The Journal of Maternal-Fetal & Neonatal Medicine

ISSN: 1476-7058 (Print) 1476-4954 (Online) Journal homepage: http://www.tandfonline.com/loi/ijmf20

The impact of unicornuate uterus on perinatal outcomes after IVF/ICSI cycles: a matched retrospective cohort study

Xinxia Chen, Peihao Liu, Yan Sheng, Weiping Li, Rong Tang, Lingling Ding, Yingying Qin & Zi-Jiang Chen

To cite this article: Xinxia Chen, Peihao Liu, Yan Sheng, Weiping Li, Rong Tang, Lingling Ding, Yingying Qin & Zi-Jiang Chen (2018): The impact of unicornuate uterus on perinatal outcomes after IVF/ICSI cycles: a matched retrospective cohort study, The Journal of Maternal-Fetal & Neonatal Medicine, DOI: 10.1080/14767058.2018.1438403

To link to this article: https://doi.org/10.1080/14767058.2018.1438403

Published online: 12 Apr 2018.

THE JOURNAL OF MATERNAL-FETAL & NEONATAL MEDICINE, 2018
https://doi.org/10.1080/14767058.2018.1438403

Taylor & Francis
Taylor & Francis Group

ORIGINAL ARTICLE

The impact of unicornuate uterus on perinatal outcomes after IVF/ICSI cycles: a matched retrospective cohort study

Xinxia Chen[a,b,c,d*], Peihao Liu[a,b,c*], Yan Sheng[a,b,c], Weiping Li[e], Rong Tang[a,b,c], Lingling Ding[a,b,c], Yingying Qin[a,b,c] and Zi-Jiang Chen[a,b,c,e]

[a]Center for Reproductive Medicine, Shandong University Shandong Provincial Hospital, Jinan, China; [b]National Research Center for Assisted Reproductive Technology and Reproductive Genetics, Jinan, China; [c]Key Laboratory for Reproductive Endocrinology of Ministry of Education, Jinan, China; [d]School of Nursing, Shandong University, Jinan, China; [e]Renji Hospital, Shanghai Jiao Tong University School of Medicine, Shanghai, China

ABSTRACT

Objective: To evaluate the impact of unicornuate uterus on perinatal outcomes after *in vitro* fertilization and/or intracytoplasmic sperm injection (IVF/ICSI) cycles.

Methods: We performed a retrospective cohort study including 160 women with unicornuate uterus and 1:1 matched controls with normally shaped uterus. They received IVF/ICSI treatment during January 2009 and December 2011. The perinatal outcomes were followed up till December 2014.

Results: There were no significant differences in pregnancy rate, clinical pregnancy rate or live birth rate (53.6 versus 52.7, 41.4 versus 43.5, 33.8% versus 31.8%) between unicornuate uterus group and controls. Their biochemical pregnancy rate (22.8 versus 17.5%) and miscarriage rate (16.0 versus 18.8%) were similar. No significant differences were identified in preterm birth rate (18.3 versus 11.8%), birthweight (3.24 ± 0.60 versus 3.33 ± 0.54 kg) or birth length (50.47 ± 2.33 versus 50.06 ± 2.40 cm) among the singletons. However, lower gestational age (35.56 ± 2.68 versus 36.71 ± 1.73, $p = .019$), higher preterm birth rate (55.0 versus 34.4%, $p = .038$), lower birthweight (2.33 ± 0.58 versus 2.69 ± 0.38 kg, $p = .001$), lower birth length (45.33 ± 2.46 versus 48.88 ± 2.06 cm, $p = .000$), as well as higher rate of very low birthweight (13.2% versus 0, $p = .007$) were found for the twins from unicornuate uterus group.

Conclusions: The results indicated unimpaired pregnancy and perinatal outcomes for women with unicornuate uterus conceiving one fetus. However, close attention should be paid to twin pregnancy in unicornuate uterus owing to increased risks of prematurity and low birthweight. Selected single embryo transfer is recommended for women with unicornuate uterus undergoing IVF/ICSI cycles.

