

The impact of congenital uterine abnormalities on pregnancy and fertility: a literature review

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ABSTRACT

Congenital abnormalities of the uterus result primarily from embryological maldevelopment of the paramesonephric ducts and have been associated with pregnancy complications, reduced fertility, and other adverse fetal outcomes. While such abnormalities are rare, affected patients should be correctly managed to improve psychological, sexual, and reproductive outcomes. This review intends to elucidate the impact of congenital uterine abnormalities on fertility and pregnancy outcomes. We also present the available management methods and discuss the role of assisted reproductive technologies (ART) to benefit affected women. This review clearly shows that although these disorders are generally not lethal, they critically impact the patient's reproductive health. The fertility rate of patients with uterine congenital abnormalities depends on the severity of the condition. Reproductive endocrinologists and infertility specialists must be considered as active parts of the interdisciplinary treatment team for such patients. ART practices are reasonably successful at managing fertility problems of women with these abnormalities.

Keywords: congenital abnormalities, uterus, fertility, reproductive technologies

INTRODUCTION

Congenital uterine abnormalities mainly result from embryological maldevelopment of the paramesonephric ducts and have been associated with pregnancy complications, reduced fertility and other adverse fetal outcomes (Mucowski *et al.*, 2010; Nejatbakhsh *et al.*, 2012; Parmar & Tomar, 2014). According to Saravelos *et al.* (2008), the prevalence of these abnormalities is 16% in women with recurrent miscarriages and 7.3% in infertile women. Congenital uterine abnormalities may also accompany other abnormalities, which may probably affect other organs and result in further complications (Hassan *et al.*, 2010). The first classification of congenital uterine anomalies was introduced in 1979 (Devi Wold *et al.*, 2006). In 1988, the American Society for Reproductive Medicine (ASRM) updated this classification (Figure 1) (Saravelos *et al.*, 2008; Devi Wold *et al.*, 2006).

Unfortunately, there is limited number of literature regarding the medical management of the affected women and treatment options for infertile individuals. In this

review, we discussed the fertility potential, chance of pregnancy, and pregnancy complications of patients with congenital uterine abnormalities. The potential roles of ART for treating infertility in these patients were also discussed. In general, ART procedures such as in vitro fertilization (IVF) and intracytoplasmic sperm injection (ICSI) are reasonably successful in managing fertility problems of women with these abnormalities.

EVIDENCE ACQUISITION

For data collection, published reports from the literature of the years 2000 to 2020 discussing congenital uterine malformations were searched in the PubMed database, using keywords "Congenital Malformations", "Uterine", "Fertility" and "Reproductive Technologies". Eighty-eight articles were eventually selected and included in the review.

RESULTS

Class I: Müllerian agenesis

The Müllerian duct evolves to the vagina and uterus during embryogenesis, while the ovaries originate from a different embryonic source (Stanhiser & Attaran, 2016). Therefore, a deficiency in Müllerian duct development may result in an absent or shortened vagina, or an incomplete midline uterus or uterine horns with normal ovaries. (Folch *et al.*, 2000). In this abnormality, the secondary sexual characteristic appears to be normal, but due to structural and probable functional defects of the uterus, patients are faced with fertility problems (Stanhiser & Attaran, 2016). Müllerian agenesis, also known as Mayer-Rokitansky-Kuster-Hauser (MRKH) syndrome, is the second most common cause of primary amenorrhea, with an incidence of 0.020-0.025% (Londra *et al.*, 2015).

Gestational difficulties of females with MRKH syndrome are primarily managed with the aid of a gestational surrogate (Anchan *et al.*, 2013; Razieli *et al.*, 2012). IVF followed by embryo transfer to a gestational surrogate is an option for these patients, since the embryonic origin of the ovaries is separate from the tubes and uterus that provide normal oocytes which are hyper-responsive to stimuli, independent from the menses dating (Ben-Rafael *et al.*, 1998; Cakmak & Rosen, 2015; Razieli *et al.*, 2012). Oocyte retrieval efficiency, fertilization rates, embryo quality, and successful pregnancy rates are slightly below average for MRKH patients; however, trying IVF is still an attractive option to these patients (Folch *et al.*, 2000; Pabucco *et*

