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Original Article

Recurrence Rate after "One-Step" CO_2 Fiber Laser Vaporization versus Cystectomy for Ovarian Endometrioma: A 3-Year Follow-up Study

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ABSTRACT **Study Objective:** To assess postoperative recurrence rates in patients with endometriomas managed by either "one-step" CO_2 fiber laser vaporization or cystectomy.

Design: Retrospective study with prospective recording of data.

Setting: University hospital.

Patients: One hundred twenty-five patients with symptomatic endometriomas.

Interventions: Patients underwent a standardized laparoscopic stripping technique (group 1) or cyst vaporization with CO_2 fiber laser (group 2). After surgery, patients were incorporated in a prolonged surveillance program with periodic clinical follow-up to check for recurrence of the cyst and/or recurrence of symptoms. Endometrioma recurrence was defined as an ovarian cyst (>10 mm) with a typical aspect arising on the operated ovary identified by transvaginal ultrasound.

Measurements and Main Results: The primary endpoint was the comparison of recurrence rates between the 2 groups. The secondary endpoint was the evaluation of endometriosis-related pain recurrence in the 2 groups. Other endpoints selected for analysis included the identification of risk factors for the recurrence of endometrioma and of endometriosis-related symptoms. The mean follow-up was 29 ± 13 months (range, 13−49). Recurrence of ovarian endometriosis was recorded in 6.3% of patients (n = 4) treated with cystectomy and in 4.9% of patients (n = 3) managed with CO_2 fiber laser (p = .74). Recurrence of endometriosis-related pain was observed in 5 patients (7.8%) in group 1 and in 6 patients (9.8%) in group 2 (p = .67). Mean endometrioma diameter > 5 cm at the time of surgery was identified as the only independent poor prognostic indicator for cyst recurrence (p = .008; odds ratio [OR], 2.21; 95% confidence interval [CI], 1.19−3.32). Moreover, the presence of deep endometriosis at surgery (p = .032; OR, 4.60; 95% CI, 1.14−18.57) and discontinuation of hormonal treatment (p = .015; OR, 3.18; 95% CI, 1.25−8.06) were independent poor prognostic indicators for pain recurrence.

Conclusion: This study suggests that one-step CO_2 fiber laser vaporization may be effective for endometrioma treatment because it is associated with recurrence rates comparable with those occurring after cystectomy, with the advantage of being an ovarian tissue-sparing technique. Journal of Minimally Invasive Gynecology (2019) 00, 1−8. © 2019 AAGL. All rights reserved.

Keywords: CO_2 fiber laser; Cystectomy; Endometrioma; Recurrences

The most appropriate treatment for endometrioma remains controversial. Cystectomy seems to be more beneficial than drainage and ablation with bipolar energy because it provides a higher spontaneous pregnancy rate and lower recurrence rate [1]. However, it has been demonstrated that ovarian reserve is affected after surgical excision, because of inadvertent removal and thermal destruction of healthy ovarian tissue [2,3]. For these reasons, some practitioners suggest that cyst wall ablation using energies with little thermal spread, such as CO_2 and plasma laser, is a more conservative approach that could minimize loss of ovarian reserve [4−7]. Moreover, reassuring data on the rate of long-term recurrence after laser vaporization according to the "three-step procedure" and plasma energy have been published [6,8].

At our institution, concerns about ovarian failure after cystectomy resulted in the introduction of an ablative technique involving CO_2 fiber laser technology, which has the ability to deliver energy with little thermal spread, unlike

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other energy sources such as diathermy [9−11]. It provides a precise tissue dissection, ablation, and controlled depth of tissue penetration and thermal damage; for these reasons endometrioma ablation using laser energy may represent a less destructive approach toward the healthy ovarian cortex compared with other energy sources (e.g., electrocoagulation). We previously showed the benefits of "one-step" CO_2 fiber laser vaporization (without gonadotropin-releasing hormone agonist therapy) on ovarian reserve [12,13]; however, no definitive conclusion in terms of recurrence rate could be drawn because of short term follow-up [13].

The aim of the present study was to assess postoperative recurrence rates in patients with endometriomas managed by either one-step CO_2 fiber laser vaporization or cystectomy. A further endpoint was to assess prognostic factors that might influence the recurrence rate for pain and endometrioma.

