Getting pregnant after tubal sterilization: surgical reversal or IVF?

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BACKGROUND: When women regret having had a tubal sterilization, is the pregnancy rate higher with surgical reversal or IVF? METHODS: This retrospective cohort study analyses the delivery rates of 163 patients undergoing IVF treatment (n = 79) or surgical reversal (n = 84). Pregnancy outcomes were obtained by reviewing medical records or contacting private physicians and patients. The life table method was used to calculate the chance of becoming pregnant and to construct cumulative pregnancy curves. Cumulative pregnancy curves are compared by log rank tests. A P-value of <0.05 is considered as statistically significant. The cost-effectiveness of the two strategies was also evaluated. RESULTS: Patient characteristics did not differ between the two groups. The cumulative delivery rate during 72 months was 52.0% in the IVF group and 59.5% in the reversal group (ns). Age was the only factor that influenced delivery rates significantly. The cumulative delivery rate for patients aged <37 years was 52.4% after IVF and 72.2% after reversal (P = 0.012), while cumulative delivery rates for patients aged 37 years or older were, respectively, 51.4 and 36.6%, a difference that did not reach statistical significance. The average cost per delivery was €11 707 for IVF, compared with €6015 for surgical reversal. However, in patients aged 37 years or older the difference in cost was smaller. CONCLUSION: Considering the cumulative delivery rates involved, surgical reversal is recommended for patients younger than 37; older patients are advised to opt for IVF.

Keywords: IVF; reversal; tubal sterilization; decision making; reanastomosis

Introduction

Although a wide range of other contraceptive options are available, tubal sterilization remains a widely used contraceptive method. Although female sterilization is meant to be a permanent solution in fertility control, some women may regret their decision and ask for a reversal. The probability for requesting reversal of sterilization has been reported to be as high as 14.3%, but eventually, only 1.1% of the patients had a reversal (Curtis et al., 2006).

For women regretting tubal sterilization there are two medical options: (i) surgical tubal reversal (TR) and (ii) IVF and embryo transfer. In most cases the choice between these two options is made by the preference of the patient and her doctor, or the costs involved. However, there is hardly any data available in the literature comparing TR and IVF for this indication. A cochrane protocol for the comparison of IVF versus TR has been initiated in 2003, however, so far the cochrane reviewers were unable to find any study on this subject in the literature on this topic (Yossry et al., 2003). The only retrospective study that has been published so far compares results after IVF in these patients with historical data from TR, as found in the literature (Benadiva et al., 1995). In this retrospective cohort study, we aimed to compare the results of the two treatment options for women who wished to have a child after tubal sterilization. Belgian patients have easily access to both treatments which are both financially supported by the Belgian national health system.

Materials and Methods

Patients

This study includes patients, who consulted the Centre of Reproductive Medicine, Dutch speaking Brussels Free University in Belgium, wishing to have children after tubal sterilization from the period January 1990 to December 2005. The Centre of Reproductive Medicine, Dutch speaking Brussels Free University in Belgium is a tertiary reference centre. Patients were referred by their general practitioners, their gynaecologists or they consulted on their own initiative. All had no other known factors associated with infertility.

Procedures

The choice between TR and IVF was made based on patient’s preference after being informed about both options. For IVF, outcomes were...
obtained by reviewing medical records, and for patients who underwent TR outcomes were obtained by contacting referring doctors or patients by telephone.

All patients who opted for TR underwent a diagnostic laparoscopy to assess feasibility of reversal. Whenever indicated the TR was performed during the same surgical procedure. Patients not eligible for TR were proposed IVF (n = 19). These patients were included in the IVF group because this would not interfere with their IVF outcome. All surgeries were performed by two surgeons using a microsurgical approach by laparotomy. IVF was done using methods that were published earlier (Tournaye et al., 1992). IVF cycle was included in this study when at least one cumulus–oocyte complex was obtained at oocyte retrieval.

**Outcome measurements and statistics**

The primary outcome of this retrospective cohort study was pregnancy resulting in at least one live birth. Since conception was our measure of treatment efficacy, the delivery of more than one child was given the same weight as the delivery of a singleton.

Data are expressed as mean ± SD and as percentages. Student’s t-test and Mann–Whitney U test are used to compare the variables in the two groups. The life table method is used to calculate the chance of becoming pregnant and to construct cumulative pregnancy curves. Cumulative pregnancy curves are compared by log-rank tests. Cox’s proportional hazard model is used to perform a multivariate analysis. A P-value of < 0.05 is considered as statistically significant. Statistical analysis was performed with MedCalc (MedCalc Software, Mariakerke, Belgium), and graphs were created with Prism 4.03 (Graphpad USA).