ARTICLE HISTORY
Received 3 January 2018
Accepted 5 February 2018

KEYWORDS
Unicornuate uterus; perinatal outcome; twin delivery; singleton; IVF/ICSI

Brief rationale

Most data associating unicornuate uterus with adverse obstetric complications came from natural conception in small patient numbers or including only specific cases. The lately published two comparative studies discovered different profile in pregnancy loss pattern in unicornuate uterus after IVF/ICSI treatment. This retrospective cohort study was performed to further explore the impact of unicornuate uterus on perinatal outcomes of singleton and twin deliveries after IVF/ICSI cycles.

One hundred and sixty women with unicornuate uterus and 1:1 matched controls were enrolled. The miscarriage rate was nonsignificantly different between the two groups. The gestational age at delivery, birthweight, birth length and congenital anomaly rate was also nonsignificantly different when singletons and twins were analyzed together.

For singletons, there were no differences in preterm birth rate, average birthweight, and congenital anomaly rate between groups. However, the twin neonates from unicornuate uterus group were associated with increased risk of preterm birth. Their average birthweight and birth length were significantly lower, while the rate of very low birthweight was statistically higher.

These findings indicated that with development of only half uterine musculature, the gestational capacity was jeopardized in unicornuate uterus. Though pregnancy and perinatal outcomes were unimpaired

CONTACT Yingying Qin qyy106@yahoo.com; Lingling Ding dingdang4629@163.com Center for Reproductive Medicine, Shandong University Shandong Provincial Hospital, Jinan, China
*These authors contributed equally to this work.

for singletons, twin pregnancy may face more challenges, generally in the third trimester. Selected single embryo transfer is recommended for women with unicornuate uterus undergoing IVF/ICSI treatment.

Introduction

The development of female reproductive organ involves a series of complex processes consisting of formation, fusion, and resorption of Mullerian ducts. Once any process is interrupted, Mullerian duct abnormalities (MDAs) ranging from agenesis to lateral and vertical fusion defects may occur. The prevalence of MDAs is estimated to be 4.3–6.7% in general population [1]. Given that it is difficult to reconstitute the uterus in most cases, MDAs are a problematic issue confusing both patients and doctors. MDAs have been reported to be associated with infertility, miscarriage, preterm labor, malpresentation, and other maternal-neonatal complications [2–5]. However, different anomalies may result in different pregnancy and neonatal outcomes.

Unicornuate uterus is derived from unilateral Mullerian duct development, with the contralateral duct not or partially developing [6]. It is divided into two subclasses: a unicornuate uterus with a functional rudimentary horn, either communicating or noncommunicating; and a unicornuate uterus without rudimentary cavity, characterized by nonfunctional contralateral uterine horn or no horn [1]. The prevalence of unicornuate uterus is approximately 0.78–1.0% in infertile population [7,8], accounting for 5.0–20% of all MDAs [6,9].

There have been studies on increased incidence of adverse obstetric complications in women with unicornuate uterus [10–18]. However, most data came from natural conception with small number of patients or including only specific cases. Lately, two comparative studies reported pregnancy outcomes after *in vitro* fertilization and/or intracytoplasmic sperm injection (IVF/ICSI) treatment [7,8]. One of them found increased early pregnancy loss rate, while the other reported no statistical differences in clinical pregnancy loss for unicornuate uterus. Its impact on perinatal outcomes has not been well elucidated [7,10]. The aim of this retrospective cohort study was to further explore the impact of unicornuate uterus on perinatal outcomes of singleton and twin deliveries after IVF/ICSI cycles.

Materials and methods

In this study, the process of all patients receiving IVF/ICSI treatment in Center for Reproductive Medicine, Shandong University between January 2009 and December 2011 was reviewed. All participants were aged less than 40 years old with 46, XX karyotype, normal basal hormone level and regular menstruation. Unicornuate uterus was diagnosed by transvaginal ultrasound, hysterosalpingography, and hysteroscopy/laparoscopy, as part of a systematic examination to identify infertility cause. The matched controls were randomly enrolled from infertile women with normally shaped uterus undergoing IVF/ICSI cycles during the same period.

