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Clinical implications of uterine malformations and hysteroscopic treatment results

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Uterine malformations consist of a group of miscellaneous congenital anomalies of the female genital system. Their mean prevalence in the general population and in the population of fertile women is ~4.3%, in infertile patients ~3.5% and in patients with recurrent pregnancy losses ~13%. Septate uterus is the commonest uterine anomaly with a mean incidence of ~35% followed by bicornuate uterus (~25%) and arcuate uterus (~20%). It seems that malformed uterus and especially septate uterus is not an infertility factor in itself. However, it may have a part in the delayed natural conception of women with mainly secondary infertility. On the other hand, patients with uterine malformations seem to have an impaired pregnancy outcome even as early as their first pregnancy. Overall term delivery rates in patients with untreated uterine malformations are only ~50% and obstetric complications are more frequent. Unicornuate and didelphys uterus have term delivery rates of ~45%, and the pregnancy outcome of patients with untreated bicornuate and septate uterus is also poor with term delivery rates of only ~40%. Arcuate uterus is associated with a slightly better but still impaired pregnancy outcome with term delivery rates of ~65%. Women who have undergone hysteroscopic septum resection and have been reported in the different series comprise a highly selected group of symptomatic patients with term delivery and live birth rates of only ~5%. Hysteroscopic treatment seems to restore an almost normal prognosis for the outcome of their pregnancies with term delivery rates of ~75% and live birth rates of ~85%. It seems, therefore, that hysteroscopic septum resection can be applied as a therapeutic procedure in cases of symptomatic patients but also as a prophylactic procedure in asymptomatic patients in order to improve their chances for a successful delivery.

Key words: hysteroscopic septum resection/hysteroscopy/infertility/recurrent abortions/uterine malformations

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Introduction

Uterine malformations consist of a group of miscellaneous congenital anomalies of the female genital system. They are the result of four major disturbances in the development, formation or fusion of the Müllerian or paramesonephric ducts during fetal life: (i) failure of one or more Müllerian ducts to develop (agenesis; uniconuate uterus without rudimentary horn); (ii) failure of the ducts to canalize (unicornuate uterus with rudimentary horn without proper cavities); (iii) failure of, or abnormal fusion of, the ducts (uterus didelphys; bicornuate uterus); and (iv) failure of reabsorption of the midline uterine septum (septate uterus; arcuate uterus) [American Fertility Society (AFS), 1988; Ashton *et al*., 1988; Acien, 1992; Grimbizis *et al*., 1998].

Uterine malformations are closely related to an abnormal uterine cavity, which is thought to impair the reproductive performance of the patient. The restoration of a normal uterine cavity is the basis of their treatment. However, a good surgical correction of the uterine cavity does not necessarily lead to a good reproductive prognosis, since uterine vascularization may also be

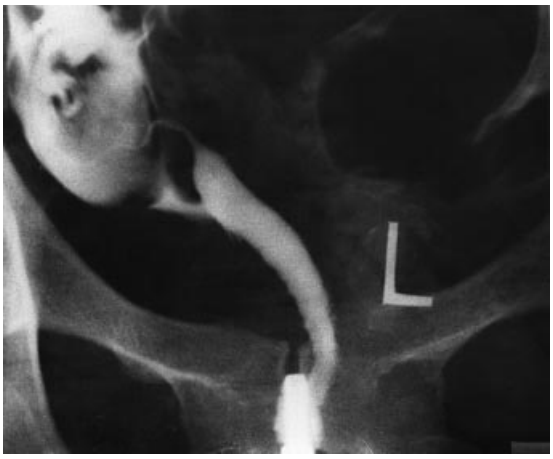

Figure 1. Hysterosalpingography showing a unicornuate uterus.

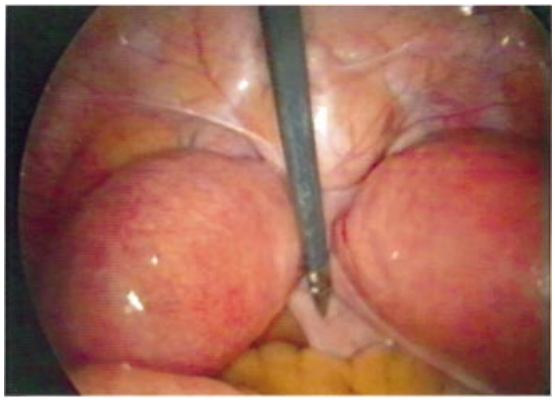

Figure 2. Laparoscopic view of a didelphys uterus.

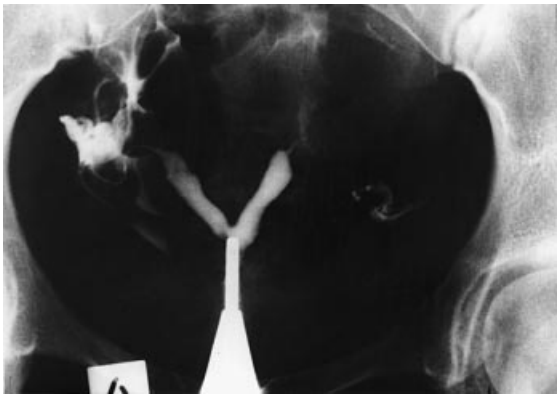

Figure 3. Hysterosalpingography showing a 'double' uterus. During laparoscopy and hysteroscopy it was found to be a septate uterus.

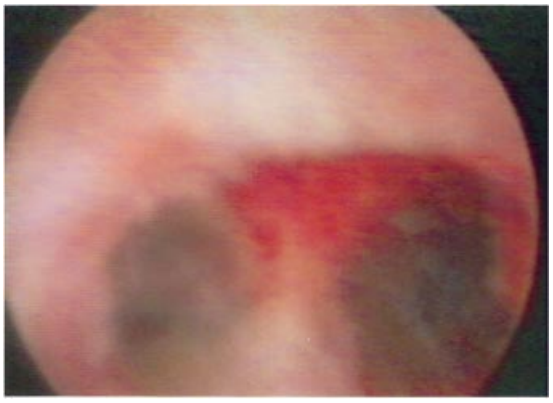

Figure 4. Hysteroscopic view of patient of Figure 3 showing a septate uterus.

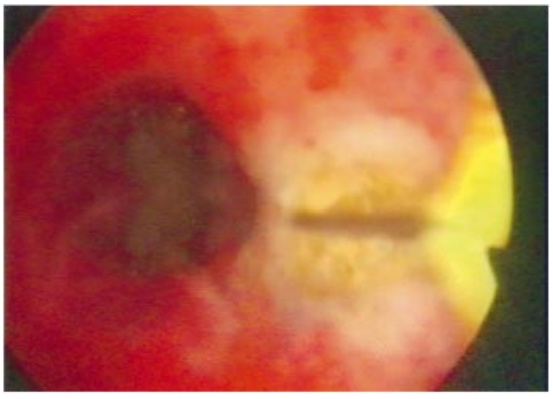

Figure 5. Laparoscopic view of resection of uterine septum with resectoscope.

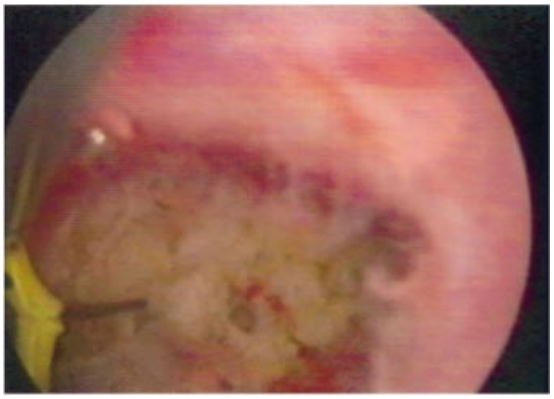

Figure 6. Laparoscopic view of the uterine cavity at the end of the operation: the uterine septum has been resected.

involved in uterine function. The initially proposed transcervical route for the treatment of a septate uterus (Ruge, 1884) was later abandoned in favour of abdominal procedures. Thus, the treatment of the malformed uterus has been classically performed by laparotomy often requiring complicated surgical procedures (Jacobsen and DeCherney, 1997; Pellicer, 1997; Jones, 1998).