**Cost-effectiveness analysis**

For cost-effectiveness analysis we used data from De Sutter et al. (2002) who calculated cost per IVF cycle in the University Hospital Ghent, Belgium, also a tertiary reference centre for infertility which work according to the Belgian health system: (i) laboratory procedures of €1187; (ii) medication €714; (iii) medical costs of €500 and (iv) €25 for paramedical acts, adding to a total of €2426. Calculations of indirect non-medical costs, such as sick leave during treatment, were based upon data from a study performed by SD WORX (2005). With an average of €15.11/h and 8 h per day, the average cost of sick leave for IVF patients was €575 (5 days). The cost of delivery or neonatal care was not included because we were not able to obtain reliable information about the method of delivery for all patients. We assumed that the cost of delivery for a healthy singleton is the same for both study groups. However, we did include an additional cost for twin pregnancies (€3000) based on data from De Sutter et al. (2002). The cost of miscarriage were not included.

The data for calculation of the costs for the TR group were obtained from the financial services of the Centre of Reproductive Medicine, Dutch speaking Brussels Free University. The average cost of a surgical reversal was €2360: (i) surgical fee of €1320; (ii) average hospital stay of 5 days (€1000) and (iii) pre- and post-hospitalization consultations €40. The indirect non-medical costs of sick leave for the TR group was €1448 (10 days). For the TR group, we included the cost of treatment of ectopic pregnancies (€1875) since this is the most important complication associated with this treatment.

**Results**

A total of 163 patients were allocated: 79 had at least one or more IVF cycles and were followed for a minimum of 18 months (range 18–163 months). In the same period, 113 patients had a surgical TR, of these 29 were lost to follow-up, because we were not able to contact them to retrieve the result of their operation, leaving 84 patients for analysis with a follow-up of a minimum of 14 months (range 14–168 months).

Fifteen patients received surgical reversal but eventually switched to IVF. Another 10 patients received surgical reversal after one or more IVF attempts. These ‘switchers’ were not included in our 163 study patients, neither were they taken in account for the statistical analysis of success rates.

Table 1 shows the main patient characteristics. No significant difference was observed between the two groups. In the IVF group, sterilization was performed by coagulation and cutting in 34%, clips in 32%, Pomeroy technique in 15%, Yoon rings in 15% and bilateral fimbriectomy in 5%. In TR group, 50% of patients were sterilized using clips, 28% with Yoon rings, 14% with coagulation and cutting and 8% with the Pomeroy technique.

Table 2 shows the outcome for all patients. In the IVF group, 79 patients underwent a total of 155 IVF cycles. In 14 cycles (9%) a single embryo was transferred, in 59 cycles (38%) two embryos were transferred and in 75 cycles (48%) more than two embryos were transferred. In seven cycles (5%) no embryo transfer was performed because of fertilization failure. In the TR group 12 patients (14%) had only unilateral reanastomosis.

For the TR group, the outcome at the end of the follow-up period is shown. For the IVF group, the outcome after either delivery of a healthy child or discontinuing the treatment is shown. In the IVF group, five patients (12%) delivered a twin. If patients had a miscarriage, but delivered a healthy baby, the miscarriage was not counted.

To compare the outcome of the two treatments as accurately as possible, we constructed a Kaplan–Meier curve with time from the start of treatment to a liveborn delivery or the end of follow-up. Fig. 1 shows the cumulative delivery rates for the two groups. There was no difference in the overall success rate for IVF or TR. We performed log-rank test for several variables possibly related to pregnancy. We analysed the variables for the two groups together and also separately. When the two groups were analysed together, age was a significant factor (P = 0.012). When we analysed success rates according to age for both groups separately, we found a difference for the TR group (P = 0.006) but no difference for the IVF group (P = 0.49).

Because age was shown to be such an important factor, we compared the two treatments in different age groups. According to previous studies from our institution that showed that 37 years is a pivotal age for the success rates after assisted

