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Cumulative pregnancy rate after ICSI–IVF in patients with colorectal endometriosis: results of a multicentre study

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BACKGROUND: There is currently no consensus about indications for surgery for infertility associated with colorectal endometriosis. The aim of this study was to evaluate cumulative pregnancy rates (CPRs) after ICSI–IVF cycles in patients with colorectal endometriosis and to identify determinant factors of fertility outcome.

METHODS: Prospective longitudinal multicentre study from January 2005 to June 2011. We included 75 patients with colorectal endometriosis and proved infertility without prior surgery for deep infiltrating endometriosis. Univariable analysis was used to identify determinant factors of pregnancy rate. CPR was calculated using cumulative-incidence methods from log-rank test and Kaplan–Meier curves. For multivariable analysis, Cox proportional hazards model was used.

RESULTS: For CPR per patient analysis, the total number of cycles was 113 and the median number of cycles per patient was 1 (range: 1–3). In the whole population the CPR per patient after three ICSI–IVF cycles was 68.6%. The CPR for patients with or without associated adenomyosis was 19 and 82.4%, respectively ($P = 0.01$). In addition, a patient age over 35 years ($P = 0.02$) and anti-Mullerian hormone serum level under 2 ng/ml ($P = 0.02$) were associated with a decreased CPR per patient. At multivariable analysis, adenomyosis [HR = 0.34, 95% CI (0.12–0.99), $P = 0.49$] was associated with a decreased CPR.

CONCLUSIONS: Our data confirm that ICSI–IVF offers a high CPR per patient. However, determinant factors of CPR should be taken into account when informing couples of their options.

Key words: colorectal endometriosis / ICSI–IVF / cumulative pregnancy rate / adenomyosis / AMH

Introduction

Colorectal endometriosis is one of the most severe forms of deep infiltrating endometriosis (DIE) and has a considerable impact on quality of life (Dubernard *et al.*, 2008). Although some controversy persists about the most appropriate indications and type of surgery for these patients (Donnez and Squifflet, 2010; Dousset *et al.*, 2010; Kondo *et al.*, 2011), previous retrospective and randomized studies have demonstrated that colorectal resection improves symptoms and quality of life but exposes patients to the risk of major complications such as neurologic bladder dysfunction and rectovaginal fistulae

(Redwine *et al.*, 1996; Dubernard *et al.*, 2008; Daraï *et al.*, 2010a,b; Dousset *et al.*, 2010; Ruffo *et al.*, 2010; Ballester *et al.*, 2011).

There is currently no consensus about indications for surgery for infertility associated with colorectal endometriosis. Vercellini *et al.* (2006) reported no benefit of rectovaginal septum resection compared with expectant management on fertility outcomes. In contrast, retrospective studies have shown that colorectal resection for endometriosis enhances fertility depending on the surgical route and the presence of adenomyosis (Ferrero *et al.*, 2009; Daraï *et al.*, 2010a,b). However, Mathieu d'Argent *et al.* (2010) reported pregnancy rates after a first ICSI–IVF cycle to be similar in patients with

colorectal endometriosis and in patients with tubal or male infertility raising the issue about the legitimacy of surgery. Conversely, Stepniewska *et al.* (2010) underlined that IVF results increased after removal of DIE and that the pregnancy rate was higher in patients undergoing colorectal resection compared with patients undergoing limited surgery leaving *in situ* colorectal endometriosis. Finally, Barri *et al.* suggested that a combination of surgery and IVF was the best option for infertility associated with endometriosis. However, none of these authors reported cumulative pregnancy in IVF to determine when best to opt for surgery in infertile women with colorectal endometriosis (Barri *et al.*, 2010).

Therefore, the aims of the present multicentre study were to evaluate cumulative pregnancy rate (CPR) after ICSI–IVF cycles in patients with colorectal endometriosis and to identify determinant factors.

Materials and Methods

Subjects

From January 2005 to June 2011, 75 women with colorectal endometriosis from three centers [Tenon Hospital (University Pierre et Marie Curie Paris 6, France), Sèvres Hospital (Sèvres, France) and La Citadelle Hospital (University of Liège, Belgium)] requiring ICSI–IVF for infertility were prospectively included in the study. All the patients had proven infertility for at least 1 year. Fertility investigations included a hysterosalpingography, cycle Day 3 serum level measurements of E2, FSH, inhibin B, anti-Mullerian hormone (AMH), transvaginal sonography and semen analysis for the partner. Diagnosis of colorectal endometriosis was based on physical examination, transvaginal sonography and magnetic resonance imaging using previously published imaging criteria (Bazot *et al.*, 2004, 2009). Adenomyosis was defined by: (i) maximal junctional zone thickness (JZ_{max}) of at least 12 mm, (ii) $ratio_{max}$ (JZ_{max}/myometrial thickness) > 40% and (iii) punctate high-density myometrial foci (Bazot *et al.*, 2001). All the patients gave informed consent to participate in the study. The protocol was approved by the Ethics Committee of the Collège National des Gynécologues et Obstétriciens Français (CNGOF).