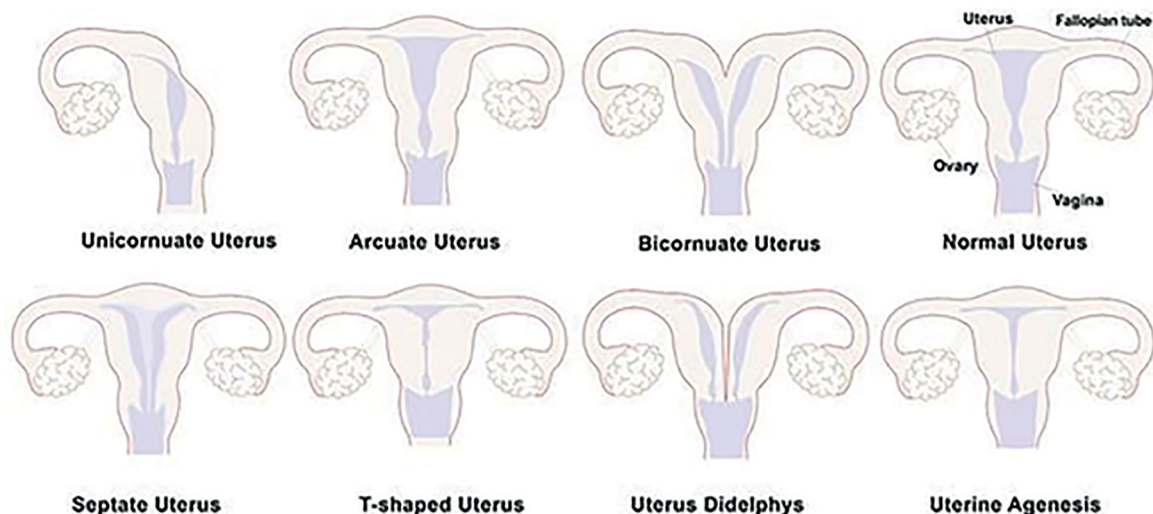


Figure 1. Schematic diagrams of uterine congenital malformations according to the American Society for Reproductive Medicine (ASRM). Based on the ASRM descriptions, malformations in the female genital tract occurred during embryogenesis that generally result from abnormal development of the Müllerian duct(s) are called uterine congenital malformations.

al., 2011; Razieli *et al.*, 2012). Because of the unique pelvic anatomy of MRKH patients, oocytes from these women should be preferably retrieved via the transabdominal rather than transvaginal route (Londra *et al.*, 2015). Conventional hyperstimulation protocols, including ovarian hyperstimulation in these cases, have been recently used in a similar fashion to urgent oocyte cryopreservation performed for cancer patients (Bakhtiari *et al.*, 2012; Ben-Rafael *et al.*, 1998; Cakmak & Rosen, 2015). Following up on the health of children born from MRKH patients may be helpful to investigate possible related etiologies (Londra *et al.*, 2015; Petrozza *et al.*, 1997).

In the treatment protocol for this type of anomaly, correct and comprehensive diagnosis as well as psychosocial consultation are necessary, while laparoscopy is principally used in patients with pelvic pain (Folch *et al.*, 2000). A new vagina can be created via surgical and nonsurgical approaches (Folch *et al.*, 2000; Morcel *et al.*, 2007).

Class II: Unicornuate uterus

In this type of anomaly, the development of the Müllerian duct is normal on one side, but on the other side the uterus shows a single horn, termed unicornuate or banana shaped uterus (Ozgun *et al.*, 2017). Typically, the dominant side of the uterus has a healthy endometrial cavity (Saravolos *et al.*, 2008). The natural horn develops from the intact paramesonephric duct, while in the abnormal side it originates from a hypoplastic paramesonephric duct and is categorized into four subtypes based on the extent of malformation (Dove *et al.*, 2018; Saravolos *et al.*, 2008). Different types of unicornuate uterus anomalies are: 1) complete unicornuate uterus lacking a second horn, 2) a primitive horn lacking endometrial cavity, 3) a primitive horn having an endometrial cavity isolated from the dominant uterine cavity, and 4) a primitive horn having the endometrial cavity, which is in contact with the dominant uterine cavity (Dove *et al.*, 2018). According to the American Fertility Society, isolated rudimentary endometrial cavities are most often seen in cases of unicornuate uterus (Bodur *et al.*, 2017). Ovarian development is typically not compromised, although the ovary on the affected side might be ectopic or even absent in rare cases (Reichman *et al.*, 2009). Accidental renal abnormalities are common,

and women with rudimentary horns are at increased risk of developing endometriosis or chronic pain because of hematometra (Fedele *et al.*, 1987; Reichman *et al.*, 2009).

