

Can the endometrioma be an obstacle to complete oocyte retrieval in IVF cycles? A retrospective study

G.M. BALDINI^{1,2}, A.S. LAGANÀ³, A. MASTROROCOCO⁴, A. MALVASI²,
D. BALDINI¹, D. FERRI¹, R. SCIORIO⁵, G. TROJANO⁶

¹IVF Center, Momo Fertilife, Bisceglie, Italy

²Obstetrics and Gynecology Unit, Department of Biomedical Sciences and Human Biology, University of Bari "Aldo Moro", Bari, Italy

³Unit of Obstetrics and Gynecology "Paolo Giaccone" Hospital, Department of Health Promotion, Mother and Child Care, Internal Medicine and Medical Specialties (PROM-ME), University of Palermo, Palermo, Italy

⁴Department of Biosciences, Biotechnologies and Environment, University of Bari "Aldo Moro", Bari, Italy

⁵Edinburgh Assisted Conception Programme, Royal Infirmary of Edinburgh, Edinburgh, UK

⁶Department of Maternal and Child Health, Madonna delle Grazie Hospital, Matera, Italy

Abstract. – OBJECTIVE: The study aimed to evaluate the utility and safety of ancillary maneuvers during oocyte retrieval for patients with endometrioma that makes ovum pick-up hard due to poor ovarian surgical accessibility.

PATIENTS AND METHODS: Cases of 251 women with ovarian endometriomas undergoing *in vitro* fertilization (IVF) in our infertility unit were retrospectively analyzed to evaluate the clinical IVF cycle outcomes after oocyte retrieval. Controls (n = 25) were age-matched women without endometriomas who underwent an uncomplicated oocyte retrieval.

RESULTS: No statistically significant differences were observed between groups for the number of oocytes retrieved, which was higher in the control group than in the group of women with endometrioma. On the contrary, there were no differences between the experimental groups in the fertilization rate and number of embryos and neither were there in the pregnancy and live birth rate. Moreover, the surgical complications were infrequent and similar between the two analyzed groups. Accidental voluntary endometrioma incisions were not accompanied by increased risk of pelvic infection.

CONCLUSIONS: In conclusion, patients with endometrioma can undergo high-performance oocyte retrieval procedures thanks to safe ancillary maneuvers during the ovum pick-up.

Key Words:

In vitro fertilization/intracytoplasmic sperm injection, Endometrioma, Oocyte retrieval.

Introduction

Endometriosis is a chronic and common estrogen-dependent inflammatory gynecologic disease

characterized by the presence and maintenance of endometrial-like tissue (glandular epithelium and stroma) in aberrant locations outside the uterus¹. Recent epidemiological studies^{2,3} have reported that it affects up to 50% of sub- and infertile women, although it can also be found in 10-15% of women of reproductive age. Endometriosis is a serious problem for women's health, and it can negatively affect the chances of pregnancy. More specifically, endometriosis is related to reduced ovarian reserve and worse fecundity rates due to altered molecular composition of follicular fluid with high concentrations of cytokines, leading to abnormal and reduced follicular and oocyte development and poor embryo quality⁴.

In addition, endometriosis may cause an endometrioma, one or more cysts in the ovarian tissues, often diagnosed during infertility work-up in about 17-44% of women with endometriosis⁵⁻⁷. For the above reasons, most women with ovarian endometrioma-related infertility generally undergo an IVF treatment to achieve pregnancy.

Most publications⁸⁻¹¹ show that surgery does not increase the success rate of *in vitro* fertilization (IVF) and may even harm assisted reproductive techniques (ART) by leading to reduced ovarian response to controlled ovarian stimulation (COH).

In addition, several studies¹²⁻¹⁵ have reported a reduction in anti-müllerian hormone (AMH) after endometriosis surgery, likely related to the removal of healthy parenchyma. Antral follicle counts appear to be relatively less affected^{16,17}. Conversely, some studies¹⁸⁻²⁰ have shown recovery of ovarian reserve after endometriosis surgery, but

only up to one year, so spontaneous conception can be expected one year after surgery.

The presence of endometrioma, however, in many cases made the ultrasound monitoring of follicular growth difficult, the ovarian response to hyperstimulation inadequate and the ovum pick-up more problematic since endometrioma may interfere with ovarian accessibility²¹. Therefore, an incomplete recovery of oocytes can occur, and the recovered oocytes may have low competence^{21,22}. Moreover, the accidental rupture of the cyst can lead to a shedding of endometriotic material into the peritoneum with possibly consequent inflammatory diseases and pelvic sepsis²³. On the other hand, there is evidence²⁴⁻²⁶ that endometrioma did not significantly affect embryo development and pregnancy rates.

In cases where the presence of an endometrioma makes ovum pick-up hard due to poor ovarian surgical accessibility, some accessory maneuvers during the procedure can be helpful.

The purposes of this study were:

- Verify whether the use of ancillary maneuvers during oocyte retrieval can help reach the ovary and collect all the present oocytes.
- Evaluate if the accidental or volunteer rupture of the endometrioma followed by total aspiration and washing of cysts may cause side effects.

