

The Impact of Excision of Ovarian Endometrioma on Ovarian Reserve: A Systematic Review and Meta-Analysis

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Context: Endometriomas are mainly treated surgically. However, there has been concern over the potential damaging effect of this surgery on ovarian reserve.

Objective: The aim of this meta-analysis was to investigate the impact of surgery for endometriomas on ovarian reserve as determined by serum anti-Müllerian hormone (AMH).

Data Sources: MEDLINE, PubMed, and Embase were searched electronically.

Study Selection: All prospective cohort studies that analyzed changes of serum AMH concentrations after surgical treatment of endometriomas were eligible. Twenty-one studies were identified, of which eight were selected for meta-analysis.

Data Extraction: Two reviewers performed the data extraction independently.

Data Synthesis: Pooled analysis of 237 patients showed a statistically significant decrease in serum AMH concentration after ovarian cystectomy (weighted mean difference -1.13 ng/ml; 95% confidence interval -0.37 to -1.88), although heterogeneity was high. Sensitivity analysis for studies with a preoperative serum AMH level of 3.1 ng/ml or greater improved heterogeneity but also still showed a significant postoperative fall in serum AMH (weighted mean difference -1.52 ng/ml, 95% confidence interval -1.04 to -2).

Conclusion: The results of this study suggest a negative impact of excision of endometriomas on ovarian reserve as evidenced by a significant postoperative fall in circulating AMH. (*J Clin Endocrinol Metab* 97: 3146–3154, 2012)

Ovarian endometriomas are found in 20% of patients with endometriosis (1) and are associated with a more severe form of the disease. There is a general consensus that endometriomas require surgical treatment due to ineffectiveness of medical therapies (2). However, surgery carries a potential risk of significant damage to ovarian reserve (3–11).

Two main surgical methods are widely used for endometriomas including cystectomy and cyst ablation. Cystectomy seems to be the favored modality by many authors as it is associated with less recurrence of the disease (12).

However, cystectomy has been associated with concomitant excision of normal ovarian tissue resulting in significant follicle loss with possible subsequent reduction in ovarian reserve (13–15).

Serum anti-Müllerian hormone (AMH) is a relatively new marker of ovarian reserve, which has gained wide popularity because it offers several advantages over other tests. It has been shown to be remarkably stable throughout the menstrual cycle (16–18) and it is not affected by the use of hormones (19). In addition, it is very sensitive to changes in ovarian reserve with advancing age and correlates well with antral follicle count (20–22).

The aim of this review was to evaluate the impact of surgical treatment of endometriomas on ovarian reserve as measured by circulating AMH.

Materials and Methods

Criteria for study selection

All published prospective cohort studies or randomized trials that analyzed the effect of surgery for endometriomas on ovarian reserve as measured by changes in serum AMH concentration were included.

Outcome measures

Primary measures

These included the change in mean serum AMH concentration after surgery.

Secondary measures

Secondary measures included the change in mean antral follicle count (AFC) after surgery.

Search strategy

An extensive electronic database search was performed using MEDLINE, PubMed, and Embase to identify published research articles between January 2000 and November 30, 2011, on the effects of surgery for endometriomas on ovarian reserve measured by AMH. No restrictions were placed on language. A combination of the following search terms was used: laparoscopy, laparotomy, general surgery, laser, ablation techniques, cystectomy, excision, anti-Müllerian hormone, endometriosis, and endometrioma. The above-mentioned searches were performed by the first author and then independently repeated using the same criteria by an accredited clinical librarian.

All relevant reports were retrieved, and their reference lists were reviewed manually to identify further studies. A manual search of related articles on PubMed was also performed.

No attempt was made to identify unpublished studies unless they had been released as online publications ahead of print. No reports from scientific meetings were included.

Data extraction

All the identified papers were evaluated according to a standardized format including study design, methods, participant characteristics, intervention, and results. When the same group

of patients was included in more than one publication by the same authors, only the most comprehensive study was included. Two investigators scored the studies and collected the information independently. In the case of discrepancies in scoring between the two investigators, a consensus was reached after discussion or after involvement of the third investigator.