Procedure

Patients were stimulated either by a long GnRH agonist, a short agonist or an antagonist protocol. Ovarian stimulation was begun once pituitary desensitization (E2 level < 50 pg/ml) had been achieved with doses of recombinant FSH ranging between 75 and 450 IU/day depending on body mass index (BMI), patient age, size and number of follicles and E2 levels. Transvaginal oocyte retrieval was scheduled 35–36 h after hCG injection and ETs performed 2–3 days later. On Day 2, individually cultured embryos were evaluated on the basis of the number of blastomeres, blastomere size, fragmentation rate and presence of multinucleated blastomeres (Scott *et al.*, 2000). Embryos with four regular blastomeres and <20% fragmentation were defined as top-quality embryos. The luteal phase was supported by vaginal administration of micronized P (400 mg/day) from the day of ovarian puncture to the day of the pregnancy test. Pregnancies were diagnosed by an increasing concentration of serum β-hCG, which was tested 14 days after ET. Clinical pregnancies were confirmed by the presence of a gestational sac on vaginal ultrasound examination during the fifth week.

Statistical analysis

To compare patients who became pregnant (clinical pregnancies as defined above) with those who did not, univariable analysis was performed by using the Student's *t*-test or Wilcoxon test for continuous variables and χ^2 test or Fisher's exact test for categorical variables. The CPR per patient was estimated from log-rank test, Kaplan–Meier curves and, cumulative-incidence methods. For multivariable analysis, Cox proportional hazards model was used. All reported *P*-values were two-sided and *P*-values of <0.05 denote a significant difference. All analyses were performed using the R package with the Verification, Design, Hmisc, DiagnosisMed, ROCR and Presence Absence libraries (available at URL: http://lib.stat.cmu.edu/R/CRAN/).

Results

The epidemiological characteristics of the population are summarized in Table I. The median age of the study population was 33 years, and the median BMI was 22.4 kg/m². Only four patients had a BMI over 30 kg/m². The median duration of infertility was 3 years. Three-quarters of the patients had undergone prior surgery for endometriosis, including diagnostic laparoscopy and cystectomy for endometriomas, but none for DIE. Hence none of them had rectal shaving, full thickness nodule resection or segmental resection.

Endometriomas and adenomyosis were associated with colorectal endometriosis in 68 and 28% of cases, respectively. The mean AMH serum level in the whole population was 2.7 ng/ml. The mean AMH serum level in patients with isolated colorectal endometriosis, with colorectal endometriosis and endometriomas, with colorectal endometriosis and adenomyosis and in patients with colorectal endometriosis, endometrioma and adenomyosis were 3.1, 3.6, 2.6 and 2.1 ng/ml, respectively ($P = 0.1$). The mean AMH serum level in patients younger or older than 35 years old was 3.7 and 2.2 ng/ml, respectively ($P = 0.002$).

No difference in age, BMI, duration of prior infertility, primary infertility, associated male infertility, prior surgery for endometriosis and total follicle count was found between patients who conceived and those who did not (Table II). The rate of associated adenomyosis was higher in the group of patients who did not conceive ($P = 0.02$). An AMH serum level > 2 ng/ml was associated with an increased pregnancy rate ($P = 0.03$).

No difference in the characteristics of ovarian stimulation was found between patients who conceived and those who did not.

Table I Epidemiological characteristics of the whole population.

	Total population (*n* = 75)
Age (year), median (range)	33 (23–42)
BMI (kg/m²), median (range)	21.4 (17.5–35.4)
Duration of prior infertility (year), median (range)	3 (1–9)
Primary infertility, *n* (%)	61 (81.3%)
Associated male infertility, *n* (%)	34 (45.3%)
Prior surgery for endometriosis, *n* (%)	56 (74.7%)
Associated adenomyosis, *n* (%)	21 (28%)
Associated endometrioma, *n* (%)	51 (68%)
Total follicle count (*n*), median (range)	7 (0–40)
AMH serum level(ng/ml), median (range)	2.7 (0.1–12.4)

Table II Characteristics of patients who became pregnant and those who did not.

