS, polycystic ovary syndrome; GnRH, Gonadotropin-Releasing Hormone; AMH, anti-Müllerian hormone; AFC, antral follicle count

Figure

Figure 1. Flow chart of the study selection process. Abbreviations: RCT, randomized controlled trial.

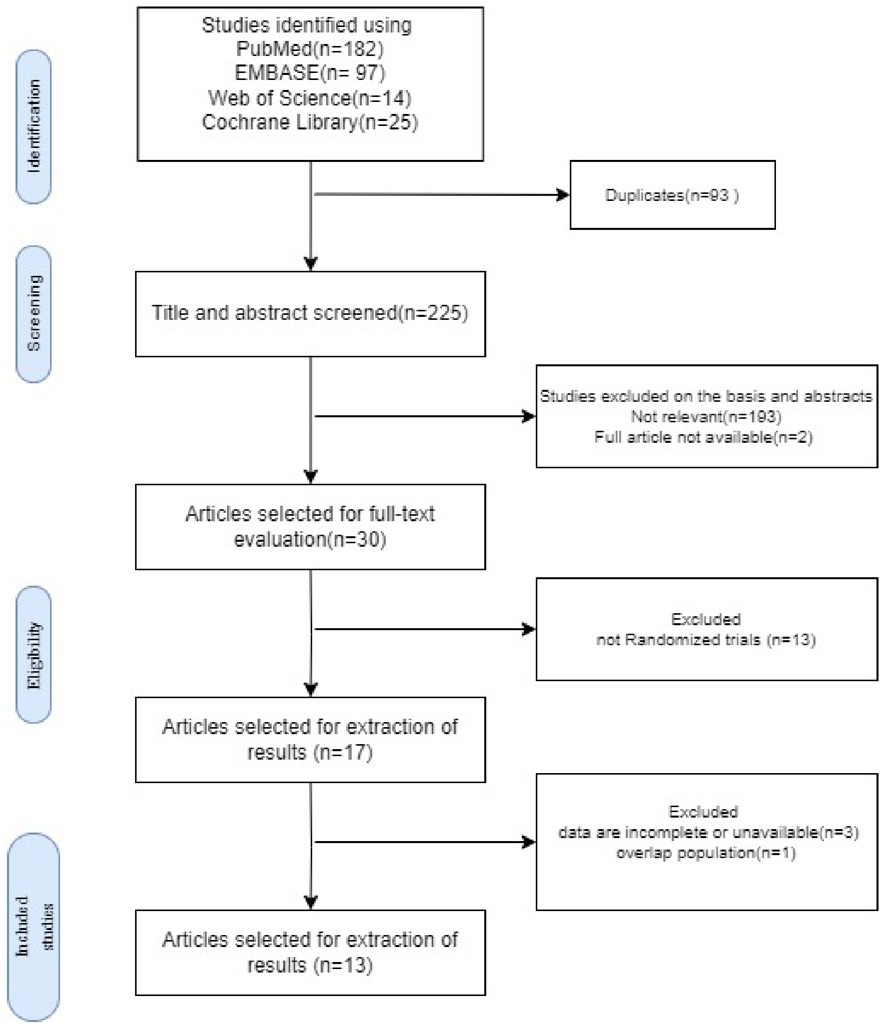
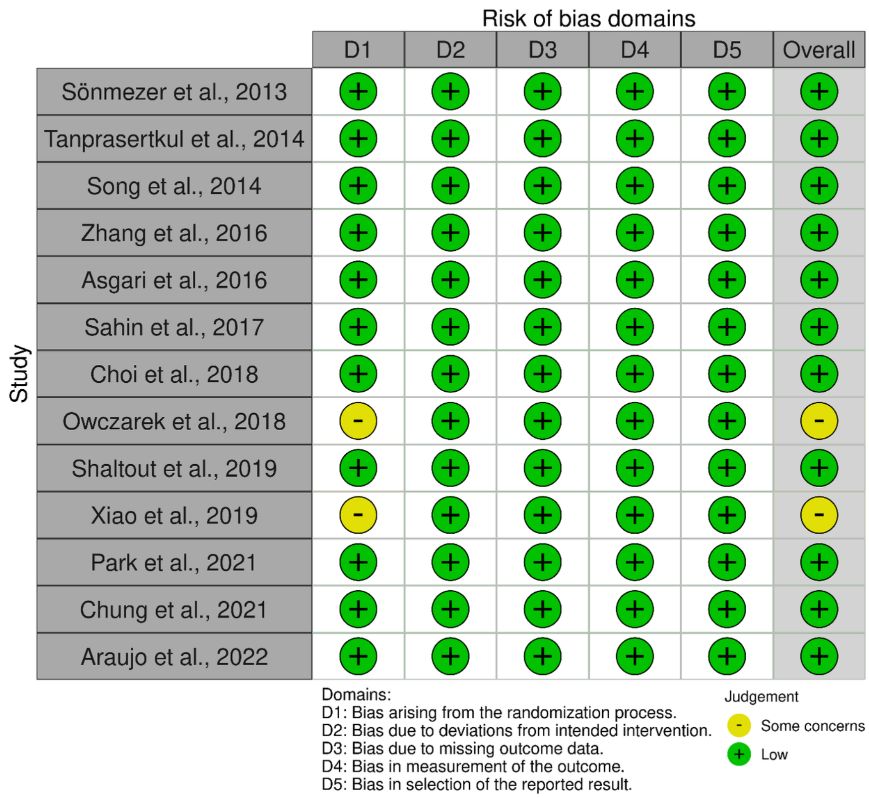


