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Fertility Options for Women with Endometriosis: In Vitro Fertilization versus Surgical Excision or Ablation

by

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Abstract

Endometriosis negatively affects the fertility of many women of reproductive age worldwide. Some women with endometriosis are able to conceive without reproductive assistance, while others require medical intervention. In vitro fertilization and surgical management are available and widely used in the treatment of endometriosis associated infertility. In vitro fertilization has been found to be effective in women with stages I-IV endometriosis, with varying degrees of success at each stage. These varying results may be due to oocyte quality and availability as well as endometriosis location. Surgical excision and/or surgical ablation of endometriosis/endometriomas may also improve chance of successful pregnancy but has been found to decrease ovarian reserve and therefore decrease future fertility as a result of ovarian damage and decreased ovarian reserve. This project will discuss surgical treatment of endometriosis and in vitro fertilization in patients with endometriosis and the result of each on achieving and maintaining pregnancy.

Keywords: endometriosis, infertility, in vitro fertilization, surgical excision, surgical ablation, pregnancy, endometrioma, live birth.

Introduction

Endometriosis is a condition characterized by endometrial tissue implanted outside of the uterus. This endometrial tissue is stimulated by estrogen and proliferates, responding like endometrial tissue that lines the uterus. Endometriosis affects 10-15% of reproductive age women- but not all are symptomatic (Polat, Yarali, Boynukalin, & Yarali, 2015). Fertility may be negatively affected by endometriosis but there are many fertility options available for women trying to achieve and maintain pregnancy.

Endometriosis can be diagnosed in many ways, with clinical diagnosis being the most common and least invasive. Many diagnostic procedures are available including ultrasonography, MRI, and laparoscopy- with laparoscopy being the gold standard for endometriosis diagnosis (Bulun, 2019). Endometriosis can be classified by location, depth, and severity of ectopic endometrial lesions to include pelvic endometriosis, ovarian endometrioma, and deep infiltrating endometriosis (Bulun, 2019). The purpose of this project is to determine which method is most effective for achieving and maintaining pregnancy in women with pelvic endometriosis and ovarian endometriomas: comparing in vitro fertilization and surgical excision/ablation.

Statement of the Problem

Many women with endometriosis struggle with achieving pregnancy, and many women struggling with infertility are found to have endometriosis. There is no single way to increase fertility in women with endometriosis, and the most effective way to achieve and maintain pregnancy is still under study. There are many methods of achieving and maintaining pregnancy at this time including in IVF, IVF/ICSI, hormonal therapy, surgical excision/ablation, and other pharmacological treatments.

Research Question

In patients with pelvic endometriosis and/or ovarian endometriomas, which is the most effective way to achieve and maintain pregnancy: IVF or excision/ablation?

Methodology

Multiple searches were performed using Clinical Key and PubMed electronic databases between July 2018 and January 2019. Terms used in these searches included “endometriosis”, “endometriosis, pathophysiology”, “endometriosis, pregnancy, infertility”, “endometriosis, in vitro fertilization”, “endometriosis, surgery”, “endometriosis surgical treatment”, “endometriosis IVF pregnancy”, “endometriosis live birth rate”, “endometriomas, “endometriosis, pregnancy, surgery, infertility”, and “endometriosis, surgery, fertility preservation.” Filters were applied to display only English language entries and to remove all articles published greater than ten years prior to the search date.

Anticipated Results

Infertility will likely be greatly improved with either treatment- IVF or surgical resection- yet neither will have success rates comparable to women without endometriosis. Success rates will also be greatly dependent on the severity of endometriosis the patient exhibits. Additionally, success rates may be higher in patients who have used IVF compared to surgical resection alone due to scar tissue accumulation resulting from the surgical procedure.

Literature Review

Pathophysiology of Endometriosis

In Yen & Jaffe’s Reproductive Endocrinology text (Bulun, 2019), a well-known and respected medical textbook, many women’s health issues are discussed. This chapter by Dr. Serdar E. Bulun, the chair of the Department of Obstetrics and Gynecology at Northwestern

University, Feinberg School of Medicine, explains the pathophysiology of endometriosis in a comprehensive yet understandable way. This chapter references articles ranging from how endometriosis was initially understood to how endometriosis is understood today. Dr. Bulun (2019) explains the classifications of endometriosis, including pelvic endometriosis, ovarian endometrioma, or deeply infiltrating endometriosis. Dr. Bulun (2019) goes on to discuss the pathophysiology, staging, and treatment options available for women with endometriosis. This chapter is very beneficial to this research as it breaks down endometriosis and gives a broad base of knowledge to help the audience of this study further understand the topics discussed.

