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ORIGINAL ARTICLE *Gynaecology*

Surgical approach to and reproductive outcome after surgical correction of a T-shaped uterus

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BACKGROUND: The aim of this study was to describe the surgical approach to, and evaluate the reproductive outcome of, a T-shaped uterus.

METHODS: The study included 97 women who were eligible for hysteroscopic surgery, by either monopolar or bipolar electrosurgical instruments. All had diagnostic hysteroscopy 2 months afterwards to assess the success of the procedure and determine whether any synechiae were present.

RESULTS: Forty-eight women (49.5%) became pregnant after metroplasty. The overall live birth rate per pregnancy before surgery was 0%; for these patients, it increased to 73%, and their miscarriage rate fell from 78 to 27% ($P < 0.05$). For all 57 pregnancies in 48 women, the ectopic pregnancy rate was 9% ($n = 5$), the miscarriage rate 28% ($n = 16$), the preterm delivery rate 14% ($n = 8$), the term delivery rate 49% ($n = 28$) and the live birth rate was 63% ($n = 36$).

CONCLUSIONS: Hysteroscopic metroplasty improves the live birth rate for women with a T-shaped uterus and a history of primary infertility, recurrent abortion or preterm delivery, although it is not a treatment of infertility.

Key words: metroplasty / T-shaped uterus / DES / hysteroscopy

Introduction

A T-shaped uterus is a rare uterine malformation, except in woman exposed *in utero* to diethylstilbestrol (DES), which was given in France until 1977 (Kaufman *et al.*, 1977). Acquired forms also exist, for example, in cases of Asherman syndrome. A T-shaped uterus is classified in the American Fertility Society (AFS) Classification of Anomalies of the Müllerian Duct only generally as type VII (DES-related abnormalities). The pathogenesis remains unclear and its cause is still unknown. Several studies have showed very poor reproductive performance when this uterine malformation is not treated (Berger and Goldstein, 1980; Herbst *et al.*, 1981). Reproductive performance after hysteroscopic metroplasty in women with a T-shaped uterus is not well documented: there are only three reports (Nagel and Malo, 1993; Katz *et al.*, 1996; Garbin *et al.*, 1998), compared with numerous reports of surgery for a septate uterus (Homer *et al.*, 2000).

In the past, metroplasty has been offered to women with reproductive failure, in particular, recurrent or missed abortions. The development of operative hysteroscopy has simplified the treatment of these malformations, which were previously treated by laparotomy. Surgical hysteroscopy is no longer performed with rigid scissors attached to a channel. Today, these metroplasties use monopolar instruments. Bipolar instruments, which have been introduced more recently, seem to be as effective and result in less morbidity (Fernandez *et al.*, 2000).

The objective of our study was to evaluate the reproductive outcome at the first pregnancy after surgical correction of a T-shaped uterus in 97 women.

Materials and Methods

The retrospective study was based on records of women with a hypoplastic uterus, a cylindrical uterine cavity and bulging of the uterine side walls,

combined with a history of primary infertility, recurrent abortion or preterm delivery before 30 weeks, with or without live birth. From 1995 through 2005, 97 women who filled these criteria were treated in two surgical departments; 63 of these women had DES exposure.

Preoperative work-up

The preoperative work-up is important and includes hysterosalpingography, diagnostic hysteroscopy, two-dimensional pelvic ultrasound (2D-US) or three-dimensional ultrasound (3D-US) and sometimes magnetic resonance imaging (MRI). 3D-US (Voluson 730 Expert: GE Healthcare, Zipf, Austria) equipped by an endovaginal volume probe with a frequency of 5–9 MHz provided images of the uterus in three planes, displayed simultaneously, and produced has a high rate of accuracy for both diagnosis and classification of congenital anomalies (Figs 1 and 2).

During the ultrasonography, it is essential to measure the bulging of the uterine side walls, their thickness and the depth of the healthy myometrium up to the serosa (Figs 3 and 4).

Surgery should be scheduled for early in the follicular phase; otherwise, a preoperative 1-month progestogen treatment (e.g. pregnane) or GnRH analogues (gonadotrophin-releasing hormone) can be prescribed to prepare the endometrium. The procedure should then be performed about 28 days after starting the treatment.

Operating room set-up, patient and surgery

General anaesthesia or local-regional anaesthesia is proposed. The patient is in a lithotomy position: legs spread at a 45° angle, thighs at a 90° angle from the surface of the table and knees bent at a 90° angle, with an optional urinary catheter.

Prophylactic antibiotics are given when anaesthesia is induced to prevent endometritis, however, there is no evidence to support their systematic indication.