The association between unicornuate uterus and infertility is less clear. A retrospective observational study including 3181 women reported that 23.7% of the patients with a unicornuate uterus were diagnosed with subfertility (Chen *et al.*, 2018). Only one third of the pregnancies of patients with a unicornuate uterus ended with live births, while a significant portion (~50%) resulted in preterm delivery and 4% in ectopic pregnancy (Chan *et al.*, 2011a). Single and multiple miscarriages and intrauterine fetal demise were prevalent in these patients (Reichman *et al.*, 2009). The pathological mechanisms involved in such reproductive failures relate to pregnancy maintenance regulating procedures such as incompetent uterine and placental blood flow, uterine muscle insufficiency, and cervical weakness (Khati *et al.*, 2012).

Cases of unicornuate uterus account for a significant portion of congenital uterine anomalies, with an incidence in the general population of about 0.1% (Agarwal *et al.*, 2017; Ozgun *et al.*, 2017). Unicornuate uterus is one of the main etiologies of infertility in the general population (Li *et al.*, 2017). Surgery is not needed before IVF in such cases (Ludwin *et al.*, 2011). According to the comparative study by Li *et al.* (2017), early pregnancy loss, premature delivery, and perinatal mortality in patients with a unicornuate uterus occurred much more frequently than in controls. The live birth rate after IVF-ET decreases in such patients, while the risk of premature delivery increases (Li *et al.*, 2017). Ozgun *et al.* (2017) reviewed previously published data on the pregnancy, perinatal, and obstetric rates seen in patients with a unicornuate uterus after ICSI. Their retrospective study confirmed the observation of low pregnancy rates, low birth weight, high risk of miscarriage, premature birth, and stillbirth.

Ectopic pregnancies are also prevalent in women with a unicornuate uterus (Yoldemir, 2015). Very sporadically, pregnancy may occur within the non-communicating rudimentary horn (1 out of 76,000), with high risk of uterine rupture occurring mostly in the sixth month of pregnancy (Rackow & Arici, 2007). However, there are exceptional cases such as one of the twin fetuses reported by Nanda

et al., which successfully grew in the non-communicating rudimentary horn of a unicornuate uterus (Caserta *et al.*, 2014).

In spite of the odds, successful pregnancy and delivery are not impossible in women with a unicornuate uterus if the pregnancy is well monitored in terms of intrauterine growth retardation. Laparoscopy can be used in the excision of rudimentary horns in non-pregnant patients (Ben-Rafael *et al.*, 1998).

Class III: Uterus didelphys

Uterine didelphys accounts for about 10% of uterine anomalies and 0.2% of cases of infertility (Al-Hussaini, 2017; Yang *et al.*, 2015). Patients with the condition develop two uteri and two cervixes and may have two vaginas in very few cases. This is a congenital malformation resulting from deficient embryonic lateral fusion of the two Müllerian ducts. It is mostly diagnosed during infertility workup or examination for recurrent miscarriage (Yang *et al.*, 2015). The diagnosis of uterus didelphys is mostly incidental, since it is often asymptomatic. However, the presence of a vaginal septum may be associated with painful intercourse, menstruation, or abdominal pain as the vagina or the vagina and uterus are filled with menstrual blood (Park & Lee, 2013), in addition to occasional genital neoplasms and endometriosis (Heinonen, 2000; Rezai *et al.*, 2015). The reproductive performance of patients with uterus didelphys is relatively less problematic compared to other more common Müllerian duct malformations such as septate or bicornuate uterus (Table 1) (Park & Lee, 2013; Rezai *et al.*, 2015). However, women with this condition struggle with the risk of miscarriage, intrauterine growth retardation, and a high rate of preterm delivery with the lowest rate (<50%) of full-term pregnancy (Chan *et al.*, 2011a; Raga *et al.*, 1997). Consequently, fertility efficiency is considered weak and successful cases have been scarcely reported (Raga *et al.*, 1997; Sanfilippo & Peticca, 2016). Although performed with a small population (40 women), a study by Heinonen (2000) found no significant difference in the fertility and miscarriage rates of patients with uterus didelphys, septate and bicornuate uteri. Published reports of twin and triplet pregnancies of women with uterus didelphys show the competence of one of the uteri in carrying healthy fetuses (Okafor *et al.*, 2016; Nohara *et al.*, 2003; Tuteja *et al.*, 2015; Al Yaquobi & Fatema, 2017). Nevertheless, increased rates of prematurity have been reported for women with uterus didelphys compared to individuals with other Müllerian duct anomalies (MDA) (Heinonen, 2000).

