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REPRODUCTIVE MEDICINE

The risk of ectopic pregnancy following tubal reconstructive microsurgery and assisted reproductive technology procedures

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Abstract
Purpose The incidence of ectopic pregnancy (EP) in the general population is 2%, whereas the EP rate following assisted reproductive technologies (ART) is between 2.1 and 11%. EP is also an adverse effect of tubal surgery with incidences up to 40% depending on the type, location, and severity of tubal disease and the surgical procedure.
Methods This paper looks at the incidence of EP following tubal reconstructive microsurgery, analyzes risk factors for EP following own 1,295 ART cycles and looks on the incidence of EP in 128,314 pregnancies following ART according to the presence or absence of tubal infertility using data from the German IVF Registry (DIR).
Results In our clinic, the EP rate following resterilization was 6.7%. In the presence of acquired tubal disease, the EP rate following adhesiolysis, salpingostomy, salpingoneostomy, fimbrioplasty, and anastomosis was 7.9%. The EP rate following ART in our clinic was 5.6%. Previous abdominal surgeries, microsurgical procedures, hydro-/sactosalpinges, salpingitis, salpingitis isthmica nodosa, and periadnexal adhesions showed a significant positive correlation with EP as outcome. Data of DIR demonstrate a significantly increased incidence of EP in the presence of tubal pathology. The highest EP rate related to all clinical pregnancies was 4.5% (95% CI 3.0–6.0) in smoking women <30 years with tubal pathology following IVF.
Conclusions In the presence of tubal infertility, the incidence of EP following ART and tubal microsurgery are approximately comparable with each other and higher than in women without tubal infertility. The success of infertility surgery depends on a careful selection of appropriate patients.

Keywords Ectopic pregnancy · Tubal reconstructive surgery · Microsurgery · Tubal infertility · Assisted reproductive technology · IVF

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Introduction

Ectopic pregnancy (EP) is a serious and nowadays a cause of maternal mortality in early pregnancy. The risk factors for EP in general population are pelvic infection, tubal disease, endometriosis, previous tubal surgery, age >35 years and smoking [1–8]. The incidence of EP in general population is approximately 2% [3], whereas the EP rate following assisted reproductive technology procedures (ART) is between 2.1% and up to 11% in tubal infertility [2, 9]. Tubal ectopic pregnancy is also a known adverse effect of tubal reconstructive surgery; however, the incidence varies widely between 0% and up to 40% depending on the type, location, and severity of the tubal disease and the surgical procedure. Furthermore, the varying numbers of patients in the studies reported in literature (22 patients in the study of Carey and Brown [10] vs. 1,118 patients in the study of Kim [11]) may influence the statistical analysis and consecutively the interpretation of the surgical procedures.

Disease or damage of the fallopian tube accounts for 25–35% of reported cases of infertility [12]. Decreased fecundity may be caused by previous sterilization, tubal occlusion, fimbrial damage, and/or peritubal adhesions, usually related to previous pelvic inflammatory disease, endometriosis, pelvic surgery, salpingitis isthmica nodosa or otherwise unknown causes. The limitations of surgical repair in many cases have been the driving force behind the rising numbers of ART. However, the success of either treatment (even when attempted multiple times) cannot be guaranteed.

The aim of this paper is to discuss and analyze the incidence of ectopic pregnancy and the risk factors associated with ectopic pregnancy after tubal microsurgery and ART in recent publications, in our clinic and in Germany using data from the German IVF Registry.

This paper is divided into three parts:

1. Ectopic pregnancy rate following reconstructive microsurgery of the fallopian tubes in our own patient database and in literature
2. Analysis of risk factors for ectopic pregnancy following 1,295 ART cycles in our clinic
3. Analysis of the incidence of ectopic pregnancy in 128,314 pregnancies following in vitro fertilization (IVF) and intracytoplasmatic sperm injection (ICSI) considering the presence or absence of tubal infertility in Germany using data from the German IVF Registry ("Deutsches IVF Register") from 1999 to 2009.