The surgeon is seated between the patient's legs and the assistant stands to the surgeon's right.

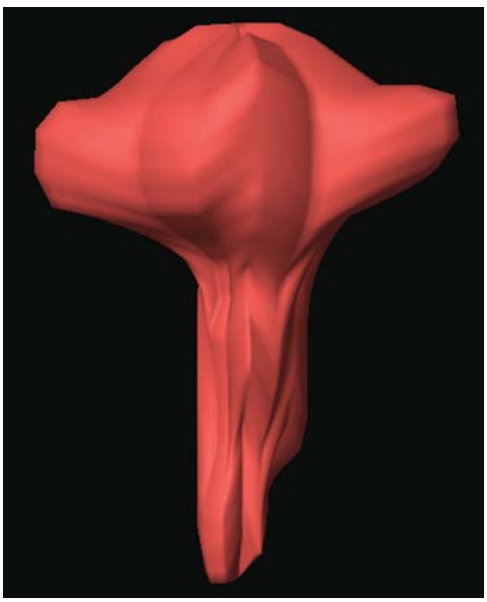

Figure 1 Reconstruction in 3D-US of T-shaped uterus.

Equipment

The equipment is on the surgeon's left: an endocamera and monitor, and devices to control pressure and flow of distension media to maintain a constant uterine distension, with pressure controlled continually by suction and irrigation pumps. The distension medium is hyperosmolar glycine solution with a monopolar instrument (Glycocolle 1.5%®, Aguettant Laboratory, Lyon, France) or saline with a bipolar instrument.

A high-frequency electrosurgical generator is used: with unipolar electrosurgery, a high-frequency current (>300 000 Hz), unmodulated for tissue division, produces a rapid rise in temperature.

For bipolar electrosurgery, the Versapoint® bipolar vaporization system (Gynecare Laboratory, Issy-les-Moulineaux, France) has a 5-French operating channel. Saline is used as the distension medium to decrease the risk of metabolic complications.

Adjustment of the system

Monopolar resectoscope

The resection techniques described use a monopolar electrode (Resectoscope 26F, optical lens 2.9 mm, Ref. 260020FA; Iglesias's jacket, Ref. 26055 SL; monopolar hook, Ref. 26055 L, Karl Storz, Tuttlingen, Germany). The suction–irrigation pump must be pre-set to maintain an

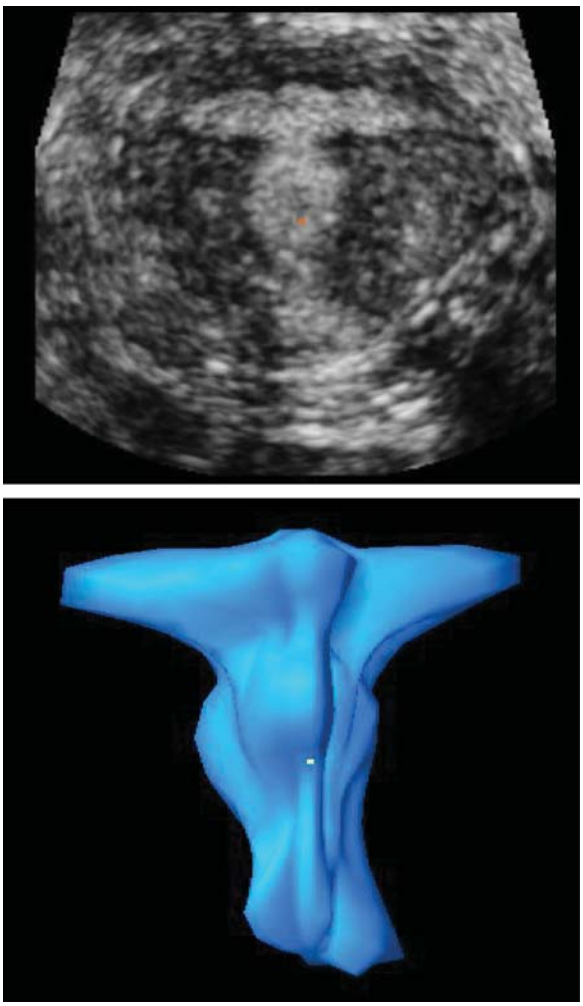

Figure 2 3D-US images of T-shaped uterus (the top image shows a coronal view and the bottom image shows a reconstruction).

