The effect of laparoscopic ovarian cystectomy versus coagulation in bilateral endometriomas on ovarian reserve as determined by antral follicle count and ovarian volume: a prospective randomized study

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Objective: To evaluate the effect of two different laparoscopic methods on ovarian reserve as determined by antral follicle count (AFC) and ovarian volume in patients with bilateral endometriomas.
Design: Randomized prospective study.
Setting: Tertiary education and research hospital.
Patient(s): Forty-eight patients with bilateral endometriomas.
Intervention(s): AFC and ovarian volumes determined before and after surgery; coagulation and cystectomy performed on one randomly selected side of each patient for their endometriomas; in vitro fertilization and embryo transfer.
Main Outcome Measure(s): Ovarian reserve damage as determined by AFC and ovarian volume, and number of dominant follicles and retrieved oocytes after controlled ovarian hyperstimulation.
Result(s): In vitro fertilization and embryo transfer were performed for 37 of 48 patients. The number of dominant follicles and the retrieved oocytes were assessed after controlled ovarian hyperstimulation. The postprocedural AFC was 3.67 ± 1.26 and 4.75 ± 0.60 after cystectomy and coagulation, respectively. A statistically significantly greater decrease in AFC was found after cystectomy as compared with coagulation. Postprocedural ovarian volumes were 6.27 ± 1.95 and 9.87 ± 2.01 after cystectomy and coagulation, respectively. A decrease in ovarian volume was found after cystectomy when compared with coagulation.
Conclusion(s): The decreases in AFC and ovarian volume were found for both coagulation and cystectomy, but the decrease was statistically significantly more frequent in cystectomized ovaries than in coagulated ovaries. Also, in the in vitro fertilization cycles, the ovarian response to ovulation induction was statistically significantly reduced in cystectomized ovaries as compared with coagulated ovaries. (Fertil Steril® 2011;95:2247–50. ©2011 by American Society for Reproductive Medicine.)

Key Words: AFC, antral follicle count, bilateral endometriomas, bipolar coagulation, cystectomy, retrieved oocytes, ovarian reserve, ovarian volume

Although laparoscopy is the primary surgical option for endometriosis, there is no definitive laparoscopic technique preferred (1). Stripping, fenestration and coagulation, and fenestration and vaporization are the most commonly used techniques (2). Recently, techniques such as combining cystectomy and ablative surgery, or a three-stage procedure, have been used to reduce the damage that cystectomy causes to the ovaries (3, 4).

Ovarian reserve has been defined as a woman's reproductive potential in terms of the number of ovarian follicles and the oocyte quality. Moreover, ovarian reserve can be screened by use of various tests (e.g., age, endocrine tests, and dynamic endocrine tests). In recent years, attention has shifted to direct tests such as ovarian volume and antral follicle count (AFC). Previous studies have shown that ovarian volume and the number of antral follicles are meaningful variables for determining ovarian reserve (4–9).

Cystectomy may be destructive to the ovary, decreasing fertility, and ablation may be an incomplete treatment with a high risk of recurrence. Several reports comparing cystectomy with fenestration and coagulation (10–14) have demonstrated that coagulation was associated with a higher recurrence rate and lower cumulative pregnancy rate when compared with cystectomy. In contrast, Hemmings et al. (13) found that patients who underwent laparoscopic fenestration and coagulation achieved pregnancy in a shorter time (1.4 years) when compared with patients who underwent laparoscopic cystectomy (2.2 years).

To evaluate the ovarian reserve before and after surgery in patients with bilateral endometrioma on whom single-side coagulation and cystectomy were performed, we used two different techniques (coagulation and cystectomy) in the same patient group during the same session and with the same surgeon so as to minimize other factors that may affect the study, then we measured AFC and ovarian volume in the patient group. In addition, we compared the dominant follicle numbers and the retrieved oocyte numbers in patients who underwent in vitro fertilization (IVF) after either technique.

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MATERIALS AND METHODS

Our study enrolled infertile women applying to Zekai Tahir Burak Women's Hospital, Reproductive Endocrinology Clinic between 2006 and 2008. Laparoscopy was performed on patients diagnosed with bilateral endometrioma.

Patients

The study inclusion criteria were the following: [1] patients aged between 20 and 35 years, [2] diagnosis of bilateral endometrioma, [3] similar endometrioma sizes, and [4] endometriomas sized between 4 and 6 cm. Women who had previously undergone ovarian surgery or received suppressive treatment due to endometriosis were not included in the study. Approval for the study was obtained from the local ethics committee of the hospital, and all patients were informed about the procedures and asked to complete informed consent forms.