Methods

This study included patients who underwent surgery for primary unilateral or bilateral symptomatic endometriomas larger than 3 cm at San Raffaele Scientific Institute between January 2015 and January 2018. Inclusion criteria were symptomatic (pain and/or infertility) patients of reproductive age, primary unilateral or bilateral endometriomas identified by transvaginal ultrasound, and largest diameter of the endometrioma $\geq$ 3 cm and $\leq$8 cm. The diameter cutoff was chosen according to previous data present in the literature and guidelines for the management of endometriomas [14]. Exclusion criteria were patients aged $\geq$ 40 years, unilateral oophorectomy, previous surgical procedures on the ovaries, and previous salpingectomy or hysterectomy.

Operative laparoscopy was performed by a team of surgeons with extensive experience in the treatment of endometriosis (M.C., S.F.). All laparoscopies were carried out with patients under general anesthesia. The pneumoperitoneum was created by using a Veress needle and the primary trocar (10 mm) introduced via the umbilicus. The insufflation pressure was approximately 12 to 14 mm Hg. The laparoscope was inserted through the primary trocar, and 3 accessory ports (5 mm incisions) were placed under visual control in the right and left iliac fossae and central suprapubic.

Patients underwent a standardized laparoscopic stripping technique (group 1) [10] or one-step vaporization with a CO_2 fiber laser (group 2). The cystectomy started with adhesiolysis, performed to free the ovaries from the surrounding structures. If the cyst remained unruptured despite manipulation, it was punctured to drain the "chocolate" content. A sharp cortical incision was made to identify the correct cleavage plane. The cyst was then stripped out from the healthy ovary by delicate traction and countertraction maneuvers. After the removal of the cyst, hemostasis was achieved by selective bipolar coagulation, mainly on the edges of the ovary. The procedure for CO_2 fiber laser vaporization has been previously described [12,13] (Fig. 1). First, the cyst content was drained and the cyst everted to expose the inner cystic wall completely. A biopsy of the cyst wall was sent for routine histologic examination to confirm the diagnosis of endometriosis. After that, the cystic lining was completely vaporized with a CO_2 fiber laser (UltraPulse Duo system; Lumenis Ltd., Santa Clara, CA) in a radial way starting from the center to the periphery at a mean power density of 13 W/cm^2 (range, 10−15). Care was taken not to leave any untreated sites and to ablate the edges of the invagination site and the corresponding peritoneal implants on the ovarian surface and on the adjacent broad ligament. Laser technology was also used to vaporize superficial peritoneal implants and to excise deep infiltrating nodules, if present.

In all patients the diagnosis of endometrioma was confirmed by surgical exploration and histopathologic examination. Endometriosis was staged according to the revised American Fertility Society (r-AFS) classification [15]. According to the standards of the r-AFS classification, the lesion score and total score (r-AFS score) were calculated at the end of surgery based on the surgery report. After surgery, patients were then referred to the Endometriosis Outpatient Clinic for follow-up.

Only patients whose follow-up exceeded 12 months were enrolled in the present study.

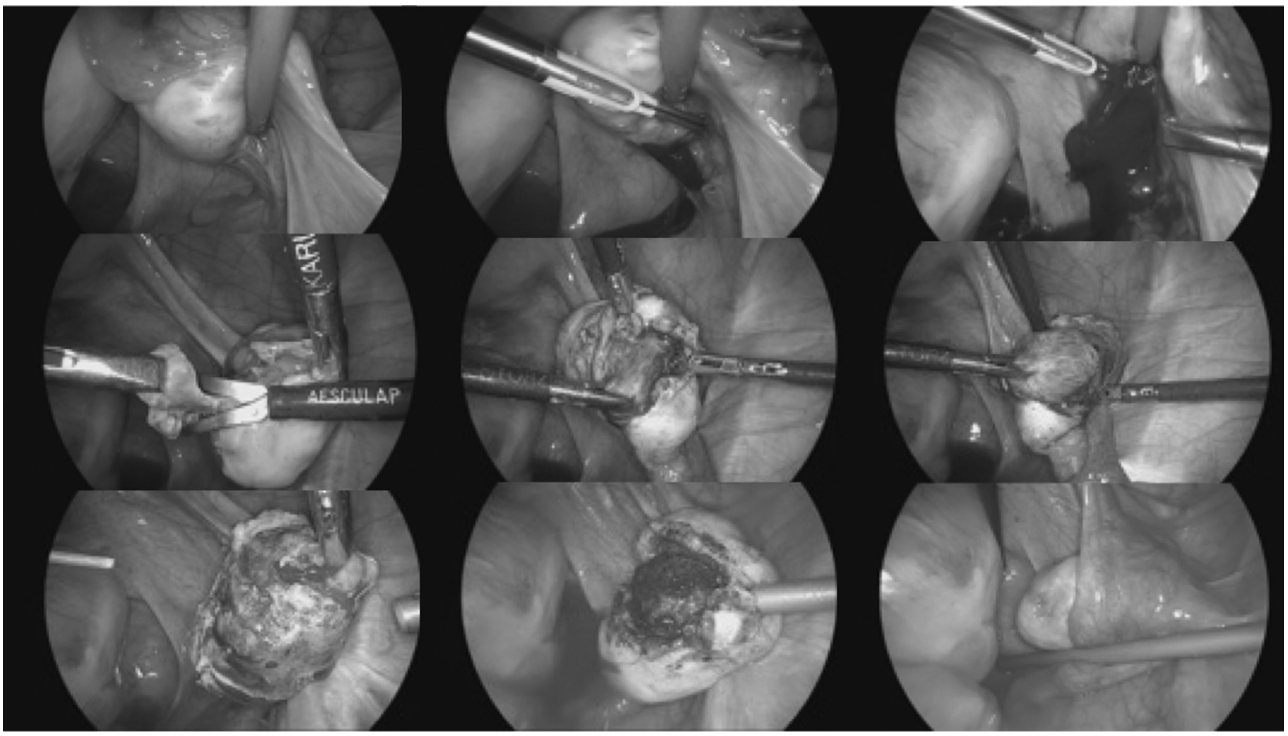
All patients who had no immediate pregnancy intention after surgery received medical therapy (estroprogestins in continuous administration) throughout the follow-up to reduce the risk of pain and endometriomas recurrences.