Part 1: Ectopic pregnancy rate following reconstructive microsurgery of the fallopian tubes

The success of infertility surgery and the risk for EP depend on the careful selection of appropriate patients. Decisive are the type, location, and severity of the tubal disease as well as other factors such as complex ovulatory disorders, severe male infertility, and other major reproductive problems like repeated extrauterine pregnancies. When compared with the macrosurgical approach, the use of a microsurgical technique has significantly improved the outcome of tubal anastomosis with reduced EP rates [13]. In the presence of only mild or moderate tubal pathology, term pregnancy rates of 65–80% for salpingoneostomy, adhesiolysis, and reversal of sterilization have been reported [4, 14, 15]. The ectopic rate for mild disease is reported to be 1–10% [16–18]; in contrast, EP rates can increase 20–40% in the presence of intrinsic tubal damage, salpingitis isthmica nodosa, and severe tubal pathology [12, 19, 20].

Reversal of sterilization

In 1980, Gomel reported a 65% pregnancy rate and a low EP rate of just 1% following the reversal of tubal ligation [21], whereas Hirth et al. [22] recently reported an EP rate of 19% after microtubal reanastomosis. In a large study of 1,118 cases of microsurgical resterilization, the overall pregnancy rate was 54.8% (505/922), and the EP rate was 5%, respectively [11]. Seven large series including a total of 2,018 sterilized patients showed a pregnancy rate of 68% and an EP rate of 4% after microsurgical reversal either open or laparoscopically [23]. In general, microsurgical reversal of sterilization leads to a cumulative pregnancy rate ranging from 40 to 84% and monthly fecundability of 8–10% [11, 24], the overall risk of EP appears to be <10% [4, 20]. Possible prognostic factors include the type of performed sterilization procedure, the site of anastomosis, and the postoperative tubal length [20]. Tubal occlusion with rings or clips, isthmic-isthmic anastomosis and a tubal length >5 cm are associated with a greater likelihood of successful pregnancy after resterilization [4].

In our own study, the EP rate following the microsurgical reversal of sterilization was 6.7% (6/89 patients), and the intrauterine pregnancy rate was 73.0%, respectively (65/89 patients) (Table 1). The reconstructive surgical techniques include the following elements [25, 26]: atraumatic surgical technique, complete removal of diseased tissue, careful hemostasis, preparation layer by layer and exact adaptation of the tissue structures, complete peritonealization, and continuous irrigation of exposed peritoneal tissue surfaces (Fig. 1).

Peritubal adhesiolysis

Overall intrauterine pregnancy rates following adhesiolysis by microsurgery vary widely from 21 to 80% [20, 23, 27], mainly because of bias in case selection and the absence of

Table 1 Results of reversal of sterilization (refertilization)

Method of surgery (microsurgery)	Number of patients (percent)	Pregnancy rate	Ectopic pregnancy rate	Abortion rate	Birth rate
Refertilization after previous sterilization	89 (100%)	65 (73.0%)	6 (6.7%)	14 (15.7%)	45 (50.6%)

All types of anastomoses and length of fallopian tubes; 127 patients contacted, 89 patients answered; median age 35.4 years (26–42); percentages are related to all patients. The analysis considered only the first pregnancy that followed the operation, even if an EP or abortion was followed by a normal pregnancy with subsequent childbirth

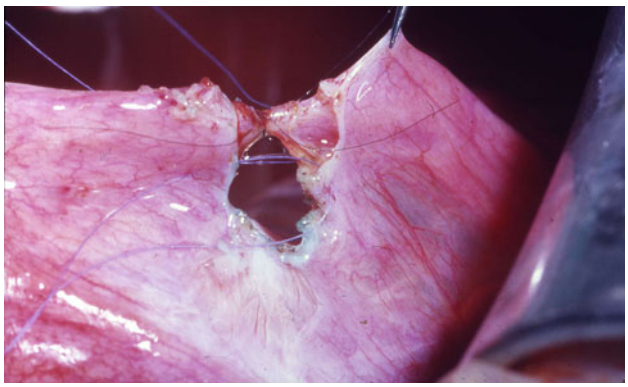

Fig. 1 Isthmic-isthmic reanastomosis of the fallopian tube after sterilization (refertilization) using sutures 8-0 and 6-0 Vicryl

standardized assessment of the extent of tubal damage, especially the mucosal state. In patients with only filmy adhesions, the cumulative pregnancy rate following microsurgery is high, whereas the delivery rate decreases dramatically to a maximum of 20% in case of dense adhesions [28]. In an analysis including 9 studies with 456 patients, an EP rate of 0–16% following adhesiolysis by microsurgery, and a rate of intrauterine pregnancy (IUP) of 21–68%, respectively, is reported [20]. A small study from 1987 with 22 patients undergoing lysis of adhesions reported a pregnancy rate of 41% (9/22 patients) and an EP rate of 23% [10]. Patients were further subdivided according to the severity of adhesions. Those patients with severe tubal disease showed a trend to worse results, though this finding was not statistically significant.