The authors of seven studies were contacted to identify missing information (23–29). The authors of four studies replied, providing further information on their exclusion criteria, results, and unpublished data (25, 27–29). This information was used in the review.

Quality of included studies and risk of bias assessment

The quality and risk of bias of the included studies were assessed using the Newcastle-Ottawa scale for the assessment of cohort studies, based on the recommendation of the Cochrane Collaboration (30, 31). This scale uses a star rating system to assess three main categories: selection, comparability, and outcomes. A maximum of four stars, two stars, and three stars can be awarded respectively for each category.

The Newcastle-Ottawa scale was modified to suit the nature of our study. We considered confounding factors such as age (≤ 40 yr), size of the endometriomas (> 5 cm), baseline preoperative serum AMH level (≥ 3.1 ng/ml), and laterality of the disease. The star scoring system was redistributed to have a maximum of three stars for selection (recruitment bias, selection of consecutive patients, and power calculation), four stars for comparability (studies including patients aged ≤ 40 , endometriomas > 5 cm, preoperative serum AMH ≥ 3.1 ng/ml, and studies analyzing unilateral and bilateral lesions separately), and two stars for outcome criteria (completeness of follow-up, which is at least 3 months long after surgery). The total score was the same as for the original scale (a maximum of nine stars), making our results comparable with those of the original Newcastle-Ottawa scale.

Although no cutoff limit exists to classify good or bad studies, a limit of five stars has been suggested to identify studies at low risk of bias (32, 33). This is based on the assumption that all different parameters analyzed have the same weight. However, in this study, we considered the comparability factors as especially important. We therefore used the cutoff level of six stars as long as at least three stars were obtained in the comparability category. Table 1 shows the results of quality scores of the studies and risk of bias assessment.

Data analysis

Results on the preoperative and postoperative mean serum AMH levels measured in nanograms per milliliter and SD were ex-

TABLE 1. Modified Newcastle-Ottawa scale for risk of bias and quality assessment of the included studies

Author	Year	Selection	Comparability	Outcome	Total score
Biacchiardi <i>et al.</i> (28)	2011	*	*	**	4
Ercan <i>et al.</i> (34)	2010	*	***	*	5
Ercan <i>et al.</i> (27)	2011	*	***	**	6
Hirokawa <i>et al.</i> (35)	2011	*	***	*	5
Hwu <i>et al.</i> (29)	2011	*	***	**	6
Kitajima <i>et al.</i> (25)	2011	*	****	**	7
Lee <i>et al.</i> (36)	2010	*	**	**	5
Tsolakidis <i>et al.</i> (24)	2009	***	**	**	7

The star scoring system was redistributed to have a maximum of three stars for selection, four stars for comparability, and two stars for outcome criteria.