The following matched criteria were used: age (± 1 year), body mass index (BMI), infertility type (primary or secondary) and history of spontaneous abortion. The exclusion criteria were as follows: oocyte donor treatment cycles, abnormal uterine bleeding, endometrial fibroids or polyps, intrauterine adhesion, premature ovary insufficiency, polycystic ovary syndrome, and consecutive spontaneous abortion history $\geq$ three times.

Written informed consent was obtained from each participant. This study was approved by the Review Board of Reproductive Medicine of Shandong University.

Data collection

Demographic information, reproductive history, ovarian reserve, and controlled ovarian hyperstimulation (COH) protocols were collected. Perinatal outcomes were followed up by telephone till Dec 2014.

Pregnancy was defined as serum β-hCG concentration $\geq$10 IU/l 14 days after embryo transfer. Clinical pregnancy was diagnosed when gestational sac(s) was observed by ultrasonography 4 weeks after embryo transfer. Ifβ-hCG dropped down before identifying gestational sac(s), biochemical pregnancy was determined. Ectopic pregnancy was defined as a pregnancy with gestational sac(s) observed outside the uterine cavity. Miscarriage was defined when a clinical pregnancy failed to progress to 28 gestational weeks. Early miscarriage referred to miscarriages that occurred before 12^{+6} gestational weeks while late miscarriage was a miscarriage at 13 and 27^{+6} gestational weeks. Total pregnancy loss consisted of biochemical pregnancy and miscarriage. Preterm birth was defined as the delivery of an infant during 28 and 36^{+6} gestational weeks. Term delivery referred to childbirth after 37 but before 42 weeks of gestation. A live birth referred to the delivery of a live infant surviving more than 7 days after week 28 of gestation. A stillbirth referred to the delivery of a deceased infant after 28 weeks of

gestation. Low birthweight was defined as a birthweight <2.5 kg and very low birthweight was <1.5 kg.

Pregnancy rate, clinical pregnancy rate, ectopic pregnancy rate, live birth rate, preterm birth rate, cycle cancelation rate, total pregnancy loss rate, biochemical pregnancy rate, early and late miscarriage rate were compared between the unicornuate uterus group and controls. Birthweight, birth length, gestational age at delivery, preterm birth rate, and congenital anomaly rate of live infants was compared between the two groups stratified by singletons and twins.

Statistical analysis

The data were analyzed by SPSS 20.0 (SPSS Inc, Chicago, IL). Student's *t*-test was used for continuous variables. The chi-square test and Fisher's exact test were used to compare categorical variables. $p < .05$ was considered statistically significant.

Results

One hundred and sixty women with unicornuate uterus undergoing 329 cycles of IVF/ICSI and 160 women with normal uterus undergoing 390 cycles were enrolled. 150 (93.8%) women had unicornuate uterus without rudimentary cavity, 143 (89.4%) of whom had isolated unicornuate uterus and the other seven (4.4%) had unicornuate uterus with nonfunctional contralateral uterine horn. The rest 10 women had rudimentary cavity, all of whom had received horn resection before IVF/ICSI cycles due to a history of rudimentary horn pregnancy.

Table 1. Clinical characteristic of women with unicornuate uterus and controls.

	Unicornuate	Control	*p* value
Cycles	329	390	–
Age (y)	30.3 ± 4.1	30.3 ± 4.1	.935
BMI (kg/m^2)	22.6 ± 3.3	22.5 ± 3.0	.684
Primary infertility	84 (52.5)	83 (51.9)	.911
History of spontaneous abortion (once or twice)	16 (10.0)	19 (11.9)	.591
Prior ectopic pregnancy	29 (18.1)	12 (7.5)	.004
Indication for IVF/ICSI			
Tubal factor	117 (73.1)	105 (65.6)	.146
Male factor	43 (26.9)	46 (28.8)	.708
Endometriosis	8 (5.0)	7 (4.4)	.791
Combined female and male factors	10 (6.2)	4 (2.5)	.101
Other	13 (9.1)	10 (6.2)	.516
Antral follicle count	12.7 ± 5.4	12.9 ± 5.1	.774
Day 3 serum FSH (IU/ml)	6.7 ± 2.1	6.7 ± 1.6	.938
Day 3 serum LH (IU/ml)	4.8 ± 2.5	4.9 ± 2.6	.635
Endometrial thickness on HCG day (cm)	1.1 ± 0.1	1.1±.0.2	.933
Oocytes retrieved	11.7 ± 6.0	12.4 ± 5.6	.324
No. of good quality embryos	4.0 ± 2.4	4.0 ± 2.3	.904
Fresh embryo transfer	214 (70.9)	268 (72.8)	.573

NS: not significant;
Values are number *n* (%) or mean ± SD.