With all things considered, artificial reproductive technologies and embryo transfer may be occasionally helpful, such as in the case of a patient with a complete longitudinal vaginal septum described by Al-Hussaini (2017), who conceived twice after several failed ICSI attempts. Another case of IVF and embryo transfer involving a woman with uterus didelphys was reported by Yang *et al.* (2015) as having reached successful gestations. Since data on the precise frequency of reconstructive surgery for congenital anomaly repair (metroplasty) is not available, the ability to achieve pregnancy of women with uterus didelphys is not well understood. The vaginal septum, for example, should be removed in symptomatic uterus didelphys cases. However, a cesarean section is recommended whenever a thick and inelastic vaginal septum is present (Rezai *et al.*, 2015). Having uterus didelphys does not necessarily correlate with cervical weakness. However, it has been recommended that patients with uterus didelphys be examined for renal anomalies to rule out Herlyn-Werner-Wunderlich (HWW) syndrome out (Rezai *et al.*, 2015). HWW is another infrequent congenital anomaly affecting the paramesonephric and mesonephric ducts characterized by uterus didelphys, obstructed hemivagina, and ipsilateral renal agenesis (Khaladkar *et al.*, 2016).

Nevertheless, women with uterus didelphys can have healthy pregnancies using split embryo transfer in IVF/ICSI cycles with no need for cerclage. Hysteroscopy is a viable diagnostic tool to find horn embryos, which are better candidates to be replaced. It also helps to diagnose other abnormalities that might interfere with implantation, especially in cases of recurrent implantation failure (Al-Hussaini, 2017).

Class IV: Bicornuate uterus

Similar to uterus didelphys, bicornuate uterus derives from deficient fusion of Müllerian ducts during fetal development; in this case, the two cavities are entirely or partially unified by caudal fusion (Doruk *et al.*, 2013). Both endometrial cavities frequently open to a single vagina via a single uterine cervix (unicollis) or via separate uterine cervixes in rare cases (bicollis) (Chan *et al.*, 2011b; Gasim & Al Jama, 2013; Nitzsche *et al.*, 2017). Bicornuate uterus competes with arcuate uterus for the place of third most frequent congenital Müllerian malformation in unselected populations (0.4%) (Dohbit *et al.*, 2017; Kowalik *et al.*, 2011). It is often asymptomatic and remains unidentified before puberty, showing a significant correlation with infertility and miscarriage (Dohbit *et al.*, 2017).

Table 1. Pregnancy outcomes from different types of congenital uterine malformation.

Study	Pregnancy outcome	Unicornuate n (%)	Didelphys n (%)	Arcuate n (%)	Septate n (%)	Bicornuate n (%)
Michalas, 1991	Spontaneous miscarriage	(5)	(8)	-	(19)	(14)
Raga <i>et al.</i> , 1997	Early miscarriage Ectopic pregnancy Preterm delivery	6 (37.5) 0 4 (25.0)	3 (20.0) 1 (6.6) 8 (53.3)	14 (12.7) 3 (2.7) 5 (4.5)	37 (25.5) 3 (2.1) 21 (14.5)	14 (25.0) 0 14 (25.0)
Salim <i>et al.</i> , 2003	Recurrent miscarriage	2 (0.4)	-	86 (16.9)	27 (5.3)	6 (1.2)
Yassaee & Mostafae, 2011	Preterm delivery	-	-	1 (33.3)	-	8 (72.7)
Butt, 2011	Miscarriage Ectopic pregnancy	1(2.5) 1(2.5)	1(2.5) 0	2(5) 1(2.5)	2(5) 0	4(10) 0
Bailey <i>et al.</i> , 2015	Recurrent pregnancy loss.	6(0.7)	2(0.2)	-	43 (4.9)	7(0.8)