Excellent results have been reported after laparoscopic adhesiolysis. High pregnancy rates of about 60% with EP rates of 6% have been reported in cases of the absence of peritoneal damage of serosa after the surgical procedure and a complete removal of adhesions with a good anatomical reconstruction of ovaries and fallopian tubes. EP rates increased up to 20% if at least one of these criteria was not fulfilled [20, 29] or if the tubal damage was severe [16, 23, 30]. For this reason, patients with dense adhesions and a severe tubal pathology are best referred to IVF. In our study, the rate of EP following microsurgical adhesiolysis was 7.8% (9/116 patients), and the intrauterine pregnancy rate was 42.2% (49/116), respectively (Table 2).

Distal tubal surgery: fimbrioplasty and salpingostomy

Pregnancy outcome after distal tubal microsurgery has been related to several factors such as pre-existing tubal disease, the extent of adnexal or even dense adhesions, the ampullary dilatation, the wall thickness, and the lack of normal mucosa [20]. In a study of 65 patients from 1987, 18% conceptions and 9% EP out of these pregnancies occurred within a follow-up of 18 months after salpingostomy including lysis of adhesions.

In general, salpingostomy has the lowest success rate among the tubal microsurgeries. Pregnancy rates following fimbrioplasty are higher than those after salpingostomy (60 vs. 31%) [31]. The term pregnancy rates following distal tubal surgery varied from 3–59% when patients had only few and non-fixed adhesions, a thin tubal wall, and normal mucosal appearance of the endosalpinx [16]. A meta-analysis including eight studies with 399 patients showed EP rates from 3 to 23% with an intrauterine pregnancy rate of 0–51% [20] following salpingostomy, salpingoneostomy, and fimbrioplasty.

Another analysis with a total of 1,514 patients showed an intrauterine pregnancy (IUP) rate and recurrent EP rate following salpingostomy for the treatment of EP of 61 and 15%, respectively [32]. A history of previous tubal pathology detected at the time of surgery had the strongest impact on women's fertility. Patients with none of these risk factors had a 75% IUP rate after salpingectomy for EP, whereas patients with risk factors had a 36.6% IUP rate [33]. In a study of microsurgical fimbrioplasty due to post-

Table 2 Results of reconstructive tubal surgery due to acquired tubal damages

Method of surgery (microsurgery due to acquired tubal damages)	Number of patients	Pregnancy rate	Ectopic pregnancy rate	Abortion rate	Birth rate
Adhesiolysis (128%)	116	49 (42.2%)	9 (7.8%)	3 (2.6%)	37 (31.9%)
Fimbrioplasty (17.3%)	55	30 (54.6%)	3 (5.5%)	6 (10.9%)	21 (38.2%)
Salpingostomy (49.7%)	153	53 (34.6%)	12 (7.8%)	7 (4.6%)	34 (22.2%)
Anastomosis (20.2%)	68	38 (55.9%)	7 (10.3%)	9 (13.2%)	22 (32.4%)
Total (100%)	392 interventions (287 patients)	170 (43.4%) related to total number of surgeries	31 (7.9%)	25 (6.4%)	114 (29.2%) related to total number of surgeries

426 patients contacted, 287 patients answered; median age 31.0 years (21–42); multiple methods of surgeries during one intervention possible; total rates are related to total number of interventions

The analysis considered only the first pregnancy that followed the operation, even if an EP or abortion was followed by a normal pregnancy with subsequent childbirth

inflammatory tubal disease in 161 patients, the rate of EP was 12% following salpingoneostomy, whereas the rate of EP increased to 14% when combined procedures for proximal and distal disease had been performed [34]. A large review of ten case series in women who underwent salpingoneostomy due to distal tubal occlusion ($n = 1{,}128$) reported a cumulative EP rate per pregnancy of 23% [35] and an EP rate of 8% in women who underwent tubocornual anastomosis for proximal tubal occlusion ($n = 118$) [36].

In our own patient database (Table 2), the EP rates had been 7.8% (12/153 patients) when salpingotomy was performed and 5.5% (3/55 patients), respectively, when fimbrioplasty was done (Fig. 2a, b). The pregnancy rates had been 34.6% (53/153 salpingotomy) and 54.6% (30/55 fimbrioplasty), respectively.