Figure 2. Risk of bias assessment summary in the included studies.



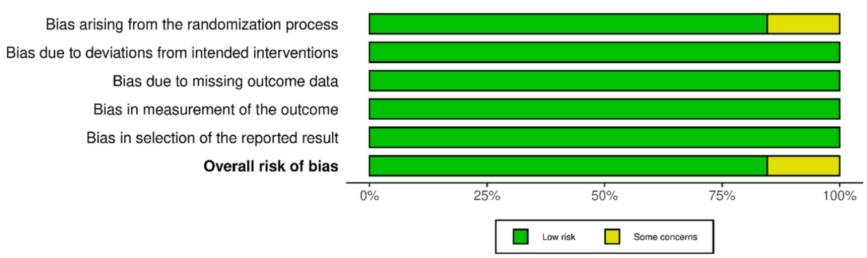


Figure 3. Forest plots of the (A) 1-month; (B) 3-month; (C) 6-month; (D) 12-month postoperative AMH.

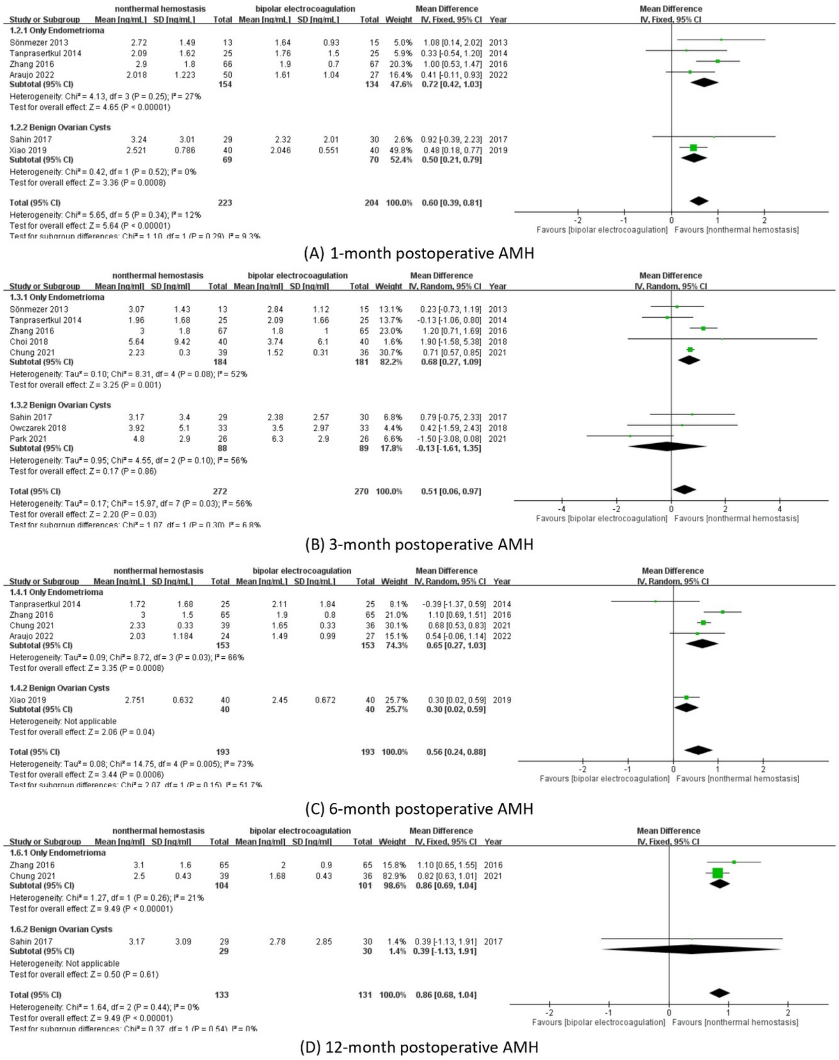