Effectiveness of IVF vs Surgical Excision/Ablation

To achieve and maintain pregnancy in patients with pelvic endometriosis and ovarian endometriomas, two options will be discussed below: IVF and excision/ablation. Each of these options has risks and benefits, and each option has varying success in different patient populations.

IVF

A multicenter retrospective cohort study performed by Benaglia et al. (2013) evaluated in vitro fertilization-intracytoplasmic sperm injection (IVF-ICSI) responsiveness of women with unoperated bilateral endometriomas compared to the control group: women without bilateral endometriomas, without a history of endometriosis, that participated in IVF-ICSI at the same time as those being studied. There were a total of 117 women being studied: 39 women with bilateral endometriomas and 78 control subjects (Benaglia et al., 2013). Those with bilateral endometriomas required a definitive diagnosis by ultrasound that was documented on two separate occasions at least two menstrual cycles apart from one another (Benaglia et al., 2013). It was found that the fertilization rate, implantation rate, quality embryos per oocyte, and chances

of pregnancy were similar in both groups (Benaglia et al., 2013). Additionally, Benaglia et al. (2013) stated "the presence of bilateral endometriomas at the time of IVF seems to affect responsiveness to hyperstimulation" (p. 1718). It was determined that "the quality of the oocytes retrieved and the chances of pregnancy" were not affected by ovarian endometriomas (Benaglia et al., 2013, p. 1718).

This study evaluated by Benaglia et at. (2013) is pertinent to this research in that it is very specific to women with bilateral endometriomas, therefore excluding women with endometriosis outside of the pelvic cavity. Benaglia et al. (2013) does admit that some of the control group may have still had endometriosis as they did not undergo diagnostic laparoscopy prior to IVF cycle. This study is also relatively small, with a total population of only 117 participants.

Neto et al. (2016) reviewed a retrospective cohort study that evaluated women undergoing IVF/ICSI in Brazil from January 2011-December 2012. Neto et al. (2016) focused primarily on number of oocytes received as well as live birth rates. The control group was composed of women without the diagnosis of endometriosis, and the experimental group was composed of women with endometriosis which was then further divided into two groups: those with poor ovarian reserve, and those with normal ovarian reserve (Neto et al, 2016). There was a total of 787 women undergoing IVF/ICSI, with 241 of these women having the diagnosis of endometriosis participating (Neto et al., 2016). Neto et al. (2016) found that women with endometriosis are likely to have poor ovarian reserve compared to those without endometriosis but conceiving via IVF/ICSI is just as likely to occur as in patients without endometriosis and similar ovarian reserve. Neto et al. (2016) determined live birth rates were slightly lower in women with endometriosis compared to those without endometriosis (19.1% vs 22.5%). It is shown that women with endometriosis have poorer ovarian reserve which may contribute to

decreased success with IVF/ICSI (Neto et al., 2016). Women with endometriosis were found to have similar rates of conception as those with comparable ovarian reserve without endometriosis (Neto et al., 2016).

This study by Neto et al. (2016) is pertinentl to this project and has a large patient population which should yield reliable results. It is also very specific in diagnostic criteria of endometriosis. To have the diagnosis of endometriosis, 12.4% were diagnosed by ultrasound, 75.5% by laparoscopy, and 12% by both laparoscopy and ultrasound (Neto et al., 2016). There was also no significant difference in age or BMI between either group, which should further strengthen the results.

In a systematic review and meta-analysis by Harb, Gallos, Chu, Harb, and Coomarasamy (2013), IVF outcomes are measured in women with endometriosis compared to women without endometriosis. Women with endometriosis were classified by stage: with one group including stages I/II and the other including stages III/IV. Twenty-seven observational studies with a total of 8984 women involved were evaluated (Harb et al., 2013). Harb et al. (2013) stated that more than one third of women participating in IVF have endometriosis. This study excluded the studies of women who had previous surgical or medical treatment of their endometriosis prior to starting IVF. Six studies reported live birth rate in women with stages I/II endometriosis and results showed there was no difference in live birth rates as compared with the controls (Harb et al., 2013). Harb et al. (2013) found that nine studies reported live birth rate in women with stages III/IV endometriosis and “did not show a statistically significant difference in this outcome” (p. 1315).