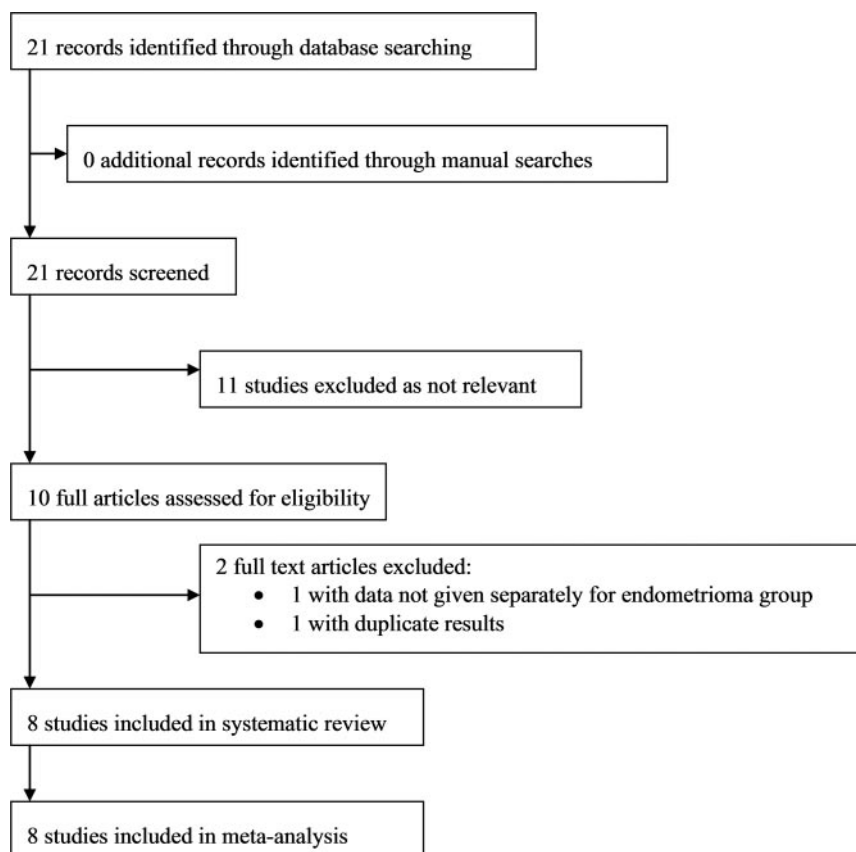


FIG. 1. Flow chart of the study selection process.

tracted from the individual studies. The authors provided unpublished data in one study (25). In two other studies (24, 29), the SD was calculated manually from the published data.

The data were pooled using RevMan software (Review Manager, version 5.1, The Cochrane Collaboration, 2011; The Nordic Cochrane Centre, Copenhagen, Denmark). The weighted mean difference (WMD) between pre- and postoperative serum AMH concentration and AFC was calculated. Statistical heterogeneity was determined by examining the results of the χ^2 and I^2 statistics. A χ^2 statistic that was larger than its degree of freedom or an I^2 with a value greater than 50% provided evidence for significant heterogeneity between studies. A random-effect model was used for meta-analysis in cases of high heterogeneity, and a fixed effect model was used in cases of low heterogeneity.

Initially all the studies were combined, irrespective of length of follow-up (using the mean AMH at the furthest interval from surgery if multiple measurements were taken) and laterality of the endometrioma (using the results for the combined groups). Subgroup analyses of outcomes were then performed based on the laterality of the endometriomas, AMH kit used, and duration of follow-up. To examine and account for heterogeneity, several sensitivity analyses were subsequently performed.

Results

A total of 21 articles were identified (Fig. 1). Initially all articles were screened on the basis of the title and abstract to exclude studies that were not relevant to our objectives.

Subsequently, 10 articles were reviewed in full (23–29, 34–36).

Excluded studies

After the initial screening on the basis of the title and abstract, 11 articles did not investigate endometriomas and were therefore excluded (37–47).

Of the remaining 10 articles, two were excluded. One of these excluded studies (26) presented the changes in AMH as a percentage fall without giving the mean AMH concentrations. The other study (23) was excluded because 21 of the 29 participants were also included in a more recent larger study (35), which has been included in our analysis. The authors of both studies were contacted to obtain the required data, but no reply was received.

Included studies

Details of the eight included studies are shown in Table 2.

Study design

All studies were prospective and were published between 2009 and 2011. Seven were cohort studies (25, 27–29, 34–36) and one was a randomized controlled trial (24). For the latter, only one arm of the study (patients undergoing cystectomy) was included in this analysis.

Participants

Selection criteria were appropriate for all studies. In the majority of the cohort studies (25, 27–29, 34, 35), all eligible patients underwent the same type of surgery. In one study however (36), patients underwent different types of surgery (cystectomy or oophorectomy), depending on the surgeon's choice. Cystectomies tended to be performed in younger women with smaller cysts, therefore suggesting a certain degree of selection bias. Nevertheless, patients were consecutive, followed up within their particular group, and results were given separately. We therefore concluded that the cystectomy group of patients was comparable with the other studies in the meta-analysis. In the randomized controlled trial (24), patients were allocated to a different arm randomly and then followed up in their group. All studies reported inclusion criteria that were appropriate, and all studies apart from one (34) also defined exclusion criteria. Two studies did not mention previous ovarian surgery as an exclusion criterion (28,