Patients were incorporated in a prolonged surveillance program with periodic clinical follow-up at intervals ranging from 3 to 12 months or when they needed medical evaluation. At every follow-up visit a gynecologic examination and a transvaginal ultrasound were performed to check for recurrence of the endometriotic cyst. Moreover, during follow-up visits patients completed specific questionnaires (visual analog scale) to assess recurrence of any type of typical pain related to endometriosis (i.e., dysmenorrhea, deep dyspareunia, nonmenstrual chronic pelvic pain). Cyst recurrence was considered as the presence of a cyst with a typical sonographic aspect and a diameter of more than 10 mm arising on the operated ovary identified by transvaginal ultrasound [16]. All scans were performed by experienced operators (J.O., I.T.).

Patient data were prospectively recorded in a database that included information about age at diagnosis, indications for surgery, type of surgery, intraoperative findings, r-AFS score [15], operative time required to treat endometriomas, postoperative medical therapy, recurrence of symptoms, recurrence of the cyst, and time to recurrence. This is a retrospective study with prospective recording of data. However, patients included in the present study were mostly patients who were initially part of a pilot study [12] and other patients who were part of a randomized clinical trial started in 2017 [13], both assessing the postoperative changes of ovarian

Fig. 1

"One-step" CO_2 fiber laser vaporization: laparoscopic view.



reserve after treatment (cystectomy vs CO_2 fiber laser vaporization). After showing the benefits of CO_2 on ovarian reserve, we decided to focus our attention on the recurrence rate after the 2 surgical procedures.

The primary endpoint was the comparison of recurrence rates between the 2 groups. The secondary endpoint was the evaluation of endometriosis-related pain recurrence in the 2 groups. Other endpoints selected for analysis included the identification of risk factors for the recurrence of endometrioma and of endometriosis-related symptoms.

Written informed consent for data collection and anonymous publication of disease-related information is routinely obtained in our Institution during the patient interview preceding surgical treatment. The Institutional Review Board of our Institution approved the study.

Statistical analysis

Descriptive statistics were used to characterize the patient population. Kaplan-Meier curves were built to estimate the probability of recurrence according to surgical procedures and depending on postoperative time. The log-rank test was used to test the statistical significance. Cox's regression model with stepwise variable selection was performed to analyze in univariate and multivariate analyses the role of clinical and surgical parameters as predictive factors for recurrence. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated as a measure of the risk of recurrence. Statistical calculations were performed using the Statistical Package for the Social Sciences, version 21.0 (SPSS Inc., Chicago, IL). A $p < .05$ was considered to be statistically significant.

Results

Between January 2015 and January 2018, 125 patients with symptomatic endometriomas were managed with cystectomy (group 1, $n = 64$) or ablation with CO_2 fiber laser (group 2, $n = 61$) at San Raffaele Scientific Institute. The baseline clinical characteristics and ultrasonographic findings of the 2 study groups are reported in Table 1. The 2 study groups were homogeneous with regard to mean age, mean endometrioma diameter, bilateral involvement, concomitant deep endometriosis, r-AFS score, and pregnancy intent after surgery. The mean follow-up was 29 ± 13 months (range, 13−49) and length of follow-up comparable between the 2 groups.