This research by Harb et al. (2013) is pertinent to this research as it demonstrates results of IVF in women with varying stages of endometriosis and compares them to women without

endometriosis. This systematic review and meta-analysis references many different studies with a large patient population of 8984 women (Harb et al., 2013). Harb et al. (2013) does admit it "cannot rule out the possibility that there may have been a degree of unreported concurrent treatment in some studies" (p. 1316). This could skew the evidence slightly in that women may not have been monitored as closely. The study by Harb et al. (2013) did show there was a 14% decrease in live births in women undergoing IVF with stages III/IV endometriosis, but the study admits these results did not reach statistical significance.

A retrospective database-searched cohort study by Lin et al. (2012) evaluates women who underwent IVF/ICSI between January 2006 and December 2010. The main focus of this study was to evaluate the pregnancy rate achieved via IVF/ICSI in the control group, women without endometriosis (n=4267), and the experimental group, women with endometriosis (n=177) (Lin et al., 2012). Lin et al. (2012) reported the following results: clinical pregnancy rate of women with endometriosis =45.2%, clinical pregnancy rate or women without endometriosis =55.2%. It was found that there is no significant difference in pregnancy rate in women with mild vs severe endometriosis (Lin et al., 2012). The study concluded by Lin et al. (2012) stated that women undergoing IVF/ICSI with endometriosis "suffer a decreasing IVF pregnancy rate mainly caused by reducing oocytes number and fertilization rate, regardless of the severity of the disease."

This study by Lin et al. (2012) demonstrates what many of the other studies found addressing pregnancy rates via IVF/ICSI in women with endometriosis: that the clinical pregnancy rate is only slightly lower in these women compared to the control group. This helps to strengthen the evidence previously found. This article does have its drawbacks, in that the

experimental group is only comprised of 177 women, whereas the control group is much larger- which may skew the results of this study.

A journal article by Polat, Yarali, Bonyukalin, and Yarali (2015) addressed many topics, including: effect of endometriosis on in vitro fertilization (IVF) results, effect of surgical treatment of early-stage endometriosis on IVF outcome, relationship of endometriomas to decreased pregnancy rates with IVF, effect of cystectomy of endometriomas on IVF outcome, effect of surgical excision of deep infiltrating endometriosis on IVF outcome, which controlled ovarian hyperstimulation has the most successful IVF outcome, and determining if IVF has an impact of the progression of endometriosis. Pola et al. (2015) concluded that endometriosis is not directly related to poorer IVF outcomes as compared to women enduring IVF who do not have endometriosis.

Polat et al. (2015) found statistics from many different studies that relate to the topics listed above. The results most pertinent to this project include patients with endometriosis stage III or stage IV experiencing significantly reduced implantation and clinical pregnancy rates compared to controls without endometriosis- but live birth rates in patients with stage III-IV endometriosis were equivalent to the controls (Polat et al., 2015). Patients with early stage I-II endometriosis exhibited comparable implantation rates, clinical pregnancy rates, and live birth rates as the controls (Polat et al., 2015). Polat et al. (2015) found that patients with endometriosis, stage I-IV, did not affect IVF pregnancy rates. One randomized control study looking at the effect of surgical treatment in early-stage disease and its effect on IVF outcome showed that surgical resection of endometriomas significantly improved live-birth rate (20.6% vs 27.7%) (Polat et al., 2015). Long term GnRHa suppression prior to IVF was studied in a Cochrane review that contained three randomized control trials and exhibited GnRHa

administration for 3-6 months before IVF increased the odds of clinical pregnancy fourfold in patients with endometriosis (Polat et al., 2015). This information is important to this research as it directly compared patients with endometriosis and those without endometriosis and their live birth rates following IVF.

Surgical excision/ablation

Berlanda et al. (2013), in an analysis of published series, demonstrated less than 25% of sub-fertile patients undergoing surgery for endometriosis of any type were able to conceive spontaneously. The average postoperative pregnancy rate following excision of ovarian endometriomas was about 50%, but this surgical procedure also induced gonadal damage (Berlanda et al., 2013).