TABLE 2. Characteristics of the studies included in the meta-analysis

Author	Country	Design	Number of patients	Number of excisions	Age (yr) mean (range)	Laterality	Minimum cyst size and mean diameter (MD)	Follow-up (months)	Outcomes
Biacchiardi <i>et al.</i> (28) (2011)	Italy	Prospective cohort	43	43	34 (18–42)	Unilateral (n = 33) Bilateral (n = 10)	Not specified 3.7 ± 1.1 cm	9	AMH, FSH, LH, inhibin B, E ₂ , AFC
Ercan <i>et al.</i> (34) (2010)	Turkey	Prospective cohort	64	47	28 (19–35)	Unilateral (n = 33) Bilateral (n = 14)	≥4.5 cm 6.7 ± 0.91 cm	1	AMH
Ercan <i>et al.</i> (27) (2011)	Turkey	Prospective cohort	36	36	29 (21–39)	Unilateral only	≥4 cm 5.2 ± 1.4 cm	3	AMH, AFC, ovarian volume & dopplers
Hirokawa <i>et al.</i> (35) (2011)	Japan	Prospective cohort	38	38	34 (18–45)	Unilateral (n = 20) Bilateral (n = 18)	Not specified 6.4 ± 2.2 cm	1	AMH
Hwu <i>et al.</i> (29) (2011)	Taiwan	Prospective cohort	31	31	31 (22–39)	Unilateral only	≥3 cm MD not reported	3	AMH
Kitajima <i>et al.</i> (25) (2011)	Japan	Prospective cohort	32	19	30 (<40)	Unilateral only	≥4 cm 6.7 ± 1.9 cm	3	AMH
Lee <i>et al.</i> (36) (2010)	Korea	Prospective cohort	27	13	30 (21–46)	Unilateral only	Not specified 4 ± 1.8 cm	3	AMH
Tsolakidis <i>et al.</i> (24) (2009)	Greece	RCT	20	10	33 (22–40)	Unilateral and bilateral, no numbers given	≥3 cm 3.8 ± 0.5 cm	6	AMH, FSH, AFC, LH, E ₂ , inhibin B

RCT, Randomized controlled trial; E₂, estradiol.

29). The authors of both studies were contacted and confirmed that they had not included any patients with previous ovarian surgery. Patients' ages ranged between 18 and 46 yr (mean 28–34 yr). All patients were accounted for in all studies. Numbers lost to follow-up were small (two to four patients) and were all excluded from the analysis (27, 34, 36).

Endometriomas

The diagnosis of endometrioma was made by ultrasound scan in all studies. The mean diameter of the endometrioma was determined in seven (3.7–6.7 cm) and missing in one study (29). Five studies commented on the minimum size of the endometriomas (24, 25, 27, 29, 34). The cysts were exclusively unilateral in four (25, 27, 29, 36) and both unilateral and bilateral in three studies (28, 34, 35). In one study (24), the laterality of endometrioma was not clear. However, one of the tables in that study showed more endometriomas than patients, suggesting either bilaterality or multiplicity of endometriomas in some patients.

Surgery and length of follow-up

The treatment modality was cyst excision in all studies. One study (24) also investigated the effect of the three-step technique (laparoscopic cyst drainage followed by 3 months of GnRH analogs and then laparoscopic cystectomy) as one arm in a randomized controlled trial. That arm of the trial was excluded from our meta-analysis. No studies investigating ablative surgery were found.

In all but one study (35), surgery was performed laparoscopically. The surgery was comparable and described appropriately in all studies. Excision of the endometriotic cyst was performed by stripping off the cyst wall with the use of two pairs of atraumatic grasping forceps. Hemo-

stasis was achieved with bipolar diathermy if necessary. Histological confirmation of the diagnosis of endometrioma was obtained in all studies. The length of follow-up was 1 (34, 35), 3 (25, 27, 29, 36), 6 (24), or 9 months (28). If more than one postoperative AMH result was given (28, 36), then the one farthest from the date of surgery was taken.