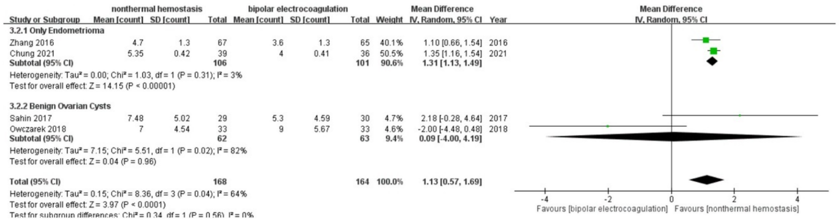
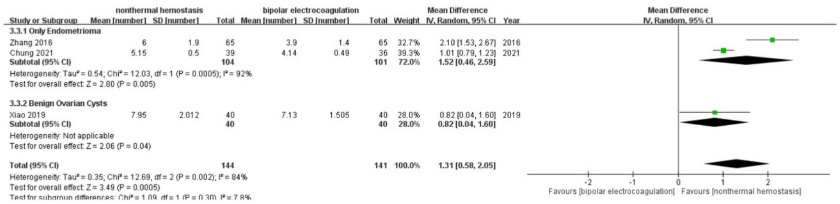


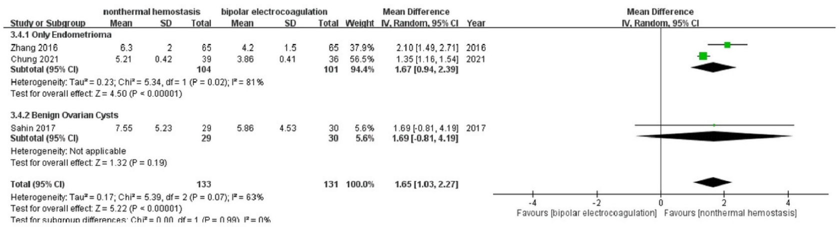
Figure 4. Forest plots of the (A) 3-month; (B) 6-month ;(C) 12-month postoperative AFC. Abbreviations: AFC, antral follicle count; CI, confidence interval.