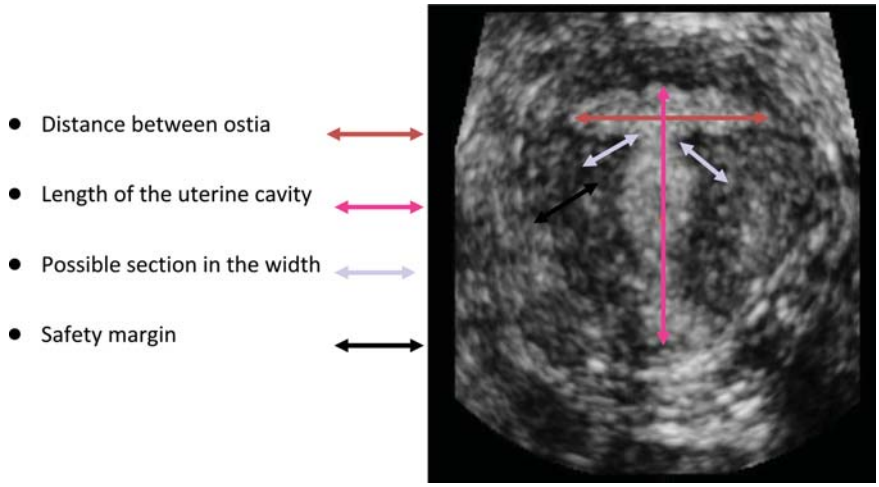

Figure 3 Essential preoperative measurements of T-shaped uterus.

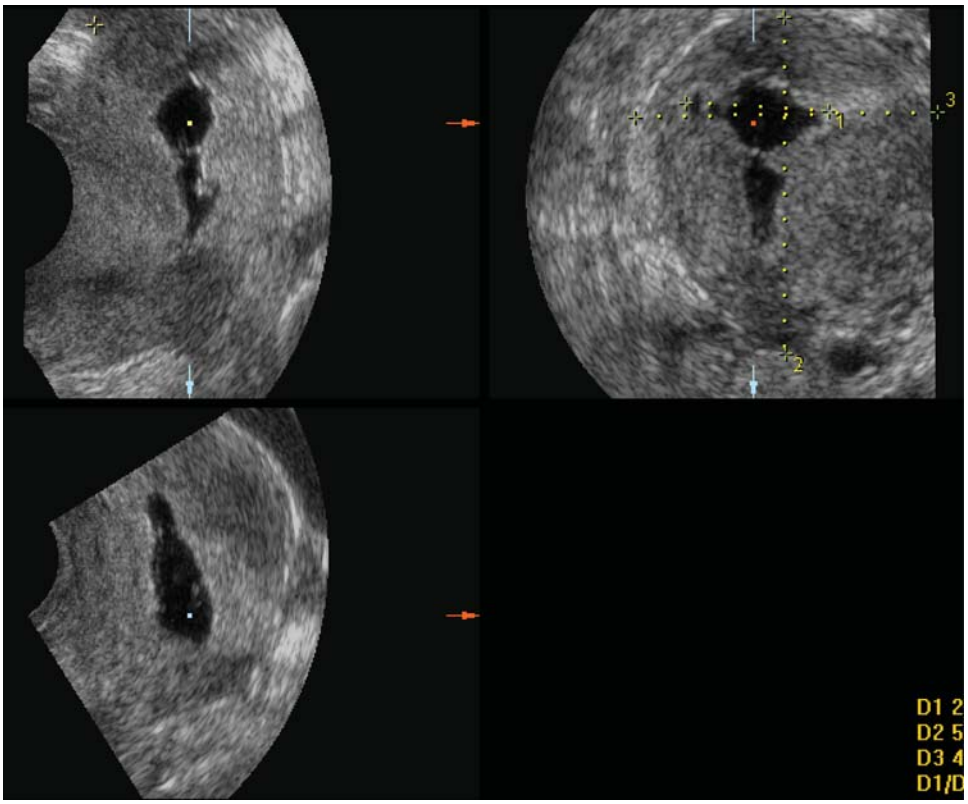

Figure 4 Hysterosonography of T-shaped uterus.

intrauterine pressure <100 mmHg, a 250 ml/s flow rate, a 0.2 bar suction pressure and power of 45 watts. The distension liquid inflow and outflow must be monitored precisely, and the procedure must be stopped immediately if there is a difference between the irrigation and suction flow rates. Cerebral edema can occur at an absorbed volume of 500 ml (Istre, 1997). If there is too much of a difference, or if the procedure lasts too long, a chemistry panel must be performed immediately after the procedure to check for metabolic complications (hyponatremia).