AMH kits

AMH concentration was measured by using one of the two currently available kits: IOT AMH/MIS enzyme immunoassay (EIA) kit (Immunotech, Beckman Coulter, Marseille, France) (25, 28, 35, 36) or DSL active Mullerian-inhibiting substance/AMH ELISA kit (Diagnostic Systems Laboratories, Webster TX) (24, 27, 29, 34). The intra- and interassay coefficient variations (CV) for the IOT assay were 12.3 and 14.2%, respectively, and the limit of detection was 0.14 ng/ml. With regard to the DSL assay, the intraassay CV ranged from 0.8 to less than 10%, and the interassay CV ranged from 0.8 to 8%. The limit of detection was 0.006 ng/ml. Preoperative serum AMH levels ranged between 1.62 and 4.69 ng/ml (Table 3). All results were reported as mean serum AMH measured in nanograms per milliliter except for one study (25), which reported the percentage change of serum AMH concentrations after surgery. The authors were contacted and they provided the mean and SD for their results. The SD was reported for all studies, except for two (24, 29) that used the SE. This was converted to a SD using this formula: $SD = SE \times \sqrt{(\text{sample size})}$.

Potential sources of bias

Selection bias may have occurred in one study (36) as discussed earlier. As for the remaining studies, it is not clear whether patients were selected in a consecutive fash-

TABLE 3. Serum AMH values before and after surgery for all studies included in the meta-analysis

Author	Number of excisions	Baseline (preoperatively)	1 wk postoperatively	1 month postoperatively	3 months postoperatively	6 months postoperatively	9 months postoperatively
Biacchiardi et al. (28) ^a	43	3.0 ± 0.4			1.4 ± 0.2		1.3 ± 0.3
Ercan et al. (34) (2010)	47	1.62 ± 1.09		1.39 ± 1.16			
Ercan et al. (27) (2011)	36	2.03 ± 0.41			1.95 ± 0.62		
Hirokawa et al. (35) ^a	38	3.9 ± 2.5		2.1 ± 1.6			
Hwu et al. (29)	31	3.95 ± 2.34			2.01 ± 1.17		
Kitajima et al. (25) ^a	19	4.27 ± 3.0			3.024 ± 2.48		
Lee et al. (36) ^a	13	4.69 ± 2.5	2.77 ± 1.56	2.77 ± 1.46	3.29 ± 2.11		
Tsolakidis et al. (24)	10	3.9 ± 1.26				2.9 ± 0.63	

Results are in nanograms per milliliter. Mean and sd are given.

^a Studies that used IOT AMH/MIS EIA kit (Immunotech, Beckman Coulter) to measure AMH.

ion. We are therefore unable to assess selection bias in these studies.

Results

Primary outcome: AMH

Overall pooled results for all studies

The eight studies included a total of 237 patients who underwent cystectomy for unilateral or bilateral endometriomas. The weighted overall average preoperative AMH was 3.0 ng/ml, and this fell by a statistically significant amount (38%) postoperatively (WMD −1.13 ng/ml; 95% confidence interval (CI) −0.37 to −1.88). Heterogeneity between studies was high ($I^2 = 95\%$) (Fig. 2).

Subgroup analysis

Unilateral endometriomas

Six studies with 152 excisions were included (25, 27, 29, 34–36). The weighted average preoperative AMH was 3.3 ng/ml. A statistically significant fall (30%) in serum AMH was seen postoperatively (WMD −0.96 ng/ml; 95% CI −0.22 to −1.70; $I^2 = 76\%$).

Bilateral endometriomas

Two studies with 32 patients were identified (34, 35). The weighted average preoperative AMH was 2.7 ng/ml. A trend toward a postoperative fall (44%) in serum AMH

was seen at 3–9 months, although this did not reach statistical significance (WMD −1.18; 95% CI 1.07 to −3.34; $I^2 = 89\%$).

Studies with at least 6 months follow-up

Two studies were included with 53 excisions (24, 28). A statistically significant fall in serum AMH was seen at 6–9 months follow-up after surgery (WMD −1.49 ng/ml; 95% CI −0.86 to −2.12; $I^2 = 58\%$).