	Patients who did not become pregnant (n = 43)	Patients who became pregnant (n = 32)	P-value
Age > 35 years, n (%)	22 (48.9%)	10 (24.4%)	0.06
BMI (kg/m^2), median (range)	22.1 (17.5−35.4)	20 (17.6−30.1)	0.4
Duration of prior infertility (year), median (range)	3 (1−9)	2.5 (1−6)	0.6
Primary infertility, n (%)	34 (79%)	27 (84.3%)	0.7
Associated male infertility, n (%)	20 (46.5%)	21 (43.8%)	1
Prior surgery for endometriosis, n (%)	32 (74.4%)	24 (75%)	0.8
Associated adenomyosis, n (%)	17 (39.5%)	4 (12.5%)	0.02
Associated endometrioma, n (%)	31 (72%)	20 (62.5%)	0.44
Total follicle count (n), median (range)	6 (0−30)	9 (0−40)	0.15
AMH serum level > 2 (ng/ml), n (%)	22 (51.1%)	25 (76.5%)	0.03
Type of ART, n (%)			
ICSI	14 (32.5%)	11 (34.3%)	0.9
IVF	29 (67.5%)	21 (65.7%)	

The AMH serum levels in patients with colorectal endometriosis with or without adenomyosis were 2.5 and 3.4 ng/ml, respectively (P = 0.14). No difference in inhibin B, estradiol serum levels, antral follicle count, in the rate of ICSI or IVF procedures, types of ovarian stimulation, total dose of gonadotrophin used, number of mature follicles > 14 mm, total number of oocytes retrieved, total number of Day-2 embryos, number of top Day-2 embryos replaced, thickness of endometrium or number of embryos cryopreserved was found between the groups.

Thirty-two (42.7%) of the 75 patients became pregnant. Among the 32 pregnancies, we found: 24 deliveries (corresponding to 22 singleton and 2 twins) and 8 miscarriages.
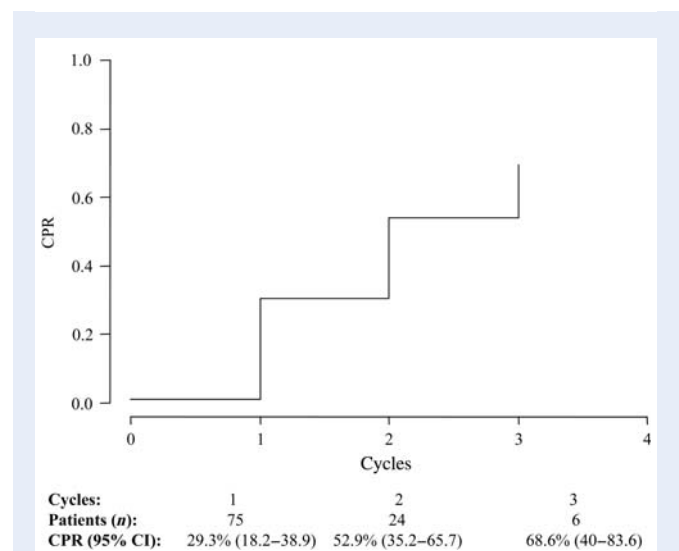
For CPR per patient analysis, the total number of cycles was 113 and the median number of cycles per patient was 1 (range: 1−3). In the whole population the CPR per patient after one, two and three ICSI−IVF cycles were 29.3, 52.9 and 68.6%, respectively (Fig. 1). An increase in the CPR was observed after each ICSI−IVF cycle. Among the 75 patients, 22 (29.3%) became pregnant after the first ICSI−IVF cycle. Among the 53 patients who did not become pregnant, 24 underwent a second cycle and 29 did not. Among the 24 patients who underwent a second cycle, 8 (33.3%) became pregnant and 16 did not. Six of the 16 patients started a third cycle, of whom 2 (33.3%) became pregnant.

The CPR after ICSI−IVF cycles for patients with or without associated adenomyosis was 19 and 82.4%, respectively (P = 0.01; Fig. 2). For patients without adenomyosis, the CPR per patient increased until the third cycle. For patients with associated adenomyosis, no benefit was found after the first ICSI−IVF cycle.

In addition to adenomyosis, in the whole population a patient age over 35 (P = 0.02; Fig. 3) and AMH serum level lower than 2 ng/ml (P = 0.02; Fig. 4) were determinant factors of CPR per patient. Bilateralism of endometriomas and the presence of multiple endometriomas as well as type of infertility (primary versus secondary), type of assisted reproduction treatments (ART) (ICSI versus IVF) and prior surgery for endometriosis were not significant determinant factors of CPR per patient.