The introduction of operative hysteroscopy has renewed interest in the transcervical approach since it has greatly simplified the treatment of special categories of uterine malformations. Nowadays, septate and arcuate uterus can be effectively treated with operative hysteroscopy and in these cases restoration of the uterine cavity is almost perfect (Pellicer, 1997; Jacobsen and DeCherney, 1997; Grimbizis *et al*., 1998; Jones, 1998; Horner *et al*., 2000). A partial restoration of the uterine cavity using hysteroscopic techniques is also possible in some cases of partial bicornuate uterus (Vercellini *et al*., 1999). On the other hand, correction of the uterine cavity in cases of complete bicornuate uterus still requires complicated surgical procedures,

while in cases of didelphys and unicornuate uterus it is not possible to correct the anomaly surgically (Pelosi and Pelosi, 1996; Pellicer, 1997; Jones, 1998).

Hence, hysteroscopic techniques offer the possibility of a successful and easy correction of the uterine cavity only in certain cases of uterine anomalies, mainly of the septate and arcuate uterus. However, the question of whether these types of malformations should be operated upon varies depending on the prognosis of a given malformation as well as on the effectiveness of treatment to restore not only normal anatomy but also, and more importantly, the normal function of the uterus.

Classification of uterine malformations: clinical implications

Based on the previous work by Buttram and Gibbons (1979), the AFS (1988) classified the anomalies of the female reproductive tract according to the degree of failure of normal development into groups with similar clinical manifestations, treatments and possible prognoses for their reproductive performance (Buttram and Gibbons, 1979; AFS, 1988). This classification organizes the anomalies into six major uterine anatomic types: type I: hypoplasia/agenesis; type II: unicornuate uterus (IIa: with a communicating rudimentary horn; IIb: with a non-communicating rudimentary horn; IIc: with a rudimentary horn without a cavity; IId: without a rudimentary horn; Figure 1); type III: didelphys uterus (Figure 2); type IV: bicornuate uterus (IVa: complete; IVb: partial); type V: septate uterus (Va: complete; Vb: partial; Figure 3); type VI: arcuate uterus.

However, although the classification of the AFS is nowadays widely accepted and used by most of the authors, there still significant problems regarding the exact classification of each case. These are mainly due to: (i) the different diagnostic methods used to classify the patients (simple clinical examination, hysterosalpingography, transvaginal or transabdominal ultrasonography, three-dimensional ultrasound, hysteroscopy, laparoscopy, and even magnetic resonance tomography); (ii) the different criteria used to classify the different types of congenital anomalies, especially subseptus and septus uterus versus arcuate and bicornuate uterus (Acien, 1997). This gives rise to a wide variation in the reported incidence of uterine anomalies and their various types.

The identification of these anomalies has historically been made by hysterosalpingography, but this approach allows only the diagnosis of a 'double' uterus (Buttram, 1983; Rock and Schlaff, 1985; Fedele and Bianchi, 1995). An accurate diagnosis should also be based on the estimation of the uterine serosal surface. Thus, a combination of laparoscopy and hysteroscopy seems to be necessary for the precise classification of uterine malformations (Buttram, 1983; Rock and Schlaff, 1985; Fedele and Bianchi, 1995; Grimbizis *et al*., 1998). Nevertheless, some authors have suggested that the differential diagnosis of 'double' uterus can be based only on the use of abdominal ultrasonography in the luteal phase (Fedele *et al*., 1988; Fedele and Bianchi, 1995), transvaginal ultrasonography (Nasri *et al*., 1990) and, more recently, three-dimensional ultrasound (Jurkovic *et al*., 1995; Raga *et al*., 1996).

However, even with the use of laparoscopy for the evaluation of the uterine serosal surface, the classification may differ from one observer to another depending on the criteria used. For example, for Acien (1997) the existence 'of any visible depression in the middle part of the fundic uterine wall accompanied by an overall widening' are thought to be enough to classify the patient as having bicornuate uterus. However, as the same author pointed out, some of these cases may possibly be classified as having partial or complete septate uterus (Acien, 1997).

The differential diagnosis between arcuate and partial septate also seems difficult. Despite the creation of a separate category for arcuate uterus by the AFS, the classification committee mentioned that 'because the arcuate uterus is externally unified, it

Table I. Prevalence of uterine malformations in the general population or in the population of fertile women

Study	Population studied	Women *n*	Diagnosis	Uterine malformations *n* (%)
Ashton *et al*. (1988)	Transcervical tubal sterilization	840	HSG/Hyst	32 (3.8)
Nasri *et al*. (1990)	Varied indications	300	TVS	8 (2.7)
Maneschi *et al*. (1995)	Abnormal uterine bleeding	322	Hyst	19 (5.9)
Acien (1997)	Consulted for contraception	241	TVS/HSG/Lap	21 (8.7)
	Without previous pregnancy	72		12 (16.7)
	With previous pregnancy and live newborns	131		6 (4.6)
	With previous pregnancy and some reproductive loss	38		3 (7.8)
Raga *et al*. (1997)[a]	Fertile for tubal sterilization	1289	HSG/Lap/Hyst	49 (3.8)
Total		2992		129 (4.3)

[a]Including also the patients of a previous study from the same group (Simon *et al*., 1991).
HSG = hysterosalpingography; TVS = transvaginal ultrasonography; TDU = three-dimensional ultrasound; Hyst = hysteroscopy; Lap = laparoscopy.

could be classified as a form of partial septate uterus' (AFS, 1988). It should be noted also that they have the same embryological origin (failure of reabsorption of midline septum) and that they have exactly the same surgical therapy (resection of the midline septum). The criterion for a separate classification of the arcuate uterus by the AFS was the hypothesis that 'the arcuate uterus appears to behave benignly' (AFS, 1988). Consequently, the classification of a patient as having arcuate or partial septate uterus depends on the estimation of the severity of midline uterine abnormality, which is subjective. On the other hand, the reproductive performance of arcuate uterus calls for further scrutiny.

The problems in the differential diagnosis of Müllerian defects have resulted in differences in the incidence of the various types of uterine malformations found by different investigators. This may further influence the results regarding the reproductive performance of each type of anomaly and also the clinical conclusions on the necessity of hysteroscopic treatment.

Incidence of uterine malformations in the general population

Overall incidence of uterine malformations

The true incidence of Müllerian defects in the general population is not accurately known. The initial studies on the prevalence of uterine anomalies (Dunselman, 1959; Greiss and Mauzy, 1961; Strassmann, 1961, 1966; Green and Harris, 1976) had serious limitations mainly because of the diagnostic methods used at that time, which, in many of these studies, was by clinical examination only. The lack of a standard system of classification and the fact that the population studied was not representative of the general population were also limiting factors (Acien, 1997; Pellicer, 1997). Furthermore, many cases of uterine malformations remained undiagnosed since they were asymptomatic (Pellicer, 1997). The incidence found in these reports varied between 0.1 and 3.5% (Dunselman, 1959; Greiss and Mauzy, 1961; Strassmann, 1961, 1966; Green and Harris, 1976)

However, it seems that uterine defects are not uncommon. In a review of five studies and ~3000 cases, the mean overall incidence of uterine malformations in the general population and/or the population of fertile women was 4.3% (Table I).

