The Impact of Laparoscopic Ovarian Cystectomy Versus Laparoscopic Deroofing upon Ovarian Reserve in Endometriomas

Ahmed G. Ahmed *, Mohamed A. Mohamed, Mohamed A. El nory and Basma E. Sakr

Obstetrics and Gynecology Department, Faculty of Medicine, Benha University, Benha, Egypt

E-Mail:

Abstract

Background: Endometriomas are commonly managed surgically through laparoscopic procedures, but the impact of different surgical techniques on ovarian reserve remains a subject of investigation. This study aimed to evaluate the impact of laparoscopic ovarian cystectomy versus laparoscopic cyst de-roofing of endometriomas on ovarian reserve measured by serum levels of AMH and AFC. **Methods:** This study was carried out on 100 subjects with endometrioma. They were divided into 2 groups; the cystectomy group: patients who underwent laparoscopic ovarian cystectomy (N=50), and the deroofing group: patients who underwent laparoscopic cyst deroofing (N=50). **Results:** Mean difference and mean difference percentage were significantly higher in cystectomy group according to AMH level, AFC and ovarian volume. Mean difference and mean difference percentage of VAS was not significantly difference between the two groups. AMH level showed significantly lower measurement in cystectomy group one month compared with deroofing group in bilateral lesion cases. AMH showed a significant positive correlation with lesion size, AFC and ovarian volume ($p<0.001$). While no significant correlations were found regarding age BMI and VAS. **Conclusions:** In endometriomas cases, laparoscopic cyst deroofing had a less damaging effect for ovarian reserve as observed through higher serum AMH level, AFC and ovarian volume than cystectomy with positive correlation between AMH level and lesion size, AFC and ovarian volume.

Keywords: Endometriomas; Laparoscopic Ovarian Cystectomy; Laparoscopic Cyst De-Roofing; Ovarian Reserve; Anti-Müllerian Hormone; Antral Follicle Count.

1. Introduction

Endometriosis is the presence of tissue that normally lines the uterus in sites other than the uterine cavity, such as the ovaries, fallopian tubes and the pelvis usually cause pain, infertility, and other symptoms which can reduce quality of life [1] affecting 7% to 10% of the general female population reaching up to 50% in infertile women [2].

Endometriomas are the most common manifestation of endometriosis on the ovary. However, implants can also be found throughout the abdomen, such as on the bowel, within prior surgical incisions, and even in rare cases in distant locations of the

body such as the cerebellum [3]. Approximately 17-44% of women diagnosed with endometriosis will experience an endometrioma. These lesions are commonly referred to as chocolate cysts, due to the thick dark brown appearance of the fluid that is contained within them [4].

While the topic of ovarian endometrioma is widely discussed several issues related to its space occupying effects, local reactions and surgical removal remain actively debated today. The impact of ovarian endometrioma on ovarian reserve is still controversial [5].

Laparoscopic cystectomy provides more favorable outcomes as regards the recurrence of endometriomas & subsequent clinical pregnancy rate when compared with drainage & ablation [6]. But unfortunately, two studies declared significant reduction in the ovarian reserve after surgical excision of endometrioma cyst wall due to the inevitable removal of unaffected ovarian tissue [7].

Repeated surgeries have been associated with severe decreases in ovarian reserve and it has been demonstrated that considerable surgical expertise is necessary to maintain the ovarian reserve following endometrioma surgery [8]. In all procedures, recurrence remains a challenge to the surgeons who must balance complete eradication of the endometriotic tissue against inadvertent destruction of healthy ovarian tissue and compromising ovarian reserve [9].

Ovarian reserve has been defined as a lady's regenerative potential as far as the quantity of ovarian follicles, the oocyte quality [10]. Anti Mullerian Hormone (AMH) had been recognized as the most valuable, dependable hormonal serum marker of the ovarian primordial follicle pool compared with other known serum markers [11]. Furthermore, serum AMH levels are strongly correlated to Antral Follicle Count (AFC) measured by ultrasound [12].

The comparison between different surgical techniques (laparoscopic cystectomy and laparoscopic cyst de-roofing) to deal with ovarian endometriomas remains a main point of debate regarding ovarian reserve and follicle loss [8].