The rate of the Premature Rupture of Membranes (PROM), preterm separation of the placenta, miscarriage, premature delivery, and Intrauterine Growth Restriction (IUGR) is higher in cases of bicornuate uterus (Mastrolia *et al.*, 2017). Bicornuate uterus significantly contributes to uterine ruptures in first pregnancy patients and at any gestational age (Nitzsche *et al.*, 2017), as well as cervical incompetence, which can significantly increase the perception of birth risk (Mastrolia *et al.*, 2017). However, there are several reports of successful gestations involving bicornuate uterus patients. Prognosis remains debatable, since pregnancy may be compromised by cervical atresia, cervical mucus absence, upper congenital anomalies, recurrence of the anomaly after cervical corrective surgery, and postoperative retrograde adhesions (Acien *et al.*, 2008; Aimen *et al.*, 2016; Deffarges *et al.*, 2001; Radhouane *et al.*, 2015).

Nevertheless, pregnancy may be possible after surgical corrections through natural or artificial insemination (Table 2). In a rare case, Li *et al.* (2016) reported a successful full-term twin pregnancy in each cavity of a bicorporeal septate uterus of a patient with two cervixes and a longitudinal vaginal septum via natural insemination. Furthermore, a woman with bicornuate unicollis uterus with twins successfully delivered at 35 weeks of gestation through a bilateral cesarean section (Doruk *et al.*, 2013). In addition, several cases of successful pregnancies of women with a bicornuate uterus have been reported without surgical correction of the anomaly. A successful gestation in one of the horns in a woman with a bicornuate uterus has been referenced by Adeyemi *et al.* (2013). To our knowledge, surgical corrections or IVF procedures have not been reported in women with a bicornuate uterus.

Nevertheless, one cannot deny that pregnancies of women with Müllerian anomalies associate with potential obstetric complications. However, pregnancies in a bicornuate uterus have shown more favorable obstetric outcomes than pregnancies in patients with other Müllerian fusion disorders. Considering the rare occurrence of such cases and the potential contributing risks, pregnancies of women with a bicornuate uterus, and twin pregnancies in particular, should be managed carefully, in a tailored fashion (Doruk *et al.*, 2013).

Class V: Septate uterus

This class of uterine anomalies constitutes the most frequent uterine malformation (35%), outranking before bicornuate uterus and arcuate uterus (Kowalik *et al.*, 2011). The uterus of these patients is partitioned into two cavities because the midline septum has not been reabsorbed partially or entirely during fetal development (Kowalik *et al.*, 2011; Valle & Ekpo, 2013). Therefore, the septum that begins from the uterine fundus may extend from before or

after the internal cervical os (partial or complete uterine septum) to the external cervical os (complete uterine septum with septate cervix) or to the upper vagina (complete uterine septum with cervical and vaginal septations) (Valle & Ekpo, 2013).

Uterine septum anomaly increases the risk of obstetrical complications, recurrent miscarriage (Nouri *et al.*, 2010), infertility (Nouri *et al.*, 2010; Seet *et al.*, 2015), preterm birth, fetal malpresentation, and miscarriage before six months (Seet *et al.*, 2015), in addition to reducing the rate of clinical fertilization success (Table 1) (Chan *et al.*, 2011a). Two mechanisms with suggested associations with spontaneous miscarriage are decreased septum vascular supply and an abnormal overlying endometrium, resulting in abnormal implantation (Ali *et al.*, 2017; Freud *et al.*, 2015). Müllerian malformations, including septate uterus, are among the several possible underlying causes of persistent decreased fetus movement. Repeated differential diagnostic evaluations are especially important when the fetus is diagnosed as healthy in examinations (Ali *et al.*, 2017). A complete septate uterus may be confused with uterus didelphys, especially in the presence of a duplicated cervix and a longitudinal septum in the vagina (Patton *et al.*, 2004).

The management of these anomalies is controversial; thus, proper diagnosis with the aid of different imaging resources – HSG, US, and Magnetic Resonance Imaging (MRI) – is a key element in planning for surgical interventions (Patton *et al.*, 2004; Seet *et al.*, 2015). One of the interventions is hysteroscopic resection (HR) of the uterine septum, a procedure known to provide better reproductive outcomes in patients with a track record of spontaneous miscarriage or premature labors (Freud *et al.*, 2015).

