**Outcome in a series of 1135 twin pregnancies: does the type of conception play a role?**

Pilar Prats, MD, PhD; Janire Zarragoitia, MD; María Ángeles Rodríguez, MD, PhD; Ignacio Rodriguez, Msc; Francisca Martinez, MD, PhD; Alberto Rodríguez-Melcon, MD; Bernat Serra, MD

**BACKGROUND:** The rate of twin pregnancies conceived via assisted reproductive technology has increased markedly in recent years. The elevated number of multiple pregnancies is the most serious and frequent complication of assisted reproductive technology. Twin pregnancies are associated with higher rates of obstetrical complications, preterm delivery, and perinatal morbidity and mortality than singleton pregnancies.

**OBJECTIVE:** This study aimed to investigate the association between the mode of conception and obstetrical and perinatal outcomes in twin pregnancies, adjusting for parity, age, and chorionicity.

**STUDY DESIGN:** This was a retrospective cohort study of 1135 twin pregnancies between May 2006 and April 2021. All spontaneous (n=369) and assisted reproductive technology—conceived (n=766) twin pregnancies with antenatal care and delivery in the Universitari Quiron-Dexeus Hospital, Barcelona, Spain, a tertiary obstetrical care center, were studied according to chorionicity.

**RESULTS:** The mean maternal age was higher among assisted reproductive technology twin pregnancies than among naturally conceived ones, and there were also less parous women in the assisted reproductive technology twin group. The global survival rates in both groups of twins were practically identical, namely 744 of 766 (97.1%) assisted reproductive technology twins and 357 of 369 (96.8%) spontaneously conceived twins. Patients with dichorionic assisted reproductive technology twins had a higher incidence of gestational diabetes (relative risk, 1.69; 95% confidence interval, 1.10–2.59) and gestational hypertension or preeclampsia (relative risk, 2.75; 95% confidence interval, 1.60–4.729). Monochorionic diamniotic assisted reproductive technology twins had a higher risk for gestational diabetes (relative risk, 4.12; 95% confidence interval, 1.35–12.56). We analyzed the gestational age at delivery, onset of labor, type of delivery, rate of preterm births, weight discordance, rate of small for gestational age neonates and intrauterine growth restriction, and admission to the neonatal intensive care unit. We could not find any statistical differences between monochorionic diamniotic assisted reproductive technology twins and spontaneously conceived twins. Among dichorionic twins, those conceived by assisted reproductive technology had an earlier gestational age at delivery (36.3±2.29 vs 36.6±2.12; P<.05) and we found statistical differences in the onset of labor with more cesarean deliveries (relative risk, 1.27; 95% confidence interval, 1.06–1.51). When adjusting for confounding factors (maternal age, parity, chorionicity), the type of conception remained an independent risk factor for gestational hypertension and preeclampsia but not for gestational diabetes or cesarean delivery.

**CONCLUSION:** Pregnancy outcomes are comparable between assisted reproductive technology and spontaneously conceived twins, and when adjusted for confounding factors, only the risk for gestational hypertension and preeclampsia remained increased in the assisted reproductive technology group.

**Key words:** assisted reproductive techniques, chorionicity, obstetrical complications, outcome, perinatal morbidity, twins

**Introduction**

In the past 3 decades, assisted reproductive technologies (ARTs) have become a real option for the treatment of human infertility worldwide. Pressure to achieve high pregnancy rates with ART has been one of the main reasons for the transfer of more than 1 embryo in infertility treatments. Therefore, the rate of twin pregnancies conceived via ART have increased markedly in recent years.1,2

The elevated number of multiple pregnancies is the most serious and frequent complication of ART. Twin
Twin pregnancies have worse outcomes than singleton pregnancies. Whether the type of conception plays a role in this risk is not very clear. This study aimed to provide an accurate risk prediction for twin pregnancies conceived by assisted reproductive technology (ART).

Key findings

The risk for gestational hypertension or preeclampsia was increased among those in the ART twin group.

What does this add to what is known?

An accurate protocol and strict follow-up in twin pregnancies better the perinatal outcomes of these pregnancies independently of their type of conception. Special concerns should be focused on the screening and early diagnosis of gestational hypertension and preeclampsia in ART-conceived twin pregnancies.

These inconsistent findings could be explained by differences in the study population, different protocols in the management of twin pregnancies, and especially whether or not chorionicity was considered as a cofounding factor.