Berlanda et al. (2013) states that "in case of recurrent endometriosis, in vitro fertilization should generally be preferred to surgery." The main role of surgical endometrioma removal is for pain relief in women trying to achieve conception spontaneously. This article does not include statistics from the studies it reviewed, but it does address the effect of endometrioma excision and its effect on achieving conception spontaneously.

Muzii et al. (2017) reviews many different studies involving different types of surgical procedures for women with endometriosis. Data from three randomized control trials and a Cochrane meta-analysis was evaluated and it was determined that excision of ovarian endometriomas "yields better results in terms of subsequent pregnancy rates, pain control rates, and cyst recurrence rates, compared with fenestration and coagulation/ablation of the cyst wall" (Muzii et al., 2017, p. 26). There are multiple techniques to remove endometriomas including a "three-stage" technique and a "combined technique" (Muzii et al., 2017). These techniques

alternate the timing of surgery, the use of GnRH analog treatment, the type of surgical procedure and the order of which these steps occur (Muzii et al., 2017).

This article by Muzii et al. (2017) is pertinent to this research as it goes into great detail each type of surgical procedure that may be used to treat or manage endometriosis. Infertility is addressed in this article, and each procedure is evaluated on its impact of fertility of the patient. This article is very specific and also primarily used to discuss different surgical options rather than specifically addressing fertility. There is some valuable information in this article that pertains to this project, but the bulk of this information is beyond the scope of this research.

Rizk et al. (2015) reviews evidence-based practice regarding endometriosis-associated infertility and its surgical treatment. Rizk et al. (2015) found that patients with minimal/mild stage endometriosis had increased pregnancy rates following excision/ablation of peritoneal endometriosis. Controlled trials suggested an increased pregnancy rate in patients with severe endometriosis following excision/ablation of peritoneal endometriosis (Rizk et al., 2015). Women with large ovarian endometriomas (>4cm) showed increased pregnancy rate and decreased recurrence rate following ovarian cystectomy (Rizk et al., 2015). According to Rizk et al., (2015), patients who failed the initial surgical procedure were proven to have significantly greater chances at achieving pregnancy with assisted reproduction versus repeat surgery. Finally, it was determined that the first line treatment for women with minimal/mild endometriosis was surgical excision/ablation and resulted in doubling of the pregnancy rate (Rizk et al., 2015).

This article by Rizk et al. (2015) is very pertinent to this research as it reviews studies regarding endometriosis excision/ablation and how it likely increases the pregnancy rate. These results confirm the initial hypothesis that surgical treatment is appropriate first-line treatment for achieving and maintaining pregnancy. Rizk et al. (2015) does disclose there are no randomized

control trials on surgical excision/ablation of women with moderate to severe endometriosis and its results on pregnancy rate. Rizk et al. (2015) all stated that many of these studies used included patients that had not previously tried to conceive before surgical excision/ablation and therefore they were not necessarily infertile to begin with.

Roman (2018) wrote a journal article that is tailored to surgeons performing procedures on women with endometriosis, who may or may not be wanting to conceive. Roman (2018) discussed different surgical techniques depending on where endometriosis is located in the patient. The results in this article confirm there is a high rate of achieving pregnancy in women with deep infiltrating endometriomas following surgical excision/ablation (Roman, 2018).

The limitations of this article by Roman (2018) include its very specific audience. It is aimed at surgeons that perform specialized women's health or abdominal surgeries. The article is very informative in different technique and styles of surgical procedures that may be involved in endometriosis treatment that precedes successful conception and pregnancy. It does discuss pregnancy rates following surgery, which is pertinent to this study.

Discussion

Women with endometriosis are affected by their diagnoses in many ways: dysmenorrhea in 50-90% of cases, chronic pelvic pain, dyspareunia, menorrhagia, dysuria, dyschezia, constipation, hematochezia, and infertility (Bulun, 2019). Peak incidence of endometriosis occurs in women ranging from ages 25-29 years, with most women experiencing symptoms for 6-12 years before diagnosis (Bulun, 2019). With multiple forms of treatment available to manage symptoms of endometriosis, including hormonal, surgical, or nonsteroidal anti-inflammatory drug (NSAID) therapies, and more, not all forms are appropriate in treating women of reproductive age that are wanting to achieve and maintain pregnancy. With endometriosis

present in 21-40% of women undergoing infertility treatment, it appears there is a strong correlation between endometriosis and infertility (Bulun, 2019). With this high prevalence among women being treated for infertility, it is clear that fertility options need to be available for women with endometriosis.