At multivariable analysis, using Cox proportional hazards ratio, adenomyosis [HR = 0.34, 95% CI (0.12−0.99), P = 0.049] was the only parameter significantly associated with a decreased CPR.

In patients with colorectal endometriosis and associated adenomyosis, the CPR per patient was 19%. The CPR per patient for patients older than 35 years and patients younger than 35 years was 8.3 and 33.3%, respectively (NS). No benefit was found after the first ICSI−IVF cycle in these two subgroups. In patients with colorectal endometriosis without adenomyosis, the CPR per patient was 82.4%. The CPR per patient for patients older than 35 years and patients younger than 35 years was 52.9 and 80.2%, respectively (NS). A benefit was found after each ICSI−IVF cycle.

Cycles:	1	2	3
Patients (n):	75	24	6
CPR (95% CI):	29.3% (18.2−38.9)	52.9% (35.2−65.7)	68.6% (40−83.6)

Figure 1 CPR after successive ICSI−IVF cycles in the whole population.

Figure 2 Impact of adenomyosis on CPR in patients with colorectal endometriosis.
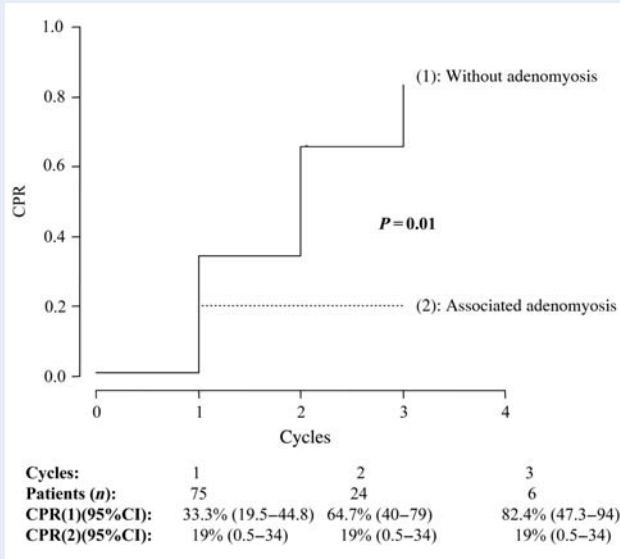

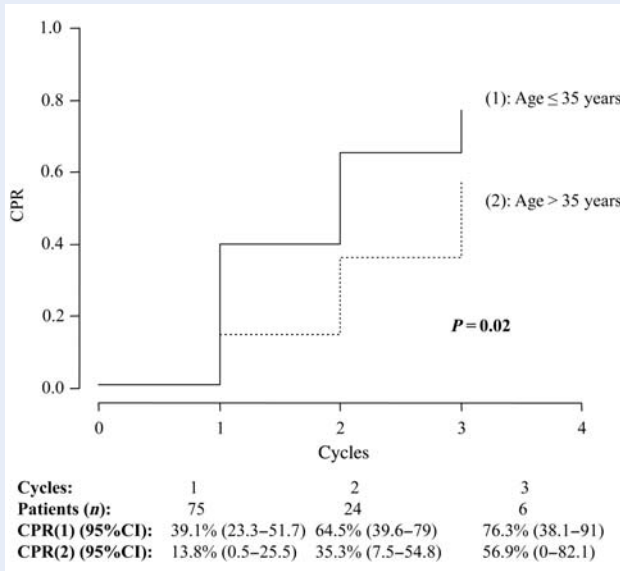**Figure 4** Impact of AMH serum level on CPR in patients with colorectal endometriosis.

Figure 3 Impact of age on CPR in patients with colorectal endometriosis.

Discussion

This prospective multicentre study demonstrates that ICSI–IVF offers a high CPR in patients with colorectal endometriosis. However, the CPR differed considerably mainly depending on the presence of adenomyosis, AMH serum level and patient age.