Patients And Methods

Patients

From January 2012 to December 2023, 6,204 IVF cycles at the Momò Fertility Center for Reproductive Medicine in Bisceglie (Italy) were performed. Of these, 4,241 were fresh embryo transfers, and 1,963 were frozen embryo transfers. Of 4,241 cycles, 861 patients (20,7%) had a primary or secondary diagnosis of endometriosis. Patients were selected against their eligibility criteria. Exclusion criteria included previous pelvic and abdominal surgery and surgery to remove endometriosis, pelvic inflammatory disease (PID) anamnesis, non-endometriosis ovarian cysts, body mass index (BMI) greater than 30, concomitant male infertility factor, adenomyosis, deep endometriosis.

Considering exclusion criteria, 616 cycles of 793 were selected. 251 patients of 616 (42%) had endometrioma diagnosis. 7 patients were lost to follow-up. The representativeness of the sample size was achieved with a 95% confidence interval and a margin of error of 5.2% for approximately

861 patients with endometriosis in the same study period. These data resulted in an optimal sample calculation of 251 cases.

The sampling was random stratified cluster type. Considering exclusion criteria, 3,363 of the remaining 4,241 fresh embryo transfer cycles were eligible as controls since those patients did not have an endometriosis diagnosis. From that group, 251 patients with similar social-demographical characteristics to the group of patients with endometrioma were selected as controls by using Meditex software version number 2.8.7.4 (available at: www.meditex-italia.com) (Figure 1).

All the women underwent baseline evaluation transvaginal ultrasound, antral follicles count (AFC), and blood tests, including hormone analysis [AMH, basal follicle stimulating hormone (FSH), and estradiol level] two months before starting the ART cycle date.

The diagnosis of presumed ovarian cysts was recorded at the baseline transvaginal ultrasound evaluation and examination on at least two menstrual cycles apart. Moreover, the presence of the ovarian cysts was confirmed during ovarian stimulation. Cystic mass of round shape, with a minimum diameter of 10 mm, thick walls, regular margins, low homogeneous exogenous fluid content with scattered internal echoes, and without papillary projections was defined as endometrioma²⁷. Endometrioma diameter was calculated as the average of three perpendicular diameters.

Exclusion criteria were patients with one or more clinically atypical or suspected lesions (cysts whose ultrasound appearance was compatible but not distinctive of endometriosis) and/or with deep invasive endometriosis nodules.

All patients who underwent oocyte retrieval were monitored and managed according to standard procedures. The starting dose of gonadotrophin was determined based on maternal age, ovarian reserve (AMH and AFC) hormone tests and any outcomes of previous fertilization cycles. Thereafter, the patients underwent controlled ovarian stimulation (COS) using the gonadotrophin-releasing hormone (GnRH) antagonist protocol. The recombinant follicle-stimulating hormone (FSH; GONAL f, Merck Serono, Weiterstadt, Germany) was administered from the second day of menstruation; the starting dose was determined always using age, AMH, and AFC. Follicular maturation was monitored through serum estradiol (E2) and progesterone (P) levels and in parallel, also with transvaginal follicular ultrasound, respectively, on days 5, 7,