Endometriosis is classified into 4 stages by the American Society for Reproductive Medicine shown below (Bulun, 2019):

- Stage I: minimal- Superficial lesions in peritoneum and/or ovary; filmy adhesions are possible
- Stage II: mild- In addition to stage I findings, deep lesions may be detected in peritoneum
- Stage III: moderate- In addition to stage I and II findings, deep lesions may be detected in ovary, cul-de-sac may be partially obliterated, or filmy adhesions may be detected in fallopian tubes
- Stage IV: severe- In addition to stage I- III findings, deep lesions and dense adhesions may be detected in several regions, as well as complete obliteration of cul-de-sac

The effectiveness in achieving and maintaining pregnancy in women with endometriosis, stages I-IV, with the use of IVF and surgical excision/ablation will be discussed.

IVF is a multistep procedure with a desired end result of pregnancy. The steps involved include ovarian stimulation, oocyte retrieval, fertilization with capacitated sperm and ICSI, embryo culture, and embryo transfer (Michalakis, DeCherney, and Penzias, 2013). Superovulation is almost universally used in all types of assisted reproductive technology (ART) (Michalakis et al., 2013). Superovulation is achieved with the following therapies, alone or in combination: gonadotropins and gonadotropin-releasing hormone (GnRH) analogues,

gonadotropins and GnRH antagonist, follicle-stimulation hormone (FSH) products- urinary or recombinant, human menopausal gonadotropins – urinary or recombinant, luteinizing hormone (LH) agonists, and clomiphene citrate (rarely) (Michalakis et al., 2013). IVF is one type of ART used to increase the likelihood of achieving pregnancy in many different sub fertile populations including patients with any of the following conditions: male factor infertility, tubal disease (tubal and pelvic adhesions), absent or damaged fallopian tubes, endometriosis, preimplantation genetic diagnosis, need for third-party reproduction/donor eggs or gestation surrogate, unexplained infertility, age-related infertility, decreased ovarian reserve, and recurrent intrauterine insemination failure (Michalakis et al., 2013). With many possibilities to achieve superovulation available, only a few options, specific to patients with pelvic endometriosis or ovarian endometriomas, and their outcomes will be discussed below.

Administering GnRH agonists to women with endometriosis prior to IVF or ICSI for 3-6 months before IVF or ICSI increased odds of clinical pregnancy fourfold (Polat, Yarali, Boynuklain, and Yarali, 2015). Another pretreatment method for IVF and/or ICSI is oral contraceptives given for 6-8 weeks prior to IVF and ICSI, which was shown to have higher pregnancy rates per retrieval than controls (35 vs 12.9%; p=0.01) and this was even greater in women with presumed endometriomas (Polat et al., 2015). According to Polat et al. (2015), "since endometriosis is an estrogen-dependent disease, [controlled ovarian stimulation] COH for IVF may theoretically lead to a higher recurrence rate of endometriosis" (p. 638). This should be taken into account when considering fertility treatment in women with endometriosis, as they should be informed of the potential of worsening symptoms during the first phases of IVF/ICSI. According to Polat et al. (2015), women with endometriosis should expect to have similar IVF outcomes as women without endometriosis.

IVF has proven to be successful in women with endometriosis in various clinical trials and studies. IVF is often preceded by ovarian hyperstimulation. According to Benaglia et al. (2013), ovarian responsiveness to hyperstimulation is decreased in women with bilateral endometriomas, though these bilateral endometriomas do not affect oocyte quality, fertilization rate, implantation rate, or chance of pregnancy. Studies performed by Harb, Gallos, Chu, Harb, and Coomarasamy (2013) have shown ovarian hyperstimulation response reduction in women with oocytes retrieved in women with bilateral endometriomas compared to controls, resulting in 7.1 ± 3.2 and 9.8 ± 5.5, respectively. Harb et al. (2013) also made clear oocyte retrieval was not affected by ovarian endometriomas. In this study explained by Harb et al. (2013), 39 women with bilateral endometriomas were compared to 78 controls, with all of the participants going through IVF/ICSI, and the main outcomes measured were oocyte quality and ovarian hyperresponsiveness.