This study aimed to evaluate the impact of laparoscopic ovarian cystectomy versus laparoscopic cyst de-roofing of endometriomas on ovarian reserve measured by serum levels of AMH and AFC.

2. Methods

Patient Population:

The prospective, randomized clinical trial study was conducted at Benha University hospital and private hospitals and included 100 women aged between 18 and 35 years who have been diagnosed with endometrioma (unilateral or bilateral) and they were candidates for laparoscopic surgery.

All included women were informed clearly about the aim of the study, the required procedures and the follow-up plan, and they gave their

written, informed consent before inclusion.

Inclusion criteria were cases aged 18 to 35 years with endometrioma (unilateral or bilateral) diagnosed by transvaginal ultrasound with a diameter of ≥3 cm.

Exclusion criteria were prior ovarian surgery, evidence of polycystic ovary syndrome as per Rotterdam criteria, premature ovarian failure diagnosed by follicle-stimulating hormone level ≥40 IU/L, any endocrine disorders affecting ovarian function (e.g., thyroid dysfunction, hyperprolactinemia), recent hormonal medication use within the last 3 months before surgery (e.g., oral contraceptive pills, gonadotropin-releasing hormone analogues), suspected ovarian malignant disease identified through transvaginal ultrasound, and individuals with contraindications to surgery.

100 women were divided into two groups: Group 1: underwent laparoscopic ovarian cystectomy and **Group 2:** underwent laparoscopic cyst deroofing.

Methodology:

All patients were subjected to detailed history taking and general examination. In the history-taking phase, essential demographic information, chief complaints, presenting symptoms related to endometrioma, past medical history, gynecological history, medication history, and family history are recorded. Demographic details, chief complaints, and presenting history provide insight into the patient's condition and its progression. Past medical and gynecological histories, medication usage, and family history offer a comprehensive background. The general examination, on the other hand, involves measuring vital signs, assessing the patient's general appearance and well-being, calculating the body mass index (BMI), conducting abdominal and pelvic examinations, and performing other systemic evaluations as needed based on the patient's specific symptoms and medical history. All patients are evaluated for general anesthesia.

AMH is measured is measured preoperatively and one-month following the surgery, venous blood samples are collected and centrifuged, and serum samples are stored at –20°C until assayed using commercially available ELISA kits. The detection range of AMH is 0.5 to 25 ng/mL[13].

Antral follicle count and ovarian volume are assessed on the third day of the last cycle before surgery and the second cycle following the surgery. Antral follicle count is measured as the total number of follicles identified ranging 2 to 9 mm in diameter. The ovarian volume is calculated using the prolate ellipsoid formula: volume (cm 3) = 0.5233 X anteroposterior diameter (cm) X transverse diameter (cm) X longitudinal diameter (cm). Ovarian volume is calculated by subtracting the cyst volume from the total ovarian volume [14].

Figure 1: Bilateral Endometrioma.

Figure 2: Bilateral Endometrioma after laparoscopic cystectomy.

Interventions

Group (1): Active Comparator: laparoscopic ovarian cystectomy was performed on proliferative phase of menstrual cycle. Anti-mullerian hormone level measurement and estimation of antral follicle count were done before surgery and repeated one month after surgery. **Procedure:** It was performed using video control under general anesthesia, pneumoperitoneum was induced by carbon dioxide, with three 5-mm trocars in the lower abdomen and a 10-mm intraumbilical main trocar, and we used 5-mm scissors and graspers, and Ringer's lactate solution for irrigation. Before initiating ovarian surgery, the ovaries were completely freed with blunt and sharp dissection. After a cleavage plane between the cyst wall and ovarian cortex was identified, the ovaries are pulled slowly and gently in opposite directions by means of two atraumatic grasping forceps. After removing the pseudo capsule from the abdominal cavity, selective minimal (15 watt) bipolar coagulation of bleeding was performed, without excessive coagulation of the surgical defect to avoid damaging the ovary.

Figure 3: laparoscopic cystectomy of unilateral endometrioma.