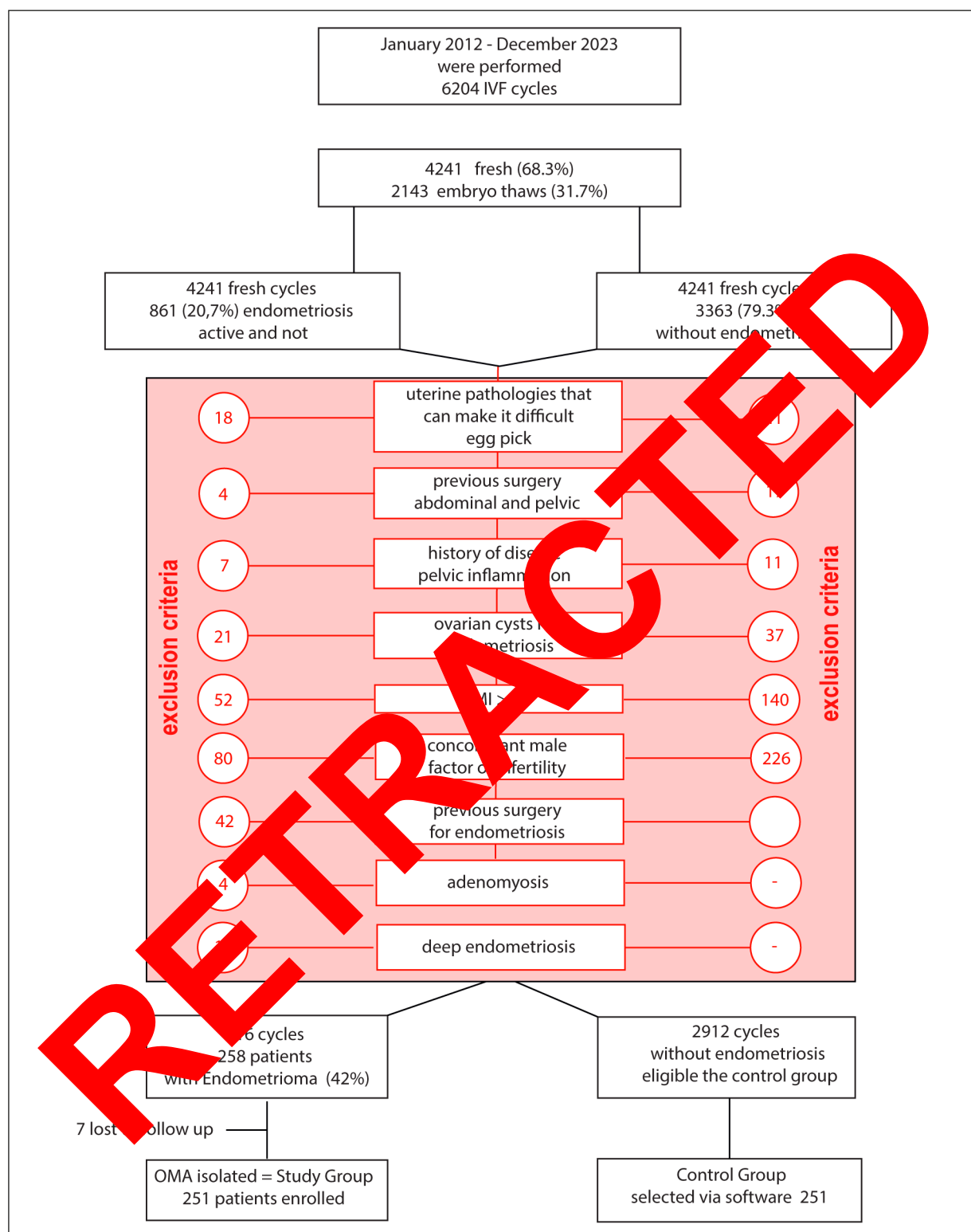


Figure 1. Study design. The flow diagram shows a selection of IVF/ICSI cycles.

10 and 12 from the start of therapy. When one or more follicles reached 13-14 mm size, 0.25 mg of Cetrotide (Merck Serono, Weiterstadt, Germany)

was administered daily to avoid ovulation. To induce ovulation, the final dose of 10,000 IU of human Chorionic Gonadotropin (hCG; GONASI,

IBSA, Lugano, Switzerland) injection was administered subcutaneously when three or more follicles reached > 18 mm diameters and 34-37 hours later the pick-up takes.

All patients enrolled voluntarily in the study provided written informed consent after being well-informed of the aims and procedures of the study, and all the procedures were performed according to the Declaration of Helsinki relevant guidelines and regulations. Moreover, the patients enrolled in the study provided written consent to the use of their clinical data for research purposes. The Clinical Research Local Ethics Committee approved the present study (No. 7; registration date, 12/07/2018).

Oocyte Collection Procedures

Oocyte aspiration was performed with the administration of anesthetic drugs intravenously (15 mg Midazolam and 0.05 mg Fentanyl). Oocytes were collected by follicular puncture using a 17-gauge aspiration needle (COOK Medical, Bloomington, IN, USA) connected to a guide on the transvaginal ultrasound device (GE Voluson S8, GE Co Ltd, Boston, MA, USA).

IVF procedures were performed by three different doctors, and experts in *in vitro* fertilization. The capability of these doctors to be able to fully oocyte recovery in 98% of cases and carry out additional maneuvers in case of difficulty was evaluated²⁸. All these aspects were given a positive medical expertise evaluation.

Oocyte recovery was performed by using the standard procedure used in our clinic²⁹. Briefly, this technique provides the minimal insertion of the oocyte aspiration needle into the ovaries, and all the follicles present were aspirated thanks to probe and needle maneuvers. Moreover, during the final stage of follicle aspiration, a needle spinning around its axis was performed. If the doctor could not aspirate all the follicles with a single insertion of the needle into the ovary, a new introduction of the needle into the ovary was made.

Ancillary maneuvers were carried out in the presence of endometriomas or misplaced ovaries. Ovary position was defined as dislocated about its normal anatomic position (each ovary is normally allocated laterally to the uterus in the ovarian fossa and behind and inside the external iliac vessels³⁰).

The maneuvers were:

- 1st Maneuver: bimanual abdominal pressure and vaginal probe pressure
- 2nd Maneuver: anti Trendelenburg position

- 3rd Maneuver: cervical clamp traction
- 4th Maneuver: trans-abdominal oocyte retrieval
- 5th Maneuver: trans-myometrial oocyte retrieval

In the event that the above-mentioned manipulations were not sufficient to perform the complete follicle aspiration, endometrioma was transfixied. Endometrioma transfixion consisted of the passage through the endometrioma, without aspirating, to reach the follicles behind the cyst, and the needle was washed with oocyte culture media. At the end of the follicle aspiration procedure with endometrioma transfixion, the cysts were completely aspirated and washed with physiological solution. The cyst fluid was discarded.