Studies using IOT AMH assay

Four studies with 113 excisions were included (25, 28, 35, 36). The overall baseline AMH concentration was 3.7 ng/ml. A statistically significant postoperative fall (46%) in AMH was observed (WMD −1.7 ng/ml; 95% CI −1.84 to −1.55; $I^2 = 0\%$). Heterogeneity between studies was low.

Studies using DSL AMH assay

Four studies with 124 excisions were included (24, 27, 29, 34). The overall baseline AMH concentration was 2.5 ng/ml. A statistically significant postoperative (27%) fall was seen in AMH (WMD −0.68 ng/ml; 95% CI −0.03 to −1.33; $I^2 = 83\%$). Heterogeneity between studies was high.

Sensitivity analysis

A sensitivity analysis was carried out based on risk of bias, age, size of the endometrioma, and preoperative se-

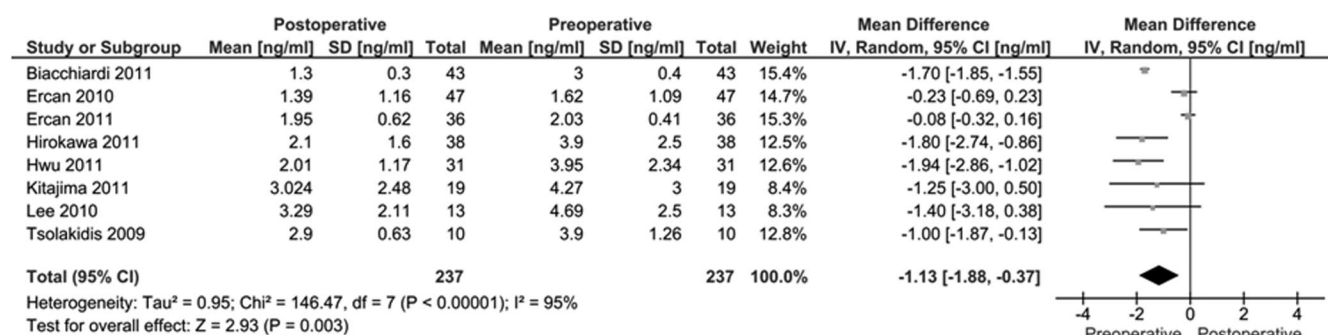


FIG. 2. Meta-analysis. Weighted mean difference in serum AMH after surgery for endometrioma: pooled results for all studies.

rum AMH level. All studies thought to contain confounding factors were excluded.

Studies with the lowest risk of bias (score of ≥ 6 on modified Newcastle-Ottawa scale, as long as more than three stars obtained on comparability score)

Three studies (25, 27, 29), with 86 cystectomies, were identified. There was a trend toward a postoperative fall in serum AMH levels (WMD -1.02 ng/ml), although this did not reach statistical significance (95% CI 0.40 to -2.44 ; $I^2 = 87\%$).

Studies in which age was not a significant confounding factor (age ≤ 40 yr)

Five eligible studies (24, 25, 27, 29, 34), including 143 cystectomies, were identified. Pooled analysis showed a statistically significant postoperative fall in serum AMH (WMD -0.73 ng/ml; 95% CI -0.11 to -1.34 ; $I^2 = 79\%$).

Studies with endometriomas 5 cm greater than in diameter

Four studies (25, 27, 34, 35), involving 140 cystectomies, were identified. The weighted average preoperative AMH was 2.7 ng/ml, and this fell by 23% postoperatively, although this did not reach statistical significance (WMD -0.61 ng/ml; 95% CI 0.03 to -1.25 ; $I^2 = 78\%$).

Studies with analysis of changes in AMH stratified by baseline AMH (≥ 3.1 ng/ml)

Five studies (24, 25, 29, 35, 36), including 111 cystectomies, were identified. Pooled analysis showed a statistically significant postoperative fall in serum AMH with low heterogeneity between studies (WMD -1.52 ng/ml; 95% CI -1.04 to -2.00 ; $I^2 = 0\%$) (Fig. 3).