This study aimed to investigate the association between mode of conception and obstetrical and perinatal outcomes in twin pregnancies with adjustment for parity, age, and chorionicity.

Materials and Methods

This was a retrospective analysis of data obtained from women undergoing a routine ultrasound examination at 11 to 13 weeks' gestation in the Department of Obstetrics, Gynecology and Reproductive Medicine at the Universitari Quiron-Dexeus Hospital, Barcelona, Spain, from May 1, 2006 to April 30, 2021.

The inclusion criteria for this study were dichorionic (DC) and monochorionic diamniotic (MCDA) twin pregnancies conceived by means of ART or spontaneously with 2 live fetuses at 11 to 13.6 weeks' gestation and a complete follow-up history and delivery in our hospital. We excluded twin pregnancies with chromosomal abnormalities or major defects diagnosed prenatally or postnatally. We also excluded the monochorionic monoamniotic twin pregnancies in this study because the number of cases in our series was very low (6 cases).

Baseline maternal characteristics (maternal age, weight, height, ethnicity, parity, smoking habit) and the mode of conception were collected from our medical records. The ART group included different infertility treatments (in vitro fertilization [IVF], IVF with intracytoplasmic sperm injection [ICSI], intrauterine insemination [IU], and ovulation induction). At the 11- to 13-week scan, gestational age was determined by measurement of the crown-rump length of the larger twin, and chorionicity was determined from the number of placentas and the presence or absence of the lambda sign at the intertwin membrane-placenta junction. All ultrasound examinations were carried out by expert obstetricians skilled in prenatal ultrasound.

After the 11- to 13+6-week scan, patients were scanned from 16 weeks onward at 4-week intervals in the case of DC twins and at 2-week intervals until delivery in the case of MCDA twins. We recommended delivery at 38 to 39 weeks' gestation for DC twins and at 37 to 38 weeks for MCDA twins if there were no pregnancy complications.

Data on obstetrical complications (gestational diabetes, hypertensive disorders and preeclampsia [PE], placenta previa, placental abruption) and pregnancy outcomes (abortion, survival of one or both twins, fetal loss <24 weeks' gestation, stillbirth or neonatal death, gestational age at delivery or fetal death, labor onset, type of delivery, birthweight) of the 2 study groups (spontaneously conceived twins vs ART-conceived twins) were collected from the electronic medical records.

A diagnosis of gestational diabetes was based on the National Diabetes Data Group criteria. PE was defined according to the International Society for the Study of Hypertension in Pregnancy criteria. Gestational hypertension was defined as a systolic blood pressure ≥140 mm Hg and/or diastolic blood pressure ≥90 mm Hg without significant proteinuria. Placenta previa was diagnosed by transvaginal ultrasound when the placental edge overlapped or if it was within 2 cm of the internal cervical os in late pregnancy. Placental abruption was defined as the premature detachment of the placenta from the uterine wall before birth and after 20 weeks of gestation. Abortion was defined as pregnancy loss before 20 weeks of gestational age. Stillbirth was defined as an intrauterine fetal demise of a fetus >500 g and/or ≥24 weeks of gestation. Neonatal death was defined as the death of a child during the first 28 days after birth. Small for gestational age (SGA) was defined as a birthweight <10th percentile, and intrauterine growth restriction (IUGR) was defined as a birthweight <third percentile based on our own twin curves. Preterm uterine contraction was defined as regular uterine contractions with shortening of the cervical length or disclosure that required tocolytic treatment. Preterm birth was defined as delivery before 37 weeks' gestation.
Statistical analysis
Means and standard deviations were used for continuous variables, and percentages and numbers were used for categorical variables. Continuous variables were compared between the groups using t tests or Wilcoxon Mann-Whitney tests according to normality criteria. The chi-square test or Fisher exact test was applied to compare categorical variables.

The cumulative risk for fetal loss during pregnancy was compared between ART and spontaneous twins using a Kaplan-Meier analysis and a log-rank (Mantel-Cox) test.

Logistic regression models were used to estimate the associations among the type of twin pregnancies, the mode of conception, and the presence of gestational diabetes, gestational hypertensive disorders, preterm deliveries, placenta previa, and cesarean delivery adjusted for maternal age and parity.

A P value <.05 was considered statistically significant for all comparisons. Statistical analyses were performed using R software (R Core Team, Vienna, Austria).28

Ethical approval
This study was approved by our institutional review board under number 022020012902 (Catedra de Obstetricia y Ginecologia de la UAB).