Follicle retrieval was considered completed after the aspiration of all follicles with > 11-12 mm diameter. In some cases, the complete aspiration could not be finalized due to the inability to achieve all the follicles, which could pose additional risks for the patient. In the case of accidental endometrioma aspiration reported by the doctor, it was confirmed by follicular fluid evaluation under a stereomicroscope with the presence of endometrioma content in aspirated follicular fluid: a cloudy, dark brown fluid with several fine black particles^{31,32}.

To assess ovum pick-up side effects and any risks of complications, the medical conditions (ultrasound and blood count) of the patients were evaluated immediately after 24 hours of the ovum pick-up. Oocytes retrieved from tubes contaminated with endometrioma contents and those not contaminated were treated similarly.

Insemination Procedure

Conventional IVF

The semen was prepared following the density gradient procedure. Then, the sperm sample was washed with a media for sperm handling (G-MOPS, Vitrolife, Gothenburg, Sweden) to remove any debris, non-motile sperm, and seminal fluid components that could potentially interfere with fertilization. Then, the sample underwent a swim-up for about 30/45 min in the incubator at 37°C. Subsequently, the supernatant was collected to prepare the IVF insemination by diluting it with sperm handling media (G-Mops, Vitrolife, Viby J, Denmark) until we reached the sperm concentration between 50.000 to 100.000 sperms per milliliter. Finally, the IVF insemination was placed in drops containing individual oocytes and left overnight.

ICSI (Intracytoplasmic Sperm Injection)

Cumulus-oocyte complexes were immediately collected, washed, and transferred in IVF medium (G IVF, Vitrolife, Sweden) for 3 hours at 37°C, 5% CO₂. Then, cumulus-oocyte complexes were exposed to a hyaluronidase solution (25 IU/ml) to remove the corona radiata. The cleaned oocytes were inspected and evaluated under the stereomicroscope (Nikon SMZ 1500, Tokyo, Japan) to select only metaphase II (MII) oocytes. Semen was collected after 3 to 4 days of sexual abstinence and prepared according to the method used in our center³³.

The ICSI procedure was performed at 37°C under an inverted microscope (Nikon Eclipse, TE 200, Tokyo, Japan) using a microinjection system with 400x magnification. After insemination, fertilized oocytes were cultured in Global medium (Cooper Surgical, Trumbull, CT, USA) for up to 6 days.

The obtained embryos were cultured in the Geri-time Lapse system (Genea Biomedx, Sydney, Australia) to check fertilization and cleavage rates.

Transfer Procedure

On the third and fifth days of culture, fresh embryos were transferred as single embryo transfer (SET). The best-quality embryos were transferred. In cases where fewer than three embryos were available, SET was performed after 48 hours after the fertilization procedure. The transfer was performed under ultrasound guidance (6000, GE Sonos 8, GE Co Ltd., Boston, MA, USA) with the transabdominal probe. Pregnancy was confirmed by serum levels of beta human chorionic gonadotropin (beta-hCG) exceeding 100 IU/mL, 9 days after transfer and intrauterine gestational sac identification via transvaginal ultrasonography.

The criteria for selecting embryo transfer on day 3 or day 5 were mainly based on the number of embryos obtained and the patient's age. In fact, when the number of embryos was less than 3 and the age was ≥ 40 , the embryo transfer on day 3 was chosen over day 5.

Statistical Analysis

Patients' demographic characteristics were homogeneous using the Student's *t*-test (Table I). The data were analyzed using Prism version 8.4.3 software (GraphPad Software, Boston, MA, USA). An accurate statistical assessment of the samples was obtained by analyzing general characteristics such as age, and clinical data of patients.

Data were presented as mean and standard deviation for continuous parametric variables or as percentages for categorical variables. Statistical evaluations of the clinic parameters were compared between groups using the Student's *t*-test or Chi-square test. Differences with *p*-value < 0.005 were considered statistically significant in the present study.

In detail, statistical evaluations regarding the characteristics of fertilization rate, number of viable embryos, fresh transfer performed at the cleavage stage, fresh transfer performed at the blastocyst stage, the pregnancy rate per retrieval, the live birth rate per retrieval, the number of retrieved oocytes, displaced ovaries, and the average number of entry needles were compared using the Chi-square test.

Accessory maneuvers to complete the pick-up, incomplete right pick-up, incomplete left pick-up, transfixion endometrioma, bleeding ovary, minimal vaginal bleeding, vaginal suture, homeostatic clamping, pelvic infection, normal check after 24

Table I. Demographic and clinical characteristics of the two groups.