Incidence of the different types

From a therapeutic point of view, it is interesting to know the prevalence of the different types of uterine anomalies. Acien (1997), in a review of the distribution of Müllerian defects in different reported series, found a mean incidence for arcuate uterus 15%, septate uterus 22% (complete septate 9%, partial septate 13%), bicornuate uterus 46% (complete bicornuate 9%, partial bicornuate 37%), didelphys uterus 11%, unicornuate uterus 4.5% and Müllerian agenesis ~4%.

However, this review included series which covered nearly half of the reported cases, and in which the diagnostic methods used were not clearly stated (Semmens, 1962; Rock and Schlaff, 1985). The incidence of septate uterus in these studies was extremely low (Rock and Schlaff, 1985) or even zero (Semmens, 1962), and the incidence of bicornuate uterus approximated (Rock and Schlaff, 1985) or even exceeded (Semmens, 1962) 50%. But it has been known that for many years the diagnosis of Müllerian anomalies was based on incomplete analysis of the uterine morphology, so the majority of 'double' uteri identified by hysterosalpingography and classified as bicornuate uteri were actually septate uteri (Buttram and Gibbons, 1979; Raga *et al*., 1997). Hence, it is possible that diagnostic biases may impair the results of this review and the true incidence of septate uterus may be higher.

On the other hand, the prevalence of the different types of Müllerian defects seems to be different when the series of Semmens (1962) and Rock and Schlaff (1985) are excluded and

Table II. Uterine malformations: prevalence of the different types

Study	Cases *n*	Diagnosis	Arcuate *n* (%)	Septate *n* (%)	Bicornuate *n* (%)	Unicornuate *n* (%)	Didelphys *n* (%)	Agenesis *n* (%)
Exalto *et al*. (1978)	25	Echo/Lap	1 (4.0)	10 (40.0)	10 (40.0)	3 (12.0)		
Musich and Behrman (1978)	41	HSG	3 (7.3)	14 (34.1)	12 (29.3)	1 (2.4)	11 (26.8)	
Heinonen *et al*. (1982)	182	Varied	20 (11.0)	52 (28.5)	59 (32.4)	13 (7.1)	21 (11.6)	17 (9.3)
Stein and March (1990)	150	Varied	9 (6.0)	45 (30.0)	59 (39.3)	12 (8.0)	25 (16.7)	
Kovacivic *et al*. (1990)	127	HSG	76 (59.8)	19 (15.0)	27 (21.2)	4 (3.1)	1 (0.8)	
Ugur *et al*. (1995)	120	Echo	9 (7.5)	61 (50.8)	26 (21.7)	13 (10.8)	11 (9.2)	
Acien (1996)	249	TVS/HSG/Others	65 (27.1)	41 (17.1)	88 (36.5)	29 (12.1)	17 (7.1)	9 (4.0)
Raga *et al*. (1997)	127	HSG/Lap/Hyst	42 (32.8)	43 (33.6)	26 (20.3)	8 (6.3)	8 (6.3)	
Vercellini *et al*. (1999)	371		30 (8.1)	201 (54.2)	55 (14.8)	51 (13.7)	20 (5.4)	14 (3.8)
Total	1392		255 (18.3)	486 (34.9)	362 (26.0)	134 (9.6)	114 (8.2)	40 (2.9)

HSG = hysterosalpingography; TVS = transvaginal ultrasonography; TDU = three-dimensional ultrasound; Hyst = hysteroscopy; Lap = laparoscopy.

two more recent series are incorporated (Raga *et al*., 1997; Vercellini *et al*., 1999). Thus, the mean incidence of arcuate uterus is found to be 18.3%, of septate uterus 34.9%, of bicornuate uterus 26%, of unicornuate uterus 9.6%, of didelphys uterus 8.4% and of Müllerian agenesis 2.9% (Table II). Furthermore, most of the cases of bicornuate uterus seem to have been partial bicornuate uterus (Exalto *et al*., 1978; Musich and Behrman, 1978; Heinonen *et al*., 1982; Kovacevic *et al*., 1990; Stein and March, 1990; Ugur *et al*., 1995; Acien, 1996; Vercellini *et al*., 1999). Although it is also possible that some diagnostic biases may have an effect on the results (mainly due to the limitations stated above in the discussion of the classification problems), it seems that this distribution of the different types is closer to reality.

In conclusion, it seems that ~55% of the uterine malformations are either septate or arcuate uterus. This is clinically interesting since it means that more than half of the cases of uterine malformations belong to the types that can be treated successfully and easily (Raga *et al*., 1997). This proportion may become even higher with the addition of some cases of partial bicornuate uterus, which can be also treated hysteroscopically (Vercellini *et al*., 1999).

Patients with uterine malformations and their reproductive performance

Fertility of the patients with uterine malformations

The interference of Müllerian defects with patients' fertility is an interesting but still debatable issue. Useful information could be derived from the study of the prevalence of uterine malformations in infertile patients and the incidence of infertility in patients with malformed uterus (Acien, 1993, 1997), as well as from the analysis of infertility factors in infertile patients with uterine malformations (Grimbizis *et al*., 1998).

Incidence of uterine malformations in infertile patients

The reported incidence in various series of infertile patients varies between 1 and 26.2%. However, high incidence of uterine malformations in infertile patients has been reported (Raga *et al*., 1996) in a rather small, selected group of patients, as well as by Sorensen (1981) and Acien (1997) with the inclusion of cases with hypoplastic uterus and minor malformations (Sorensen, 1981; Acien, 1997)

The mean incidence of Müllerian defects in infertile patients is 3.4% (Table III), which is similar to the prevalence of 4.3% found in the general population and/or in fertile women. This is an indirect indication that Müllerian defects have no impact on women's fertility.

Infertility in patients with uterine malformations: incidence and aetiology

The frequency of infertility observed in patients with uterine malformations, as well as the study of infertility causes and, especially, the incidence of unexplained infertility in infertile patients with Müllerian defects could offer useful information for the interference of uterine anomalies with fertility. A possible contribution from the Müllerian defect can only be suggested in patients with unexplained infertility (Grimbizis *et al*., 1998).

Acien (1993) reported that 34 out of 176 (19.3%) patients with Müllerian defects experienced infertility, although there was no information whether it was primary or secondary. Other causes of infertility were not detected in 10 of the patients, which means that unexplained infertility was found in 5.7% of the patients with Müllerian defects and in 29.4% of the infertility cases. The 19.3% frequency of infertility was not significantly different from the 11% incidence of infertility in a control group of 28 patients with normal uterus (Acien, 1993) and it is also close to the observed ~15% incidence of infertility in the general population. Acien (1993) also suggested that the 5.7% incidence of unexplained infertility in his studied population was low. However, unexplained infertility represented 29.3% of the infertility cases, an incidence of unexplained infertility higher than that observed in the general infertile population (ESHRE Capri Workshop, 1996).

Grimbizis *et al*. (1998) studied 46 patients with septate uterus who presented infertility; 26 with primary and 20 with secondary. All couples underwent a thorough evaluation of their infertility. Other factors of infertility were not detected in 19.6% of the patients; in 3.8% of the patients with primary and in 40% of the patients with secondary infertility. The 19.6% prevalence of unexplained infertility found in infertile patients with septate uterus is similar to that observed in the general infertile population. Thus, these data do not support the notion that uterine septum is really a factor in infertility (Grimbizis *et al*., 1998). On the other hand, the incidence of unexplained infertility was significantly higher in patients with secondary infertility. Thus, a contribution in delayed conception of patients with secondary infertility cannot be excluded (Grimbizis *et al*., 1998).