Results
A total of 1135 twin pregnancies fulfilled the inclusion criteria, including 766 ART (67.5%) and 369 (32.5%) naturally conceived twins. Of all the twins included, 136 (12%) were MCDA twin pregnancies and 999 (88%) were DC twin pregnancies. Moreover, 73.7% of the DC twins were conceived by ART, and 22% of the MCDA twins (P<.001) (Table 1).

Demographic characteristics of the study population are described in Table 2. The mean maternal age was higher in ART twin pregnancies than in naturally conceived ones, and there were also less parous women in the ART twin group (P<.001).

The global survival rates in both groups of twins were practically identical, namely 744 of 766 (97.1%) ART twins and 357 of 369 (96.8%) spontaneously conceived twins. Intrauterine demise of both fetuses before 24 weeks’ gestation occurred in 15 (1.96%) ART twin pregnancies and in 6 (1.63%) spontaneously conceived twin pregnancies. There were no cases of intrauterine death of both fetuses from 24 weeks’ gestation onward. When evaluating the mortality rates based on chorionicity, no statistical differences were found between the 2 study groups (Table 3).

We studied the accumulative risk for fetal loss during pregnancy between the ART and spontaneous twin pregnancies using a Kaplan-Meier analysis (Figure). Survival curves were similar in both groups (P=.76).

In Table 4, we show the incidence of obstetrical complications by method of conception. DC ART twin pregnancies had a higher incidence of gestational diabetes (relative risk [RR], 1.69; 95% confidence intervals [CI], 1.10–2.59) and gestational hypertension or preeclampsia (RR, 2.75; 95% CI, 1.60–4.729). MCDA ART twins had a higher risk for gestational diabetes (RR, 4.12; 95% CI, 1.35–12.56).

We studied the perinatal outcomes for ART and spontaneous twin pregnancies with adjustment for chorionicity. We analyzed the gestational age at delivery, onset of labor, type of delivery, rate of preterm births, weight discordance, rate of SGA and IUGR, and admission to the neonatal intensive care unit (NICU). We could not find any statistical differences between MCDA ART and spontaneously conceived twins. Among DC twins, those conceived by ART had an earlier gestational age at delivery (36.3±2.29 vs 36.6±2; P<.05), and we found statistically significant differences in the onset of labor with more cesarean deliveries (1.27; 95% CI, 1.06–1.51). We found similar results in terms of the rate of preterm birth, weight discordance, rate of SGA neonates and IUGR, and admission to the NICU among DC twins when stratified according to type of conception (Table 5).

When adjusting for cofounding factors (maternal age, parity, and chorionicity), the type of conception remained an independent risk factor for gestational hypertension and preeclampsia but not for gestational diabetes or cesarean delivery. We could not include placenta previa in the analysis because the number of cases was low (n=18) (Table 6).

Monochorial complications were diagnosed in 17 cases (12.5%), including 8 cases of twin-to-twin transfusion

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**TABLE 1**

| Flowchart describing twin pregnancies included in the study |
|-----------------------------------------------------------|
| Twin pregnancies N=1135 |
| ART N=766 |
| DC N=736 |
| MCDA N=30 |
| Spontaneous N=369 |
| DC N=263 |
| MCDA N=106 |

ART, assisted reproductive technology; DC, dichorionic; MCDA, monochorionic diamniotic.

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syndrome (TTTS) (5.8%) and 9 cases of selective IUGR (6.6%). Of those, 7 of 8 and 8 of 9 cases of TTTS and selective IUGR, respectively, were among spontaneously conceived MCDA twin gestations.

**Discussion**

Nowadays, ART is a standard and widespread practice. Because of the transfer of 2 or more embryos to maximize the possibility of obtaining a healthy newborn, the rate of twin pregnancies has increased. As is commonly known, twin pregnancies are associated with high obstetrical and perinatal risks. Therefore, there are strong recommendations about preconception counseling and the transfer of only a single embryo. Couples using ART have special concerns because of their fertility history and generally more advanced age. Having information regarding their personalized risk associated with ART twin pregnancies regardless of the type of placentation is highly valued by them.