Bipolar instrument

The bipolar electrode or resectoscope is a more recent system developed for use with saline solution. Its efficacy appears equivalent to that of

monopolar instrument and morbidity appears to be lower. The suction–irrigation pump should be pre-set to maintain a flow of 150 ml/s, a pressure of 80 mmHg and power of 100 watts or less. There are no limits to the duration of the procedure, but a strict monitoring of input and output is important as fluid overload can still occur with risk of pulmonary edema or death by excess load.

Bipolar instruments have the advantage of being safer, because they can be used with saline, thereby decreasing metabolic complications. In contrast to the monopolar system which penetrates into the tissues and can be partly obscured at certain points, the bipolar system is constantly visible.

Operative steps

Dilatation of the cervix

Bimanual examination is carried out to evaluate the position of the uterus before dilatation. A speculum is inserted and the cervix is grasped with Pozzi tenaculum forceps, tips placed in a 3 o'clock and 9 o'clock position to exert traction on the uterus, to bring it into an intermediate position, rectify either an anteversion or a major retroversion, and minimize the risk of perforation. The cervix is then dilated with progressively larger Hegar's dilators. The monopolar system with resectoscope 26 F requires very careful dilatation of the cervix. No dilatation is necessary with the bipolar system.

Thorough visual exploration of the entire uterine cavity is essential. The two tubal ostia must be perfectly discernable at the end of surgery.

Specific procedure for T-shaped uterus

The hook or the 5 F bipolar probe is introduced into the uterine horn and an incision is made from the fundus to the isthmus, under direct vision. It is perpendicular to the lateral wall of the uterus and its depth decreases as the section advances. Two incisions are made in the same groove, until the uterine cavity is normal, both triangular and symmetric. The same incisions are repeated on the other lateral wall. The depth of incision does not exceed 5–7 mm.

Post-surgery

All women were discharged on the day of surgery with post-operative medication including sequential estroprogestative combination medication for 2 months (50 μg of ethinylestradiol).

In all cases, diagnostic hysteroscopy was repeated 2 months zpost-operatively to identify any marginal synechiae and to evaluate the configuration of the uterine cavity. A second procedure was performed if synechiae were observed during the diagnostic hysteroscopy.

Statistical analysis

The results are given as means (minimum–maximum). Student's *t*-test was used to compare the means of quantitative values and the χ^2 test was used to compare proportions. These analyses were performed with STATA/SF software, version 10. A *P*-value of <0.05 was considered statistically significant.

Results

Of the 97 women studied, 40 had infertility factors (tubal, $n = 18$; male factors, $n = 12$, polycystic ovarian syndrome, $n = 4$ and other factors, $n = 6$) and 23 had been treated by ovarian hyperstimulation and/or IVF. While 63 had a history of DES exposure, 34 (35%) had either a congenital malformation attributable to another cause, or an acquired T-shaped malformation. The median age of the patients was 31 years (range: 23–41 years), and all were Caucasian.

Table I Post-operative reproductive performance as a function of obstetric history.

	Preoperative pregnancies	Post-operative pregnancies[a]	
		Primary infertility	Secondary infertility
Number	78	31	26
Miscarriage	61 (78.2%)	9 (29%)	7 (26.9%)
Ectopic pregnancy	14 (17.9%)	5 (16.1%)	0
Preterm delivery	3 (3.8%) (Neonatal death)	3 (9.7%)	5 (19.2%)
Term delivery	0	14 (45.2%)	14 (53.8%)
Live birth	0	17 (54.8%)	19 (73.1%)
		36 live births (63% of all pregnancies) in 36 women (37% of the total 97 patients)	

[a]There were 57 post-operative pregnancies in 48 women. Of the 36 deliveries, 19 (53%) were by Caesarean section.

The mean follow-up period of the 97 patients of our series was 39 months (range: 18–80 months). There were 48 women (49.5%) who became pregnant after metroplasty. The reproductive outcomes for their 57 pregnancies are presented in Table I. A severe haemorrhage occurred in one woman and was successfully treated by ligation of the hypogastric artery. During pregnancy after metroplasty, 10 patients had cervical cerclage, 5 for cervical incompetence and 5 for a history of late miscarriage or preterm delivery.

The mean time until the first conception was 10.5 months (range: 2–36 months) after the metroplasty. Of the 57 pregnancies, 36 resulted in the birth of a live infant. Of these 36 deliveries, 19 (53%) were by Caesarean section. Nine women were pregnant twice during the study period. Among the women who had been pregnant previously (i.e. those with secondary infertility), the first trimester miscarriage rate, with or without detection of fetal heart beat, decreased from 78.2 to 26.9% ($P < 0.05$). Of the seven post-operative miscarriages, four occurred after IVF. The live birth rate increased from 0% before to 73% after the metroplasty (Table I).