Studies with endometriomas 5 cm greater than and baseline serum AMH 3.1 ng/ml or greater

Two studies were identified (25, 35), involving 57 cystectomies. Pooled analysis showed a statistically significant

postoperative fall in serum AMH after surgery with low heterogeneity between studies (WMD -1.68 ng/ml; 95% CI -0.84 to -2.51 ; $I^2 = 0\%$).

Secondary outcome: antral follicle count

Three studies including 79 patients were identified (24, 27, 28). There was no statistically significant change in AFC postoperatively (WMD 0.37; 95% CI 2.16 to -1.42). Heterogeneity between studies was high ($I^2 = 73\%$).

Discussion

The current study is the first meta-analysis to investigate the effect of surgery for endometriomas on ovarian reserve as determined by circulating AMH. The initial results suggest a significant loss of ovarian reserve after excision for endometriomas with up to 40% fall in AMH. However, there was significant heterogeneity between the included studies. Sensitivity analysis for studies with a preoperative serum AMH level of 3.1 ng/ml or greater improved heterogeneity and still showed a significant fall in serum AMH.

Timing of postoperative serum AMH measurement

The timing of postoperative serum AMH measurement varied in different studies, although the majority of studies (five studies, 142 excisions) performed the measurement at the 3-month follow-up (25, 27–29, 36), and only two studies (28, 36) performed multiple measurements (56 excisions). In these two studies, we used the latest sample (9 and 3 months of follow-up) because this is likely to represent the most sustained postoperative change of serum AMH. This is clinically more important than the immediate effect of surgery, which may be only temporary.

A subgroup analysis for studies assessing AMH at 6–9 months after surgery was also carried out. This analysis was important to investigate the possibility of recovery of ovarian reserve with time as suggested by a previous study

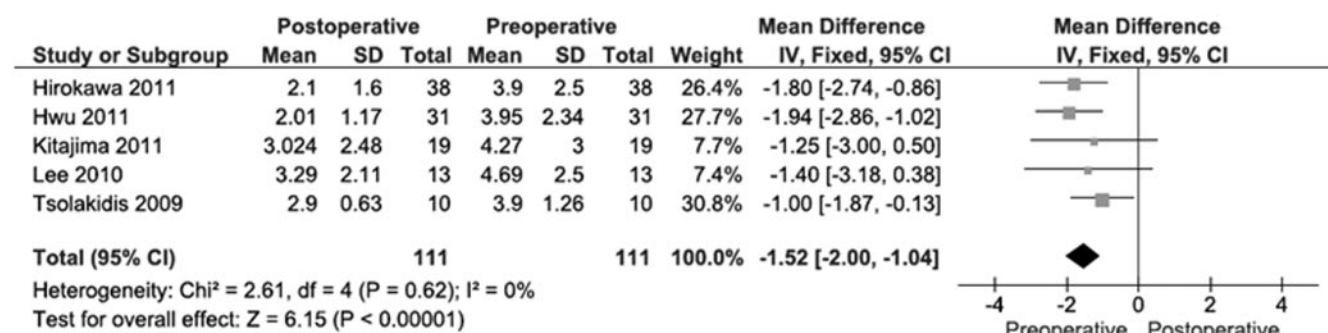


FIG. 3. Meta-analysis. Weighted mean difference in serum AMH after surgery for endometrioma: pooled results for studies with analysis of changes in AMH stratified by baseline AMH (≥ 3.1 ng/ml).

(26). The results showed a sustained fall in AMH during the follow-up period, suggesting that the compromised ovarian reserve does not recover within 6–9 months. However, heterogeneity of the included studies was high, casting doubts on these results.

Surgery for bilateral endometriomas

Subgroup analysis was performed for bilateral endometriomas (34, 35) because intuitively these were expected to show more surgical damage to ovarian reserve. Postoperatively there was a trend toward a greater fall (44%) in AMH in this subgroup compared with that (30%) in the unilateral surgery group (WMD -1.18 ng/ml *vs.* WMD -0.96 ng/ml). However, the change in the bilateral group did not reach statistical significance, possibly due to the small numbers involved (two studies involving 85 patients). This supports the hypothesis that more damage to ovarian reserve is expected after surgery for bilateral *vs.* unilateral disease.