We report pregnancy outcomes for a series of 1135 twin pregnancies. In our population, 67.5% (766/1135) of the twin pregnancies were conceived by ART and 88% (999/1135) were DC twin pregnancies. As expected, most of the ART twins were DC (96% DC twins vs 4% MCDA twins; P<.005). Global survival rates were similar in the ART and spontaneous twin pregnancies (97.1% vs 96.8%). Obstetrical complications, such as placenta previa, pregnancy-induced hypertension or preeclampsia, and gestational diabetes mellitus were more common in the ART cohort. In the DC twin group, patients were more likely to deliver earlier and by cesarean delivery if the twin pregnancy was conceived by ART. However, when adjusting for age, parity, and chorionicity, ART conception remained an independent risk factor.

### TABLE 2
Demographic characteristics of our study population according to the type of conception

| Characteristics          | ART (n=766) | Spontaneous (n=369) | P value |
|--------------------------|-------------|---------------------|---------|
| Maternal age at US       | 36.9 (4.71) | 34.1 (3.68)         | <.001*  |
| GA (wk)                  | 12.5 (0.58) | 12.6 (0.57)         | <.001*  |
| Weight (kg)              | 62.2 (10.5) | 62.8 (11.0)         | .416*   |
| Height (cm)              | 164 (8.18)  | 164 (6.36)          | .272*   |
| Racial origin            |             |                     | .796b   |
| White                    | 690 (96.8%) | 334 (96.3%)         |         |
| Other                    | 23 (3.23%)  | 13 (3.75%)          |         |
| Smokers                  | 56 (7.87%)  | 27 (7.80%)          | 1.00b   |
| Parity                   |             |                     | <.001b  |
| Nulliparous              | 620 (80.9%) | 206 (55.8%)         |         |
| Parous                   | 146 (19.1%) | 163 (44.2%)         |         |
| Chorionicity             |             |                     | <.001b  |
| DC                       | 736 (96.1%) | 263 (71.3%)         |         |
| MCDA                     | 30 (3.92%)  | 106 (28.7%)         |         |

The data are presented as mean ± standard derivation or number (percentage).

ART, assisted reproductive technology; DC, dichorionic; GA, gestational age; MA, maternal age; MCDA, monochorionic diamniotic; US, ultrasound.

* Statistical differences determined using t tests; † Statistical differences determined using chi-square tests.

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### TABLE 3
Fetal demise rates in twin pregnancies in the 2-group study as it relates to chorionicity

| Outcome                | DC (n=999)        | Spontaneous (n=263) | P value | RR (95% CI)       |
|------------------------|-------------------|---------------------|---------|-------------------|
| ART (n=736)            |                   |                     |         |                   |
| Fetal death <24 wk     |                   |                     | .311    |                   |
| 1 twin                 | 5 (0.68%)         | 4 (1.52%)           | 0.44    | (0.120−1.65)      |
| Both twins             | 15 (2.04%)        | 3 (1.14%)           | 1.78    | (0.52−6.12)       |
| Fetal death <24 wk     |                   |                     | 1.00    |                   |
| 1 twin                 | 20 (2.72%)        | 7 (2.66%)           | 1.02    | (0.43−2.38)       |
| Perinatal death >24 wk |                   |                     | 1.00    |                   |

| Outcome                | MCDA (n=136)      | Spontaneous (n=106) | P value | RR (95% CI)       |
|------------------------|-------------------|---------------------|---------|-------------------|
| ART (n=30)             |                   |                     |         |                   |
| Fetal death <24 wk     |                   |                     | 1.00    |                   |
| 1 twin                 | 2 (0.68%)         | 4 (1.52%)           | 1.42    | (0.30−6.68)       |
| Perinatal death >24 wk |                   |                     | 1.00    |                   |
| 1 twin                 | 8 (1.09%)         | 1 (3.33%)           | 1.42    | (0.30−6.68)       |

**ART**, assisted reproductive technology; CI, confidence interval; DC, dichorionic; MCDA, monochorionic diamniotic; RR, relative risk.

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only for gestational hypertension and preeclampsia.