Group (2): Active Comparator: laparoscopic cyst deroofing was performed on proliferative phase of menstrual cycle.Anti-mullerian hormone level measurement and estimation of antral follicle count was done before surgery and repeated one month after surgery. **Procedure:** It was performed using video control under general anesthesia, pneumoperitoneum was induced by CO2, with three 5-mm trocars in the lower abdomen and a 10-mm intraumbilical main trocar, and we used 5-mm scissors and graspers, and Ringer's lactate solution for irrigation. Before initiating ovarian surgery, the ovaries were completely freed with obtuse and sharp dissection. after mobilizing the ovary, the contents of the cyst was removed with the suction-irrigator probe and the cavity was irrigated. The inside of the cyst was evaluated and the portion of ovarian cortex involved with endometriosis was removed. Small blood vessels from the

ovarian bed and bleeding from the ovarian hilum could be controlled with bipolar electro coagulation (15 watt). Low-power bipolar coagulation applied to the inside wall of the redundant ovarian capsule.

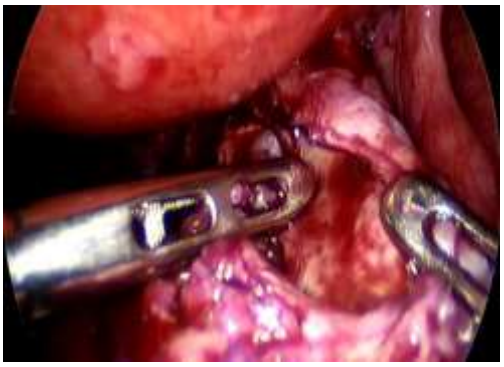

Figure 4: Unilateral endometrioma cyst deroofing.

Visual Analogue Scale (VAS) was also used to evaluate the cases' pain.

Outcome Measures: Comparison between the impacts of laparoscopic ovarian cystectomy and laparoscopic cyst deroofing on ovarian reserve as determined by alteration of AMH level and antral follicle count estimation in endometrioma patients 1 month later.

AMH sample requirements and precautions: Medium in which measured: Serum (preferred); plasma (lithium heparin). Samples should be separated within 2 h of collection. Once separated, samples can be refrigerated for 2–5 days. They should be frozen at -20°C for medium term storage or at -80°C for longer term storage.

Antral follicle count: Pelvic ultrasound assessments were performed between days 3 and 5 of the woman's menstrual cycle using a transvaginal ultrasound probe. The recorded antral follicle count (AFC) represents the combined total antral follicles between 2 and 10 mm from the left and right ovaries.

Statistical analysis:

The collected data underwent revision, coding, and tabulation using the IBM SPSS Statistics software (Version 25.0, IBM Corp., Released 2017, Armonk, NY). To test the normality, the Shapiro-Wilk test was employed. Descriptive statistics included means, standard deviations (± SD) for numerical data, and frequency/percentage calculations for non-numerical data. Analytical tools included the Chi-Square test for examining relationships between qualitative variables, the Mann Whitney Test for assessing non-parametric variable differences among study groups, and Repeated ANOVA for comparing dependent variable measurements. For categorical dependent variables, logistic regression facilitated risk prediction through odds ratios (OR), indicating the odds of an outcome with a specific exposure versus its absence, alongside a 95% confidence interval (CI) signifying OR precision. Results were deemed significant with a p-value < 0.05 at a 95% CI.

3. Results

There was no statistically significant difference between the studied groups according to age, BMI, parity and lesion criteria. **Table 1**

Table 1: Demographic data and Lesion criteria of the studied groups

		Laparoscopic ovarian cystectomy n=50	Laparoscopic cyst deroofing n=50	*test*	*p*
Age, (y)	mean±SD	27.19 ± 2.38	26.69 ± 2.35	t=1.064	0.290
	Median (Range)	27.06 (23.20 - 32.65)	26.39 (23.00 - 32.30)		
BMI, (kg/m2)	mean±SD	23.17 ± 2.52	22.97 ± 1.70	t=0.479	0.633
	Median (Range)	22.88 (20.49 - 28.59)	22.41 (21.12 - 27.57)		
Parity, n (%)	Nulligravida	20(60%)	32(64%)	X^2=0.170	0.837
	Multigravida	20(40%)	18(36%)		
Lesion size, cm3	mean±SD	5.17±0.44	5.32±0.46	Z=1.724	0.085
	Median (Range)	5.07(4.66 - 6.4)	5.26(4.76 - 6.53)		
Lesion laterality, n(%)	Unilateral	28(56%)	35(70%)	X2=2.102	0.214
	Bilateral	22(44%)	15(30%)		

t= t student test; X^2=Chi square test; Z=Mann-Whitney test, *: Significant ≤0.05