(A) 3-month postoperative AFC



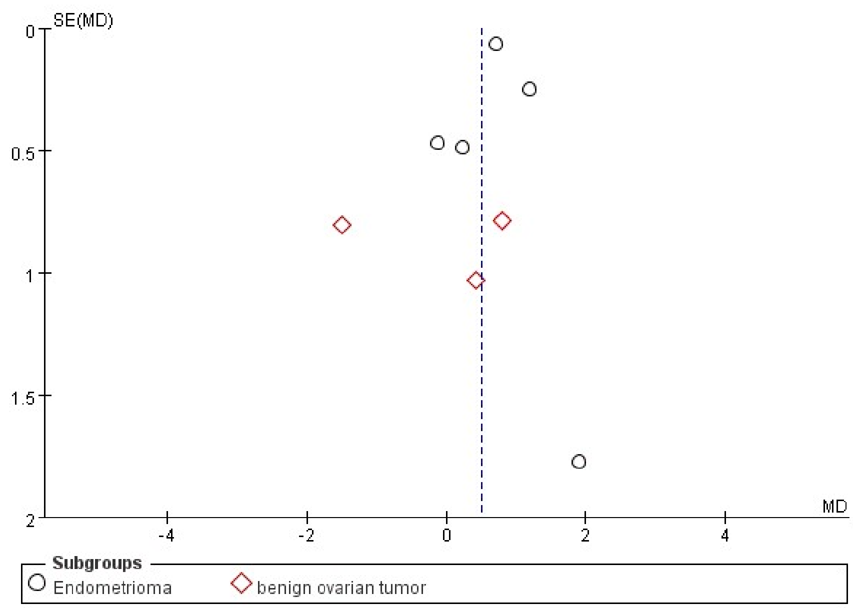
(B) 6-month postoperative AFC



(C) 12-month postoperative AFC

Supplementary material

Supplementary Figure 1. Funnel plot of the 3-month postoperative AMH.



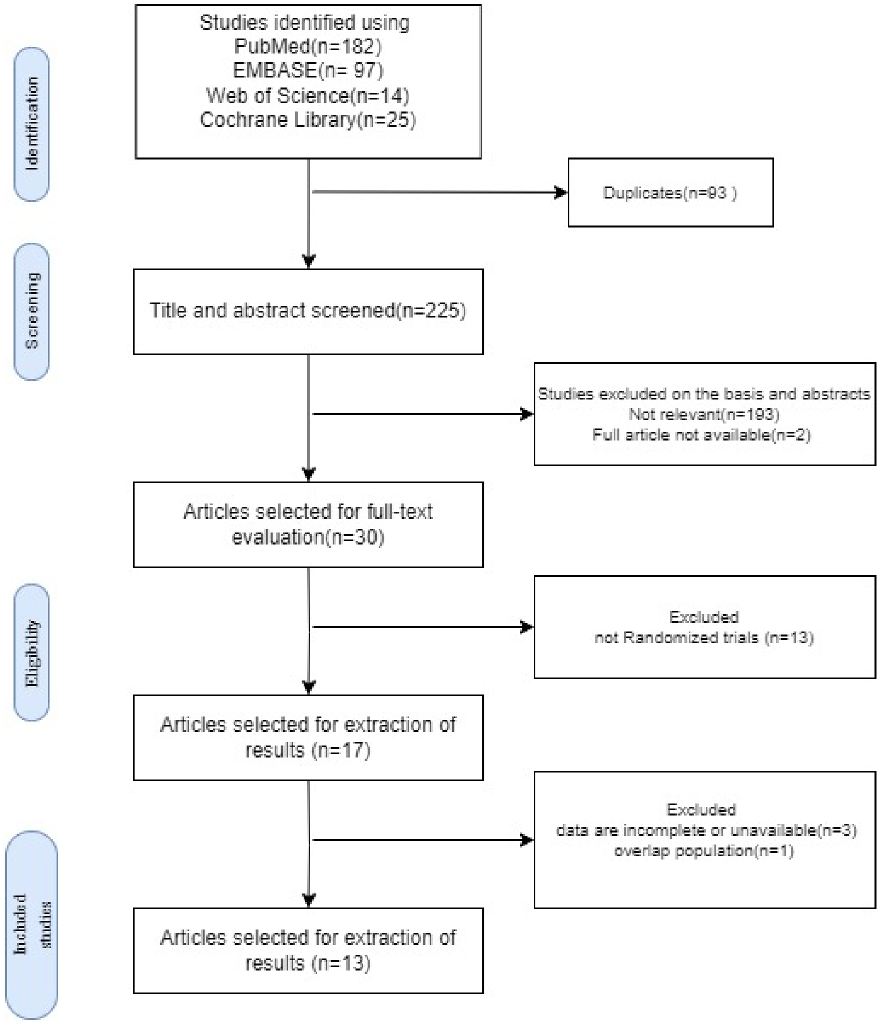
Supplementary Table 1. Histologic types of the ovarian cysts in the two groups of included studies.