The main issue in patients with colorectal endometriosis is to determine the therapeutic strategy according to the patient's priority. When the priority is to improve symptoms and quality of life, several studies have underlined the positive impact of colorectal resection—mainly bas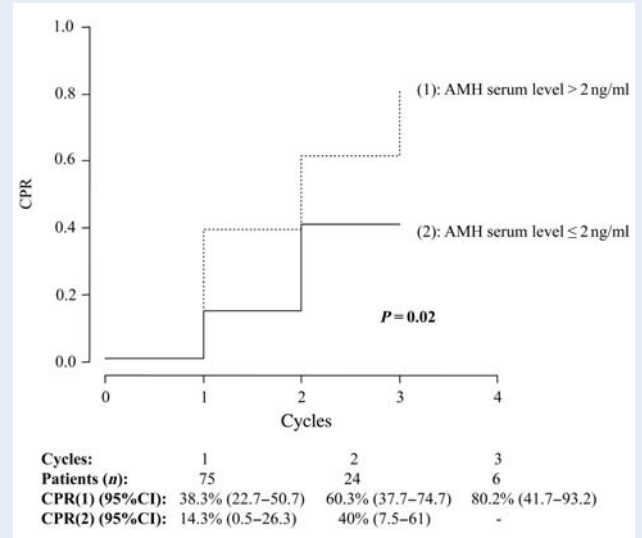ed on a laparoscopic approach—on both symptoms and subsequent fertility (Daraï *et al.*, 2011; Meuleman *et al.*, 2011). Conversely, when the patient's priority is to conceive, there is no clear consensus (first surgery or first ICSI–IVF), and determinant factors of fertility outcome thus need to be identified to inform patients about the various therapeutic options. In this study, the CPR per patient after one, two and three ICSI–IVF cycles were 29.3, 52.9 and 68.6% underlining a progressive increase in the CPR. However, the presence of adenomyosis appears to be a major negative determinant factor of fertility outcome in ICSI–IVF: the CPR in patients with colorectal endometriosis with or without adenomyosis was 19 and 82.4%, respectively. These results are in agreement with previous studies showing that uterine adenomyosis is a negative predictive factor of fertility outcome (Kunz *et al.*, 2005; Ferrero *et al.*, 2009; Daraï *et al.*, 2010a,b). From a pathological point of view, Tremellen and Russell (2011) showed that adenomyosis was associated with a prominent aggregation of macrophages within the superficial endometrial glands, potentially interfering with embryo implantation. However, several studies have found that adenomyosis had no adverse effects on IVF–ICSI outcome in infertile women with proved endometriosis pretreated with long-term GnRH agonist (Lin *et al.*, 2000; Wang *et al.*, 2000; Mijatovic *et al.*, 2010). In our series, although some of the patients underwent a long-term GnRH agonist treatment, the sample size was too low to prove its potential relevance. In addition to a low CPR in patients with colorectal endometriosis and adenomyosis, despite the small number of patients, our results do not demonstrate a benefit of additional ICSI–IVF cycles after the first attempt, especially in patients older than 35 years. This might be due to a rapid inclusion of these patients in an oocyte donation program. Soares *et al.* (2008) suggested that endometriosis, and possibly adenomyosis, did not have a negative impact on oocyte donation programs when standard endometrial priming protocols were used. Another option for patients with colorectal endometriosis and adenomyosis could be cytoreductive surgery. However, although surgery seems to improve short-term symptoms (Wood, 1998; Sun *et al.*, 2011), fertility results are modest and myometrial healing

poor with an elevated risk of uterine rupture (Takeuchi et al., 2010). In this specific setting, preliminary results show that ultrasound-guided high-intensity focused ultrasound ablation could be a non-invasive alternative but further data on fertility outcome are required (Kim et al., 2011; Zhou et al., 2011).

In addition to adenomyosis, our univariate analysis was consistent with reports that the AMH serum level is a predictor of CPR after ICSI–IVF cycles. Gonzalez-Fernandez et al. (2011) showed that patients with endometriosis are a heterogeneous group including patients with poor ovarian reserve (who behave like other poor responder patients) and patients with good response to ovarian stimulation (who have a specific alteration of the FSHR signalling pathway). In addition, Shebl et al. found low AMH serum levels in women with severe endometriosis (ASRM III–IV) compared with healthy women although the authors did not take into account the presence of DIE (Shebl et al., 2009). Finally, Buyuk et al. (2011) reported that patients with elevated AMH serum levels had twice the number of oocytes retrieved, a greater number of Day 3 embryos and a higher clinical pregnancy rate. However, the main issue is to identify patients with poor ovarian reserve in the absence of a consensual AMH serum cutoff level. In the present study, poor ovarian reserve was defined by an AMH serum level under 2 ng/ml while other authors have used a cutoff of 1 or 0.6 ng/ml. Despite these discrepancies, our results showed a progressively higher CPR in patients with an AMH serum level above 2 ng/ml while no benefit seemed to be observed after two ICSI–IVF cycles for those with an AMH under this level. In this specific setting, surgery with complete removal of DIE should be discussed. Indeed, Stepniewska et al. (2010) assessing fertility after surgery for DIE with colorectal involvement, noted that both spontaneous and IVF pregnancy rates were significantly higher after complete resection of DIE including resection of colorectal lesions. In a recent review of the management of infertile patients with associated endometriosis, de Ziegler et al. (2010) suggest that surgery should be considered in patients younger than 38 years with good ovarian reserve and no semen characterisics or tubal status that are incompatible with natural conception. Similarly, Barri et al. (2010) showed that the combined strategy of endoscopic surgery and subsequent IVF led to a higher clinical pregnancy rate (65.8%) than that obtained with surgery alone or IVF alone, especially in patients younger than 35 years. Finally, in a randomized study comparing laparoscopy to open surgery for colorectal endometriosis, Daraï et al. reported a high pregnancy rate even in patients with prior IVF failure (Daraï et al., 2011). In view of this published data coupled with our results, surgery should be considered after failure of two ICSI–IVF cycles for patients younger than 35 years with poor ovarian reserve before opting for an oocyte donation program.