There was a significant decrease in AMH level in cystectomy group after one-month post-surgical procedure. There was a significant decrease in AFC in cystectomy group after one-month post-surgical procedure. There was a significant decrease in ovarian volume in cystectomy group after one-month post-surgical procedure. Pain (VAS) was significantly lower in both groups post operation compared to pre operation. There was no statistically significant difference between the two groups (in preoperative and postoperative pain (VAS)). **Table 2**

Table 2: AMH, AFC, Ovarian volume and VAS measurement at preoperative and postoperative in the studied groups

Variable		Laparoscopic ovarian cystectomy n=50	Laparoscopic cyst deroofing n=50	*test*	*p*
Preoperative AMH level, ng/ml	mean±SD	4.29 ± 0.82	4.30 ± 1.37	Z=0.093	0.926
	Median (Range)	4.20 (3.47 - 6.03)	4.23 (2.68 - 7.06)		
Postoperative AMH level, ng/ml	mean±SD	1.82 ± 0.91	2.35 ± 1.33	Z=.929	0.042*
	Median (Range)	1.58 (0.74 - 4.17)	2.40 (0.82 - 5.68)		
	Same group comparison	p1= **<0.001***	p1= **<0.001***		
Preoperative AFC, n	mean±SD	8.56 ± 1.27	7.78 ± 2.28	t=0.985	**0.452**
	Median (Range)	8 (7 - 12)	8 (6 - 10)		
Postoperative AFC, n	mean±SD	3.46 ± 1.09	5.79 ± 1.14	t=7.173	**<0.001***
	Median (Range)	3 (5 - 6)	6 (5 - 8)		
	Same group comparison	p1= **<0.001***	p1= **<0.001***		
	mean±SD	8.62 ± 1.56	7.51 ± 1.80		0.458

Preoperative ovarian volume, Cm3	Median (Range)	8.95 (6.50 - 11.43)	6.94 (5.60 - 11.65)	Z=0.987	
Postoperative ovarian volume, cm3	mean±SD	3.09 ± 1.33	5.78 ± 1.32	Z=7.648	**<0.001***
	Median (Range)	2.99 (1.66 - 8.32)	5.58 (4.26 - 9.46)		
	Same group comparison	**p= <0.001***	**p= <0.001***		
Preoperative pain (VAS)	mean±SD	7.71 ± 0.98	7.86 ± 1.12	t=0.769	0.442
	Median (Range)	8 (6- 10)	8 (6 - 11)		
1-month postoperative pain (VAS)	mean±SD	1.99 ± 0.84	2.00 ± 1.01	t=0.451	0.758
	Median (Range)	2 (1 - 4)	2 (1 - 4)		
	Same group comparison	**p= <0.001***	**p= <0.001***		

Z=Mann-Whitney test; VAS: Visual analog scale, *: Significant ≤0.05

Mean difference and mean difference percentage were significantly higher in cystectomy group according to AMH level, AFC and ovarian volume. Mean difference and mean difference percentage of VAS was not significantly difference between the two groups. **Figure 1**