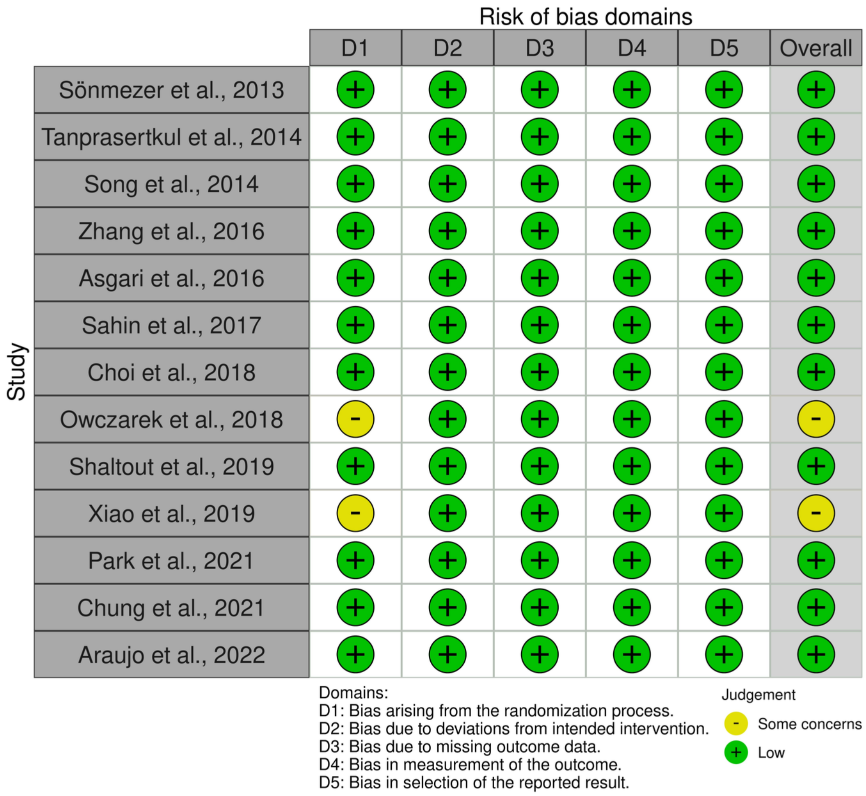
Study and year	Ovarian cysts type	Non thermal method N (%)	Electrocoagulation using bipolar curren
Sönmezer et al., 2013	Endometrioma	13	15
Tanprasertkul et al., 2014	Endometrioma	25	25
Song et al., 2014	Endometrioma	28	28
	Mature cystic teratoma	16	11
	others	6	11
Zhang et al., 2016	Endometrioma	65	65
Asgari et al., 2016	Endometrioma	45	47
Sahin et al., 2017	Endometrioma	19 (65.5%)	16 (53.3%)
	Non-endometrioma	10 (34.5%)	14 (46.7%)
Choi et al., 2018	Endometrioma	40	40
Owczarek et al., 2018	Endometrioma	24 (72.8%)	16 (48.5%)
	Dermoid cyst	6 (18.2%)	8 (24.2%)
	Simple cyst	3 (9%)	9 (27.3%)
Shaltout et al., 2019	Endometrioma	50	50
Xiao et al., 2019	Endometrioma	13 (32.5%)	13 (32.5%)
	Dermoid cyst	13 (32.5%)	16 (40%)
	other	14 (35%)	11 (27.5%)
Park et al., 2021	Endometrioma	12 (46.2%)	14 (53.8%)
	Mature cystic teratoma	8 (30.8%)	10 (38.5%)
	Serous cystadenoma	2 (7.7%)	0 (0%)
	Mucinous cystadenoma	1 (3.8%)	0 (0%)
	Functional cyst	2 (7.7%)	2 (7.7%)
	others	1 (3.8%)	0 (0%)
Chung et al., 2021	Endometrioma	39	36
Araujo et al., 2022	Endometrioma	50	27