Recurrence of ovarian endometriosis was recorded in 4 patients (6.3%; 95% CI, 2.5−15) treated with cystectomy and in 3 patients (4.9%; 95% CI, 1.7−13.5) managed with CO_2 fiber laser ($p = .74$). The mean diameter of recurrent endometriomas was significantly larger in group 2 compared with group 1 (group 1, 1.6 ± .9 cm; group 2, 3.8 ± .3 cm; $p = .012$). Moreover, the mean diameter of recurrent endometriomas was smaller in patients under hormonal

Table 1

Baseline clinical characteristics, intraoperative findings, and follow-up of 2 groups of patients

Characteristics	Group 1 (n = 64)	Group 2 (n = 61)	p
Age, yr	31.9 ± 4.9	32.7 ± 4.1	.17
Indications for surgery			
Dysmenorrhea	35 (54.7)	30 (49.2)	.41
Chronic pelvic pain	30 (46.9)	26 (42.6)	.18
Dyspareunia	10 (15.6)	8 (13.1)	.21
Infertility	30 (46.9)	32 (52.5)	.08
Body mass index, kg/m^2	21.6 ± 3.1	20.1 ± 2.1	.047
Diameter of the cyst, cm	5.3 ± 1.5	4.2 ± 1.3	.27
Bilateral endometrioma	14 (21.9)	17 (27.9)	.44
r-AFS score	43.2 ± 23.5	41.1 ± 18.7	.59
Associated deep endometriosis	22 (34.4)	20 (32.8)	.85
Uterosacral ligaments	8 (12.5)	8 (13.1)	.91
Rectovaginal septum	12 (18.8)	12 (19.7)	.89
Ureter	3 (4.7)	3 (4.9)	.76
Bladder	4 (6.3)	8 (13.1)	.19
Follow-up, mos	30.2 ± 10.5	24.2 ± 11.4	.44
Postoperative pregnancy intent	30 (46.9)	36 (59)	.07
Hormonal therapy after surgery	34 (53.1)	25 (41)	.07
Recurrence of symptoms	5 (7.8)	6 (9.8)	.67
Recurrence of disease	4 (6.3)	3 (4.9)	.74
Diameter of recurrent endometrioma, cm	1.6 ± .9	3.8 ± .3	.012
Recurrence on the contralateral ovary	1 (1.6)	3 (4.9)	.29

Values are mean ± standard deviation or n (%).

treatment compared with nonusers (1.2 ± .4 cm vs 3.6 ± .5 cm; p = .021). We observed shorter time to recurrence in group 2 compared with group 1, although this finding did not reach statistical significance (group 1, 18 ± 9.8 months; group 2, 8.6 ± 6.7 months; p = .21).

Kaplan-Meyer survival analysis failed to demonstrate a significant difference in recurrence-free survival between the 2 groups (log-rank p = .91) (Fig. 2). All recurrent patients in group 2 were not taking medical therapy because of pregnancy intention, whereas 2 of 4 recurrent patients (50%) in group 1 were under hormonal treatment.

Characteristics of patients with postoperative endometrioma recurrence and with no recurrence are shown in Tables 2 and 3. Recurrence of endometriosis-related pain was observed in 5 patients (7.8%) in group 1 and in 6 patients (9.8%) in group 2 (p = .67). Seven patients with pain recurrence (63.6%) were receiving hormonal treatment.

Cyst recurrence was associated with pain recurrence in 2 patients (28.6%), whereas in the remaining 5 patients (71.4%) the recurrence was asymptomatic. Recurrence on the contralateral untreated ovary was observed in 1 patient (1.6%) in group 1 and in 3 patients (4.9%) in group 2 (p = .29). All patients were not taking medical therapy and were symptomatic for endometriosis-related pain. No patient with cyst recurrence underwent further surgery.

A Cox proportional hazard analysis was performed to identify independent predictors of cyst and pain recurrence. Mean endometrioma diameter > 5 cm at the time of surgery was identified as the only independent poor prognostic indicator for cyst recurrence (p = .008; OR, 2.21; 95% CI, 1.19−3.32). Age, unilateral versus bilateral involvement, r-AFS score, concomitant deep endometriosis, obliteration of the pouch of Douglas, type of surgery (cystectomy vs ablation with CO_2 fiber laser), and postoperative medical therapy did not retain significant predictive value for endometrioma recurrence.