Proximal tubal disease: tubocornual anastomosis

Case series and cohort studies demonstrated high pregnancy rates following microsurgical tubocornual anastomosis [37]. Livebirth rates of 27, 47 and 53% within 1, 2 and 3.5 years, respectively, were reported after microsurgical tubocornual anastomosis [38]. A review of 11 case series in women who underwent proximal tubal operations by microsurgery ($n = 490$) reported a cumulative EP rate of 0–12% and a rate of intrauterine pregnancies of 22–74% concerning all patients [20]. The largest study from 1997 showed an EP rate of 11% and an IUP rate of 74% after a 3-year follow-up [39]. Negative prognostic factors on the pregnancy rate after tubocornual anastomosis are reduced residual length, damaged intramural portion, presence of chronic inflammation and tubal inclusion in the tubal wall, and tubal endometriosis [20].

In our own study of 68 patients, the EP rate was 10.3% (7/68 patients), whereas the intrauterine pregnancy rate was 55.9% (38/68 patients) when tubal anastomosis (reversal of sterilization excluded) was performed (Table 2).

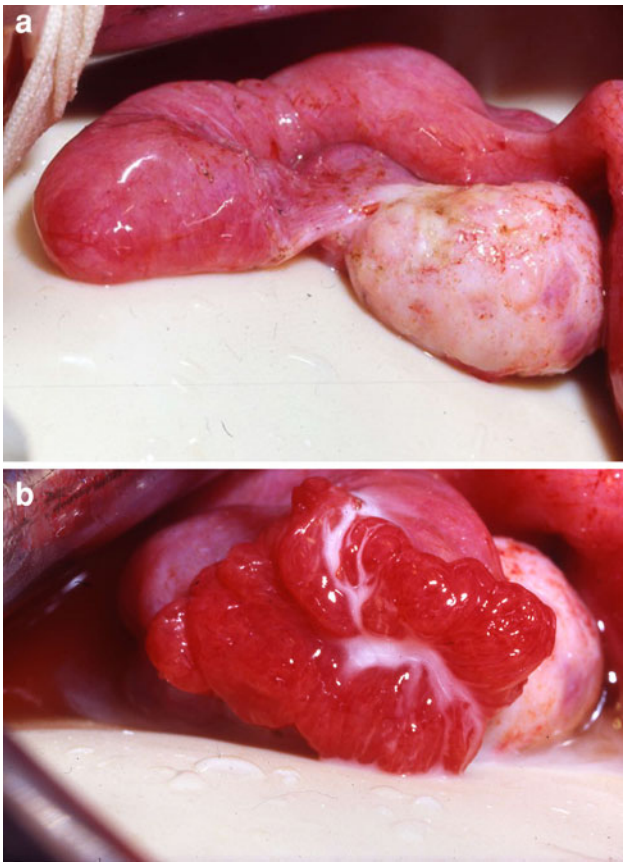

Fig. 2 **a** Fimbrial phimosis and **b** fimbrioplasty in fimbrial phimosis

Part 2: Ectopic pregnancy following ART/IVF

Analysis of risk factors for ectopic pregnancy following 1,295 ART cycles in our clinic

The first pregnancy conceived after ART and embryo transfer was ectopic [40]. The risk factors for ectopic pregnancy following ART with an incidence of 2.1–9.4% [9] in all ART patients and up to 11% in patients with tubal infertility [2] are reported to be tubal disease, history of pelvic infection [3, 41], and tubal infertility as it is considered to be the indication for ART [2, 42, 43].

In a retrospective case–control study of our IVF outpatient clinic, we analyzed a total of 1,295 embryo transfers following IVF and ICSI which resulted in 338 pregnancies in 306 women (pregnancy rate 26.1%). The EP rate was 5.6% related to all pregnancies (19 pregnancies in 17 women). The median age of the women with EP was 33.2 years (27–39), whereas the median age of the women with IUP was 32.4 years (23–43). The EP rate in the group of women who conceived by IVF with the total number of 847 embryo transfers was 7.4% with a pregnancy rate of 20.7%, respectively. In the ICSI group, there was a pregnancy rate of 36.4% following 448 embryo transfers; the EP rate was 3.6%, respectively. Background factors, medical history, and the indication for ART were analyzed for possible correlation with the outcome of EP. Cycles that resulted in EP (19 EP, 17 women) were compared with cycles that resulted in intrauterine pregnancy (319 IUP, 289 women).