It is known that monochorionic twins have worse pregnancy outcomes than DC twins, irrespective of mode of conception. In the literature, we found different studies in which the obstetrical and neonatal outcomes of DC and MCDA twins were compared. However, some series had small numbers and/or also included fetuses with anatomic abnormalities. In 2020, Litwinska et al reported that MCDA twin pregnancies had a higher rate of fetal loss <24 weeks’ gestation and >24 weeks’ gestation than DC twin pregnancies (7.7% vs 2.3% and 2.5% vs 1%, respectively). Our results on DC twin pregnancies were similar to those reported by Litwinska et al. However, our rate of fetal loss <24 weeks’ gestation among MCDA twin pregnancies was lower (2.9%). In twin pregnancies, the assessment of chorionicity and amniocity in the first or early second trimester is essential to properly plan the pregnancy management and to offer accurate counseling. We presume that because all our MCDA twin pregnancies were diagnosed during the first trimester, our low rate of fetal loss among the MCDA twins is likely because of the early diagnosis, proper management, and endoscopic laser surgery for severe early TTTS and/or selective IUGR.

With the increasing number of twin pregnancies caused by the increase in ART use, the question on whether twin pregnancies conceived by ART should be considered at higher risk than those conceived spontaneously arises.

In terms of maternal complications, some studies reported comparable maternal outcomes for ART and spontaneously conceived twin pregnancies, and some reported that maternal complications (gestational diabetes, pregnancy-induced hypertension, placenta previa, etc.) were significantly more common in ART pregnancies, although most of the complications were related to maternal age. A meta-analysis published in 2016 reported that in ART DC twins, most maternal complications were similar in the 2 groups and only placenta

| TABLE 4 |
| Obstetrical complications in ART and spontaneously conceived twins adjusted by chorionicity |

| Obstetrical condition | DC (n=999) | | | MCDA (n=136) | |
|----------------------|-----------|----------------|---------------|-----------|----------------|
|                      | ART (n=736) | Spontaneous (n=263) | P value | RR (95% CI) | ART (n=30) | Spontaneous (n=106) | P value | RR (95% CI) |
| Placenta previa       | 18 (2.50)  | 0 (0.00)         | .006      | —          | 0 (0.00)  | 0 (0.00)         | —       | —          |
| Placental abruption   | 5 (0.69)   | 0 (0.00)         | 1.00      | 1.80 (0.21—15.36) | 0 (0.00)  | 0 (0.00)         | —       | —          |
| Gestational diabetes mellitus | 108 (15.0) | 23 (8.85) | .017 | 2.75 (1.60—4.72) | 6 (20.0) | 5 (4.85) | .016 | 4.12 (1.35—12.56) |
| Gestational hypertension and preeclampsia | 107 (14.8) | 14 (5.38) | <=.001 | 2.75 (1.60—4.72) | 4 (13.3) | 7 (6.80) | .267 | 1.96 (0.61—6.25) |
| Preterm delivery <37 wk | 345 (47.9) | 112 (43.1) | .211 | 1.11 (0.94—1.30) | 21 (70.0) | 76 (73.8) | .859 | 0.94 (0.73—1.23) |

*ART, assisted reproductive technology; CI, confidence interval; DC, dichorionic; MCDA, monochorionic diamniotic; RR, relative risk.*

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The data are presented as mean ± standard deviation or number (percentage).

ART, assisted reproductive technology; DC, dichorionic; GA, gestational age; IUGR, intrauterine growth restriction; MA, maternal age; NICU, neonatal intensive care unit; SGA, small for gestational age.

a Values are compared with spontaneous DC twin pregnancies; significance is indicated by P<.05.

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ART groups. In our series, the risk for hypertensive complications in singleton pregnancies, leading to higher incidence in multiple pregnancies than in singleton pregnancies, was smaller. This was likely because gestational hypertension and preeclampsia are known to have a higher prevalence in multiple pregnancies than in singleton pregnancies, leading to higher risks for hypertensive complications in both the spontaneous conception and ART groups. In our series, the increased risk for gestational hypertension and preeclampsia was 1.93 (RR, 1.93; 95% CI, 1.13–3.44) for ART twin pregnancies. If we compare our results with the meta-analysis conducted by Qin in 2015, their slightly lower RR (1.13; 95% CI, 1.02–1.26) could be explained by the inclusion of other fertility treatments, such as ovulation induction and IU, in the control group, potentially underestimating the risk of IVF and ICSI on the outcome. Although the mechanism by which ART increases the risk for preeclampsia remains unknown, there exists a great body of literature in which potential causes were studied and identified, including baseline maternal characteristics (advanced maternal age, obesity, and medical comorbidities) and the underlying infertility diagnosis. The differences observed in singleton pregnancies in the outcomes between fresh-embryo transfer, frozen-embryo transfer, or oocyte donation also suggested a potential role of the procedure on the development of hypertensive complications. Various recent publications have studied the role of the corpus luteum in the development of hypertensive disorders of pregnancy and how its absence could be associated with an increased risk for hypertensive disorders and preeclampsia during pregnancy. In terms of neonatal outcomes (preterm delivery, SGA, IUGR, stillbirth, fetal loss, congenital malformations), Hack et al concluded that spontaneously conceived twins had worse neonatal outcomes than twins conceived via ART. These authors did not distinguish between DC or MCDA twins and their results could be explained by the greater proportion of MCDA twins in the spontaneously conceived group. On the contrary, another study concluded that ART DC twins had poorer neonatal outcomes. Our results are in concordance with the ones reporting that neonatal risks are not increased in the ART group. Our rates of preterm deliveries, stillbirths, SGA, IUGR, and fetal loss were not significantly different between the 2 study groups.