**Table 1: Characteristics of patients who wished to have a child after tubal sterilization and underwent IVF or TR**

<table>
<thead>
<tr>
<th></th>
<th>IVF group, n = 79, mean ± SD (range)</th>
<th>TR group, n = 84, mean ± SD (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>36 ± 4 (25–42)</td>
<td>35 ± 5 (22–43)</td>
</tr>
<tr>
<td>Age at sterilization</td>
<td>28 ± 4 (20–39)</td>
<td>28 ± 5 (18–42)</td>
</tr>
<tr>
<td>Time interval</td>
<td>7 ± 4 (1–16)</td>
<td>7 ± 4 (1–19)</td>
</tr>
<tr>
<td>BMI</td>
<td>24 ± 3 (18–36)</td>
<td>24 ± 4 (18–33)</td>
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reproduction techniques, the two groups were defined according to this age (Osmanagaoglu et al., 1999, 2002). For the IVF group, there were 42 patients <37 years and 37 patients who were 37 years or older. For the TR group, there were 54 patients <37 years and 30 patients who were 37 or older. Fig. 2 shows delivery rates for the two groups according to age. Cumulative delivery rates for patients <37 years were 52% (n = 22) for the IVF group and 72% (n = 39) for the TR group. Cumulative delivery rates for patients who were 37 years or older were 51.4% (n = 19) for the IVF group and 36.6% (n = 11) for the TR group. Cumulative delivery rates for TR group were higher than for the IVF group when patients were young (i.e., <37 years) and delivery rates were lower for TR group than for the IVF group. The differences, however, did not reach statistical significance.

Time between patient’s sterilization and subsequent treatment was not a factor that influenced delivery rates: in the IVF group, 54% (19/35) up to 5 years, 53% (10/19) for 6–10 years and 50% (9/18) for >10 years duration of sterilization, and delivery rates according to time sterilized for the TR group were, respectively, 63 (25/40), 73 (16/22) and 43% (6/14). There was no significant difference in delivery rate according to time between sterilization and subsequent treatment for the whole group; neither was there a difference for the IVF group or the TR group. The method of tubal ligation had no influence on the delivery rate in either the IVF- or the TR group.

Delivery rates were not significantly associated with BMI for the entire group, the IVF group or the TR group. Delivery rate according to BMI for the IVF group was 67% (two-third) for BMI <20 kg/m², 47% (7/15) for BMI 20–24 kg/m², 44% (4/9) for BMI 25–29 kg/m² and 100% (2/2) for BMI ≥30 kg/m². Delivery rate according to BMI for the TR group was 50% (one-half) for BMI <20 kg/m², 58% (19/33) for BMI 20–24 kg/m², 58% (7/12) for BMI 25–29 kg/m² and 33% (one-third) for BMI ≥30 kg/m².

Of the 15 patients who underwent IVF after they had had TR, 11 (73%) patients delivered at least one healthy baby. Two (13%) patients delivered a twin. Cox analysis for time between IVF and surgery showed no significant influence on delivery rates.

For the 10 patients who underwent surgical TR after IVF, 6 (60%) patients delivered a healthy baby. No twins were born. The number of IVF attempts before switching to surgical reversal did not significantly influence the delivery rate.

The average cost per delivery was €11,707 for IVF, compared with €6015 for surgical reversal of tubal ligation. Because of the difference in delivery rates according to age, especially in the TR group, we also calculated the cost-effectiveness for the two treatments for the different age groups. We used the same methods as described above. The cost per delivery for patients younger than 37 years was €12,140 for IVF and €4953 for TR, while for patients aged 37 or older, costs were €11,214 and 9740, respectively.

Discussion

Women who regret their decision of Fallopian tube ligation have two medical options: surgical TR or IVF and embryo transfer. However, there is hardly any data available in the literature comparing TR and IVF for this indication. A Cochrane review on this relevant topic failed to include any study so far, even a retrospective one.

Our cohort study shows that, considering the cumulative delivery rates and costs involved, surgical reversal is recommended over IVF for patients younger than 37 years. Given the smaller difference in cost after 37 years of age, older patients may be advised to opt for IVF instead.
Patient’s characteristics showed no statistical significant difference for age at the beginning of treatment, age at tubal ligation or time between tubal ligation and IVF or surgical reversal. Neither was there a significant difference in BMI between the two groups.

This study being retrospective in nature has some weaknesses. First, the selection of TR versus IVF. Except for four patients (out of 163) who had a bilateral fibriectomy, the choice between IVF or TR was not based on factors that could bias the patients decision such as age or type of sterilization. There was no difference in the method of sterilization applied according to women’s age.

However, 19 patients (out of 103) initially opting for surgical reversal were redirected to an IVF approach because the laparoscopy showed that the surgical reversal was technically impossible due to a limited tubal length. Although this subgroup is small (n = 19), this redirection of patients may have biased the results in the TR group favourably.

The long follow-up period in this study might have biased the results in favour of the TR group. A shorter follow-up period in the IVF group might be due to discontinuation. However, when we truncated the follow-up period after 3 years (plus 9 months for the pregnancy duration) we did not observe any difference in the trends observed. In the IVF group all patients had a complete follow-up. The 26% of patients lost to follow-up in the TR group only included patients that could not be reached for further follow-up information request. Although we have no indication to assume that in this subgroup the outcome after TR would have been different it can not be excluded that this created a bias in favour of the TR results.