Institutional review board approval was not necessary because we only used retrospective, anonymized data from the patients who had been treated at our IVF clinic. Risk factors for EP were identified by χ^2 test in bivariate data analysis: previous abdominal surgeries by laparotomy in general, previous microsurgical procedures of the female genital tract, the presence of hydro-/sactosalpinges,

Table 3 Distribution of factors analyzed for possible correlation with risk of ectopic pregnancy in women who conceived after ART

Variable (χ^2 test)	Finding p value
Salpingitis in history	0.000
Presence of salpingitis isthmica nodosa	0.001
Presence of sactosalpinx in history	0.004
Presence of periadnexal adhesions in history	0.001
Previous abdominal surgeries by laparotomy in general	0.001
Previous microsurgical procedures of the female genital tract	0.000
Previous salpingostomies	0.000

A p value of <0.005 was considered statistically significant

Table 4 Results of stepwise logistic regression analysis to assess the risk of subsequent ectopic pregnancy

Variable	Odds ratio
Presence of salpingitis isthmica nodosa	14.53
Salpingitis in history	5.53
Previous microsurgical procedures of the female genital tract	3.61

previous salpingostomies, previous salpingitis, salpingitis isthmica nodosa, and periadnexal adhesions showed a significant positive correlation with EP as outcome ($p < 0.005$ determined by χ^2 test) (Table 3). A history of endometriosis did not increase the risk for EP ($p = 0.450$).

Stepwise logistic regression analysis was used to identify prognostic variables among the preselected variables. Statistical analysis was performed with the SPSS software system (SPSS/7.5). Salpingitis isthmica nodosa had a 14.5-fold, salpingitis in history had a 5.5-fold, and previous microsurgical procedures of the female genital tract had a 3.6-fold higher risk for EP after ART (Table 4).

Part 3: Analysis of the incidence of ectopic pregnancy in 128,314 pregnancies achieved after IVF and intracytoplasmatic sperm injection (ICSI) considering the presence or absence of tubal pathology in Germany using data from the German IVF Registry ("Deutsches IVF Register/DIR") from 1999 to 2009

Since 1996, the structure of the German IVF Registry report has combined standard analysis and special charts focusing on new aspects. The huge dataset with more than 1 million cycles collected also allows investigating specific aspects such as lifestyle factors (smoking, weight) or reproductive history (former pregnancies, miscarriages, etc.). The greatest advance of the German IVF Registry lies in the decision of nearly every IVF unit to support its work through a prospective data collection. We now present an analysis of the incidence of EP (always related to the overall clinical pregnancy rate) after IVF and ICSI with the special focus of the presence or absence of tubal pathology.

In 2009, the clinical pregnancy rate per embryo transfer following 11,715 IVF cycles in 2009 was 29.53%, compared with a clinical pregnancy rate per embryo transfer of 28.63% following 37,006 ICSI cycles [44], and 30.93% when a simultaneous treatment of IVF and ICSI (IVF/ICSI) in one cycle was performed in 881 cycles. The overall pregnancy rates had been relatively stable within the last decade. It is because of German legal restrictions that no embryo selection is permitted and the German Embryo Protection Act, passed in 1991, permits no more than three embryos to be transferred. Oocyte donation as well as surrogate motherhood is illegal.

From 1999 to 2009, there was a total number of 128,314 clinical pregnancies (IVF 44,644; ICSI 83,670). In 25,498 pregnancies (19.9%), the women had a history of tubal pathology and tubal infertility. The overall rate of EP related to all clinical pregnancies following ART procedures in Germany from 1999 to 2009 was 2.0% [95% confidence interval (CI) 1.9–2.1] with a maximum of 2.2% in the group of women >39 years of age (95% CI 1.8–2.5) (Fig. 3).

In 19.9% of the pregnancies (25,498), the ART cycles are done in couples who had an infertility diagnosis of "tubal factor" or "tubal disease." The incidence of EP related to all clinical pregnancies according to the presence or absence of tubal pathology ranges from 2.3 to 3.7% in the presence of tubal pathology and from 1.7 to 2.1% in