Finally, some authors also found differences in the mode of delivery between the 2 twin groups, with a higher proportion of elective cesarean deliveries conducted in the ART group. Our cesarean delivery rate was higher in the ART DC twin group than in the spontaneously conceived pregnancies. We believe that this higher rate of cesarean delivery in the ART group might be caused by excessive caution and concern for delivery complications both by the obstetricians and patients. We presumed that the substantial heterogeneity in the results found in the literature may be caused by the differences in the different geographic regions owing to differences in the obstetrical management of twin pregnancies, ethnic backgrounds, socioeconomic situations, maternal education, food and life habits, ART procedures and prenatal care services, and whether or not DC and MCDA twin pregnancies were assessed separately.

The main strength of our study is the size of the study population of twins without major abnormalities. Our series is one of the largest ones reported in a single center in Europe and over a relatively short and recent period of time, with homogeneous management, follow-up, and delivery and with accurate data collection. The main limitation of this study was that it was a retrospective study with an inherent risk of bias. Another limitation is that the mode of ART pregnancy was not analyzed separately by ART technique, that is, whether the endometrium was under gonadotropin stimulation (IVF), hormone substitutive therapy (frozen-embryo transfer or oocyte donation), or natural menstrual cycle.

Conclusion

Pregnancy outcomes were comparable between ART and spontaneously conceived twins, and when adjusting by main confounding factors, only the risk for gestational hypertension and preeclampsia was increased in the ART group. We hope that these data are useful in counseling parents on the outcomes of their twin pregnancy. The design of

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**TABLE 6**

Multivariable logistic regression analysis of obstetrical outcomes and type of conception for main confounding factors in twin pregnancies

| Confounding factor      | Gestational diabetes mellitus (aOR 95% CI) | EHE/PE (aOR 95% CI) | Cesarean delivery (aOR 95% CI) |
|-------------------------|--------------------------------------------|---------------------|-------------------------------|
| Parity                  | 1.13 (0.74–1.75)                           | 2.45 (1.47–4.31)    | 1.46 (1.08–1.97)              |
| Age                     | 1.13 (1.09–1.18)                           | 1.07 (1.03–1.12)    | 1.08 (1.05–1.12)              |
| ART vs spontaneous      | 1.37 (0.84–2.30)                           | 1.93 (1.13–3.44)    | 1.33 (0.98–1.81)              |
| DC vs MCDA              | 0.86 (0.41–1.66)                           | 1.06 (0.50–2.09)    | 1.13 (0.75–1.72)              |

The reference group is spontaneous pregnancy. The results were adjusted for parity, maternal age, and chorionicity.

aOR, adjusted odds ratio; ART, assisted reproductive techniques; CI, confidence interval; DC, dichorionic; EHE/PE, gestational hypertension/preeclampsia.

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proper strategies for better surveillance, follow-up, and management of twin pregnancies have been proven to reduce their risks and to improve their outcome.

ACKNOWLEDGMENTS

Under the auspices of the Cátedra d’ Investigació en Obstetrícia i Ginecologia de la Universitat Autònoma de Barcelona.