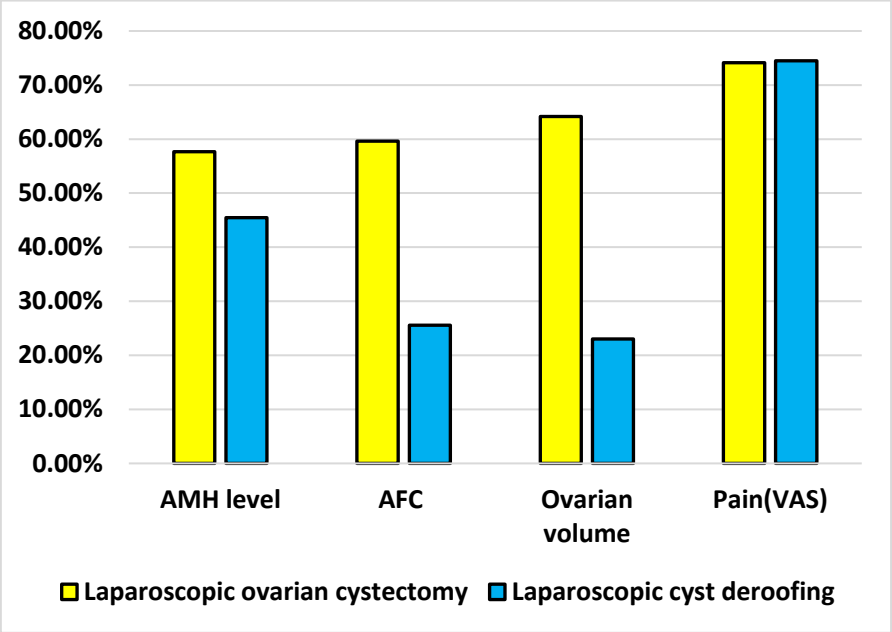

Figure 5: Preoperative and postoperative mean difference percentage difference between the studied groups

AMH level showed significant lower measurement in cystectomy group one month compared with deroofing group in bilateral lesion cases. **Figure 2**

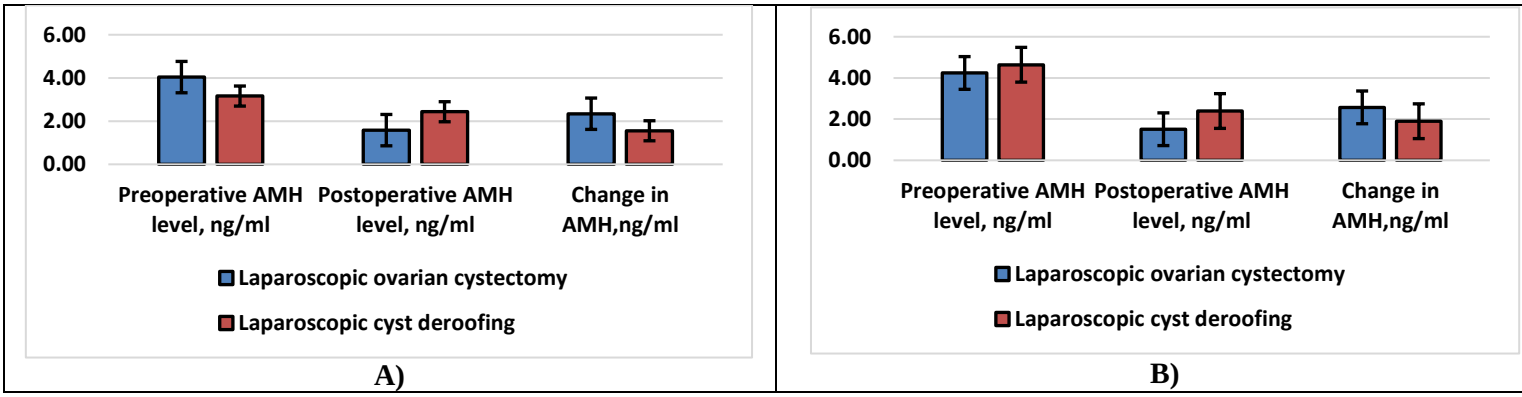

Figure 6: A) **AMH level among unilateral lesion cases** and B) **AMH level among bilateral lesion cases**

AMH showed a significant positive correlation with lesion size, AFC and ovarian volume (p<0.001). While no significant correlations were found regarding age BMI and VAS. **Table 3**

Table 3: Correlation between AMH and other studied parameters among studied subjects

	AMH	
	r_s	p
Age	0.003	0.568
BMI	0.017	0.190
Lesion size	0.806	<0.001*
AFC	0.982	<0.001*
Ovarian volume	0.690	<0.001*
VAS	0.016	0.209

rs: Spearman correlation coefficient, *: Significant ≤0.05

Regression analysis was conducted for prediction of factors associated with change in ovarian volume using age, BMI, laterality of lesion and type of surgical procedures used in study. Cystectomy was significantly associated with change in ovarian volume (p<0.001). **Table 4**