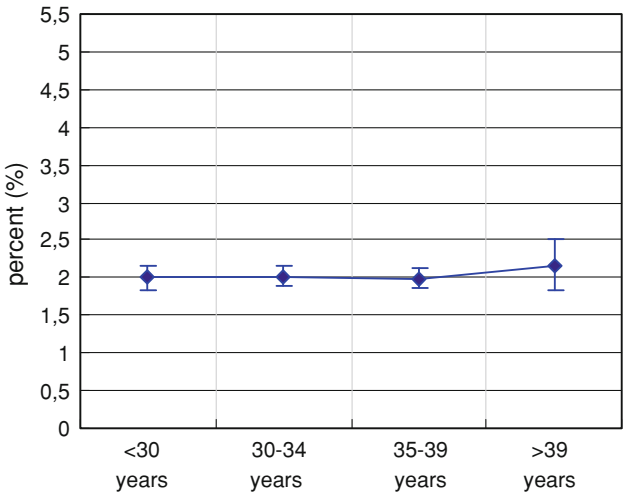

Fig. 3 Ectopic pregnancy rate related to all pregnancies following ART (*blue circle* including 95% CI); data from the German IVF Registry, 1999–2009

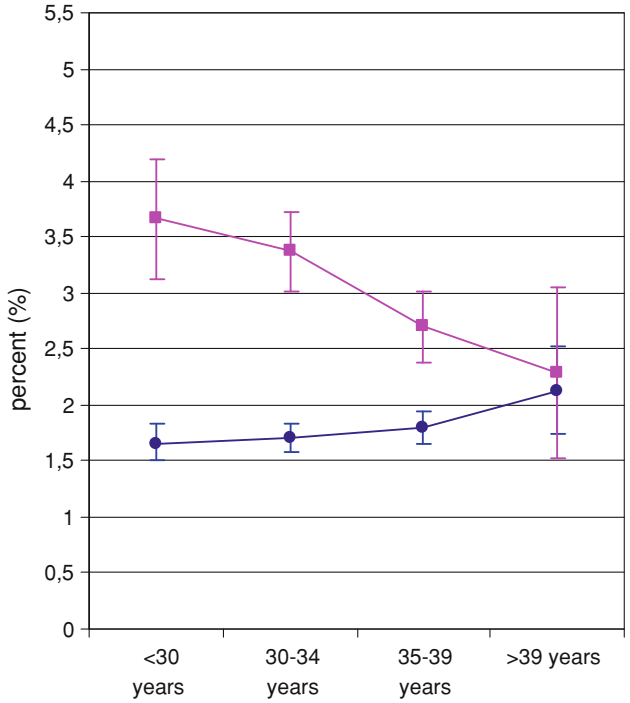

Fig. 4 Ectopic pregnancy rate related to all pregnancies depending on the presence of tubal pathology (*pink quadrate* including 95% CI) or absence of tubal pathology (*blue circle* including 95% CI), in Germany, data from the German IVF Registry, 1999–2009

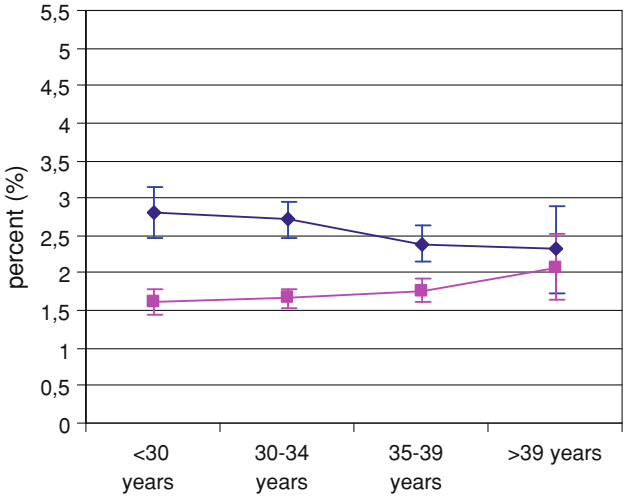

Fig. 5 Ectopic pregnancy rate related to all pregnancies following IVF (*blue circle* including 95% CI) and ICSI (*pink quadrate* including 95% CI) in Germany, data from the German IVF Registry, 1999–2009

women without documented tubal disease. The differences are statistically significant in all age groups except in the age group of women >39 years (Fig. 4).

The incidence of EP in IVF pregnancies in comparison to ICSI pregnancies was significantly increased in the IVF cohort in all age groups except in women over the age of 39 years. The EP rate following IVF pregnancies (44,644) ranges from 2.3 to 2.8%; the EP rate following ICSI pregnancies (83,670) ranges from 1.6 to 2.1% (Fig. 5).