REFERENCES

1. Moini A, Shiva M, Arabipoor A, Hosseini R, Chehrazi M, Sadeghi M. Obstetric and neonatal outcomes of twin pregnancies conceived by assisted reproductive technology compared with twin pregnancies conceived spontaneously: a prospective follow-up study. Eur J Obstet Gynecol Reprod Biol 2012;156:29–32.
2. Shevell T, Malone FD, Vidaver J, et al. Assisted reproductive technology and pregnancy outcome. Obstet Gynecol 2005;106:1039–45.
3. Cheong-See F, Schuit E, Arroyo-Manzano D, et al. Prospective risk of stillbirth and neonatal complications in twin pregnancies: systematic review and meta-analysis. BMJ 2016;354:i4353.
4. Rissinan AS, Jerman RM, Gissler M, Nupponen I, Nuutila ME. Maternal complications in twin pregnancies in Finland during 1987-2014: a retrospective study. BMC Pregnancy Childbirth 2019;19:337.
5. Deltombe-Bodart S, Deruelle P, Drumez E, Cordiez S, Catteau-Jonard S, Garabedian C. Obstetrical and perinatal complications of twin pregnancies: is there a link with the type of infertility treatment? Acta Obstet Gynecol Scand 2017;96:844–51.
6. Henningsen GA, Gissler M, Skaeerven R, et al. Trends in perinatal health after assisted reproduction: a Nordic study from the CONAR-TaS group. Reprod Biomed Online 2013;26:454–61.
7. Farsi A, Reichman B, Boyko V, Hourvitz A, Ron-EI R, Lerner-Geva L. Maternal and neonatal health outcomes following assisted reproduction. Reprod Biomed Online 2013;26:454–61.
8. Jackson RA, Gibson KA, Wu YY, Croughan MS. Perinatal outcomes in singlets following in vitro fertilization: a meta-analysis. Obstet Gynecol 2004;103:551–63.
9. McDonald SD, Murphy K, Beyene J, Ohls- son A. Perinatal outcomes of singleton preg- nancies achieved by in vitro fertilization: a systematic review and meta-analysis. J Obstet Gynaecol Can 2005;27:449–59.
10. Pandey S, Shetty A, Hamilton M, Bhatta- charya S, Maheshwari A. Obstetric and perinatal outcomes in singleton pregnancies resulting from IVF/ICSI: a systematic review and meta-analysis. Hum Reprod Update 2012;18:485–503.
11. McGovern PG, Llorens AJ, Skumick JH, Weiss G, Goldsmith LT. Increased risk of preterm birth in singleton pregnancies resulting from in vitro fertilization-embryo transfer or gamete intrafallopian transfer: a meta-analysis. Fertil Steril 2004;82:1514–20.
12. Vasanio V, Borgarello V, Bossotti C, et al. IVF twins have similar obstetric and neonatal outcome as spontaneously conceived twins: a prospective follow-up study. Reprod Biomed Online 2010;21:422–8.
13. Dhont M, de Neubourg F, van der Elst J, de Sutter P. Perinatal outcome of pregnancies conceived after assisted reproduction: a case-control study. J Assist Reprod Genet 1997;14:575–80.
14. Isakssson R, Gissler M, Tiitinen A. Obstetric outcome among women with unexplained infertility after IVF: a matched case-control study. Hum Reprod 2002;17:1755–61.
15. Joy J, McClure N, Cooke IE. A comparison of spontaneously conceived twins and twins conceived by artificial reproductive technologies. J Obstet Gynaecol 2008;28:580–5.
16. Pinborg A, Loft A, Rasmusson S, et al. Neonatal outcome in a Danish national cohort of 3438 IVF/ICSI and 10,362 non-IVF/ICSI twins born between 1995 and 2000. Hum Reprod 2004;19:435–41.
17. Suzuki S, Miyake H. Perinatal outcomes of elderly primiparous dichorionic twin pregnancies conceived by in vitro fertilization compared with those conceived spontaneously. Arch Gynecol Obstet 2010;281:87–90.
18. Weghofer A, Klein K, Stromler-Safar M, et al. Severity of prematurity risk in spontaneous and in vitro fertilization twins: does conception mode serve as a risk factor? Fertil Steril 2009;92:2116–8.
19. Ombelet W, Poreoer K, de Sutter P, et al. Perinatal outcome of ICSI pregnancies compared with a matched group of natural conception pregnancies in Flanders (Belgium): a cohort study. Reprod Biomed Online 2005;11:244–53.