As previously mentioned, the patient's age is also a determinant factor of fertility outcome. CPR was 76.3% for patients younger than 35 years compared with 57% for older patients. These results are in agreement with those of La Marca et al. (2011) showing that age coupled with AMH serum level were the sole factors to predict live birth in assisted reproduction. Moreover, Cai et al. (2011), in a logistic regression model to predict the cumulative fertility outcome in ICSI–IVF, found that age was an independent factor. However, despite a lower CPR for patients older than 35 years, we observed a benefit after each ICSI–IVF cycle which does not resolve the issue of when to opt for a surgical approach or oocyte donation for these patients.

Some limitations of the present study have to be underlined. First, no attempt was made to differentiate focal from diffuse adenomyosis and the two forms seem to have a different impact on fertility (Wang et al., 2006). However, we distinguished internal from external adenomyosis. In our study, we considered patients with adenomyosis only those with internal adenomyosis. Secondly, we calculated the CPR based on three ICSI–IVF cycles and did not evaluate the impact of additional cycles. This decision was based on routine practice in France and on French law which allows for a last reimbursed cycle in an oocyte donation program in case of failure. Moreover, our results underline that, in patients with colorectal endometriosis without adenomyosis, the CPR was over 80% after three ICSI–IVF cycles with potentially little additional benefit for a fourth cycle. Thirdly, our study assumes that the CPR per patient is an appropriate tool to evaluate pregnancy rates in ICSI–IVF as recently demonstrated by Garrido et al. (2011). Finally, the sample size was too low to build a model to predict fertility outcomes in patients with colorectal endometriosis.

Our data on CPR per patient in patients with colorectal endometriosis undergoing ICSI–IVF cycles confirm a high pregnancy rate and that adenomyosis, AMH serum level and age are determinant factors of fertility outcome. These parameters should be taken into account when informing couples of their options. Further studies are needed to determine when to switch from first ICSI–IVF to an alternative including surgery or oocyte donation.

Authors' roles

All authors took part in the design and implementation of the study, and read and approved the final report. The corresponding author has had access to all data in this study and he had final responsibility for the decision to submit for publication. The first author, M.B. from the Department of Obstetric and Gynecology, 'Hôpital Tenon, Assistance Publique des Hôpitaux de Paris, Paris, France', collected and analyzed all the data, performed the statistical analysis and wrote the article. E.M.A., K.M. collected the data from patients and analyzed all the data. J.B.-A. collected the data from patients. M.N. collected the data from patients, analyzed all the data and approved the final version of the article. E.D. collected the data from patients, performed the statistical analysis and wrote the article.

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Conflict of interest

None declared.

References

Ballester M, Chereau E, Dubernard G, Coutant C, Bazot M, Daraï E. Urinary dysfunction after colorectal resection for endometriosis: results of a prospective randomized trial comparing laparoscopy to open surgery. Am J Obstet Gynecol 2011;**204**:303 e1–303 e6.

Barri PN, Coroleu B, Tur R, Barri-Soldevila PN, Rodriguez I. Endometriosis-associated infertility: surgery and IVF, a comprehensive therapeutic approach. *Reprod Biomed Online* 2010;**21**:179−185.

Bazot M, Cortez A, Daraï E, Rouger J, Chopier J, Antoine JM, Uzan S. Ultrasonography compared with magnetic resonance imaging for the diagnosis of adenomyosis: correlation with histopathology. *Human Reprod* 2001;**16**:2427−2433.