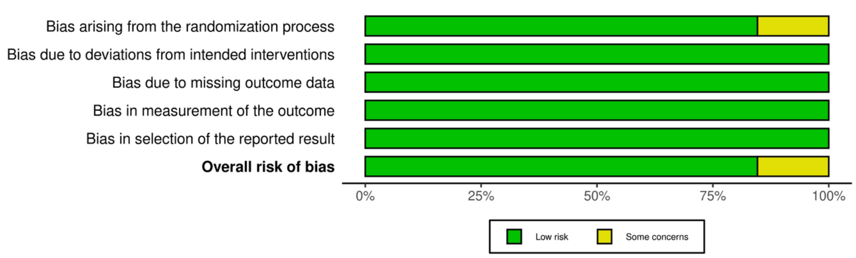
Supplementary Table 2. The certainty of evidence for various outcomes was evaluated by GRADE system

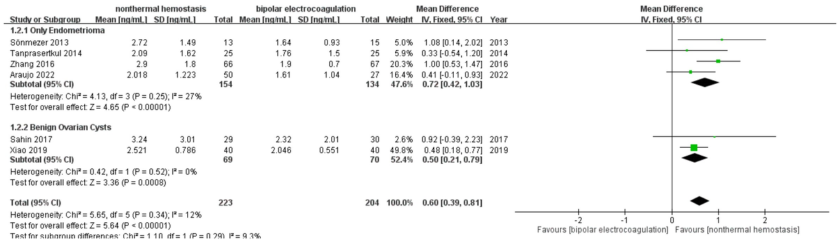
Certainty assessment	**Certainty assessment**	**Certainty assessment**	**Certainty assessment**	**Certainty asse**
of studies	**Study design**	**Risk of bias**	**Inconsistency**	**Indirectness**
6	randomised trials	not serious	not serious	not serious
8	randomised trials	not serious	not serious	not serious
5	randomised trials	not serious	not serious	not serious
3	randomised trials	not serious	not serious	not serious
4	randomised trials	not serious	not serious	not serious
1	randomised trials	not serious	not serious	not serious
1	randomised trials	not serious	not serious	not serious
4	randomised trials	not serious	not serious	not serious
3	randomised trials	not serious	not serious	not serious
3	randomised trials	not serious	not serious	not serious

CI: confidence interval; MD: mean difference

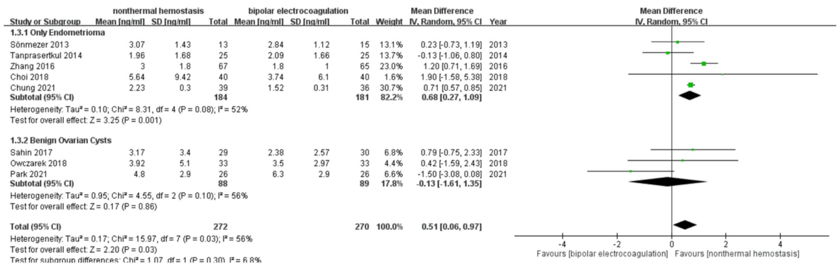

Identification
Screening
Eligibility
Included studies
Studies identified using
PubMed(n=182)
EMBASE(n= 97)
Web of Science(n=14)
Cochrane Library(n=25)
Duplicates(n=93)
Title and abstract screened(n=225)
Studies excluded on the basis and abstracts
Not relevant(n=193)
Full article not available(n=2)
Articles selected for full-text evaluation(n=30)
Excluded
not Randomized trials (n=13)
Articles selected for extraction of results (n=17)
Excluded
data are incomplete or unavailable(n=3)
overlap population(n=1)
Articles selected for extraction of results (n=13)


Risk of bias domains
D1
D2
D3
D4
D5
Overall
Study
Sönmezer et al., 2013
Tanprasertkul et al., 2014
Song et al., 2014
Zhang et al., 2016
Asgari et al., 2016
Sahin et al., 2017
Choi et al., 2018
Owczarek et al., 2018
Shaltout et al., 2019
Xiao et al., 2019
Park et al., 2021
Chung et al., 2021
Araujo et al., 2022
Domains:
D1: Bias arising from the randomization process.
D2: Bias due to deviations from intended intervention.
D3: Bias due to missing outcome data.
D4: Bias in measurement of the outcome.
D5: Bias in selection of the reported result.
Judgement
Some concerns
Low