The presence of deep endometriosis at surgery (p = .032; OR, 4.60; 95% CI, 1.14−18.57) and discontinuation of hormonal treatment (p = .015; OR, 3.18; 95% CI, 1.25−8.06) were independent poor prognostic indicators for pain recurrence. Age, unilateral versus bilateral involvement, endometrioma size at surgery, r-AFS score, obliteration of the pouch of Douglas, and type of surgery (cystectomy vs ablation with CO_2 fiber laser) were not associated with recurrence of symptoms.

Discussion

The aim of the present study was to assess the effectiveness of cystectomy and one-step CO_2 fiber laser vaporization (without gonadotropin-releasing hormone agonist therapy) for the management of endometrioma in terms of recurrence of the cyst and recurrence of pain symptoms. Our results suggest that ablation with CO_2 laser technology is associated with recurrence rates similar to those observed after cystectomy.

Fig. 2

Recurrence-free survival in patients submitted to cystectomy (*dashed line*) or CO_2 laser vaporization (*continuous line*) (log-rank p = .91).

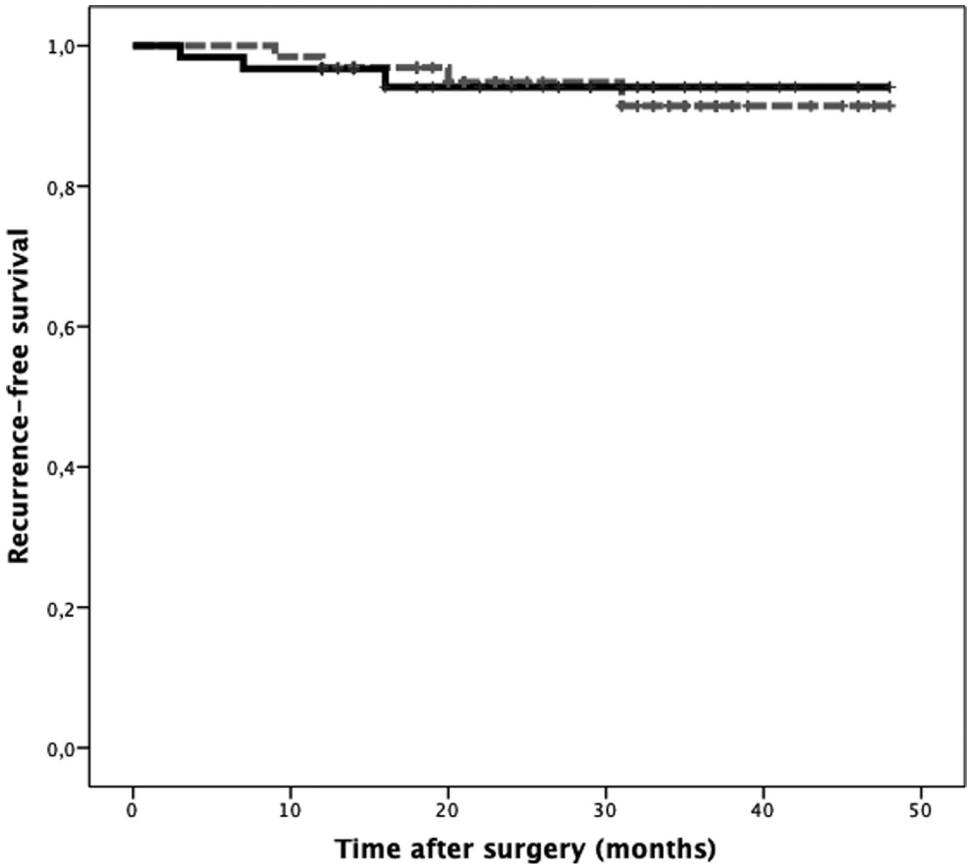


Table 2

Characteristics of women with endometrioma recurrence

Patient no.	Age (yr)	Type of surgery	Diameter (cm)	Unilateral/ bilateral	Associated DIE	r-AFS score	Pregnancy intent	Postoperative pregnancy	Follow-up (mo)	Time to recurrence (mon)	Diameter of recurrent cyst (cm)	Hormonal treatment at recurrence
1	27	Cystectomy	4	Unilateral	No	52	No		48	31	1.5	cCOC*
2	35	Cystectomy	6	Unilateral	Yes	38	Yes	Yes	35	20	3	No
3	35	Cystectomy	5	Unilateral	No	24	No		33	12	1	cCOC
4	29	Cystectomy	6	Bilateral	No	98	Yes	No	24	9	1	No
5	34	Laser	5	Bilateral	Yes	70	Yes	Yes	37	16	3.5	No
6	33	Laser	5	Unilateral	No	28	Yes	Yes	20	7	4	No
7	34	Laser	6	Unilateral	Yes	40	Yes	No	13	3	4	No

cCOC = continuous combined oral contraceptive therapy; DIE = deep infiltrating endometriosis.