A total of 48 patients fulfilled the study criteria. One month before and 6 months after the surgery, the antral follicle numbers and ovarian volumes of each patients' ovaries were assessed in the early follicular stage (days 1 to 5). The AFC was recorded as the total number of follicles with a diameter <9 mm. The ovarian volume was calculated using the prolate ellipsoid formula: Volume: 0.5233 × Anteroposterior diameter × Transverse diameter × Longitudinal diameter (in cm). The ultrasonographic assessment was performed by the same radiologist with an Aloka 7.5-MHz transvaginal probe (Aloka Co., Tokyo, Japan). Preoperation ovarian volume values were obtained by removal of the cyst volume from the total ovarian volume.

The primary outcome of the study was the impact on ovarian reserve, as determined by AFC and ovarian volume, before and after performing the two surgical techniques (i.e., coagulation; cystectomy) for the treatment of endometriomas. Coagulation and cystectomy were performed on either side of patients for their endometriomas, randomly. For all subsequent patients, cross-randomization was used to determine which procedure was performed on the right or left endometriomas.

Procedure

Laparoscopic operations were performed using video control under general anesthesia. Laparoscopic operations were performed with three 5-mm trocars in the lower abdomen and a 10-mm intraumbilical main trocar. 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.

In the stripping group of ovaries, after a cleavage plane between the cyst wall and ovarian cortex was identified, the ovaries were pulled slowly and gently in opposite directions by means of two atraumatic grasping forceps. After removing the pseudocapsule 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.

In the coagulation group of ovaries, fenestration was first performed, and a biopsy sample was obtained for histologic examination. Then the inner cyst wall was coagulated by the touch technique using 30-W current bipolar forceps (Karl Storz GmBH, Tuttlingen, Germany). No sutures were used in either group, and the ovaries were left open.

All operations were performed by the same surgeon. No complications occurred during or after surgery. Shifting from laparoscopy to laparotomy was not needed in any patient. Postoperatively, the pathology results were examined, and endometriosis was confirmed in all patients.

A total of 37 patients participated in the in vitro fertilization and embryo transfer (IVF-ET) procedure. For 18 patients, IVF was performed 3 months after the initial procedure because of bilateral tubal occlusion. In 19 patients, IVF was performed 1 year after the operation because they had not been able to conceive spontaneously. Patients were enrolled only for their first oocyte retrieval cycle, performed during the study period. The long protocol with gonadotropin-releasing hormone (GnRH) agonist was used in all the patients. After gonadotropin induction, the patients' responses to the treatment were evaluated via the number of developed dominant follicles (>14 mm) and the number of retrieved oocytes.

Sample Size

We compared differences in ovarian volume and the number of basal follicles. A total sample size of at least 88 cases (44 per group) was required to detect at least 2.5 mm^3 and 1-unit differences in variation of ovarian volume and basal follicle number, respectively, with a power of 90% at the 5% significance level. The differences of 2.5 mm^3 and 1-unit were taken from both the pilot study and clinical experience. The sample size estimation was performed by use of NCSS and PASS 2000 software (NCSS, Kaysville, UT).

Statistical Analysis

Analysis of the data was performed using SPSS (SPSS, Inc., Chicago, IL). The paired and unpaired Student's *t*-test and Wilcoxon signed rank test were used to test for statistical significance. $P<.05$ was considered statistically significant.

RESULTS

The mean age of the 48 participants of the study was 27.04 ± 3.90 years (± standard deviation) (range: 20 to 35 years). According to American Fertility Society scoring, all patients were in stage 4 endometriosis and had the score point 81.22 ± 11.88 (range: 40 to 98). The mean diameter of endometriomas in the ovary cystectomy group was 4.4 cm; that of the ovary coagulation was 4.6 cm.

In the coagulated ovary, the number of preoperative and postoperative follicles was compared; the precoagulation number of 5.42 ± 0.77 had fallen to 4.75 ± 0.60 by the postcoagulation stage. The difference was statistically significant ($P=.02$). In the cystectomized ovaries, the preoperative number of follicles was 5.58 ± 1.13, which fell to 3.67 ± 1.26 in the postcystectomy stage. The difference was statistically significant ($P=.001$) (Table 1). The antral follicle numbers fell after both operations.