Ovarian reserve has proven to be an important factor in increased success rates for patients diagnosed with endometriosis that are undergoing IVF and/or ICSI. A study by Neto et al. (2016) evaluated 787 women undergoing IVF/ICSI with 241 of these women having a diagnosis of endometriosis. The endometriosis patients were diagnosed via ultrasound (12.4%), laparoscopy (75.5%), and both (12.0%) (Neto et al., 2016). In this study, the primary outcomes measured were ovarian reserve and chance of live birth. It was found that women with endometriosis versus the control had similar chances of life birth when compared with members with similar ovarian reserve, with chance of live birth in endometriosis patients vs control resulting in 19.1% vs 22.5%, respectively (Neto et al., 2016). Ovarian reserve in patients with endometriosis was shown to be decreased compared to controls, 39.8% vs 22.7%, correspondingly (Neto et al., 2016).

Lin et al. (2012) evaluated a study comparing clinical pregnancy rate in 177 women with endometriosis and 4267 women without endometriosis as the control group. Clinical pregnancy rate was reduced in women with endometriosis, 45.2%, compared to the control, 55.2% (Lin et al., 2012). The significantly reduced pregnancy rate may be explained by a lower ratio of high-quality embryos transferred in the endometriosis group, 53.7%, compared to the control, 71.8% (Lin et al., 2012). This study did evaluate fertilization, implantation, and clinical pregnancy rates across the spectrum of mild vs severe endometriosis and no significant difference was found (Lin et al., 2012). This is encouraging to women with severe endometriosis in that their chance of achieving and maintaining pregnancy is similar to women with mild endometriosis. Lin et al. (2012) also evaluated a 5-year database cohort study that found women with endometriosis have a decreased IVF pregnancy rate vs control which is mainly due to reduced oocytes and fertilization rate, also regardless of endometriosis severity. Lin et al. (2012) stated "ICSI might improve the outcomes of IVF."

In multiple studies evaluated by Polat et al. (2015), endometriosis patients were compared to the control group, women without endometriosis, and implantation rate, clinical pregnancy rate, and live birth rate were compared. Implantation rate, clinical pregnancy rates, and live birth rates were comparable in women with stage I-II endometriosis to the control group (Polat et al., 2015). Women with endometriosis stages III-IV showed significantly less implantation and clinical pregnancy rates vs controls but did have comparable live birth rates (Polat et al., 2015).

Polat et al. (2015) also discussed the difficulty of comparing infertility treatments in women with endometriomas vs women with endometriosis without endometriomas. Women with endometriomas are difficult to compare to women without since women with

endometriomas are more likely to have deep infiltrating endometriosis which has its own effect, and/or associated peritoneal disease (Polat et al., 2015). Women with endometriomas were previously found to have increased pregnancy loss, decreased oocytes, and adverse effects on embryo quality (Polat et al., 2015). However, Polat et al. (2015) found no adverse effects on any outcome. Women with endometriomas may consider surgical excision prior to IVF but it has not been found to increase odds of successful IVF treatment and should be considered only in cases of symptomatic patients with severe pelvic pain or concern of rupture during pregnancy due to size (Polat et al., 2015).

Surgical excision or ablation of endometriosis or endometriomas is effective for symptoms relief, mainly pain management, as well as increasing fertility. According to a review of evidence-based practice of surgical treatment for fertility in women with endometriosis by Rizk et al. (2015), surgery doubled pregnancy rates in patients with minimal to mild endometriosis (stage I-II) and is therefore considered first line therapy. In patient's with severe endometriosis, there was a suggested increase in pregnancy rate (Rizk et al., 2015). According to Roman (2018), pregnancy rates following surgical removal of endometriosis is dependent on multiple factors including duration of follow-up, other endometriosis locations, uterine adenomyosis, and the patient's pre-operative history of infertility.