Although many investigators have reported the hysteroscopic treatment of infertile women with septate uterus (Fayez, 1986; March and Israel, 1987; Perino *et al*., 1987; Daly *et al*., 1989; Choe and Baggish, 1992; Fedele *et al*., 1993; Goldenberg *et al*., 1995, Grimbizis *et al*., 1998), only a few of them gave data on infertility factors (Fayez, 1986; Perino *et al*., 1987; Daly *et al*., 1989; Fedele *et al*., 1993; Grimbizis *et al*., 1998). Grimbizis *et al*. (1998) reported that 12 (26.1%) out of their 46 infertile patients

Table III. Incidence of uterine malformations in infertile patients

Study	Women *n*	Diagnosis	Total *n* (%)
Tulandi *et al*. (1980)	2240	HSG	123 (1.0)
Sorensen (1981)	134	HSG	132 (23.9)
Raga *et al*. (1996)	142	HSG/TVS/TDU/Lap	112 (26.2)
Acien (1997)	1200	HSG/TVS/Lap	132 (16.0)
Raga *et al*. (1997)[a]	1024	HSG/Lap/Hyst	125 (2.4)
Total	3640		124 (3.4)

[a]Including the patients of a previous study from the same group (Simón *et al*., 1991).
HSG = hysterosalpingography; TVS = transvaginal ultrasonography; TDU = three-dimensional ultrasound; Hyst = hysteroscopy; Lap = laparoscopy.

with septate uterus had laparoscopic findings of endometriosis. Fedele *et al*. (1993) also found endometriosis in 11 (35%) out of 31 infertile patients with uterine septum and Fayez (1986) found endometriosis in three (43%) out of seven similar patients. Thus, it seems possible that the uterine septum may be implicated in the pathogenesis of endometriosis by enhancing retrograde menstruation, suggesting an indirect relationship between septate uterus and infertility. However, further studies would be necessary in order to verify these limited data.

In conclusion, it seems that malformed uterus, especially septate uterus, is not an infertility factor, although it may contribute to the delayed natural conception of patients with mainly secondary infertility. A possible involvement in the pathogenesis of endometriosis in infertile patients with uterine malformations requires further careful investigation.

Pregnancy rates after assisted conception

The question of a possible effect of Müllerian defects on the results of assisted conception is of great clinical significance. Marcus *et al*. (1996) have reported the treatment of 24 patients with various congenital anomalies by means of IVF. Pregnancy rates were not impaired since 19 (79.2%) of them became pregnant after a mean of 2.1 attempts/patient. Regardless of the type of anomaly pregnancy rates were similar. Guirgis and Shrivastav (1990) have reported the treatment of 14 patients with bicornuate uterus by gamete intra-Fallopian transfer; eight (57.1%) of them achieved a pregnancy after a mean of 2.1 attempts per patient. Moreover, the ovarian response to stimulation and implantation rates observed in these two studies were similar to those for the general infertile population (Guirgis and Shrivastav, 1990; Marcus *et al*., 1996).

Although the chances of conception in patients with untreated uterine malformations and infertility seem to be similar to those of the general infertile population, they seem to have a poor pregnancy outcome. Marcus *et al*. (1996) observed increased abortion and preterm delivery rates as well as low term delivery rates in patients with uncorrected septate and bicornuate uterus presenting with infertility and treated with IVF. Thus, although hysteroscopic metroplasty is not indicated for the enhancement of the fertility potential of infertile patients with uterine malformations, it is indicated for the improvement of their pregnancy outcome (Grimbizis *et al*., 1998).

Pregnancy outcome

The presence of a malformed uterus in a woman is thought to impair normal reproductive performance by increasing the incidence of early and late abortions, preterm deliveries (often as a result of premature rupture of the membranes), as well as the rate of obstetric complications (Heinonen *et al*., 1982; Buttram, 1983; McShane *et al*., 1983; Worthen and Gonzalez, 1984; Rock and Schlaff, 1985; Stein and March, 1990; Golan *et al*., 1992; Acien, 1993; Fedele and Bianchi, 1995; Acien, 1997; Pellicer, 1997; Grimbizis *et al*., 1998). However, each type may have a different impact on pregnancy outcome (Buttram, 1983). Thus, although most of the authors have found that patients with septate uterus have the poorest reproductive performance (Rock and Jones, 1977; Musich and Behrman, 1978; Buttram, 1983; Rock and Schlaff, 1985; March and Israel, 1987), others report that they have a better pregnancy outcome and that therefore metroplasty is not reasonable, with the exception of specific cases (Acien, 1993).

Incidence of uterine malformations in patients with recurrent pregnancy losses

The incidence of uterine malformations in patients with recurrent pregnancy losses varied in the different series between 1.8 and 37.6% (Table IV). This variability in the reported incidence may be due, at least partly, to the different inclusion criteria for recurrent pregnancy losses used by the different investigators (two, three or more, early, late and/or immature deliveries). Furthermore, there are differences in the types of uterine malformations included in each study (inclusion or not of hypoplastic and/or arcuate uterus).

Apart from these limitations, it seems that the mean overall incidence of Müllerian defects in patients with recurrent pregnancy losses is 12.6% (Table IV). This incidence is higher than the prevalence of 4.3% observed in the general population and/or in the population of fertile women. The incidence of uterine malformations seems to be higher in patients with late abortions or immature deliveries compared to patients with early abortions (Acien, 1996). Furthermore, in a study by Acien (1997), in 38 fertile patients with live newborns and with a history of pregnancy loss, the incidence of uterine malformations (including arcuate uterus) was found to be 7.5%, which was higher than the 4.6% found in 131 fertile patients with live newborns and no pregnancy loss.

Table IV. Incidence of uterine malformations in women with recurrent pregnancy losses

Study	Women *n*	Diagnosis	Total *n* (%)
Tho *et al*. (1979)	100	HSG	14 (14.0)
Harger *et al*. (1983)	155	HSG/Hyst	19 (12.3)
Coulam (1986)	110	HSG	11 (10.0)
Makino *et al*. (1992a)	1200	HSG	188 (15.7)
Makino *et al*. (1992b)	1000	HSG	147 (14.7)
Hatasaka (1994)	158	Workup for RPL	10(6.0)
Raziel *et al*. (1994)	106	HSG/Hyst	19 (18.0)
Clifford *et al*. (1994)	500	HSG/TVS	9 (1.8)
Jurkovic *et al*. (1995)	61	HSG/TVS/TDU	12 (19.7)
Acien (1996)	189	HSG	71 (37.6)
Acien (1997)	59	TVS/HSG/Lap	15 (25.4)
Raga *et al*. (1997)[a]	868	HSG/Lap/Hyst	54 (6.3)
Total	4506		569 (12.6)

[a]Including also the patients of a previous study from the same group (Simón *et al*., 1991).
HSG = hysterosalpingography; TVS = transvaginal ultrasonography; TDU = three-dimensional ultrasound; Hyst = hysteroscopy; Lap = laparoscopy; RPL = recurrent pregnancy loss.

Incidence of pregnancy loss in patients with uterine malformations

Patients with Müllerian defects have pregnancy losses more frequently in their obstetric history than patients with normal uterus. There are several reports indicating a severe impairment of reproductive performance in patients with mainly septate uterus before their treatment with hysteroscopic techniques (McShane *et al*., 1983; Fayez, 1986; March and Israel, 1987; Perino *et al*., 1987; Choe and Baggish, 1992; Grimbizis *et al*., 1998), but these are probably selected cases with poor reproductive performance. Thus, the conclusion on the pregnancy outcome of patients with uterine malformations should be mainly based on untreated cases.