The possibilities offered by ART interventions to enhance the reproductive outcomes of patients with uterine septa have not been well documented. However, data from relative population studies showed that pregnancy and miscarriage outcomes of patients submitted to hysteroscopic septoplasty and IVF were similar to the outcomes of individuals with a normal uterine cavity (Abuzeid *et al.*, 2014). In this regard, several studies showed that uterine septum HR might improve pregnancy and live birth rates while decreasing the risk of miscarriage in patients receiving IVF or ICSI workup (Ban-Frangez *et al.*, 2009; Ozgur *et al.*, 2007; Tomažević *et al.*, 2010). Therefore, hysteroscopic procedures may be considered in uterine anomaly repairs not only for women with recurrent pregnancy loss and preterm labor, but also for infertile women. This technique is a simple method with minimal postoperative sequelae that may improve reproductive outcomes, especially in cases where IVF is an option (Tomažević *et al.*, 2010). In such cases, it is important to make the best of every single chance of pregnancy, because of the adverse

Table 2. Reproductive performance according to the study by Prior *et al.* (2018) in women with congenital uterine malformations and women with normal uteri following assisted reproductive technology (ART) treatment. Live birth and clinical pregnancy rates were similar between the two groups, although preterm births were more common in women with uterine malformations than in controls.

		Normal uterus (n=1943)	Congenital uterine malformations (n=432)	p
Total number of retrieved oocytes		12±7.6	12±6.5	0.75
Clinical pregnancy		850 (44%)	180 (42%)	0.45
Preterm birth	<37 weeks	102/722 (14%)	33/152 (22%)	0.026
	<34 weeks	20/722 (3%)	12/152 (8%)	0.007
	<32 weeks	13/722 (2%)	11/152 (7%)	0.001
Live birth		722 (37%)	152 (35%)	0.47

effects of multiple pregnancies on the possibility of taking pregnancies to full-term (Abuzeid *et al.*, 2014).

Class VI: Arcuate uterus

This mild uterine anomaly sometimes considered normal is characterized by an arcuate uterus that produces little or no impact on reproductive outcomes (Fatema, 2011; Grimbizis *et al.*, 2001). The uterine cavity is normally straight or pulvinate towards the fundus of the uterus, while in the arcuate uterus, the uterine cavity is curved against the fundus and the myometrium of the fundus is a bit extended toward the cavity, sometimes displaying a small septum (Mucowski *et al.*, 2010; Mueller *et al.*, 2007; Saravelos *et al.*, 2008). In addition, differentiating an arcuate uterus from a septate uterus is still controversial, since the distinctions between them have not been standardized (Mucowski *et al.*, 2010). The intrinsic mechanism that occurs during embryo development to result in an arcuate morphology is unknown. However, it has been suggested that it may be linked to partial septal resorption (Tomažević *et al.*, 2010).

Although an arcuate uterus scarcely requires treatment on account of its minimal association with poor reproductive outcomes (Fatema, 2011; Grimbizis *et al.*, 2001), a few reports have described an association with increased risk of spontaneous miscarriage, preterm labor, and second-trimester pregnancy loss, which result in a marginal reduction in term delivery rates (Table 1) (Woelfer *et al.*, 2001; Zlopasa *et al.*, 2007). The mechanism underlying the occurrence of late pregnancy complications in arcuate uterus patients has not been elucidated (Lin, 2004; Mucowski *et al.*, 2010).

Regarding reports on successful reproductive outcomes after HR, guidelines for arcuate anomaly management, including cases of recurrent pregnancy loss, have not been consolidated. HR may be prescribed to individuals with recurrent pregnancy loss without a distinguishable alternative etiology. However, there is no universally agreed method to treat individuals with an arcuate uterus. Nevertheless, hysteroscopic septoplasty may help patients with primary and secondary infertility and an arcuate uterus before they undergo infertility treatments such as IVF-ET (Abuzeid *et al.*, 2014; Chan *et al.*, 2011a).