Table 4: Regression analysis for determinants of change in ovarian volume

	p	OR	95% CI
Age	0.207	1.166	0.918-1.481
BMI	0.667	0.944	0.752-1.229
Laterality of lesion	0.524	1.459	0.456-4.666
Surgical procedure (cystectomy)	**<0.001***	0.022	0.01-0.052

OR: odds ratio, CI: confidence interval, *: Significant ≤0.05

Regression analysis was conducted for prediction of factors associated with change in AMH using age, BMI, laterality of lesion and type of surgical procedures used in study. Cystectomy was significantly associated with change in AMH (p<0.001). **Table 5**

Table 5: Regression analysis for determinants of change in AMH

	p	OR	95% CI

Age	0.685	0.971	0.843-1.119
BMI	0.984	0.998	0.854-1.168
Laterality of lesion	0.307	0.699	0.352-1.39
Surgical procedure (cystectomy)	**<0.001***	1.124	0.309-1.154

OR: odds ratio, CI: confidence interval, *: Significant ≤0.05.

4. Discussion

Endometriosis is defined as abnormally situated endometrial glands and stroma outside the uterine cavity and usually presents with pelvic pain, dysmenorrhea, and infertility, affecting 7% to 10% of the general female population reaching up to 50% of infertile women [15].

In the present study, there were no statistically significant differences between the studied groups according to age, BMI, and parity.

In agreement with our results, a recent clinical randomized study conducted by [16] enrolled 120 women diagnosed with unilateral or bilateral ovarian endometriomas to evaluate either laparoscopic ovarian cystectomy or cyst deroofing for ovarian reverse. They showed that the demographic data and baseline clinical and sonographic preoperative characteristics showed no statistical difference between the cystectomy and cyst deroofing groups.

Consistently, [17] conducted their randomized prospective study on 84 patients with bilateral endometriomas to determine the effect of coagulation and cystectomy performed on one randomly selected side of each patient on the AFC and ovarian volumes before and after surgery. They found that the demographic data was comparable between groups.

In our study, there were no statistically significant differences between the studied groups as regards lesion size and laterality.

In accordance with our findings, [16] reported that there was no significant difference between the laparoscopic ovarian cystectomy group and the cyst deroofing group regarding the laterality and the size of lesions.

Recently, AMH has been suggested as the most reliable and reproducible marker, because it is menstrual cycle independent and unaffected by the use of hormonal drugs [18].

In the current study, the AMH level was significantly decreased in both groups 1-month post-surgery with superior decrease in the cystectomy group compared to the deroofing group. Compatible with our results, [16] showed that the AMH level was significantly decreased both 1 month and 1 year postoperatively, with a more prevalent decrease in the cystectomy group when compared with the deroofing group.

In the same context, [19] conducted their prospective study on a total of 44 women presented with pain or infertility due to ovarian endometriomas and subjected to

laparoscopic cystectomy. They found that there was a statistically significant reduction in postoperative median values of serum AMH when compared to preoperative measurements following laparoscopic cystectomy.

The results of the current study are in agreement with [20] and [21] who first described the adverse impact of cystectomy for ovarian endometrioma on the ovarian reserve through the lower value of AMH level and AFC.

Subsequently, previous two meta-analyses [7, 22] showed a significant adverse impact such as decreased AMH level of surgical cystectomy of endometriomas on ovarian reserve.

In the systematic review and meta-analysis **[7]** 21 studies were reviewed; of them, 8 were included in the meta-analysis. Pooled analysis of 237 patients showed a significant reduction in the serum AMH concentration following cystectomy for ovarian endometrioma.

Sonographic assessment of the AFC has been strongly associated with the primordial follicle pool and is used as a reliable sonographic indicator of ovarian reserve **[23]**. In cystectomies ovaries, decreased follicular ovarian response was shown in natural and clomiphene citrate–stimulated cycles. Ovarian volume has also been reported as a reliable indicator of ovarian reserve **[24]**.

According to our results, AFC was significantly decreased in both groups 1-month post-surgery with more reduction in the cystectomy group compared to the deroofing group. Our findings agree with Sweed et al. **[16]** who reported that AFC significantly decreased both 1 month and 1 year postoperatively, with a more prevalent decrease in the cystectomy group when compared with the deroofing group.