A total of 182 women with untreated uterine malformations over a period of 18 years were studied (Heinonen *et al*., 1982). In this group, 126 women conceived and there were 265 pregnancies in total. The authors observed a 29% abortion rate, a 16.5% preterm delivery rate and only a 55.5% term delivery rate. Overall live birth rate in this study was 66%. In another study the pregnancy outcome of 127 patients with untreated uterine malformations was studied in a total of 342 gestations (Raga *et al*., 1997). The respective rates were 26% for abortions, 14.9% for preterm deliveries, 57% for term deliveries, and 66.3% for live births. Acien (1993) compared the reproductive performance of 173 patients with untreated uterine malformations and a total of 383 pregnancies with the performance of another group of 28

Table V. Pregnancy outcome in patients with untreated unicornuate uterus

Study	Patients *n*	Conceiving *n*	Pregnancies *n*	Ectopics *n* (%)	Abortions *n* (%)	Preterm deliveries *n* (%)	Term deliveries *n* (%)	Live births *n* (%)
Baker *et al*. (1953)	4	4	5	0	0	0	5 (100.0)	4 (80.0)
Wajntraub *et al*. (1975)	1	1	3	0	2 (66.7)	0	1 (33.3)	1 (33.3)
Beernink *et al*. (1976)	5	4	8	0	1 (12.5)	3 (37.5)	4 (50.0)	6 (75.0)
Andrews and Jones (1982)	5	5	13	0	7 (53.8)	2 (15.4)	4 (30.8)	6 (46.1)
Heinonen *et al*. (1982)	13	10	15	0	7 (46.7)	3 (20.0)	5 (33.3)	6 (40.0)
Buttram (1983)	31	?	60	0	29 (48.3)	10 (16.7)	21 (35.0)	24 (40.0)
Fedele *et al*. (1987)	19	13	29	1 (3.5)	17 (58.6)	3 (10.3)	8 (27.6)	11 (37.9)
Stein and March (1990)	12	12	16	0	0	5 (31.2)	11 (68.8)	16 (100.0)
Moutos *et al*. (1992)	29	20	40[a]	1 (2.8)	13 (36.1)	3 (8.3)	19 (52.8)	21 (58.3)
Acien (1993)	24	21	55	1 (1.8)	12 (21.8)	9 (16.4)	33 (60.0)	39 (70.9)
Raga *et al*. (1997)	8	?	16	0	7 (43.7)	4 (25.0)	5 (31.3)	7 (43.7)
Total	151	90/112[b]	260	3 (1.2)	95 (36.5)	42 (16.2)	116 (44.6)	141 (54.2)

[a]Four pregnancies ended in elective abortion.
[b]Total number of patients from series with data on conception.

Table VI. Pregnancy outcome in patients with untreated didelphys uterus

Study	Patients *n*	Conceiving *n*	Pregnancies *n*	Ectopics *n* (%)	Abortions *n* (%)	Preterm deliveries *n* (%)	Term deliveries *n* (%)	Live births *n* (%)
Michalas *et al*. (1976)	3	3	5	0	3 (60.0)	2 (40.0)	0	2 (40.0)
Heinonen *et al*. (1982)	21	13	25	0	8 (32.0)	6 (24.0)	11 (44.0)	16 (64.0)
Buttram (1983)	4	3	5	0	3 (60.0)	1 (20.0)	1 (20.0)	2 (40.0)
Fedele *et al*. (1988)	13	11	29	0	20 (69.0)	7 (24.1)	2 (6.9)	7 (24.1)
Stein and March (1990)	25	25	27	0	0	7 (25.9)	20 (74.1)	22 (81.5)
Moutos *et al*. (1992)	25	13	28[a]	1 (4.1)	6 (25.0)	9 (37.5)	8 (33.3)	17 (70.8)
Acien (1993)	15	10	18	0	5 (27.8)	3 (16.7)	10 (55.5)	13 (72.2)
Raga *et al*. (1997)	8	?	15	1 (6.7)	4 (26.7)	8 (53.3)	3 (20.0)	6 (40.0)
Total	114	78/106[b]	152	2 (1.3)	49 (32.2)	43 (28.3)	55 (36.2)	85 (55.9)

[a]Four pregnancies ended in elective abortion.
[b]Total number of patients from series with data on conception.

patients with normal uterus and 47 pregnancies. The abortion rate in the patients with uterine malformations was 36% and the preterm delivery rate was 18%, which were significantly higher ($P < 0.01$) than the abortion rate of 8% and the preterm delivery rate of 6% in the patients with a normal uterus. The term delivery rate of the patients with uterine malformations was 44% and the fetal survival rate was 53%, which were significantly lower ($P < 0.001$) than the term delivery rate of 85% and the fetal survival rate of 89% of patients with a normal uterus (Acien, 1993).

Patients with unicornuate and didelphys uterus seem to have a poor pregnancy outcome. In a review of 151 patients with untreated unicornuate uterus who had a total of 260 pregnancies, the mean abortion rate was 37.1%, the mean preterm delivery rate 16.4%, the mean term delivery rate 45.3% and the mean live birth rate 55.1% (Table V). Furthermore, a review of 152 pregnancies by 114 patients with untreated didelphys uterus revealed a mean 32.9% abortion rate, a mean 28.9% preterm delivery rate, a mean 36.2% term delivery rate with a mean 56.6% live birth rate (Table VI). Thus, unicornuate and didelphys uterus seem to have a similar effect on reproduction, since didelphys uterus can be seen as a symmetrical duplication of unicornuate uterus (Buttram, 1983; Rock and Schlaff, 1985; Marcus *et al.*, 1996).

Patients with bicornuate uterus have also a poor pregnancy outcome. In a review of 261 patients with untreated bicornuate uterus who had a total of 627 pregnancies, the mean abortion rate was 36%, the mean preterm delivery rate 23%, the mean term delivery rate 40.6% and the mean live birth rate 55.2% (Table VII). The pregnancy outcome of patients with bicornuate

Table VII. Pregnancy outcome in patients with untreated bicornuate uterus

Study	Patients	Conceiving	Pregnancies	Ectopics	Abortions	Preterm deliveries	Term deliveries	Live births
Heinonen *et al.* (1982)	59	44	98	0	27 (27.5)	22 (22.5)	49 (50.0)	62 (62.1)
Buttram (1983)	110	?	313	0	110 (35.0)	72 (23.0)	131 (42.0)	178 (57.0)
Acien (1993)	66	57	160	2 (1.3)	73 (46.0)	36 (22.0)	49 (31.0)	71 (44.4)
Raga *et al.* (1997)	26	?	56	0	16 (28.6)	14 (25.0)	26 (46.4)	35 (62.5)
Total	261	101/125[a]	627	2 (0.3)	226 (36.0)	144 (23.0)	255 (40.6)	346 (55.2)

[a]Total number of patients from series with data on conception.

Table VIII. Pregnancy outcome in patients with untreated septate uterus

Study	Patients	Conceiving	Pregnancies	Ectopics	Abortions	Preterm deliveries	Term deliveries	Live births
Heinonen *et al.* (1982)	52	41	81	0	21 (25.9)	7 (8.6)	55 (67.9)	61 (68.5)
Buttram (1983)	72	?	208	0	139 (67.0)	69 (33.0)	0	58 (28.0)
Acien (1993)	31	24	65	0	15 (23.0)	15 (23.0)	35 (54.0)	41 (63.1)
Raga *et al.* (1997)	43	?	145	3 (2.1)	46 (31.7)	21(14.5)	75 (51.7)	90 (62.0)
Total[a]	198	65/83[b]	499	3 (0.6)	221 (44.3)	112 (22.4)	165 (83.1)	250 (50.1)

[a]If the study of Buttram (1983) is excluded the results are as follows: abortions 82/291 (28.1%), preterm deliveries 43/291 (14.8%), term deliveries 165/291 (56.7%) and live births 192/291 (66%).
[b]Total number of patients from series with data on conception.