Several studies have been performed on the effect of surgical excision or ablation of ovarian endometriomas and improving fertility. "Ovarian endometriomas are present in 17 to 44% of patients with endometriosis" as stated by Muzzi et al. (2017, p. 25). According to Berlanda et al. (2013), no more than 25% of sub fertile patient with endometriomas are able to achieve conception spontaneously. "First-line surgery for ovarian endometriotic cysts" has a mean postoperative pregnancy rate of ~50% (Berlanda et al., 2013). After one surgical procedure

on a patient's endometriomas, a second surgery is not recommended, and IVF is considered first line treatment in women that have recurrent endometriomas over additional surgeries (Berlanda et al., 2013). Assisted reproduction is recommended if further therapy is needed after the first surgical intervention, as it seems to be more effective than another surgical procedure according to Rizk et al. (2015). Rate recurrence of endometriomas following surgical excision is 6-67%, with success in pain reduction and enhancement of fertility, as discussed by Muzii et al. (2017). According to Roman (2018), surgeons should consider conservative treatment especially in women with endometriomas, as it is better to have recurrence of endometriomas than reduction or complete destruction of ovarian reserve. Muzii et al. (2017) discusses how endometriomas do not respond to medical treatment as traditional endometriosis does, apart from success with pain management. Laparoscopic excision of the endometrioma appears to be the procedure of choice, and according to Muzii et al. (2017), the endometrioma itself may be the cause for ovarian damage and reduced ovarian reserve, and not the surgical procedure. Laparoscopic excision has proven to be the best for subsequent pregnancy rates, pain control, and cyst recurrence versus "fenestration and coagulation/ablation of the cyst wall" according to Muzii et al. (2017, p. 27). Rate of recurrence of endometriomas following surgical excision is 6-67% but is effective in pain reduction and enhancing fertility (Muzii et al, 2017).

The size of the ovarian endometrioma is important in determining which therapy is most appropriate as well as if any further testing should be performed. According to Muzii et al. (2017), "the 2005 guidelines of the European Society of Human Reproduction and Embryology (ESHRE) indicated 3 cm as the threshold above which histology, through surgical excision 'should be obtained to identify endometriosis and exclude rare instances of malignancy'" (p. 26). It has been observed that patients with ovarian endometriomas >4cm that are surgically removed

via ovarian cystectomy have exhibited a decreased ovarian reserve and recurrence rate but increased pregnancy rate (Rizk et al., 2015). Therefore, if pregnancy is not achieved following surgical removal of an ovarian endometrioma >4cm, ovarian reserve and recurrence rate will likely decrease and therefore a decreasing pregnancy rate will result if an additional procedure is required. In scenarios such as these, IVF or other ART may be recommended for these women to increase their chances of achieving and maintaining pregnancy.

Many women with endometriosis also struggle with deep infiltrating endometriosis (DIE), which is a more severe variant of endometriosis. DIE is defined as "lesions infiltrating the subperitoneal space to a depth beyond 5mm" according to Roman (2018, p. S34). Surgery is the only curative method for DIE, but fertility should be preserved in women who would like to conceive naturally, and this should be discussed before surgery is performed (Roman, 2018). Roman (2018) discovered colorectal endometriosis patients having increased rates of spontaneous conception following laparoscopic surgery vs laparotomy.

The research has shown that IVF is effective in achieving and maintaining pregnancy in women with endometriosis. Surgical excision/ablation is effective at pain and symptom management but is likely more detrimental than beneficial regarding post-procedure pregnancy rate. Surgery may be considered prior to IVF in women trying to conceive that require pain management or have DIE. IVF with or without ICSI ultimately has better post-procedure pregnancy rates than surgical excision/ablation and should therefore be considered first line treatment for women wanting to conceive.

Applicability to Clinical Practice

With endometriosis being highly prevalent in women of child bearing age, it will be beneficial to have this study comparing IVF and surgical excision/ablation which shows the

fertility option best for women with pelvic endometriosis and/or ovarian endometriomas wanting to conceive. The results of this project will be especially helpful in clinical practices that focus on women's health and infertility. These results will help to direct patients to the most successful method of achieving and maintaining pregnancy.

Due to the potential of worsening endometriosis symptoms during the first stages of IVF, patients should be made aware of all their options- to include potential risks as well as benefits. Regardless of the severity of the patient's endometriosis, research shows IVF pregnancy rates in these women is comparable to women without endometriosis. Women who choose surgical excision/ablation before assisted reproductive technology should also be made aware that the initial procedure may increase their chances of conceiving spontaneously, but if another procedure is indicated, IVF should be considered rather than another surgery due to the potential harm and decreased ovarian reserve.

Women with endometriosis have many resources available to assist them in achieving and maintaining pregnancy, but not all women are made aware of these options. Education must be provided to these women at their annual health condition review appointments, to ensure these women are able to make educated decisions about their plans to conceive regarding ART or surgical procedures.

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