Surgery for endometriomas greater than 5 cm in diameter

The initial analysis of patients with endometriomas greater than 5 cm in diameter revealed a trend toward a smaller fall in postoperative serum AMH compared with the overall group of patients (WMD -0.61 ng/ml *vs.* -1.13 ng/ml), although this trend did not reach statistical significance and heterogeneity was high. This finding may suggest a lack of gradient effect of the increasing cyst size on the magnitude of AMH fall. However, sensitivity analysis including only patients with endometriomas greater than 5 cm and preoperative AMH level of 3.1 ng/ml or greater revealed a greater reduction in AMH compared with the overall group of patients (WMD -1.68 ng/ml *vs.* -1.13 ng/ml, respectively) with a low heterogeneity between studies. This difference in reduction, which was statistically significant, suggests a gradient effect of the increasing size of the endometrioma on the magnitude of the fall in AMH.

AMH kits

In view of the differences in sensitivities and inter- and intraassay CV of the two AMH assays (IOT and DSL) used in different studies, we performed a subgroup analysis for each AMH kit. Interestingly, studies using the IOT assay showed a greater postoperative fall (46%) in AMH (WMD -1.7 ng/ml) compared with that (27%) observed with the DSL kit (WMD -0.68 ng/ml) (Table 3). Heterogeneity between studies was low with the IOT kit and high with the DSL kit. Studies using the IOT assay showed a slightly higher baseline AMH concentration (3.7 ng/ml) compared with that (2.5 ng/ml) in studies using the DSL

kit. This is consistent with previous publications, which have shown higher AMH values with the IOT kits compared with the DSL assay (48).

Heterogeneity and sensitivity analysis

Three main factors were identified as being responsible for heterogeneity between studies, including age, size of the endometrioma, and baseline serum AMH. Advancing age (>40 yr) and large endometriomas are expected to reduce ovarian reserve. Baseline serum AMH level reflects the preoperative ovarian reserve, which may differ between studies. To examine and account for these three factors, several sensitivity analyses were performed as described above. Only the sensitivity analysis considering a preoperative serum AMH level of 3.1 ng/ml or greater was associated with low heterogeneity between the studies, suggesting that baseline AMH is indeed a major factor introducing bias. This threshold AMH level of 3.1 ng/ml was chosen based on a nationally agreed cutoff level. This was obtained by contacting The Doctors Laboratory, which is the largest independent provider of clinical laboratory diagnostic services in the United Kingdom.

Antral follicle count

It was surprising not to find any significant reduction in AFC, which is another marker of ovarian reserve that correlates well with circulating AMH. This, however, may be attributed to a β -error due to the small numbers included in this analysis (79 patients). Furthermore, AFC can be difficult to assess in the presence of endometriomas and has also been shown to be less reproducible than AMH (49, 50).

Limitations of AMH and AFC as markers of ovarian reserve

Ovarian reserve has been defined as the total ovarian follicle pool including both the resting (primordial) and growing follicles, which determines the fertility potential of a woman. Currently there is no method that can directly measure the true ovarian reserve. Several surrogate markers have therefore been developed to assess ovarian reserve. Among these tests, AMH and AFC have been established as being the most reliable markers of ovarian reserve (51, 52). However, both these tests reflect the number of small antral follicles rather than the total follicle pool. Although it is thought that the number of growing follicles reflects the total follicle pool, this relationship remains largely uncertain. Furthermore, the advancing age of women may affect this relationship. AMH, and AFC should therefore be interpreted as surrogate markers that can give only a rough estimate of ovarian reserve.

Ablative surgery

Disappointingly, we found no study assessing the impact of ablative surgery on serum AMH. Because this is a commonly used treatment modality, it would be valuable for future studies to assess the impact of this type of surgery on AMH.

Conclusion

In conclusion, ovarian cystectomy for endometriomas seems to cause significant damage to ovarian reserve with up to 40% fall in serum AMH concentration. However, further high-quality, unbiased studies are required to allow a firm conclusion to be drawn. The long-term effect of surgical treatment of endometriomas on serum AMH remains to be investigated.

Acknowledgments

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