In the present study, we expected high delivery rates in sterilized women because of their fertility potential, as proven by their prior parity (95% had at least one child). Our delivery rate per treatment cycle (26%) was slightly higher than the overall reported live birth rate per treatment cycle (21%) after IVF for any indication in Belgium as reported in the European Society of Human Reproduction and IVF report (Nyboe et al., 2000). Sitko et al. (2001) investigated specific pregnancy rates in IVF after tubal sterilization. They reported an ongoing pregnancy rate per embryo transfer of 12.5% for IVF after tubal sterilization. In our study, in contrast with very large studies about factors that affect the outcome of IVF, we did not find a decline in delivery rate according to age. Although in most cycles more than one embryo was transferred, the twinning rate (12%) in our study was lower than that reported in the literature (Nyboe et al., 2000). Although some data suggests that TR may be preferred over IVF in women older then 40, our results indicated that in this subgroup IVF is to be preferred, yet this subgroup size was limited in our study (Trimbos-Kemper, 1990).

Delivery rate after surgical reversal, as observed in this study, was comparable to that reported in the literature. Several large studies of surgical reversal reported delivery rates ranging from 55 to 87% (Kim et al., 1997; Yoon et al., 1999). The results after laparoscopic TR, in experienced hands, compare favourably with the open technique as presented in this study (Yoon et al., 1999). However, we opted for a subsequent open reversal technique by mini laparotomy in eligible patients because the laparoscopic approach needs an important learning curve and experience (Cha et al., 2001). The number of patients with ectopic pregnancies after surgical reversal (3.6%) and the number of patients with miscarriages (4.8%) were also comparable to the number of patients reported by others, ranging, respectively, from 3 to 8% and 12 to 21% (Kim et al., 1997; Yoon et al., 1999; Hanafi, 2003). The small number of miscarriages may be explained by reporting bias; i.e. the fact that patients do not mention miscarriages, even when questioned, when a healthy baby was delivered afterwards. In contrast to the IVF group, statistical analysis of our data showed an important difference in delivery rate according to age after surgical reversal. Age is known to be an important factor affecting the outcome of any fertility treatment (Templetion et al., 1996). Several authors reported that pregnancy rates decreased after TR with increasing age (Glock et al., 1996; Hanafi, 2003). This was also true for our study. However, no statistical significance was obtained for IVF and surgical reversal, possibly because of the limited sample size in our study.

We did not find a difference in pregnancy rate according to BMI either in the IVF group or in the TR group. This is in contrast to Lintsen et al. (2005) who reported a significantly lower delivery rate after IVF in patients with BMI > 27 kg/m². Also Hanafi (2003) reported BMI as a significant factor that affects pregnancy outcome after TR.

The time between patient’s sterilization and subsequent treatment did not affect delivery rates, either in IVF group or in the TR group. These results are similar to those of a previous study (Nyboe et al., 2000). Some patients underwent IVF having been found not suitable for surgical reversal because of the method of sterilization; however, when suitable for surgical reversal the method of tubal sterilization did not significantly influence the delivery rate. This was also reported by other authors (Yoon et al., 1999; Hanafi, 2003).

The delivery rate after IVF was not significantly different from that after surgical reversal. Both options must be taken into consideration for patients who regret their tubal sterilization. Within the limits of this study, it seems that for younger patients surgical reversal is the better option. The great advantage of TR is also to avoid twin pregnancies once fertility is restored. The fact that women are able to conceive in every cycle without requiring further treatment and that more than one pregnancy is possible also pleads in favour of TR. For patients aged 37 or older, surgical reversal still showed cumulative delivery rates of 36.6%. However, it seems better to optimize fertility chances by offering these patients IVF because older patients should be advised to undergo treatment that provides the highest chances of success within the shortest time interval.

In conclusion, as for most fertility treatments, age was found to be the most important factor affecting delivery rates. Our results favour surgical reversal after tubal sterilization for patients younger than 37 years and suggest IVF in patients that are older. However, as there is no difference in overall success rates between IVF and TR, it is important to consider the relative costs of each of the two treatments. Costs per delivery were lower for TR than for IVF. Because of the lower
costs per delivery of TR it seems acceptable to recommend this treatment, especially for patients with the highest chance of success, i.e. younger women. The higher success rate for IVF and the smaller difference in cost per delivery for patients aged 37 or older may argue in favour of promoting IVF in these patients. Caution is needed in the interpretation of our data because of the retrospective nature of the present study, which implied that detailed clinical information was not available for all patients. Our study clearly points to the need for a large multicentre cohort study since a large multicentre randomized prospective trial comparing the success rates of surgical reversal and IVF in patients who have renewed their wish for a child after tubal sterilization will be difficult to conduct.

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