The ovarian volume was 13.03 ± 1.30 before cystectomy, but after the procedure this volume fell to 6.27 ± 1.95 ($P=.001$). Also, the ovarian volume fell from 13.56 ± 1.50 to 9.87 ± 2.01 after coagulation ($P=.01$) (Table 2).

Cystectomy and coagulation were administered to compare the two surgical techniques for the number of follicles and ovarian volumes. As a result, it was found that the postcystectomy antral follicle number was 3.67 ± 1.30 while the postcoagulation antral follicle number was 4.75 ± 0.60. Thus, more follicle loss occurred after cystectomy than after coagulation, and this was statistically significant ($P=.001$). Postprocedure ovarian volumes were 6.27 ± 1.95 and 9.87 ± 2.01 after cystectomy and coagulation, respectively. Thus, a decrease in ovarian volume was found to have occurred after cystectomy when compared with coagulation ($P=.005$) (Table 3).

For 18 patients out of 48, IVF was performed 3 months after the initial procedure because of bilateral tubal occlusion. In the remaining patients, 11 patients conceived spontaneously within 1 year. The

TABLE 1

Presurgical and postsurgical basal follicle numbers.

Surgical technique	Basal follicle number		*P* value
	Presurgical	Postsurgical	
Cystectomy	5.58 ± 1.13	3.67 ± 1.26	.001
Cauterization	5.42 ± 0.77	4.75 ± 0.60	.02

Note: $P<.05$ was considered statistically significant. Data are expressed as mean ± standard deviation.

Var. Ovarian cystectomy vs. coagulation in bilateral endometriomas. Fertil Steril 2011.

TABLE 2

Presurgical and postsurgical ovarian volumes.

Surgical technique	Ovarian volume		*P* value
	Presurgical	Postsurgical	
Cystectomy	13.03 ± 1.13	6.27 ± 1.95	.01
Cauterization	13.56 ± 1.5	9.87 ± 2.01	.01

Note: $P<.05$ was considered statistically significant. Data are expressed as mean ± standard deviation.

Var. Ovarian cystectomy vs. coagulation in bilateral endometriomas. Fertil Steril 2011.

spontaneous pregnancy rate was 22.9%. One year after the operation, IVF was performed in 19 patients who could not conceive. Results were compared for the 37 total patients in whom IVF was performed.

The number of developed dominant follicles and the number of retrieved oocytes were compared in the patients who received IVF. The number of dominant follicles was 5.05 ± 0.91 in the coagulated ovaries, and 4.37 ± 0.95 in the cystectomized ovaries. However, the number of oocytes was 3.86 ± 0.88 and 3.08 ± 0.79, respectively. These differences were statistically significant ($P=.03$, $P=.01$) (see Table 3).

The clinical pregnancy rate for IVF patients, as determined by fetal heart beat demonstration on sonography, was 39%. Within 1 year, two recurrences were detected in the coagulation group.

DISCUSSION

Laparoscopic cyst excision is considered the best treatment because of the lower recurrence and improved fertility associated with it. However, it was recently questioned whether the excision of the endometrioma could decrease the function of the operated ovary, and whether this excision could affect subsequently fertility.

Observation of the reproductive functions and the ovarian reserve should be receive more careful attention for infertile patients. Treatment of patients with endometrioma should be considered and planned not only for symptom relief and recurrence but also for ovarian function and reserve (9).

In previous reports, ovarian tissue was observed with the endometrioma capsule in pathologic assessments, and cystectomy was considered to cause ovarian tissue loss (15, 16). In many studies, when pathologic findings of endometrioma and nonendometriotic cyst were compared, much more ovarian tissue was found around the cyst wall in the endometrioma groups (17, 18).

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 (19, 20) and spontaneous pregnancy (21). In cystectomized ovaries, decreased follicular ovarian response was shown in natural and clomiphene citrate–stimulated cycles (22).Ovarian volume has also been reported as a reliable indicator of ovarian reserve (23, 24).

Due to the ovarian tissue loss in cystectomy, it seems inevitable that ovarian volume will be decreased. Some studies have demonstrated poorer outcomes in patients with ovarian volumes<3 cm^3 (23, 25). Exacoustos et al. (26) assessed endometrioma and dermoid cysts with respect to poststripping ovarian volume and found a meaningful decrease in ovarian volume in endometrioma but not ovarian dermoid cysts. Ovarian volumes have been found to be meaningfully decreased in operated ovaries, and thus ovarian reserve also decreased (27).