Table IX. Pregnancy outcome in patients with untreated arcuate uterus

Study	Patients	Conceiving	Pregnancies	Ectopics	Abortions	Preterm deliveries	Term deliveries	Live births
Heinonen *et al.* (1982)	20	18	46	0	13 (28.3)	6 (13.0)	27 (58.7)	30 (65.0)
Acien (1993)	40	30	85	4 (5.0)	33 (39.0)	7 (8.0)	38 (48.0)	38 (48.0)
Raga *et al.* (1997)	42	?	110	3 (2.7)	16 (14.5)	5 (4.5)	86 (78.3)	91 (82.7)
Total	102	48/60[a]	241	7 (2.9)	62 (25.7)	18 (7.5)	151 (62.7)	159 (66.0)

[a]Total number of patients from series with data on conception.

uterus is significantly poorer ($P < 0.001$) than that of patients with a normal uterus (Acien, 1993). Although some authors reported that patients with partial bicornuate uterus have a poorer pregnancy outcome than patients with complete bicornuate uterus (Acien, 1993), others failed to detect differences in pregnancy outcome between these two groups (Raga *et al*., 1997).

The septate uterus has usually been associated with the poorest reproductive performance, with fetal survival rates between 6 and 28% and abortion rates as high as 60% (Green and Harris, 1976; Buttram, 1983; Harger *et al*., 1983; Golan *et al*., 1992). However, it seems that although the pregnancy outcome in patients with septate uterus is poor, it is close to that of patients with bicornuate uterus. A review of 198 patients with untreated septate uterus and a total of 499 pregnancies reveals a mean 44.1% abortion rate, a mean 22.3% preterm delivery rate, a mean 32.9% term delivery rate and a mean 50% live birth rate (Table VIII). The results are better if the group studied by Buttram (1983) is excluded (see Table VIII, reported term deliveries 0%) but the pregnancy outcome is still impaired. Acien (1993) supports the view that only patients with complete septate uterus, and not those with a partial septate uterus, have an impaired pregnancy outcome. But this seems to be inconsistent with their finding that arcuate uterus has an even worse pregnancy outcome.

Arcuate uterus could be considered as a mild form of partial septate uterus. The reproductive performance of patients with arcuate uterus is also impaired, although it is better than that of patients with other types of malformed uterus. In a review of 102 patients with untreated arcuate uterus and a total of 241 pregnancies, the mean abortion rate is 25.8%, the mean preterm delivery rate 7.5%, the mean term delivery rate 62.7% and the mean live birth rate 66% (Table IX).

It seems, therefore, that patients with untreated uterine malformations have a significantly impaired pregnancy outcome. Patients with unicornuate and didelphys uterus have a similar pregnancy outcome. The reproductive performance of patients with bicornuate and septate uterus is poor. Arcuate uterus is associated with a slightly better pregnancy outcome.

Pregnancy outcome in the first and in the subsequent pregnancies

Currently, most of the authors agree that a history of recurrent pregnancy losses is a strong and perhaps the main indication for the treatment of patients with uterine malformations (McShane *et al*., 1983; DeCherney *et al*., 1986; Fayez, 1986; Valle and Sciarra, 1986; March and Israel, 1987; Candianni *et al*., 1991; Vercellini *et al*., 1993; Fedele and Bianchi, 1995; Grimbizis *et al*., 1998). However, a group of patients with uterine malformations may present other problems (e.g. infertility) and malformed uterus may be discovered during the diagnostic work-up (Fayez, 1986; Perino *et al*., 1987; Daly *et al*., 1989; Goldenberg *et al*., 1995; Grimbizis *et al*., 1998). Some authors proposed hysteroscopic metroplasty as a prophylactic procedure to prevent pregnancy complications (Daly *et al*., 1989; Fedele and Bianchi, 1995; Grimbizis *et al*., 1998). But, in order to consider prophylactic treatment as reasonable, patients with uterine malformations should have high chances for pregnancy loss starting even from their first pregnancy.

Acien (1997) examined the pregnancy outcome of 176 patients with untreated Müllerian defects in their first and in every other pregnancy. He found that these patients had in their first pregnancies exactly the same term delivery rates as after all their pregnancies had been considered (45 and 44% respectively) (Table X). There were also similar abortion rates (31 and 36%

Table X. Reproductive outcome of the patients with uterine malformations in their first and in all their pregnancies

	Arcuate ($n = 40$)		Septate ($n = 31$)		Bicornuate ($n = 66$)		Total[a] ($n = 137$)		Malformed uterus[b] ($n = 176$)		Normal uterus ($n = 28$)	
	1st preg *n* (%)	All preg *n* (%)	1st preg *n* (%)	All preg *n* (%)	1st preg *n* (%)	All preg *n* (%)	1st preg *n* (%)	All preg *n* (%)	1st preg *n* (%)	All preg *n* (%)	1st preg *n* (%)	All preg *n* (%)
Pregnancies	30	85	24	65	57	160	111	310	142	383	26	47
Ectopics	2 (7)	4 (5)	0	0	0	2 (1)	2 (2)	6 (2)	2 (1)	7 (2)	0	0
Abortions	10 (33)	33 (39)**	5 (21)	15 (23)*	22 (38)*	73 (46)*	37 (33)*	121 (39)**	43 (31)	138 (36)**	3 (12)	4 (8)
Early	9	29	5	15	19	67	33	111	39	126	3	0
Late	1	4	0	0	3	6	4	10	4	12	3	1
Preterm delivery	5 (13)	7 (8)	2 (8)	15 (23)*	18 (31)*	36 (22)*	25 (22)	58 (19)*	34 (24)	70 (18)*	2 (8)	3 (6)
22–28 weeks	1	2	1	1	4	5	6	8	6	9	1	1
29–37 weeks	4	5	1	14	14	31	19	50	28	61	1	2
Term delivery	13 (43)*	41 (48)**	17 (71)	35 (54)**	18 (31)**	49 (31)**	48 (43)**	125 (40)**	64 (45)**	168 (44)**	21 (81)	40 (85)

[a]Reproductive outcome of all cases with arcuate, septate and bicornuate uterus (malformations that can be treated hysteroscopically). Hysteroscopic metroplasty is possible in all cases of septate uterus, in most of the cases of arcuate and in same cases of bicornuate uterus.[b]Reproductive outcome of all cases with malformed uterus (arcuate, septate, bicornuate, unicornuate and didelphys uterus).
Differences in relation to the normal uterus: $*P < 0.05$, $**P < 0.001$.
Adapted from Acien, P. (1993) *Hum. Reprod*., **8**, 122–126.

respectively) and similar preterm delivery rates (24 and 18% respectively). Similar findings were observed in patients with arcuate, septate and bicornuate uterus taken as a group. The grouping of these types was made in order to avoid classification biases and all these types can potentially be treated with hysteroscopic metroplasty (with the exception of the cases of complete bicornuate uterus). They had in their first pregnancy, compared with all their pregnancies, similar term delivery rates (43 and 40% respectively), abortion rates (33 and 39% respectively) and preterm delivery rates (22 and 19%, respectively).

It seems, therefore, that patients with uterine malformations have high abortion and preterm delivery rates as well as low term delivery rates from their first pregnancy. Thus, prophylactic hysteroscopic metroplasty seems to be justified in order to avoid pregnancy complications.

Pregnancy complications

The presence of a malformed uterus is thought to be associated with abnormal presentation. Breech presentation seems to be more frequent in patients with Müllerian defects (Heinonen *et al*., 1982; Worthen and Gonzalez, 1984; Acien, 1993). It seems that septate and bicornuate uterus are more commonly associated with breech presentation than the other forms of uterine malformations (Heinonen *et al*., 1982; Worthen and Gonzalez, 1984; Acien, 1993), although some authors report that abnormal presentation is not increased in complete bicornuate (Heinonen *et al*., 1982; Acien, 1993) and complete septate uterus (Heinonen *et al*., 1982).

Hysteroscopic metroplasty: results

The impaired reproductive performance of patients with septate or arcuate uterus can be considered an indication for their treatment.