One of the most frustrating aspects of endometrioma treatment is disease recurrence. When surgically treating endometriomas, it is necessary to achieve a balance between the virtually unavoidable destruction of healthy ovarian tissue and the prevention of cyst recurrence. There is consistent literature suggesting that endometrioma ablation using energies with minor in-depth thermal spread, such as CO_2 laser, may represent an effective ovarian tissue–sparing technique [5,7,13,17]. However, only few studies have investigated the recurrence rates after cystectomy and CO_2 laser vaporization [8,18]. The present study is the first that compares cystectomy with one-step CO_2 fiber laser vaporization for endometrioma treatment in terms of recurrence rate.

Table 3

Characteristics of women with no endometrioma recurrence

Characteristics	Group 1 (n = 60)	Group 2 (n = 58)	p
Age, yr	32 ± 5	32.7 ± 4.1	.28
Diameter of the cyst, cm	5.2 ± 1.6	4.1 ± 1.3	.18
Bilateral endometrioma	12 (20)	16 (27.6)	.33
r-AFS score	39.2 ± 21.4	35.9 ± 16.9	.16
Postoperative pregnancy intent	28 (46.7)	33 (56.9)	.27
Hormonal therapy after surgery	32 (53.3)	25 (43.1)	.27

Values are mean ± standard deviation or n (%).

In our practice, since 2015 we have adopted the one-step CO_2 fiber laser vaporization (without gonadotropin-releasing hormone agonist therapy before surgery) for routine use in the surgical treatment of endometrioma. CO_2 fiber laser vaporization may represent a more advantageous approach than other energy sources (like CO_2 laser in-line-of-sight or plasma energy) for several reasons. It is easy to use, highly reproducible, and, thanks to its high precision, provides optimal ablation capabilities, minimizing the need for electrocoagulation or suturing [19].

To date the real incidence of endometrioma recurrence is uncertain. It affects between 6% and 32% of women, and this is probably because of the different techniques used to treat endometriomas and also because the definition of recurrence and follow-up duration are not the same for all studies. Most studies consider recurrence of symptoms as recurrence of disease, whereas others consider as cyst recurrence even the appearance of a cyst on the contralateral ovary.

Recurrence rates, ranging from 8% through 30%, have been reported after ablative techniques using CO_2 laser in-line-of-sight or plasma energy [6,8,18,20]. Our results showed slightly lower rates of recurrences if compared with those reported in the literature. This finding could likely be related to the specific expertise in endometriosis surgery of the surgeons who performed the procedures. It is well known that the experience of the surgeon and residual lesions are the primary reasons for disease recurrence [21]. Greater surgical experience means greater care in removing all visible peritoneal and ovarian implants, completely removing the cyst wall, or completely vaporizing the cystic lining without leaving any untreated site that may lead to recurrences.

As regards the laser procedure, we believe that a successful ablation is also related to the surgeon's patience and to the device itself. Care must be taken in adequately reversing the cyst and in ablating the whole inner surface, including the edges of the cystic capsule. At our institution this caution is achieved mainly thanks to the device itself: In particular, the long arm of the flexible fiber allows the surgeon to work in difficult to reach areas and narrow anatomic spaces. These characteristics of fiber laser could also be responsible for reducing our recurrence rates compared with those reported after CO_2 laser in-line-of-sight [8]. Moreover, fiber laser, unlike cystectomy and traditional line-of-sight CO_2 laser, does not require specific training [19]. Fiber laser is simple and easy to use and highly reproducible, thus eliminating the "surgeon experience" factor. For these reasons CO_2 laser may represent a viable alternative to traditional cystectomy requiring an experienced surgeon, especially when performed by gynecologists approaching the endometrioma without specific skill in the field of reproductive and endometriosis surgery.

In the present study time to recurrence was shorter in patients treated with CO_2 fiber laser vaporization compared with those patients who underwent cystectomy; however, this finding did not reach statistical significance. These results support other published data [8,22]. Carmona et al found a statistically significant increase in short-term recurrence rates in patients undergoing laser treatment compared with cystectomy; however, no statistically significant differences in long-term (5 years) recurrence rates were found between cystectomy and CO_2 laser vaporization [8]. Our results, along with those from the trial of Carmona et al [8], are reassuring and may contribute to re-establishing the use of ovarian endometrioma ablative techniques in common practice.