Bazot M, Daraï E, Hourani R, Thomassin I, Cortez A, Uzan S, Buy JN. Deep pelvic endometriosis: MR imaging for diagnosis and prediction of extension of disease. *Radiology* 2004;**232**:379−389.

Bazot M, Lafont C, Rouzier R, Roseau G, Thomassin-Naggara I, Daraï E. Diagnostic accuracy of physical examination, transvaginal sonography, rectal endoscopic sonography, and magnetic resonance imaging to diagnose deep infiltrating endometriosis. *Fertil Steril* 2009;**92**:1825−1833.

Buyuk E, Seifer DB, Younger J, Grazi RV, Lieman H. Random anti-Mullerian hormone (AMH) is a predictor of ovarian response in women with elevated baseline early follicular follicle-stimulating hormone levels. *Fertil Steril* 2011;**95**:2369−2372.

Cai QF, Wan F, Huang R, Zhang HW. Factors predicting the cumulative outcome of IVF/ICSI treatment: a multivariable analysis of 2450 patients. *Hum Reprod* 2011;**26**:2532−2540.

Daraï E, Dubernard G, Coutant C, Frey C, Rouzier R, Ballester M. Randomized trial of laparoscopically assisted versus open colorectal resection for endometriosis: morbidity, symptoms, quality of life, and fertility. *Ann Surg* 2010a;**251**:1018−1023.

Daraï E, Carbonnel M, Dubernard G, Lavoue V, Coutant C, Bazot M, Ballester M. Determinant factors of fertility outcomes after laparoscopic colorectal resection for endometriosis. *Eur J Obstet Gynecol Reprod Biol* 2010b;**149**:210−214.

Daraï E, Lesieur B, Dubernard G, Rouzier R, Bazot M, Ballester M. Fertility after colorectal resection for endometriosis: results of a prospective study comparing laparoscopy with open surgery. *Fertil Steril* 2011;**95**:1903−1908.

De Ziegler D, Borghese B, Chapron C. Endometriosis and infertility: pathophysiology and management. *Lancet* 2010;**376**:730−738.

Donnez J, Squifflet J. Complications, pregnancy and recurrence in a prospective series of 500 patients operated on by the shaving technique for deep rectovaginal endometriotic nodules. *Hum Reprod* 2010;**25**:1949−1958.

Dousset B, Leconte M, Borghese B, Millischer A, Roseau G, Arkwright S, Chapron C. Complete surgery for low rectal endometriosis: long-term results of a 100-case prospective study. *Ann Surg* 2010;**251**:887−895.

Dubernard G, Rouzier R, David-Montefiore E, Bazot M, Daraï E. Use of the SF-36 questionnaire to predict quality-of-life improvement after laparoscopic colorectal resection for endometriosis. *Hum Reprod* 2008;**23**:846−851.

Ferrero S, Anserini P, Abbamonte LH, Ragni N, Camerini G, Remorgida V. Fertility after bowel resection for endometriosis. *Fertil Steril* 2009;**92**:41−46.

Garrido N, Bellver J, Remohi J, Simon C, Pellicer A. Cumulative live-birth rates per total number of embryos needed to reach newborn in consecutive in vitro fertilization (IVF) cycles: a new approach to measuring the likelihood of IVF success. *Fertil Steril* 2011;**96**:40−46.

Gonzalez-Fernandez R, Pena O, Hernandez J, Martin-Vasallo P, Palumbo A, Avila J. Patients with endometriosis and patients with poor ovarian reserve have abnormal follicle-stimulating hormone receptor signaling pathways. *Fertil Steril* 2011;**95**:2373−2378.

Kim KA, Yoon SW, Lee C, Seong SJ, Yoon BS, Park H. Short-term results of magnetic resonance imaging-guided focused ultrasound surgery for patients with adenomyosis: symptomatic relief and pain reduction. *Fertil Steril* 2011;**95**:1152−1155.

Kondo W, Bourdel N, Jardon K, Tamburro S, Cavoli D, Matsuzaki S, Botchorishvili R, Rabischong B, Pouly JL, Mage G *et al*. Comparison between standard and reverse laparoscopic techniques for rectovaginal endometriosis. *Surg Endosc* 2011;**25**:2711−2717.

Kunz G, Beil D, Huppert P, Noe M, Kissler S, Leyendecker G. Adenomyosis in endometriosis−prevalence and impact on fertility. Evidence from magnetic resonance imaging. *Hum Reprod* 2005;**20**:2309−2316.

La Marca A, Nelson SM, Sighinolfi G, Manno M, Baraldi E, Roli L, Xella S, Marsella T, Tagliasacchi D, D'Amico R *et al*. Anti-Mullerian hormone-based prediction model for a live birth in assisted reproduction. *Reprod Biomed Online* 2011;**22**:341−349.