Table XI. Hysteroscopic septum resection: indications for treatment in different series

Study	Patients	Recurrent abortions	Infertility			Others
	n	n (%)	Primary *n* (%)	Secondary *n* (%)	Total *n* (%)	*n* (%)
Fayez (1986)	19	12 (63.2)	7 (100.0)	0	7 (36.8)	0
Perino *et al*. (1987)	24	16 (66.7)	8 (100.0)	0	8 (33.3)	0
March and Israel (1987)	91	58 (63.8)	10 (32.3)	21 (67.7)	31 (34.1)	1 (1.1)
Daly *et al*. (1989)	70	55 (78.6)	15 (100.0)	0	15 (21.4)	0
Choe and Baggish (1992)	19	12 (63.2)	1 (20.0)	4 (80.0)	5 (26.3)	2 (10.5)
Fedele *et al*. (1993)	102	71 (69.6)	31 (100.0)	0	31 (30.4)	0
Goldenberg *et al*. (1995)	47	11 (23.4)	NM	NM	36 (76.6)	0
Grimbizis *et al*. (1998)	57	9 (15.8)	26 (56.5)	20 (45.5)	46 (80.7)	2 (3.5)
Total	429	244 (56.9)	98/143 (68.5)	45/143 (31.5)	179 (41.7)	5 (1.2)

NM = not mentioned.

Table XII. Pregnancy outcome in patients with septate uterus before hysteroscopic metroplasty

Study	Patients *n*	Conceiving *n*	Pregnancies *n*	Ectopics *n* (%)	Abortions *n* (%)	Preterm deliveries *n* (%)	Term deliveries *n* (%)	Live births *n* (%)
Fayez (1986)[a]	19	12	21	0	19 (90.5)	2 (9.5)	0	0
Valle and Sciarra (1986)	12	12	42	0	30 (71.4)	12 (28.6)	0	3
March and Israel (1987)[a]	91	79	240	0	212 (88.3)	21 (8.8)	7 (2.9)	12
Perino *et al*. (1987)[a]	24	16	27	0	24 (88.9)	3 (11.1)	0	3
Daly *et al*. (1989)[a]	70	55	150	0	130 (86.7)	13 (8.7)	7 (4.7)	10
Choe and Baggish (1992)[a]	19	18	41	3	31 (81.6)	6 (15.8)	1 (2.6)	4
Grimbizis *et al*. (1998)[a]	57	33	78	2 (2.6)	69 (88.4)	2 (2.6)	5 (6.4)	NM
Total	292	225	599	2 (0.3)	515 (86.4)	59 (9.8)	20 (3.3)	32/521 (6.1)

[a]Including infertility patients.
NM = not mentioned.

On the other hand, the application of hysteroscopic metroplasty (Figures 4–6) as a treatment depends on the efficacy of this particular surgical approach to restore normal uterine function, since there have been reports that obstetric outcome in patients with untreated septate uterus was similar to the one after the operation (Acien *et al*., 1996). The absence of prospective randomized studies that include a control group consisting of patients with symptomatic but untreated septate uterus represents a serious limitation in the evaluation of the results of hysteroscopic metroplasty (Fedele and Bianchi, 1995; Grimbizis *et al*., 1998). Thus, the assessment of the results of hysteroscopic septum resection on uterine function can only be based on retrospective studies examining the reproductive performance of the patients pre- and postoperatively.

Analysis of the patients treated by hysteroscopic septum resection

Three different groups of symptomatic patients with septate uterus have been treated with hysteroscopic septum resection (Fayez, 1986; March and Israel, 1987; Perino *et al*., 1987; Daly *et al*., 1989; Choe and Baggish, 1992; Fedele *et al*., 1993; Goldenberg *et al*., 1995; Grimbizis *et al*., 1998) (Table XI). The first group consisted of patients with recurrent abortions. They represent the majority of the treated cases and hysteroscopic resection of uterine septum was performed as a treatment for their poor reproductive performance. In a review of 429 patients who underwent septum resection, 244 (56.9%) of them were found to suffer from recurrent abortions (Table XI). The second group consisted of patients who presented with infertility. Uterine septum in this group was discovered during the infertility work-up. This group represents the second most important category and 179 (41.7%) out of the reported 429 patients in the reviewed series were found to suffer from infertility (Table XI). However, there were two subgroups in this category. The first subgroup consisted of patients suffering from secondary infertility who had also had a history of recurrent pregnancy losses. Hysteroscopic metroplasty in this subgroup was mainly applied as treatment for their pregnancy losses. The second subgroup consisted of patients with primary infertility. Hysteroscopic metroplasty in this subgroup was applied as a prophylactic procedure to prevent spontaneous abortions and pregnancy complications (Daly *et al*., 1989; Fedele and Bianchi, 1995; Grimbizis *et al*., 1998). The third group consisted of either asymptomatic patients or patients with primary dysmenorrhoea. They represent an extremely small group in the different series and only five (1.2%) out of the reported 429 patients belong in this category (Table XI).

The reproductive history of the patients who underwent hysteroscopic septum resection and are reported in the different series seems to be extremely poor (Fayez, 1986; Valle and Sciarra, 1986; March and Israel, 1987; Perino *et al*., 1987; Daly *et al*., 1989; Choe and Baggish, 1992; Grimbizis *et al*., 1998). In a review of the pregnancy outcome of 225 patients before hysteroscopic metroplasty, it was found that 515 (86.4%) out of 596 pregnancies ended in abortions, 59 (9.9%) in preterm deliveries and only 20 (3.4%) of them ended in term deliveries (Table XII). Thus, it seems that patients who were treated with hysteroscopic septum resection represented a highly selected group of symptomatic patients with extremely poor pregnancy outcome. The pregnancy outcome in this group of patients was poorer than expected for the population of women with septate uterus (Table VIII).

The achievement of pregnancy after hysteroscopic metroplasty

The women with septate uterus who are treated with hysteroscopic septum resection are either patients with recurrent abortions and normal fertility or patients with infertility problems. The achievement of pregnancy following hysteroscopic septum resection is an important parameter in assessing the effect of hysteroscopic metroplasty on reproduction.

Patients with normal fertility

Grimbizis *et al*. (1998) reported that all their patients with recurrent abortions and normal fertility who were interested in pregnancy conceived spontaneously at least once after their treatment. Daly *et al*. (1989) reported normal postoperative monthly fecundity rates. Moreover, Fedele *et al*. (1993) studied the cumulative pregnancy and live birth rates after hysteroscopic metroplasty. They found that in patients with recurrent abortions the achievement of pregnancy was within expected ranges and it was not influenced by the number of previous abortions, the

Table XIII. Pregnancy outcome in patients with septate uterus after hysteroscopic metroplasty

Study	Patients *n*	Conceiving *n*	Pregnancies (+ ongoing) *n*	Ectopics *n* (%)	Abortions *n* (%)	Preterm deliveries *n* (%)	Term deliveries *n* (%)	Live births *n* (%)
DeCherney *et al*. (1986)[a]	72/72	67	67 (+3)	0	~8 (11.9)	1 (1.5)	58 (85.6)	58 (85.6)
Fayez (1986)[a]	19/19	16	16	0	2 (12.5)	0	14 (87.5)	14 (87.5)
Valle and Sciarra (1986)	12/12	10	10 (+3)	0	2 (20.0)	2 (20.0)	6 (60.0)	8 (80.0)
March and Israel (1987)[a]	91/66	57	56 (+7)	0	8 (14.3)	4 (7.1)	44 (78.6)	48 (85.7)
Perino *et al*. (1987)[a]	24/24	16	11 (+5)	0	1 (9.1)	0	10 (90.9)	10 (90.9)
Daly *et al*. (1989)[a]	70/66	54	84 (+4)	0	17 (20.2)	5 (6.0)	62 (73.8)	65 (77.4)
Choe and Baggish (1992)[a]	19/14	13	12 (+3)	0	1 (8.3)	1 (8.3)	10 (83.4)	10 (83.4)
Fedele *et al*. (1993)	102/?	66	66	0	10 (15.2)	10 (15.2)	45 (68.2)	55 (83.3)
Grimbizis *et al*. (1998)[a]	57/42	30	44	1 (2.3)	11 (25.0)	2 (4.5)	30 (68.8)	NM
Total[a]	466/315	329	366	1 (0.3)	60 (16.4)	25 (6.8)	279 (76.2)	268/322 (83.2)

[a]Including infertility patients.
NM = not mentioned.

patient's age, the method of septal incision (microscissors, resectoscope or laser) and the type of septum (partial or complete) (Fedele *et al*., 1993; Fedele and Bianchi, 1995). Thus, it seems that the application of hysteroscopic metroplasty does not impair the fertility potential of the woman with a history of recurrent abortions.