Characteristics	Endometrioma group (251)	Control group (251)	<i>p</i> -value
Age	36.1 $\pm$ 3.7	35.9 $\pm$ 3.6	0.471
BMI (kg/m ²)	25.3 $\pm$ 2.1	25.5 $\pm$ 2.4	0.135
Duration infertility (years)	1.9 $\pm$ 2.0	1.7 $\pm$ 2.1	0.126
Smokers (%)	28.7 $\pm$ 3.1	29.2 $\pm$ 2.7	0.178
Patients who have given birth (%)	7.4 $\pm$ 2.1	7.6 $\pm$ 2	0.189
AMH (ng/ml)	1.7 $\pm$ 1.4	1.9 $\pm$ 1.6	0.142
AFC	8.5 $\pm$ 5.1	9.4 $\pm$ 5.3	0.031
Total dose gonadotropin (UI)	2,275 $\pm$ 1,125	2,185 $\pm$ 1,205	0.362
Duration stimulation day	10 $\pm$ 3.1	9.7 $\pm$ 3.3	0.072
ICSI (%)	63	61	0.838
Classical IVF (%)	27	29	0.471

Student's *t*-test; *p*-value > 0.05 was considered not statistically significant. BMI = Body Mass Index; AMH = Anti Mullerian Hormone; AFC = Antral Follicle Count; ICSI = Intracytoplasmic Sperm Injection; IVF = *In vitro* Fertilization.

hours, abnormal check after 24 hours were compared using the Chi-square test.

The Chi-square test was also used to analyze the size of the endometrioma, complete recovery from both ovaries, and the number of transfixions according to the endometrioma location.

Results

The population consisted of 251 women with endometrioma and 251 women without endometrioma who underwent the ART cycle (control group) and showed comparable baseline characteristics (Table I). The two groups were evaluated as homogeneous and comparable.

Clinical characteristics about the number of oocytes retrieved, fertilization rate, number of viable embryos, percentage of fresh transfer at cleavage and blastocyst stage, pregnancy rate and live birth rate were reported in Table II. No statistically significant differences were observed between groups except for the number of oocytes retrieved, which was higher in the control group compared to the group of women with endometrioma (Chi-square test $p < 0.05$; Table II).

Table III reports data on the number of displaced ovaries, average number of entry needles, number of accessory maneuvers performed to complete the pick-up, number of right and left pick-ups, and number of endometrioma transfixions only for the group of women with endometrioma. No differences were noticed between groups. The health assessment of the patients was reported in the same table. As reported, all values were comparable between the two groups. Moreover, the surgical complications were infrequent and similar both immediately and after 24

h between the two analyzed groups. No serious complications occurred in either group.

Table IV reported the correlations between the endometrioma location and the size of the endometrioma, complete recovery from both ovaries and the number of transfixions. The location of the endometrioma did not affect the parameters mentioned above.

Discussion

Endometriosis is a pathology that has a major impact on female health and reproductive capacity. The treatment of endometriosis for reproductive purposes has been the subject of numerous discussions in recent years. Recently, in patients with endometriosis, it may often be best to achieve pregnancy before surgery. Endometriosis hurts ovarian reserve and the outcome of IVF treatments^{34,35}. Physiological ovulation in these patients, especially those operated for endometriomas, is also deficient³⁶. In some cases, surgery for endometrioma results in a progressive loss of the ovarian reserve, leading to atresia^{37,38}. Other studies have highlighted that even endometrioma at the time of oocyte retrieval constitutes a problem for carrying out the procedure and, in particular, for completing it. The results of the present study show that in patients with endometrioma, a complete ovum pick-up is possible. Only in a few cases was it not possible, and there were no statistically significant differences between the patients with endometrioma (5 cases) and the control group (2 patients). It is important to point out, however, that, in the present study, ovum pick-up procedures were performed by already experienced gynecologists in the field (98% success rate)

Table II. Descriptive data of reproductive clinical outcomes between the two groups.

Characteristics	Endometrioma group (251)	Control group (251)	p-value
Number oocytes retrieved	6 ± 2.1	7 ± 2.9	0.0001
Fertilization rate (%)	64	64.2	0.997
MII oocytes	4 ± 2.1	5 ± 3.9	0.051
Number of viable embryo	2.8 ± 1.2	3 ± 1.7	0.272
Top embryo quality (%)	31.4	33.1	0.239
Fresh transfer performed	101	108	0.673
At cleavage stage (%)	57	59	0.564
At blastocyst stage (%)	44	49	0.527
Pregnancy rate per retrieval (%)	33	36	0.686
Early miscarriage rate (%)	15.1	14.9	0.723
Live birth rate per retrieval (%)	26	28	0.754

Chi-square test; p-values < 0.05 were considered to be statically significant. MII= metaphase II.

and with confidence to carry out accessory maneuvers to complete difficult pick-up procedures. The other studies²² that detected incomplete follicular aspiration probably gave this result because the egg collection had been entrusted to all the doctors in the team and not only to those who had achieved documented experience.