Furthermore, our study showed a significantly larger mean diameter of recurrent endometriomas after CO_2 fiber laser than after cystectomy. We can speculate that the larger size of recurrent endometrioma in the laser group may be due to either a greater likelihood of short-term recurrences or the lack of medical therapy in these recurrent patients, which it is known to reduce disease severity [23]. We can also hypothesize that local factors after excisional surgery such as a depleted ovarian reserve and a compromised vascular supply [2,3] may cause recurrent cysts to grow less and more slowly in this group of patients [24]. Further studies are required for a definite interpretation of this result.

Moreover, this study evaluated the risk factors for recurrence of endometrioma and endometriosis-related pain. Surgical techniques (cystectomy vs ablation with CO_2 fiber laser) and postoperative medical therapy did not influence disease recurrence. The only independent poor prognostic

indicator for cyst recurrence was the diameter of the cyst at the time of surgery. These results are in line with previously published data [25−27]. This finding may probably be related to the fact that complete surgical treatment in larger endometriomas is more difficult to achieve, because it is easier to leave untreated areas.

This study has several weaknesses. The major limitation is represented by the retrospective design of the study. Moreover, the sample size is small, although comparable with previously published studies [6,8,20]. Given the low number of patients in the sample, the recurrence rate in the laser group could be estimated to be up to 13.5% (95% CI upper limit). Interestingly, this is a lower estimate compared with the highest estimated recurrence rate for patients undergoing cystectomy reported in the literature. Furthermore, there is a significant overlap in CI ranges in the cystectomy and laser group. Another limitation of the study is the relatively short follow-up and the subsequent inability to assess long-term recurrences. This restriction could have affected the low recurrence rates in the present study. In fact, the rate of endometrioma recurrences appears to be correlated to the duration of follow-up [25,28]. However, some authors suggested that disease recurrence after CO_2 vaporization may occur in the short term [8]. For this reason we considered a 3-year follow-up as an adequate time to evaluate recurrence rates. The strengths of this study are the accurate estimation of all endometrioma recurrences (we consider all recurrent cysts > 1 cm) and the accurate assessment of endometrioma recurrence independently to pain recurrence and to cyst recurrences on the contralateral ovary.

In conclusion, this study suggests that one-step CO_2 fiber laser vaporization may be effective for endometrioma treatment because it is associated with recurrence rates comparable with those occurring after cystectomy, with the advantage of being an ovarian tissue−sparing technique. Additional trials could be helpful to verify the effectiveness of endometrioma CO_2 vaporization at longer follow-up time frames.