The clinical characteristics were comparable between the two groups except for that the incidence of prior ectopic pregnancy in women with unicornuate uterus was higher than controls (18.1 versus 7.5%, $p = .004$) (Table 1).

The main pregnancy outcomes were listed in Table 2. There were no significant differences in pregnancy rate (53.6 versus 52.7%), clinical pregnancy rate (41.4 versus 43.5%), or live birth rate (33.8 versus 31.8%) between the two groups ($p > .05$). The total pregnancy loss rate in women with unicornuate uterus was non-significantly different from controls (18.9 versus 17.4%, $p > .05$). Neither biochemical pregnancy rate (22.8 versus 17.5%) nor miscarriage rate (16.0 versus 18.8%) was significantly higher in unicornuate uterus group ($p > .05$). No statistical differences were identified in early or late miscarriage rate between the two groups (10.4 versus 5.6, 5.6 versus 3.1%, respectively, $p > .05$). The rates of ectopic pregnancy (0.8 versus 3.1%), twin delivery (19.6 versus 27.4%) and term birth (69.7 versus 78.5%) showed no significant differences ($p > .05$). No stillbirth was recorded.

The perinatal outcomes were summarized in Table 3. For singletons, no significant differences for gestational ages at delivery (38.11 ± 1.90 versus 38.52 ± 1.94, $p > .05$), birthweight (3.24 ± 0.60 versus 3.33 ± 0.54 kg, $p > .05$) or birth length (50.47 ± 2.33 versus 50.06 ± 2.40 cm, $p > .05$) were observed between the two groups. However, for twins in unicornuate uterus group, higher preterm birth rate (55.0 versus 34.4%, $p = .038$) was discovered, 81.8% (18/22) of whom were delivered at 32–36^{+6} gestational weeks. Besides, the twins had lower average birthweight (2.33 ± 0.59 versus 2.69 ± 0.38 kg, $p = .027$), lower birth length (45.33 ± 2.58 versus 48.88 ± 2.09 cm, $p = .003$), as well as higher rate of very low birthweight (13.2% versus 0, $p = .007$) compared to those in the control group.

The rates of congenital anomaly for both twins and singletons seemed higher in unicornuate uterus group

Table 2. Comparison of pregnancy outcomes between women with unicornuate uterus and controls.

	Unicornuate	Control	*p* value
Cycle cancelation rate	27/329 (8.2)	22/390 (5.6)	.174
Pregnancy rate	162/302 (53.6)	194/368 (52.7)	.811
Clinical pregnancy rate	125/302 (41.4)	160/368 (43.5)	.587
Live birth rate	102/302 (33.8)	117/368 (31.8)	.586
Total pregnancy loss rate	57/302 (18.9)	64/368 (17.4)	.620
Biochemical pregnancy rate	37/162 (22.8)	34/194 (17.5)	.211
Miscarriage rate	20/125 (16.0)	30/160 (18.8)	.545
Early <12 GW	13/20 (65.0)	25/30 (83.3)	.182
Late 12–27 + 6 GW	7/20 (35.0)	5/30 (16.7)	.182
Ectopic pregnancy rate	1/125 (0.8)	5/160 (3.1)	.235
Twin delivery rate	20/102 (19.6)	32/117 (27.4)	.179
Term delivery rate	85/122 (69.7)	117/149 (78.5)	.096

NS: not significant;
Values are number *n* (%).

Table 3. Perinatal outcomes of twins and singletons between unicornuate uterus group and controls.