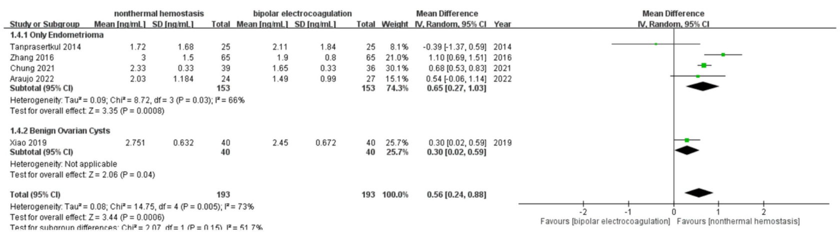

Bias arising from the randomization process
Bias due to deviations from intended interventions
Bias due to missing outcome data
Bias in measurement of the outcome
Bias in selection of the reported result
Overall risk of bias
0%
25%
50%
75%
100%
Low risk
Some concerns



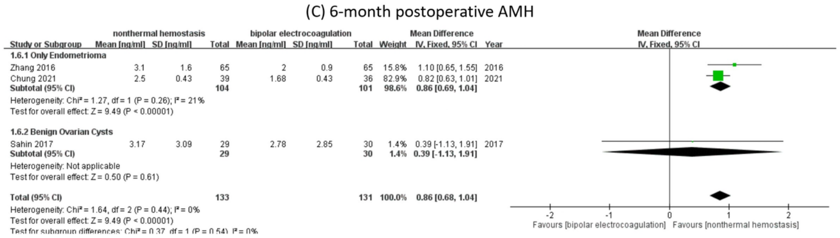
(A) 1-month postoperative AMH



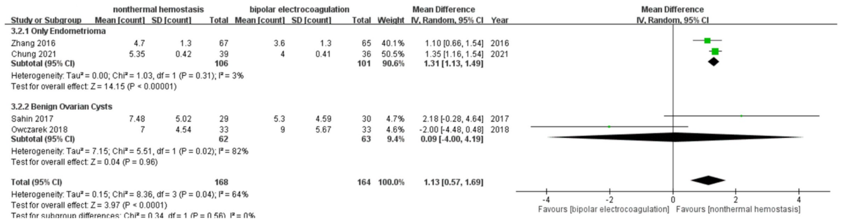
(B) 3-month postoperative AMH



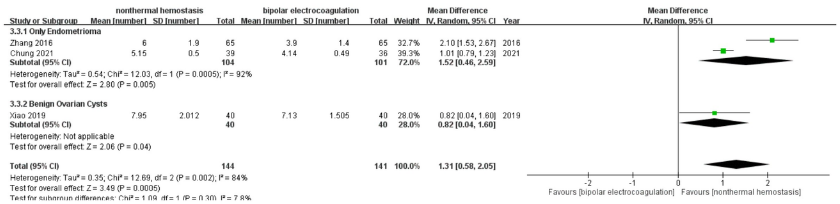
(C) 6-month postoperative AMH



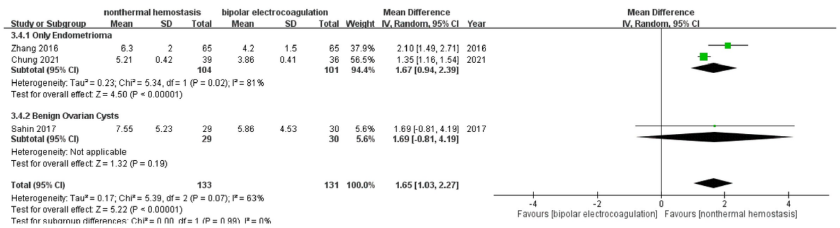
(D) 12-month postoperative AMH



(A) 3-month postoperative AFC



(B) 6-month postoperative AFC



(C) 12-month postoperative AFC

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`Lin_ref_table 2.docx` available at https://authorea.com/users/773913/articles/867405-the-potential-damage-of-laparoscopic-electrocoagulation-on-ovarian-reserve-in-endometriomas-reduced-in-benign-ovarian-cysts-a-systematic-review-and-meta-analysis