The recent studies demonstrated that three-stage procedures and combined techniques do not decrease ovarian volume (4, 8). After the introduction of the use of the laser in gynecologic operations, laser vaporization has begun to be applied for endometriomas. After laser vaporization of cyst capsules in studies by Donnez and Wyns (28, 29), ovarian function was not impaired, and ovarian responsiveness to gonadotropins was better (good response); when compared with the control group patients who had no endometriosis, the post-IVF pregnancy rates were similar.

Donnez et al. (4) used a new technique by combining the best parts of the cystectomy and laser vaporization methods. Recurrence possibility was reduced by excising 80% to 90% of the endometrioma cyst capsule, and the hilar region of the ovary was protected in maintaining blood supply, preventing ovarian damage. In endometrioma cases treated with this technique, there was no difference between AFC and ovarian volume when compared with the control group with contralateral normal ovary. They argued that this technique is not deleterious to ovaries.

Pados et al. (8) used the three-stage procedure, which was first described in 1996 by Donnez. In this method, drainage is applied during the laparoscopic operation, and then a GnRH analog is used for 3 months. The second operation cyst wall is vaporized by CO_2 laser. The investigators compared cystectomy and the three-stage procedure in patients with endometrioma, measuring AFC, ovarian volume, and ovarian artery Doppler velocity. They found increased AFC in women who had undergone the three-stage procedure, and they concluded that folliculogenesis is better restored by this method (8). In another study, when the effect of cystectomy and the three-stage procedure on ovarian reserve was evaluated by antimüllerian hormone levels and AFC, it was suggested that the three-stage procedure caused less damage to the ovary as compared with cystectomy (9).

Our study demonstrated a decrease in the number of antral follicles and the ovarian volume in both coagulation and cystectomy. These decreases were statistically significantly more frequently found in the cystectomized ovaries than in coagulated ovaries.

Postcystectomy and postfenestration ablation treatment options have been compared, mostly in IVF cycles, and the response of ovaries to gonadotropins and pregnancy rates have been studied. A reduction in responsiveness to gonadotropin (30) or a higher dose of gonadotropin (31) usage after ovarian cystectomy has been reported, although this has not affected the IVF results (32).

TABLE 3

The number of basal follicles, dominant follicles, and retrieved oocytes, and the ovarian volume after two different surgical techniques.

Parameter	Postcystectomy	Postcauterization	*P* value
Basal follicle number	3.67 ± 1.26	4.75 ± 0.60	.001
Ovarian volume	6.27 ± 1.95	9.87 ± 2.01	.005
Dominant follicle	4.38 ± 0.95	5.05 ± 0.91	.03
Retrieved oocyte	3.08 ± 0.79	3.86 ± 0.88	.01

Note: $P<.05$ was considered statistically significant. Data are expressed as mean ± standard deviation.

Var. Ovarian cystectomy vs. coagulation in bilateral endometriomas. Fertil Steril 2011.

On the other hand, some studies have reported significant decreases in the number of oocytes and embryos obtained from the ovaries of patients who had undergone laparoscopic cystectomy (33).

In a previous study from our clinic, the IVF results of patients with endometriomas pretreated with laparoscopic cystectomy were compared with age-matched tubal infertility patients. We noted that cystectomy decreased the ovarian follicle reserve but did not reduce the pregnancy rate (34). In our current study, we evaluated the patients who underwent IVF treatment after the surgery for bilateral endometriomas and found that the cystectomized ovaries had statistically significantly fewer dominant follicles and oocytes than the coagulated ovaries.

The importance of our study is that two different surgical techniques were attempted on the same patient, by the same surgeon (without interobserver and intraobserver variability). Also, our study is the first study to compare cystectomy and coagulation for ovarian reserve as determined by AFC and ovarian volume in patients who had bilateral endometriomas. Our results have demonstrated that both cystectomy and coagulation have adverse effects on ovarian reserve as determined by AFC and ovarian volume but that cystectomy was more deleterious on ovarian tissue than coagulation. Also, in the IVF cycles, the ovarian response to ovulation induction was statistically significantly less in cystectomized ovaries than in the coagulated ovaries.

In procedures for infertile patients, we prefer the technique that will cause the least damage to the ovarian reserve over techniques that will have less of an effect on recurrence or other parameters. Excision is more deleterious than coagulation. In terms of the existing literature, the relatively worse results of coagulation compared with laser could be explained by the significantly greater thermal range.

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