	Singleton and twins			Singletons			Twins		
	Unicornuate ($n = 122$)	Control ($n = 149$)	p value	Unicornuate ($n = 82$)	Control ($n = 85$)	p value	Unicornuate ($n = 40$)	Control ($n = 64$)	p value
GA at delivery	37.27 ± 2.49	37.74 ± 2.05	.097	38.11 ± 1.90	38.52 ± 1.94	.170	35.56 ± 2.68	36.71 ± 1.73	.019
$<36^{+6}$ weeks	37/122 (30.3)	32/149 (21.5)	.096	15/82 (18.3)	10/85 (11.8)	.237	22/40 (55.0)	22/64 (34.4)	.038
$<31^{+6}$ weeks	6/122 (4.9)	4/149 (2.7)	.353	2/82 (2.4)	2/85 (2.4)	.971	4/40 (10.0)	2/64 (3.1)	.201
Birth weight[a], kg	2.95 ± 0.73 (1.1–4.7)	3.06 ± 0.57 (1.8–4.6)	.182	3.24 ± 0.60 (1.5–4.7)	3.33 ± 0.54 (1.5–4.6)	.304	2.33 ± 0.58 (1.1–3.3)	2.69 ± 0.38 (1.8–3.5)	.001
<2.5 kg	23/116 (19.8)	21/142 (14.8)	.284	6/78 (7.7)	5/82 (6.1)	.690	17/38 (44.7)	16/60 (26.7)	.065
<1.5 kg	5/116 (4.3)	0/142	.018	0/78	0/82	—	5/38 (13.2)	0/60	.007
Birth length, cm	49.52 ± 3.08 (42–58)	49.62 ± 2.34 (38–55)	.825	50.47 ± 2.33 (45–58)	50.06 ± 2.40 (38–55)	.362	45.33 ± 2.46 (42–50)	48.88 ± 2.06 (45–54)	.000
Congenital anomaly	3/122 (2.5)	1/149 (0.7)	.330	2/82 (2.4)	1/85 (1.2)	.616	1/40 (2.5)	0/32	.385

Values are number n (%) or mean ± SD (minimum to maximum).
NS: not significant; GA: gestational age.
[a]Data of six neonates in unicornuate group and seven in controls were missed.

(5.0% versus 0, 2.4 versus 1.2%), but without statistical significance ($p > .05$). Among the twins, a boy with inguinal hernia was found in unicornuate uterus group; no congenital defect was found in controls. Among the singletons, a girl with knee valgus and a boy with hydrocele in unicornuate uterus group were found, and a girl with hemangioma at the left knee joint was found in controls.

Discussion

The data in this study revealed that unicornuate uterus had no obvious adverse effects on pregnancy and perinatal outcomes for women with singletons after IVF/ICSI cycles. However, twin delivery in unicornuate uterus was associated with increased risk of prematurity and low birthweight.

According to our results, the pregnancy rate between women with unicornuate uterus and controls showed no significant differences, which was consistent with previous studies [7,8,19,20]. In addition, the ectopic pregnancy rate (0.8%, 1/125) of women with unicornuate uterus in this study was similar to the incidence in general population [16]. This indicated that unicornuate uterus may not interfere with embryo implantation or compromise early embryo development.

The miscarriage rate in unicornuate group was 16.0%, not higher than the controls. When stratified by early and late miscarriage, there was still no significant difference. Our results were in consistency with a recent report, indicating no increase in clinical pregnancy loss rate for unicornuate uterus after ICSI treatment [8]. In another cohort study, the late miscarriage rate was similar between unicornuate uterus group and controls whereas the early miscarriage rate was significantly higher [7]. Venetis et al. [17] found an increased risk of combined (first trimester, second trimester, or both) but not separate first or second trimester miscarriage for unicornuate uterus. Possible explanation for the discrepancy among studies may be inconsistent definitions and classifications of miscarriage, diagnostic techniques, as well as heterogeneity of studied populations.

In this study, there were no significant differences in preterm birth rate between the two groups; however, the gestational age at delivery in unicornuate uterus was lower compared to controls. Li et al. [7] found increased risks of preterm birth both before 37 and 32 gestational weeks for unicornuate uterus, while a recent meta-analysis reported preterm birth risks before gestation week 37, but not 28 [17]. Abnormal blood flow, limited internal space, and cervical incompetency have been suggested to affect pregnancy maintenance in unicornuate uterus [16,21]. Meanwhile, unicornuate uterus may often be associated with ovary or kidney agenesis, or vaginal anomalies [1]; any coexisting pathophysiologies may increase the risk for adverse reproductive outcomes. Future studies with details of the above issues and large sample sizes may help explain the discrepancy.