Lin J, Sun C, Zheng H. Gonadotropin-releasing hormone agonists and laparoscopy in the treatment of adenomyosis with infertility. *Chin Med J (Engl)* 2000;**113**:442−445.

Mathieu d'Argent E, Coutant C, Ballester M, Dessolle L, Bazot M, Antoine JM, Daraï E. Results of first in vitro fertilization cycle in women with colorectal endometriosis compared with those with tubal or male factor infertility. *Fertil Steril* 2010;**94**:2441−2443.

Meuleman C, Tomassetti C, D'Hoore A, Buyens A, Van Cleynenbreugel B, Fieuws S, Penninckx F, Vergote I, D'Hooghe T. Clinical outcome after CO2 laser laparoscopic radical excision of endometriosis with colorectal wall invasion combined with laparoscopic segmental bowel resection and reanastomosis. *Hum Reprod* 2011;**26**:2336−2343.

Mijatovic V, Florijn E, Halim N, Schats R, Hompes P. Adenomyosis has no adverse effects on IVF/ICSI outcomes in women with endometriosis treated with long-term pituitary down-regulation before IVF/ICSI. *Eur J Obstet Gynecol Reprod Biol* 2010;**151**:62−65.

Redwine DB, Koning M, Sharpe DR. Laparoscopically assisted transvaginal segmental resection of the rectosigmoid colon for endometriosis. *Fertil Steril* 1996;**65**:193−197.

Ruffo G, Scopelliti F, Scioscia M, Ceccaroni M, Mainardi P, Minelli L. Laparoscopic colorectal resection for deep infiltrating endometriosis: analysis of 436 cases. *Surg Endosc* 2010;**24**:63−67.

Scott L, Alvero R, Leondires M, Miller B. The morphology of human pronuclear embryos is positively related to blastocyst development and implantation. *Hum Reprod* 2000;**15**:2394−2403.

Shebl O, Ebner T, Sommergruber M, Sir A, Tews G. Anti muellerian hormone serum levels in women with endometriosis: a case−control study. *Gynecol Endocrinol* 2009;**25**:713−716.

Soares SR, Velasco JA, Fernandez M, Bosch E, Remohi J, Pellicer A, Simon C. Clinical factors affecting endometrial receptiveness in oocyte donation cycles. *Fertil Steril* 2008;**89**:491−501.

Stepniewska A, Pomini P, Scioscia M, Mereu L, Ruffo G, Minelli L. Fertility and clinical outcome after bowel resection in infertile women with endometriosis. *Reprod Biomed Online* 2010;**20**:602−609.

Sun AJ, Luo M, Wang W, Chen R, Lang JH. Characteristics and efficacy of modified adenomyomectomy in the treatment of uterine adenomyoma. *Chin Med J (Engl)* 2011;**124**:1322−1326.

Takeuchi H, Kitade M, Kikuchi I, Kumakiri J, Kuroda K, Jinushi M. Diagnosis, laparoscopic management, and histopathologic findings of juvenile cystic adenomyoma: a review of nine cases. *Fertil Steril* 2010;**94**:862−868.

Tremellen K, Russell P. Adenomyosis is a potential cause of recurrent implantation failure during IVF treatment. *Aust N Z J Obstet Gynaecol* 2011;**51**:280−283.

Vercellini P, Pietropaolo P, De Giorgi O, Daguati R, Pasin R, Crosignani PG. Reproductive performance in infertile women with rectovaginal endometriosis: is surgery worthwhile? *Am J Obstet Gynecol* 2006;**195**:1303−1310.

Wang PH, Yang TS, Lee WL, Chao HT, Chang SP, Yuan CC. Treatment of infertile women with adenomyosis with a conservative microsurgical

technique and a gonadotropin-releasing hormone agonist. *Fertil Steril* 2000;**73**:1061–1062.

Wang CJ, Yuen LT, Chang SD, Lee CL, Soong YK. Use of laparoscopic cytoreductive surgery to treat infertile women with localized adenomyosis. *Fertil Steril* 2006;**86**:462 e5–462 e8.

Wood C. Surgical and medical treatment of adenomyosis. *Hum Reprod Update* 1998;**4**:323–336.

Zhou M, Chen JY, Tang LD, Chen WZ, Wang ZB. Ultrasound-guided high-intensity focused ultrasound ablation for adenomyosis: the clinical experience of a single center. *Fertil Steril* 2011;**95**:900–905.