A few studies discussed an association between arcuate anomaly and poor reproductive outcomes, although they included small populations and were affected by confounders and bias in case selections (Mucowski *et al.*, 2010). These studies described recurrent pregnancy loss and low term delivery rates among patients with an arcuate anomaly, although other reports indicated improvements in term delivery rates and decreases in miscarriage rates (Abuzeid *et al.*, 2014). These results were obtained with the aid of surgical repair (hysteroscopic septoplasty) (Abuzeid *et al.*, 2014). Therefore, more longitudinal studies enrolling larger populations should be performed to acquire accurate data on the incidence of arcuate uterus and the associated pregnancy complications in the unselected population (Mucowski *et al.*, 2010).

Class VII: T-shaped uterus

Women exposed to diethylstilbestrol (DES) *in utero* during fetal development may develop a uterine malformation referred to as T-shaped uterus. In non-exposed individuals, T-shaped uterus is a rare occurrence (Pui, 2004). DES hampers hormonal induction during embryo evolution (Golan *et al.*, 1989; Pui, 2004); however, its exact role in infertility remains unknown (Lin *et al.*, 2002). This anomaly is the only genital malformation which can be acquired as well (e.g., in Asherman syndrome) (Fernandez *et al.*, 2011). Data on ART indicates that the T-shaped

uterus anomaly has been associated with a remarkable decreases in pregnancy, implantation, and in term pregnancy rates, and with increased spontaneous miscarriage rates (SAB) (Lin, 2004; Lin *et al.*, 2002). The pathogenesis of the T-shaped uterus anomaly and its exact etiology are unknown. Apparently, its reported impacts revolve around oocyte maturation, fertilization, cleavage, and embryo quality and development (Dehdehi *et al.*, 2020; Lin *et al.*, 2002; Rennell, 1979), leading to a history of primary infertility in patients, recurrent miscarriage, or preterm delivery (Fernandez *et al.*, 2011). The side effects of DES appear to be limited to the uterus (Lin *et al.*, 2002).

The endometrial cavity of the uterus in patients with a T-shaped uterus is thin and more easily identifiable by HSG compared to US or MRI (Pui, 2004). Failure to treat individuals with a T-shaped uterus has been linked to inferior reproductive outcomes, including failed implantation, increased risk of ectopic pregnancy, miscarriage, and preterm delivery (Berger & Goldstein, 1980; Fernandez *et al.*, 2011; Katz *et al.*, 1996). Few reports described hysteroscopic metroplasty for T-shaped uterus patients, although the procedure has been often performed for septate uterus patients (Fernandez *et al.*, 2011). Therefore, hysteroscopic metroplasty may be considered as a beneficial approach to increase the live birth rates of T-shaped uterus patients; however, it does not treat infertility (Fernandez *et al.*, 2011; Giacomucci *et al.*, 2011).

CONCLUSION

This review clearly showed that congenital uterine malformations are related with poor reproductive outcomes. The exact impact is dependent on the type of anomaly and the outcome being considered. Modern clinical understanding and advanced imaging techniques allow more precise identification of congenital uterine malformations. As affected women approach childbearing age, the impact of their underlying condition on sexuality and reproductive potential assumes greater importance. It is therefore paramount for involved practitioners to be aware of the most up-to-date reproductive technologies and surgical interventions to optimally manage patients with these conditions. The present review provides the available necessary information for adequate patient counseling and treatment. Additionally, this review underscored the need for further longitudinal studies and prospective randomized trials to best define what treatments may be offered to this patient cohort.

Abbreviations

ART: Assisted Reproductive Technologies; ASRM: American Society for Reproductive Medicine; DES: Diethylstilbestrol; HR: Hysteroscopic Resection; HWW: Herlyn-Werner-Wunderlich Syndrome; ICSI: Intracytoplasmic Sperm Injection; IUGR: Intrauterine Growth Restriction; IVF: In Vitro Fertilization; IVF-ET: In Vitro Fertilization and Embryo Transfer; MDA: Müllerian Duct Anomaly; MRI: Magnetic Resonance Imaging; MRKH: Mayer-Rokitansky-Kuster-Hauser Syndrome; US: Ultrasonography; HSG: Hysterosalpingography; PROM: Premature Rupture of Membranes.

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CONFLICT OF INTEREST

The authors declare that there are no competing interests related to the subject matter or materials discussed in this article.

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