To further pinpoint the effects of unicornuate uterus on perinatal outcomes, our data stratified singleton and twin neonates. For singletons, there were no differences in preterm birth rate, average birthweight, and rate of congenital anomalies between the two groups. However, the twins' average birthweight and birth length were significantly lower. They were also associated with a significant increase of preterm birth and very low birthweight. The adverse impact of unicornuate uterus on perinatal outcomes for twin delivery was corroborated by previous studies [7,22,23].

This suggested that with development of only half uterine musculature, the gestational capacity was jeopardized in unicornuate uterus. Though most singletons can be carried to term, twin pregnancy may face more challenges, especially in the third trimester.

There have been reports that twin pregnancies in unicornuate uterus were reduced to singletons for better outcomes [24]. However, reduced singletons still had an increased risk of adverse obstetric outcome compared to primary singletons [25]. In addition, decisions to reduce pregnancies are difficult or even unacceptable for patients, especially infertile couples [26]. Thus, elective single embryo transfer is recommended for women with unicornuate uterus undergoing IVF/ICSI treatment.

Our study offered the following strengths. A relative large sample size was enrolled. The comprehensive database allowed us to analyze stratified perinatal outcomes. The combined diagnostic procedures for assessing uterus anomalies guaranteed that the particular subtype was accurately determined [27]. The control group was strictly matched with the studied patients to exclude confounding factors.

Some limitations also existed for this research. This was a retrospective study. All patients were from one IVF center. There might be a potential for selection bias or incorrect reports regarding history data. Besides, isolated unicornuate uterus constituted the major proportion of our cohort, different from some of the published data [10,11]. Further studies may be warranted to investigate the perinatal outcomes of each unicornuate uterus subgroup. Meanwhile, prospective research with large sample size is necessary to verify the adverse outcomes for twin delivery identified in this study.

In conclusion, the presence of unicornuate uterus was not associated with adverse pregnancy or perinatal outcomes for women conceiving one fetus. However, unicornuate uterus increases risks of preterm birth and low birthweight for twin deliveries. Selected single embryo transfer should be considered optimal for women with unicornuate uterus undergoing IVF/ICSI treatment.

Acknowledgements

The authors thank the 320 women for their participation in this study.

Disclosure statement

The authors report no conflicts of interest.

Funding

This work was supported by the National Natural Science Foundation of China under grant [81522018, 81471509, and 81270662], Shandong Provincial Natural Science Foundation of China under grant [ZR2014HQ040] and Young Scholars Program of Shandong University under grant [2016WLJH26].

References

[1] Grimbizis GF, Gordts S, Di Spiezio Sardo A, et al. The ESHRE/ESGE consensus on the classification of female genital tract congenital anomalies. Hum Reprod. 2013; 28:2032–2044.

[2] Chan YY, Jayaprakasan K, Tan A, et al. Reproductive outcomes in women with congenital uterine anomalies: a systematic review. Ultrasound Obstet Gynecol. 2011;38:371–382.

[3] Hua M, Odibo AO, Longman RE, et al. Congenital uterine anomalies and adverse pregnancy outcomes. Am J Obstet Gynecol. 2011;205:558.e1–558.e5.

[4] Sugiura-Ogasawara M, Ozaki Y, Suzumori N. Mullerian anomalies and recurrent miscarriage. Curr Opin Obstet Gynecol. 2013;25:293–298.

[5] Grimbizis GF, Camus M, Tarlatzis BC, et al. Clinical implications of uterine malformations and hysteroscopic treatment results. Hum Reprod Update. 2001; 7:161–174.

[6] Khati NJ, Frazier AA, Brindle KA. The unicornuate uterus and its variants: clinical presentation, imaging findings, and associated complications. J Ultrasound Med. 2012;31:319–331.

[7] Li X, Ouyang Y, Yi Y, et al. Pregnancy outcomes of women with a congenital unicornuate uterus after IVF-embryo transfer. Reprod Biomed Online. 2017; 35:583–591.