Infertile patients

It was reported that seven (53.8%) out of 13 patients with infertility conceived after septum resection (Daly *et al*., 1989). Similarly, it was observed that 18 (54%) out of 34 infertile patients with septate uterus who were interested in pregnancy achieved conception following hysteroscopic septum resection (Goldenberg *et al*., 1995). It was reported that 21 (63.6%) out of 33 patients with uterine septum and infertility conceived after hysteroscopic metroplasty (Grimbizis *et al*., 1998). Most of them (78.8%) were treated with various assisted reproduction techniques, while many (43.5%) had a long history of previous assisted reproductive treatment cycles. Furthermore, it was found that cumulative pregnancy and live birth rates after hysteroscopic septum resection were lower in infertile patients than in patients with recurrent abortions (Fedele *et al*., 1993), but this seemed to be more related with their infertility problem rather than to the procedure itself.

It seems, therefore, that the chances of conception in patients with septate uterus and infertility are similar with or without septum resection and they are close to those of the general infertile population. This is an indirect indication that uterine septum is not an infertility factor in itself and that the procedure does not adversely affect the fertility potential of the woman.

Pregnancy outcome after hysteroscopic metroplasty

Hysteroscopic metroplasty is associated with a significant decrease in the abortion and preterm delivery rates in the treated patients (DeCherney *et al*., 1986; Fayez, 1986; Valle and Sciarra, 1986; March and Israel, 1987; Perino *et al*., 1987; Daly *et al*., 1989; Choe and Baggish, 1992; Fedele *et al*., 1993; Grimbizis *et al*., 1998; Horner *et al*., 2000). In a review of 329 patients with septate uterus who conceived after hysteroscopic septum resection, only 60 (16.4%) out of 366 pregnancies ended in abortions and only 25 (6.8%) in preterm deliveries (Table XIII). These abortion and preterm delivery rates are significantly lower than the 86.4% abortion rate and the 9.8% preterm delivery rate observed in the group of symptomatic patients with septate uterus before their treatment (Table XII). Moreover, they are significantly lower than the 44.3% abortion rate and the 22.4% preterm delivery rate observed in the population of untreated patients with septate uterus (Table VIII), indicating that hysteroscopic treatment of septate uterus improves the prognosis of patients with asymptomatic uterine septum.

On the other hand, there is an impressive improvement in the pregnancy outcome after hysteroscopic septum resection; 279 (76.2%) out of 366 pregnancies ended in a term delivery and 268 (83.2%) out of 322 pregnancies resulted in a live birth (Table XIII). These term delivery and live birth rates are significantly higher than the 3.3% term delivery rate and the 6.1% live birth rate observed in the group of symptomatic patients with septate uterus before their treatment (Table XII). Furthermore, they are significantly higher than the 33.1% term delivery rate and the 50.1% live birth rate observed in the unselected population of untreated patients with septate uterus (Table VIII), and also higher than the 62.7% term delivery and the 66% live birth rate observed in the population of patients with arcuate uterus (Table IX).

It seems, therefore, that hysteroscopic treatment of patients with symptomatic uterine septum is associated with an impressive improvement in their reproductive performance. Hysteroscopic treatment seems to predict an almost normal prognosis for the outcome of their pregnancies with high term delivery and live birth rates. The reproductive prognosis of symptomatic patients with uterine septum after their treatment is better than the prognosis in the population of women with untreated septate or arcuate uterus.

Conclusions

Uterine malformations consist of a group of miscellaneous congenital anomalies of the female genital system. They are the result of major disturbances in the development, formation or fusion of the Müllerian or paramesonephric ducts during fetal life. Although the classification of the AFS into six major anatomic types is nowadays widely accepted and used by most authors, there are still significant problems concerning the exact classification of each case. These are mainly the result of: (i) the different diagnostic methods used to classify the patients; (ii) the different criteria used to classify the various types of congenital anomalies, especially subseptus and septus uterus versus arcuate and bicornuate uterus.

A combination of laparoscopy and hysteroscopy seems to be necessary for the precise classification of uterine malformations since it allows an accurate estimation of the uterine cavity and of the uterine serosal surface. Nevertheless, some authors have suggested that the differential diagnosis of 'double' uterus can be based only on the use of abdominal ultrasonography in the luteal phase, transvaginal ultrasonography and, more recently, three-dimensional ultrasound.

Uterine malformations are not uncommon. Their mean prevalence in the general population and in the population of fertile women is ~4.3%. Septate uterus seems to be the commonest uterine anomaly with a mean incidence of ~35%, followed by bicornuate uterus with a mean incidence of ~25% and arcuate uterus with a mean incidence of ~20%. The other types of uterine defects are less common.

The mean incidence of Müllerian defects in infertile patients is ~3.4%, close to that seen in the general population. Furthermore, the frequency of infertility in patients with uterine malformations as well as the chances of conception in infertile patients with untreated Müllerian defects after IVF seem to be similar to that of the general population. Moreover, the incidence of unexplained infertility in infertile patients with septate uterus is not different to that observed in the general infertile population. It seems, therefore, that malformed uterus and, especially, septate uterus is not an infertility factor in itself. However, it may contribute to the delayed natural conception of women with mainly secondary infertility since unexplained infertility is more frequent in infertile patients with septate uterus. Furthermore, some

authors found an increased incidence of endometriosis in infertile patients with septate uterus, but these observations call for further research.

On the other hand, uterine malformations seem to be associated with an impaired pregnancy outcome. Thus, uterine malformations are more frequent in patients with recurrent pregnancy losses than in the general population, with a mean incidence of ~12.6%. The incidence of uterine anomalies seems to be even higher in women with late abortions or immature deliveries. Furthermore, patients with untreated uterine malformations (taken as a group) have high abortion and preterm delivery rates and term delivery rates of only ~50%. Obstetric complications such as abnormal presentations are more frequent in these patients.

Taking a closer look at each type of anomaly in particular, unicornuate and didelphys uterus have a similar effect on reproduction and a poor pregnancy outcome (term delivery rates of ~45%). The pregnancy outcome of patients with untreated bicornuate and septate uterus is also poor (term delivery rates of only ~40%). Arcuate uterus is associated with a slightly better but still impaired pregnancy outcome (term delivery rates of ~63%). Furthermore, patients with uterine malformations have a poor pregnancy outcome starting from their first pregnancy.

Hysteroscopic techniques offer the possibility of a successful and easy correction of the uterine cavity mainly in cases of septate and arcuate uterus and in some cases of partial bicornuate uterus. However, the need for treating these particular types of malformations depends on their prognosis and on the effectiveness of treatment to restore not only normal anatomy but also normal function of the uterus.

Based on retrospective clinical studies, it seems that hysteroscopic septum resection can restore normal uterine function. Women who underwent hysteroscopic septum resection and were reported in the different series comprise a highly selected group of symptomatic patients with pregnancy outcome poorer than that expected in the population of women with septate uterus. The pregnancy outcome after hysteroscopic treatment in this group of selected patients is almost within normal ranges. It seems, therefore, that hysteroscopic septum resection can be applied as a therapeutic procedure in cases of symptomatic patients, and also as a prophylactic procedure in asymptomatic patients in order to improve their chances for a successful delivery.

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