References

1. Hart RJ, Hickey M, Maouris P, Buckett W. Excisional surgery versus ablative surgery for ovarian endometriomata. *Cochrane Database Syst Rev*. 2008:CD004992.
2. Busacca M, Riparini J, Somigliana E, et al. Postsurgical ovarian failure after laparoscopic excision of bilateral endometriomas. *Am J Obstet Gynecol*. 2006;195:421–425.
3. Benaglia L, Somigliana E, Vighi V, Ragni G, Vercellini P, Fedele L. Rate of severe ovarian damage following surgery for endometriomas. *Hum Reprod*. 2010;25:678–682.
4. Canis M, Pouly JL, Tamburro S, Mage G, Wattiez A, Bruhat MA. Ovarian response during IVF-embryo transfer cycles after laparoscopic ovarian cystectomy for endometriotic cysts of >3 cm in diameter. *Hum Reprod*. 2001;16:2583–2586.
5. Tsolakidis D, Pados G, Vavilis D, et al. The impact on ovarian reserve after laparoscopic ovarian cystectomy versus three-stage management in patients with endometriomas: a prospective randomized study. *Fertil Steril*. 2010;94:71–77.
6. Roman H, Auber M, Bourdel N, Martin C, Marpeau L, Puscasiu L. Postoperative recurrence and fertility after endometrioma ablation using plasma energy: retrospective assessment of 3-year experience. *J Minim Invasive Gynecol*. 2013;20:573–582.
7. Var T, Batioglu S, Tonguc E, Kahyaoglu I. 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. *Fertil Steril*. 2011;95:2247–2250.
8. Carmona F, Martínez-Zamora MA, Rabanal A, Martínez-Román S, Balasch J. Ovarian cystectomy versus laser vaporization in the treatment of ovarian endometriomas: a randomized clinical trial with a five-year follow-up. *Fertil Steril*. 2011;96:251–254.
9. Donnez J, Wyns C, Nisolle M. Does ovarian surgery for endometriomas impair the ovarian response to gonadotropin? *Fertil Steril*. 2001;76:662–665.
10. Donnez J, Pirard C, Smets M, Jadoul P, Squifflet J. Surgical management of endometriosis. *Best Pract Res Clin Obstet Gynaecol*. 2004;18:329–348.
11. Sutton CJG, Jones KD. Laser laparoscopy for endometriosis and endometriotic cysts. *Surg Endosc*. 2002;16:1513–1517.
12. Ottolina J, Castellano LM, Ferrari S, et al. The impact on ovarian reserve of CO2 laser fiber vaporization in the treatment of ovarian endometrioma: a prospective clinical trial. *J Endometr Pelvic Pain Disord*. 2017;9:206–210.
13. Candiani M, Ottolina J, Posadzka E, et al. Assessment of ovarian reserve after cystectomy versus "one-step" laser vaporization in the treatment of ovarian endometrioma: a small randomized clinical trial. *Hum Reprod*. 2018;33:2205–2211.
14. Dunselman GA, Vermeulen N, Becker C, et al. ESHRE guideline: management of women with endometriosis. *Hum Reprod*. 2014;29:400–412.
15. American Society for Reproductive Medicine. Revised American Fertility Society classification of endometriosis: 1996. *Fertil Steril*. 1997;67:817–821.
16. Exacoustos C, Zupi E, Carusotti C, et al. Staging of pelvic endometriosis: role of sonographic appearance in determining extension of disease and modulating surgical approach. *J Am Assoc Gynecol Laparosc*. 2003;10:378–382.
17. Pados G, Tsolakidis D, Assimakopoulos E, Athanatos D, Tarlatzis B. Sonographic changes after laparoscopic cystectomy compared with three-stage management in patients with ovarian endometriomas: a prospective randomized study. *Hum Reprod*. 2010;25:672–677.
18. Donnez J, Nisolle M, Gillet N, Smets M, Bassil S, Casanas-Roux F. Large ovarian endometriomas. *Hum Reprod*. 1996;11:641–646.
19. Vanni VS, Ottolina J, Candotti G, et al. Flexible CO2 laser fiber: first look at the learning curve required in gynecological laparoscopy training. *Min Ginecol*. 2018;70:53–57.
20. Sutton CJ, Ewen SP, Jacobs SA, Whitelaw NL. Laser laparoscopic surgery in the treatment of ovarian endometriomas. *J Am Assoc Gynecol Laparosc*. 1997;4:319–323.
21. Carmona F, Martínez-Zamora A, González X, Ginés A, Buñesch L, Balasch J. Does the learning curve of conservative laparoscopic surgery in women with rectovaginal endometriosis impair the recurrence rate? *Fertil Steril*. 2009;92:868–875.
22. Shimizu Y, Takashima A, Takahashi K, Kita N, Fujiwara M, Murakami T. Long-term outcome, including pregnancy rate, recurrence rate and ovarian reserve, after laparoscopic laser ablation surgery in infertile women with endometrioma. *J Obstet Gynaecol Res*. 2010;36:115–118.

23. Seracchioli R, Mabrouk M, Frascà C, et al. Long-term cyclic and continuous oral contraceptive therapy and endometrioma recurrence: a randomized controlled trial. *Fertil Steril*. 2010;93:52–56.
24. Somigliana E, Benaglia L, Vercellini P, Paffoni A, Ragni G, Fedele L. Recurrent endometrioma and ovarian reserve: biological connection or surgical paradox? *Am J Obstet Gynecol*. 2011;204:529.
25. Busacca M, Marana R, Caruana P, et al. Recurrence of ovarian endometrioma after laparoscopic excision. *Am J Obstet Gynecol*. 1999; 180:519–523.
26. Koga K, Takemura Y, Osuga Y, et al. Recurrence of ovarian endometrioma after laparoscopic excision. *Hum Reprod*. 2006;21:2171–2174.
27. Moini A, Arabipoor A, Ashrafinia N. Risk factors for recurrence rate of ovarian endometriomas following a laparoscopic cystectomy. *Min Med*. 2014;105:295–301.
28. Busacca M, Chiaffarino F, Candiani M, et al. Determinants of long-term clinically detected recurrence rates of deep, ovarian, and pelvic endometriosis. *Am J Obstet Gynecol*. 2006;195:426–432.