The analysis showed a significantly increased risk for EP in the presence of tubal pathology when IVF was done in all women except in the group of women over the age of 39 years. In addition to that, we can demonstrate an increased risk for EP when ICSI was done if the women also had a tubal comorbidity.

In a subanalysis, the highest EP rate related to all clinical pregnancies was 4.3% (95% CI 3.6–5.0) in the group of women <30 years. In the same age group, the EP rate was only 2.0% (95% CI 1.6–2.3) in women without a proven tubal pathology (Fig. 6).

The highest EP rate in this analysis was detected to be 4.5% (95% CI 3.0–6.0) in pregnancies of young women <30 years who firstly had a tubal pathology, who secondly had been treated with IVF, and thirdly who smoked. If these women are non-smokers, the EP rate related to all clinical pregnancies was 4.2% (95% CI 3.5–5.0). In women <30 years without tubal infertility, the EP rate in IVF pregnancies was 3.0% for smokers (95% CI 1.8–4.1), and 1.8% (95% CI 1.4–2.2) in non-smokers. Regarding the smoking habits of all patients, smoking increases the overall risk for EP both in IVF pregnancies and ICSI pregnancies though not all age- and treatment-related differences are statistically significant.

Discussion

The risk for ectopic pregnancy or the chances for an intrauterine ongoing pregnancy following tubal reconstructive surgery vary widely depending on the type, location, and severity of the tubal disease, and the performed surgical procedure. In the presence of only mild or moderate tubal pathology, term pregnancy rates of 65–80% for salpingoneostomy, adhesiolysis, and reversal of sterilization have been reported [4, 14, 15]. The ectopic rate for mild acquired tubal disease is reported to be 1–10% [16–18] and for reversal of sterilization <10% [4], but in contrast, EP rates increase up to 40% in the presence of intrinsic tubal damage, salpingitis isthmica nodosa and severe tubal pathology [12, 19, 20, 45, 46]. For this reason, patients with dense adhesions like frozen pelvis and a severe tubal pathology are best referred to IVF.

In our own patient's collective, the EP rate following reversal of sterilization was 6.7%. In the presence of acquired tubal disease, mainly because of previous pelvic inflammation and salpingitis, the overall EP rate was 7.9% following microsurgical reconstruction using the techniques of adhesiolysis, salpingostomy, salpingoneostomy, fimbrioplasty, and anastomosis.

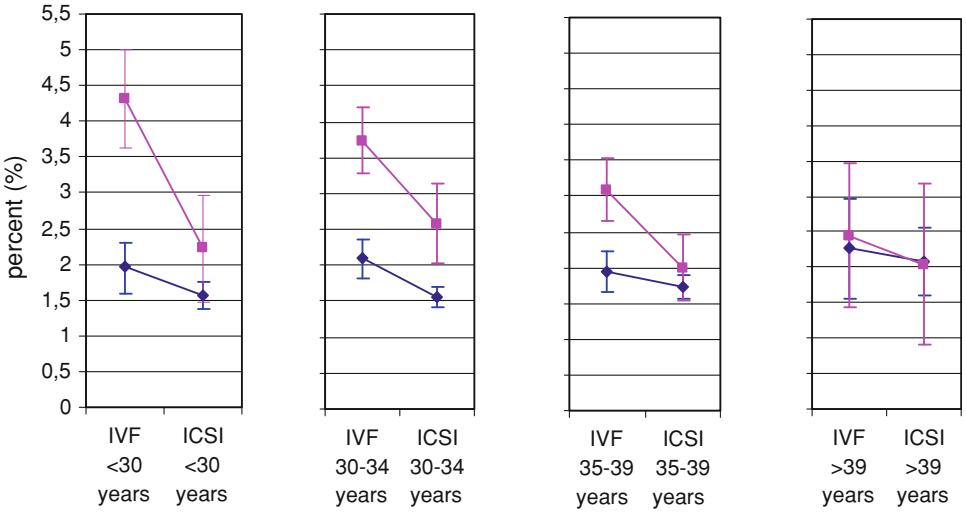

Fig. 6 Ectopic pregnancy rate related to all pregnancies depending on the age of women, IVF (*left*) versus ICSI (*right*) and the presence (*pink quadrate* including 95% CI) versus absence (*blue circle* including 95% CI) of tubal pathology, data from the German IVF Registry, 1999–2009

The risk factors for developing EP after ART still are inconsistent. The incidence is reported to be between 2.1% and up to 11% in tubal infertility. A large number of publications have extensively suggested that the presence of damaged fallopian tubes lead to a higher incidence of EP following ART procedures. In our own collective, the incidence of EP was 5.6% related to all IVF and ICSI cycles performed. We could demonstrate that previous abdominal surgeries by laparotomy in general, previous microsurgical procedures of the female genital tract, the presence of hydro-/sactosalpinges, previous salpingostomies, previous salpingitis, salpingitis isthmica nodosa, and periadnexal adhesions are associated with a higher risk for developing an EP following ART. Furthermore, salpingitis isthmica nodosa had a 14.5-fold, salpingitis in history had a 5.5-fold, and previous microsurgical procedures of the female genital tract had a 3.6-fold higher risk for EP after ART.