Moreover, [19] demonstrated that there was a statistically significant reduction in postoperative median values of AFC when compared to preoperative measurements in patients exposed to laparoscopic ovarian cystectomy. Our results are supported by Var et al. **[17]** who reported that the antral follicle number was significantly decreased post-cystectomy compared to post-coagulation.

The results of systematic review and meta-analysis conducted by [25] on 13 studies (including 597patients) showed that the AFC was significantly lower in the surgically-treated ovary when compared to the contralateral ovary.

In the same context, the investigators compared cystectomy and the three-stage procedure in patients with endometrioma, measuring AFC, ovarian volume, and ovarian artery Doppler velocity. They found decreased AFC in women who had undergone the laparoscopic ovarian cystectomy **[26]**. In another study, when the effect of cystectomy and the three-stage procedure on ovarian reserve was evaluated by AMH levels and AFC, it was suggested that the laparoscopic ovarian cystectomy caused more damage to the ovary **[27]**.

In the current study, ovarian volume showed a significant decrease in both groups post-operation compared to preoperative. In the cystectomy group, there was a significant decrease in ovarian volume after a one-month post-surgical procedure compared to the deroofing group. Our study suggested that laparoscopic cyst deroofing for the management of endometriomas seems to be less damaging to ovarian reserve when compared with cystectomy. Conforming to our results, Sweed et al. [16] reported that the ovarian volume significantly decreased at 1 month postoperatively, and the cystectomy group exhibited a more prevalent decrease than the deroofing group. Furthermore, Var et al. [17] showed that post-procedure ovarian volumes were significantly decreased following cystectomy when compared with coagulation.

In our study, the pain (VAS) was significantly lower in both groups post-operation compared to pre-operation. There was no significant difference between the two groups in preoperative and postoperative pain. Sweed et al. [16] showed different results, the pain intensity increased significantly after 1 year and was more prevalent in the deroofing group compared to the cystectomy group. The different follow-up periods as well as different sample size may account for the conflicting results.

According to the current study, the AMH level was significantly lower in the cystectomy group 1-month post-operation compared with the deroofing group in unilateral lesion cases. Contrasted to our results were observed by Sweed et al. [16] who found that there was a greater decrease in AMH levels in the cystectomy group in both patients with unilateral and bilateral endometriomas.

The laparoscopic cystectomy for endometriotic cysts caused a decrease in ovarian reserve at 3 months after surgery. Results from our study were similar to the others [28]. The proposed mechanisms for decreasing ovarian reserve include inadvertent removal of normal ovarian tissue during cystectomy and thermal injury. Ovarian parenchymal tissue and primordial follicle of normal ovarian tissue were observed in the specimens collected from the surgeries [29]. Electrocauterization, such as bipolar electrosurgery, which is often used to control bleeding during laparoscopic cystectomy, could damage ovarian follicles [30].

Our findings reported that AMH level showed a significant positive correlation with lesion size, AFC, and ovarian volume ($p<0.001$). While no significant correlations were found regarding age, BMI, and VAS. In contrary, Saito et al. [31] prospectively analyzed the serum level of AMH in 62 patients at four different time points-preoperatively and at 1 month, 6 months, and 1 year post laparoscopic cystectomy and found that the rate of AMH decline at 1 month after surgery was significantly correlated with patient age.

In our study, the univariate and multivariate analysis demonstrated that the associations between the surgical procedure (cystectomy) and the decreases in ovarian volume remained statistically significant after adjustment for age, BMI and laterality of lesion. A previous study by Sweed et al. [16] supported our results, the Multivariable regression analysis showed that the surgical procedure was a significant determinant of change in ovarian volume.

In our study, Univariate and multivariate analysis demonstrated that the associations between the surgical procedure (cystectomy) and the decreases in AMH remained statistically significant after adjustment for age, BMI, and laterality of lesion. Harmonious to our results, Sweed et al. [16] found that the multivariable regression analysis showed that the surgical procedure was a significant determinant of change in AMH level.

5. Conclusion

In endometriomas cases, laparoscopic cyst deroofing had a less damaging effect for ovarian reserve as observed through higher serum AMH level, AFC and ovarian volume than cystectomy with positive correlation between AMH level and lesion size, AFC and ovarian volume.

6. References

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