[8] Ozgur K, Bulut H, Berkkanoglu M, et al. Reproductive outcomes of IVF patients with unicornuate uteri. Reprod Biomed Online. 2017;34:312–318.

[9] Chan YY, Jayaprakasan K, Zamora J, et al. The prevalence of congenital uterine anomalies in unselected and high-risk populations: a systematic review. Hum Reprod Update. 2011;17:761–771.

[10] Heinonen PK. Unicornuate uterus and rudimentary horn. Fertil Steril. 1997;68:224–230.

[11] Akar ME, Bayar D, Yildiz S, et al. Reproductive outcome of women with unicornuate uterus. Aust N Z J Obstet Gynaecol. 2005;45:148–150.

[12] Liu J, Wu Y, Xu S, et al. Retrospective evaluation of pregnancy outcomes and clinical implications of 34 Han Chinese women with unicornuate uterus who received IVF-ET or ICSI-ET treatment. J Obstet Gynaecol. 2017;37:1020–1024.

[13] Jayaprakasan K, Chan YY, Sur S, et al. Prevalence of uterine anomalies and their impact on early pregnancy in women conceiving after assisted reproduction treatment. Ultrasound Obstet Gynecol. 2011;37: 727–732.

[14] Brody JM, Koelliker SL, Frishman GN. Unicornuate uterus: imaging appearance, associated anomalies, and clinical implications. Am J Roentgenol. 1998;171: 1341–1347.

[15] Moutos DM, Damewood MD, Schlaff WD, et al. A comparison of the reproductive outcome between women with a unicornuate uterus and women with a didelphic uterus. Fertil Steril. 1992;58:88–93.
[16] Reichman D, Laufer MR, Robinson BK. Pregnancy outcomes in unicornuate uteri: a review. Fertil Steril. 2009;91:1886–1894.
[17] Venetis CA, Papadopoulos SP, Campo R, et al. Clinical implications of congenital uterine anomalies: a meta-analysis of comparative studies. Reprod Biomed Online. 2014;29:665–683.
[18] Marcus S, al-Shawaf T, Brinsden P. The obstetric outcome of in vitro fertilization and embryo transfer in women with congenital uterine malformation. Am J Obstet Gynecol. 1996;175:85–89.
[19] Fox NS, Roman AS, Stern EM, et al. Type of congenital uterine anomaly and adverse pregnancy outcomes. J Matern Fetal Neonatal Med. 2014;27:949–953.
[20] Shim S, Hur YM, Kim DH, et al. Evidence for no significant impact of Mullerian anomalies on reproductive outcomes of twin pregnancy in Korean women. Twin Res Hum Genet. 2016;19:146–153.
[21] Lekovich J, Stewart J, Anderson S, et al. Placental malperfusion as a possible mechanism of preterm birth in patients with Mullerian anomalies. J Perinat Med. 2017;45:45–49.
[22] Heinonen PK. Twin pregnancy in the congenital malformed uterus. J Obstet Gynaecol. 2016;36:571–573.
[23] Fox NS, Roman AS, Saltzman DH, et al. Twin pregnancy in patients with a uterine anomaly. J Matern Fetal Neonatal Med. 2014;27:360–364.
[24] Gupta S, Fox NS, Feinberg J, et al. Outcomes in twin pregnancies reduced to singleton pregnancies compared with ongoing twin pregnancies. Am J Obstet Gynecol. 2015;213:580.e1–580.e5.
[25] Chen QL, Ye H, Ding XY, et al. Retrospective analysis of outcomes of selectively or spontaneously reduced multiple pregnancies out of 6 917 in vitro fertilization-embryo transfer pregnancy cycles. Zhonghua Fu Chan Ke Zhi. 2017;52:159–163.
[26] L Klitzman R. Reducing the number of fetuses in a pregnancy: providers' and patients' views of challenges. Hum Reprod. 2016;31:2570–2576.
[27] Saravelos SH, Cocksedge KA, Li TC. Prevalence and diagnosis of congenital uterine anomalies in women with reproductive failure: a critical appraisal. Hum Reprod Update. 2008;14:415–429.