In addition, the data of the German IVF Registry demonstrate a significantly increased incidence of EP in the presence of tubal pathology. The highest EP rate related to all clinical pregnancies was detected to be 4.5% (95% CI 3.0–6.0) in women <30 years who firstly had a tubal pathology, who secondly had been treated with IVF, and who thirdly smoked. If these women are non-smokers, the EP rate was 4.2% (95% CI 3.5–5.0).

In a large series from the US, 2.1% of 94,118 ART pregnancies was ectopic [1]. The EP rate was significantly increased when zygote intrafallopian transfer (ZIFT) was used (3.6%) and significantly decreased when donor oocytes were used (1.4%) or when a gestational surrogate carried the pregnancy (0.9%). In fresh non-donor IVF procedures, the risk for EP was increased among women with tubal factor infertility [odds ratio (OR) 2.0; 95% CI 1.7–2.4; reference group: ART due to male infertility], endometriosis (OR 1.3; 95% CI 1.0–1.6) and other non-tubal female factors (OR 1.4; 95% CI 1.2–1.6) and decreased among women with a previous live birth (OR 0.6; 95% CI 0.5–0.7).

In addition, both the volume of transfer medium as well as the technique of embryo transfer itself has been associated with EP [47–49]. It is suggested that an increased volume of culture media [50] or an injection of the embryo under high pressure may flush the embryo into the diseased tube [51] and that transferring the embryo too deeply into the cavity may increase the risk for EP [5, 52]. In contrast, it is reported that there was no difference in EP rate between women who had an ultrasound-guided transfer and those who had embryo transfer using a clinical touch technique [53]. A different hormonal milieu created by hyperstimulation with gonadotropins may also interfere with tubal function and embryo transport [9, 49, 54]. A difficult embryo transfer significantly increases the risk of an EP by stimulation junctional zone contractions and strong endometrium waves in the fundal area of the uterus, which can move embryos into the tubes [9]. The risk seems to be particularly higher when the women have a history of tubal damage or previous EP [9]. It is also supposed that embolization of the tubes in the presence of hydrosalpinges prior to IVF may reduce the risk for EP following ART [55]. The current Cochrane Review provides evidence that laparoscopic tubal occlusion of hydrosalpinges is an alternative to laparoscopic salpingectomy prior to the IVF procedure to improve pregnancy rates [37]. However, this meta-analysis was underpowered to demonstrate a significant difference in the OR of EP following salpingectomy for a hydrosalpinx. It is also well known that intramural pregnancies may occur in patients who previously had undergone salpingectomy [3].

However, a recent publication constitutes that "Infertility surgery is dead" [27], because, among other things, very high EP rates of 67% are proven in patients with severe pathology of the fallopian tubes who underwent

adhesiolysis [10]. The authors cited these data from 1987 [10] but avoided to report that the group of patients with severe tubal disease and the high EP rate of 67% included just three patients. The conclusion of this publication was that "ART has superseded surgery as first-line therapy for tubal factor infertility." Muzii et al. constituted that—in contrast–the "indiscriminate referral to IVF may do more harm than good to a considerable proportion of infertility patients" [56].

In the presence of tubal infertility or tubal comorbidity, the incidence of EP following ART procedures of at most 4.5% in the German IVF Registry and the incidence of EP after microsurgical reversal of sterilization of 6.7% and after tubal reconstruction due to acquired tubal damages of 7.9% (own data) are approximately comparable with each other and considerable higher than in women without tubal infertility.

Surgical tubal reconstruction still remains a significant part in the range of modern infertility treatments, however the success and/or failure of infertility surgery depends on a careful selection of appropriate patients. ART is especially recommended in women with severe tubal pathology and in the case of severe male infertility or ovarian dysfunction.

Conflict of interest We declare that we have no conflict of interest.

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