Moreover, contrary to how much was published from more papers²³, accidental or voluntary endometrioma punctures were not accompanied by increases in the risk of a pelvic infection. This finding can be explained by the fact that I) endometrioma punctures were accompanied by total aspiration and washing of the cysts as already described also by Somigliana et al³⁹; II) moreover, the accessory maneuvers have prevented the loss of endocystic content in the patient's peritoneum responsible for the inflammatory and infectious process. In our study, there have been two cases of pelvic infections, but in the control group, so they were not related to

endometrioma presence and/or transfixion. However, although it was a very wide sample group, to be sure of the validity of our conclusions, a larger sample should be treated and explored by a gynecologist with the same expertise and experience.

Another key aspect was the significant reduction in the oocyte recovery rate in the group of patients with endometrioma. It is argued that the difference is justified by the presence of the endometrioma.

On the contrary, there were no differences between the experimental group and the control group in fertilization rate and number of embryos, as well as in the pregnancy and live birth rate.

Moreover, the presence of endometrioma was not a discriminating factor of ovarian displacement, and the number of accesses and accessory maneuvers required to perform the sampling led us to believe that complete egg recovery in endometrioma patients is possible. Moreover, the position of the ovary involved did not affect the procedure.

Table III. Characteristics of oocyte retrieval in the group with and without endometrioma.

Characteristics	Endometrioma group (251)	Control group (251)	p-value
Displaced ovaries	33	38	0.997
Average number of entry needles	3	3	0.818
Accessory maneuvers to complete the pick-up	5	6	0.958
Incomplete right pick-up	3	2	0.459
Incomplete left pick-up	1	1	0.894
Trans abdominal retrieval	0	0	-
Trans myometrial retrieval	1	1	-
Trans-fixation endometrioma	14	0	-
Bleeding ovary	0	0	-
Vaginal suture	0	0	-
Hemostatic clamping	3	4	0.897
Hemoperitoneum	0	0	-
Pelvic infection	0	0	-
Normal check after 24 hours	251	251	-
Abnormal check after 24 hours	0	0	-
Pelvic infection after 6 months	0	0	-

Complications after egg retrieval. Chi-square test; *p*-values < 0.05 were considered to be statically significant.

Table IV. Topographic characteristics of the endometrioma group.

Side	Right ovary	Left ovary	Total	p-value
Endometrioma group (251)	117	134	251	
Size				
≤ 1 cm	72	86		0.758
1-3 cm	27	28		0.995
> 3 cm	18	20		0.192
Average diameter				
Total	117	134	251	

Chi-square test; *p*-values < 0.05 were considered to be statically significant.

One of this study's major limitations is its retrospective nature. Moreover, another important limit is operators' manual skills, which cannot be defined precisely for statistical purposes. Further studies are needed to clarify the impact of the endometrioma on the number of oocytes recovered, excluding endometriomas up to 3 cm that objectively rarely constitute an obstacle to ovum pick-up. In general, case studies should be increased to extract the most conclusions.

Conclusions

In conclusion, patients with endometrioma can undergo an IVF cycle and a complete oocyte recovery procedure. However, in some cases, endometrioma could be an obstacle to complete oocyte recovery, and accessory maneuvers during the ovum pick-up will be necessary to aspirate all the follicles. In cases where, despite the appropriate maneuvers, endometrioma prevented complete oocyte recovery, endometrioma transfixion could be practiced safely for patients.

Conflict of Interest

None.

Funding

None.

Ethics Approval

This study was regularly approved by the Local Ethical Board of the Momò Fertility Institute (approval number 7 on 07/2018) according to the Declaration of Helsinki ethical principles.

Informal Consent

Written informed consent was obtained at the first clinical evaluation. All patients enrolled voluntarily in the study after being well-informed about the hypothetical risks of the procedure.

Data Availability

The datasets generated during and/or analyzed during the current study are not publicly available as they are not anonymous, but they are available from the corresponding author upon reasonable request.

Authors' Contributions

Conceptualization, G.M.B. and D.B.; methodology, D.B. and A.S.L.; software, G.M.B. and D.B.; formal analysis, and

investigation, resources, R.S. and A.M.; data curation, A. Mal.; writing G.T.; original draft preparation, writing – review and editing G.M.B., supervision D.B. All authors have read and agreed to the published version of the manuscript.

ORCID ID

Giorgio Maria Baldini: 0000-0002-5061-8007
Antonio Simone Laganà: 0000-0003-1543-2802
Antonela Mastrococco: 0000-0001-7136-4029
Antonio Malvasi: 0000-0001-6940-7608
Baldini Domenico: 0000-0003-1433-5043
Daniele Ferri: 0000-0003-2921-5999
Romualdo Sciorio: 0000-0002-7608-8823
Giuseppe Trojano: 0000-0002-8750-0043.