Anatomical results on hysteroscopy were good in 94% of cases. Five women required follow-up surgery to correct synechiae or incomplete hysteroplasty, but these follow-ups did not affect their reproductive outcome. In one case, surgery was finally unsuccessful. We observed one case of perforation during the procedure, but laparoscopic rescue was not required.

Discussion

A T-shaped uterus can be a primary or congenital malformation (related to DES exposure or other causes) or can be acquired due to marginal adhesions with a T-shaped appearance. The description of the surgical technique and the results of this series are important regardless of the cause of the anomaly.

Different methods and instruments have been used for hysteroscopic metroplasty, including scissors and a resectoscope with a monopolar hook (Garbin *et al.*, 1998; Fernandez *et al.*, 2000; Homer *et al.*, 2000; Barranger *et al.*, 2002). The choice of technique seems to depend on operating time, cost of instrumentation and complication rate. Nowadays, we use the Versapoint® bipolar electrode system, which seems to have multiple benefits. The normal saline used with this electrosurgical system has ion concentrations similar to human plasma and may reduce electrolyte changes and hyponatremia. A second advantage is that avoiding cervical dilatation decreases the risk of cervical incompetence and of uterine perforation, which is the most common complication; there was one case in our series without consequence and with a subsequent pregnancy and Caesarean delivery. The use of concomitant ultrasound guidance could be an option to decrease the risk of uterine perforation during the procedure, but we did not use it in this series.

Infertility and obstetric complications are believed to be more common in women with uterine dysmorphism than in those with a normal uterine cavity. Our results are encouraging in terms of fertility, and are consistent with other studies of hysteroscopic metroplasty (Nagel and Malo, 1993; Katz *et al.*, 1996; Garbin *et al.*, 1998).

Nagel and Malo (1993) published the first study of metroplasty in eight women with a history of recurrent pregnancy loss. Their results showed a successful outcome of term deliveries in three of six women with recurrent spontaneous abortions, and no success in two women with primary infertility. Similarly, Katz *et al.* (1996) published a study of eight women with a T-shaped uterus. The post-operative performance available for seven of the eight women showed four term pregnancies and one ectopic pregnancy in three women with secondary infertility. The more recent series reported on 24 women: 10 had 12 intrauterine pregnancies (10 term deliveries, one premature delivery and one spontaneous abortion before 12 weeks; Garbin *et al.*, 1998). Among them, three with primary infertility gave birth to three live infants. These results suggest that an improved uterine contour may result in an improved pregnancy outcome and term deliveries in women with prior spontaneous pregnancy losses or primary infertility.

We note that the Caesarean rate for the term pregnancies in our study was high: only 47% of women delivered vaginally, without complications. Nevertheless, the indication for Caesarean delivery in these cases was neither the metroplasty itself nor any obstetrical indication, but rather the feelings of the mother toward the pregnancy after a personal history of infertility. Vaginal delivery is possible after metroplasty, but in the light of the literature, there should be no hesitation about choosing Caesarean as the mode of delivery. Metroplasty probably induces uterine fragility. Obstetric management must be careful, although no uterine rupture is reported in the literature.

Post-operative diagnostic hysteroscopy showed that hysteroscopic metroplasty produced good anatomical results in most cases in this series, as in most of the other series. The main interest of second-look hysteroscopy is to diagnose and to treat residual synechia to improve the reproductive outcome. No convincing data currently support the use of estrogen treatment and/or intrauterine balloon to prevent residual synechiae and we did not use them in this series. Hyaluronic acid gel after the surgery, not available at the time of our series, may be useful.

Conclusion

Our experience shows that hysteroscopic metroplasty improves the live birth rate for women with a T-shaped uterus and a history of primary infertility, recurrent abortion or preterm delivery, although it is not a treatment of infertility. These results also confirm the preliminary reports previously published in retrospective, uncontrolled pilot studies. Ideally, the efficacy of this technique should be assessed by a randomized multicentre study that can consider a relatively large number of women with this type of abnormality, although this may be difficult due to the fortunate decreases in rates of *in utero* DES exposure. Nonetheless, more than one-third of our cases had no history of DES exposure, and the results of this series are encouraging for all malformations requiring modification of the cavity volume. The question of systematic cervical cerclage during pregnancy after metroplasty remains open.

Authors' roles

H.F. conceived the project, and contributed to manuscript drafting and critical discussion. H.F., O.G., A.G. and J.M.L. contributed to patients' recruitment and follow-up. V.C. contributed mainly to data collection. O.G. and A.G. contributed mainly in critical discussion.

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