References

- 1) Macer ML, Taylor HS. Endometriosis and Infertility. *Obstet Gynecol Clin North Am* 2012; 39: 535-549.
- 2) Zeng W, Luo L, Li X, Kuan Y, Wang S, Xue Q. The presence of ovarian endometrioma adversely affects ovarian reserve and response to stimulation but not oocyte quality or IVF/ICSI outcomes: a retrospective cohort study. *J Ovarian Res* 2022; 15: 116.
- 3) Eisenberg W, Weil C, Chodick G, Shalev V. Epidemiology of endometriosis: a large population-based database study from a healthcare provider with 2 million members. *BJOG* 2018; 125: 55-62.
- 4) Laganà AS, Laganà A, Laganà S, Laganà A, Laganà A, and J. Carvalho LFP, Beste M, Bailey A, Thomas C, Abrão MS, Racowsky C, Griffith L, Missmer SA. Endometrioma, the follicular fluid inflammatory network and its association with oocyte and embryo characteristics. *Reprod Biomed Online* 2020; 40: 399-408.
- 5) Redwine DB. Ovarian endometriosis: a marker for more extensive pelvic and intestinal disease. *Fertil Steril* 1999; 72: 310-315.
- 6) Busacca M, Vignali M. Ovarian endometriosis. *Curr Opin Obstet Gynecol* 2003; 15: 321-326.
- 7) Vercellini P, Frontino G, Giorgi O De, Pietropaolo G, Pasin R, Crosignani PG. Endometriosis. *Obstet Gynecol Clin North Am* 2003; 30: 163-180.
- 8) Gupta S, Goldberg JM, Aziz N, Goldberg E, Krajaicir N, Agarwal A. Pathogenic mechanisms in endometriosis-associated infertility. *Fertil Steril* 2008; 90: 247-257.
- 9) Leone Roberti Maggiore U, Gupta JK, Ferro S. Treatment of endometrioma for improving fertility. *Eur J of Obstet Gynecol Reprod Biol* 2017; 209: 81-85.
- 10) Hamdan M, Dunselman G, Li TC, Cheong Y. The impact of endometrioma on IVF/ICSI outcomes: a systematic review and meta-analysis. *Hum Reprod Update* 2015; 21: 809-825.
- 11) Kuroda M, Kuroda K, Arakawa A, Fukumura Y, Kitade M, Kikuchi I, Kumakiri J, Matsuoka S, Brosens IA, Brosens JJ, Takeda S, Yao T. Histological assessment of impact of ovarian endometrioma and laparoscopic cystectomy on ovarian reserve. *J Obstet Gynaecol Res* 2012; 38: 1187-1193.

- 12) Somigliana E, Berlanda N, Benaglia L, Viganò P, Vercellini P, Fedele L. Surgical excision of endometriomas and ovarian reserve: a systematic review on serum antimüllerian hormone level modifications. *Fertil Steril* 2012; 98: 1531-1538.
- 13) Moreno-Sepulveda J, Romeral C, Niño G, Pérez-Benavente A. The Effect of Laparoscopic Endometrioma Surgery on Anti-Müllerian Hormone: A Systematic Review of the Literature and Meta-Analysis. *JBRA Assist Reprod* 2022; 26: 88-104.
- 14) Cranney R, Condous G, Reid S. An update on the diagnosis, surgical management, and fertility outcomes for women with endometrioma. *Acta Obstet Gynecol Scand* 2017; 96: 633-643.
- 15) Streuli I, de Ziegler D, Gayet V, Santulli P, Bijaoui G, de Mouzon J, Chapron C. In women with endometriosis anti-Müllerian hormone levels are decreased only in those with previous endometrioma surgery. *Hum Reprod* 2012; 27: 3294-3303.
- 16) Sugita A, Iwase A, Goto M, Nakahara T, Nakamura T, Kondo M, Osuka S, Mori M, Saito A, Kikkawa F. One-year follow-up of serum antimüllerian hormone levels in patients with cystectomy: are different sequential changes due to different mechanisms causing damage to the ovarian reserve? *Fertil Steril* 2013; 100: 516-522.e3.
- 17) Muzii L, Di Tucci C, Di Felicianantonio M, Marchetti C, Perniola G, Panici PB. The effect of surgery for endometrioma on ovarian reserve evaluated by antral follicle count: a systematic review and meta-analysis. *Hum Reprod* 2014; 29: 2190-2195.
- 18) Chang HJ, Han SH, Lee JR, Jee BC, Lee BI, Suh CS, Kim SH. Impact of laparoscopic cystectomy on ovarian reserve: serial changes of serum anti-Müllerian hormone levels. *Fertil Steril* 2010; 94: 223-229.
- 19) Raffi F, Metwally M, Amer M. The Effect of Excision of Ovarian Endometrioma on Ovarian Reserve: A Systematic Review and Meta-Analysis. *J Clin Endocrinol Metab* 2012; 97: 3146-3154.
- 20) Iwase A, Nakahara T, Kato M, Goto M, Takikawa S, Kondo M, Osuka S, Mori M, Kikkawa F. Anti-Müllerian hormone levels after laparoscopic cystectomy for endometriomas as a possible predictor for pregnancy in infertility treatments. *Gynecol Endocrinol* 2016; 31: 293-297.
- 21) Benaglia L, Busnelli R, Biancardi R, Vegetti W, Vercellini P, Fedele L, Somigliana E. Oocyte retrieval outcomes in women with ovarian endometrioma. *Reprod Biomed Online* 2018; 37: 77-84.
- 22) Sanchez M, Vanni VS, Bartiromo L, Papaleo E, Zilberberg E, Candiani M, Orvieto R, Viganò P. Is the oocyte quality affected by endometriosis? A review of the literature. *J Ovarian Res* 2017; 10: 43.
- 23) Grammatikakis I, Evangelinakis N, Salamalekis G, Tziortzioti V, Samaras C, Chrelias C, Kassanos D. Prevalence of severe pelvic inflammatory disease and endometriotic ovarian cysts: a 7-year retrospective study. *Clin Exp Obstet Gynecol* 2009; 36: 235-236.
- 24) Wu Y, Yang R, Lan J, Lin H, Jiao X, Zhang Q. Ovarian Endometrioma Negatively Impacts Oocyte Quality and Quantity But Not Pregnancy Outcomes in Women Undergoing IVF/ICSI Treatment: A Retrospective Cohort Study. *Front Endocrinol (Lausanne)* 2021; 12.
- 25) Reinblatt SL, Ishai L, Shehata F, Son WY, Tulandi T, Almog B. Effects of ovarian endometrioma on embryo quality. *Fertil Steril* 2011; 95: 2700-2702.
- 26) Benaglia L, Bermejo A, Somigliana E, Faulisi S, Ragni G, Fedele L, Garcia-Velasco JA. In vitro fertilization outcome in women with unoperated bilateral endometriomas. *Fertil Steril* 2013; 99: 1714-1719.
- 27) Exacoustos C, Manganaro L, Fusi F. Imaging for the evaluation of endometriosis and adenomyosis. *Best Pract Res Clin Obstet Gynaecol* 2014; 28: 655-681.
- 28) Baldini GM, Lot D, Khamis F, Maraschi C, Cascardi E, Cazzato G, Catino A, Baldini A, Trojano G. Obesity does not increase the risk of side effects and complications during retrieval delaying oocyte retrieval in obese patients is not a good strategy. *Eur Reprod Pharmacol* 2023; 27: 6384-6392.
- 29) Baldini D, Trojano G, Matteo M, Malvasi A. Oocyte Retrieval: Pick Up and Oocyte Management. Cham: Springer International Publishing; 2020. pp. 151-178.
- 30) Mihu D, Chu CM. Ultrasonography of the uterus and ovaries. *Med Ultrason* 2011; 13: 249-252.
- 31) Vercellini P, Cardellicchio L, Guarneri C, Paffoni A, Vizzelli L, Somigliana E, Fedele L. IVF outcome in women with accidental contamination of follicular fluid with endometrioma content. *Eur J Obstet Gynecol Reprod Biol* 2014; 181: 130-134.
- 32) Khamis F, Y Yavas, I C Lacanna, S Roberge, M Endman, J C Wong. Exposure of human oocytes to endometrioma fluid does not alter fertilization or early embryo development. *J Assist Reprod Genet* 2001; 18: 106-109.
- 33) Baldini D, Ferri D, Baldini GM, Lot D, Catino A, Vizziello D, Vizziello G. Sperm Selection for ICSI: Do We Have a Winner? *Cells* 2021; 10: 3566.
- 34) Baldini D, Baldini A, Silvestris E, Vizziello G, Ferri D, Vizziello D. A fast and safe technique for sperm preparation in ICSI treatments within a randomized controlled trial (RCT). *Reprod Biol Endocrinol* 2020; 18: 88.
- 35) Harb HM, Gallos ID, Chu J, Harb M, Coomarasamy A. The effect of endometriosis on in vitro fertilisation outcome: a systematic review and meta-analysis. *BJOG* 2013; 120: 1308-1320.
- 36) Kuivasaari P, Hippeläinen M, Anttila M, Heinonen S. Effect of endometriosis on IVF/ICSI outcome: stage III/IV endometriosis worsens cumulative pregnancy and live-born rates. *Hum Reprod* 2005; 20: 3130-3135.
- 37) Horikawa T, Nakagawa K, Ohgi S, Kojima R, Nakashima A, Ito M, Takahashi Y, Saito H. The frequency of ovulation from the affected ovary decreases following laparoscopic cystectomy in infertile women with unilateral endometrioma during a natural cycle. *J Assist Reprod Genet* 2008; 25: 239-244.

- 38) Kitajima M, Dolmans MM, Donnez O, Masuzaki H, Soares M, Donnez J. Enhanced follicular recruitment and atresia in cortex derived from ovaries with endometriomas. *Fertil Steril* 2014; 101: 1031-1037.
- 39) Somigliana E, Benaglia L, Paffoni A, Busnelli A, Vigano P, Vercellini P. Risks of conservative management in women with ovarian endometriomas undergoing IVF. *Hum Reprod Update* 2015; 21: 486-499.

RETRACTED