20. Adler-Livny Y, Lungenfeld E, Levy A. Obstetric outcome of twin pregnancies conceived by in vitro fertilization and ovulation induction compared with those conceived spontaneously. Eur J Obstet Gynecol Reprod Biol 2007;133:173–8.
21. Hansen M, Colvin L, Petterson B, Kurinczuk JJ, de Klerk N, Bower C. Twins born following assisted reproductive technology: perinatal outcome and admission to hospital. Hum Reprod 2009;24:2321–31.
22. Wen SW, Leader A, White RR, et al. A comprehensive assessment of outcomes in pregnancies conceived by in vitro fertilization/ intracytoplasmic sperm injection. Eur J Obstet Gynecol Reprod Biol 2010;150:160–5.
23. Boulet SL, Schieve LA, Nannini A, et al. Perinatal outcomes of twin births conceived using assisted reproduction technology: a population-based study. Hum Reprod 2008;23:1941–8.
24. Robinson HP, Fleming JE. A critical evaluation of sonar “crown-rump length” measurements. Br J Obstet Gynaecol 1975;82:702–10.
25. Sepulveda W, Seboe NJ, Hughes K, Olibo A, Nicolaides KH. The lambda sign at 10–14 weeks as a predictor of choriornioncy in twin pregnancies. Ultrasound Obstet Gynecol 1996;7:421–3.
26. Classification and diagnosis of diabetes mellitus and other categories of glucose intolerance: National Diabetes Data Group. Diabetes 1979;28:1039–57.
27. Tranquilli AL, Dekker G, Magee L, et al. The classification, diagnosis and management of the hypertensive disorders of pregnancy: a revised statement from the ISSHP. Pregnancy Hypertens 2014;4:97–104.
28. R Core Team. R: a language and environment for statistical computing. Vienna, Austria: R Foundation for Statistical Computing; 2021. p. 2022. https://www.R-project.org/.
29. Qin J, Wang H, Sheng X, Liang D, Tan H, Xia J. Pregnancy-related complications and adverse pregnancy outcomes in multiple pregnancies resulting from assisted reproductive technology: a meta-analysis of cohort studies. Fertil Steril 2015;103:1492–508.61–7.
30. Clu A, Eler M, Rodriguez D, et al. Obstetric and perinatal complications in an oocyte donation programme. Is it time to limit the number of embryos to transfer? Gynecol Endocrinol 2016:32:267–71.
31. Sperling L, Kil C, Larsen LU, et al. Naturally conceived twins with monochorionic placentation have the highest risk of fetal loss. Ultrasound Obstet Gynecol 2006;28:644–52.
32. Baghdadi S, Gee H, Whittle MJ, Khan KS. Twin pregnancy outcome and choriornioncy. Acta Obstet Gynecol Scand 2003;82:15–21.
33. Litwinska E, Syngelaki A, Cimpoca B, Frei L, Nicolaides KH. Outcome of twin pregnancy with two live fetuses at 11–13weeks’ gestation. Ultrasound Obstet Gynecol 2020;55:32–8.
34. Anbazhagan A, Hunter A, Breathnach FM, et al. Comparison of outcomes of twins conceived spontaneously and by artificial reproductive therapy. J Matern Fetal Neonatal Med 2014;27:458–62.
35. Poon WB, Lian WB. Perinatal outcome of intrauterine insemination/icsi pregnancies represent an intermediate risk group compared with in vitro fertilisation/intracytoplasmic sperm injection and naturally conceived pregnancies. J Paediatr Child Health 2013;49:733–40.
36. Li J, Yang J, Xu WM, Cheng D, Zou YJ. Comparison of the perinatal outcome of twins conceived after assisted reproductive technologies versus those conceived naturally. J Reprod Med 2015;60:37–42.
37. Ferraz Liz C, Domingues S, Guedes A, Lopes L. The impact of choriornioncy and assisted reproductive therapies in obstetric and neonatal outcomes. J Matern Fetal Neonatal Med 2022;35:1439–44.
38. Wang AY, Safi N, Ali F, et al. Neonatal outcomes among twins following assisted reproductive technology: an Australian population-based retrospective cohort study. BMC Pregnancy Childbirth 2018;18:320.
39. Qin JB, Wang H, Sheng X, Xie Q, Gao S. Assisted reproductive technology and risk of adverse obstetric outcomes in dichorionic twin pregnancies: a systematic review and meta-analysis. Fertil Steril 2016;105:1180–92.

40. Chih HJ, Elias FTS, Gaudet L, Velez MP. Assisted reproductive technology and hypertensive disorders of pregnancy: systematic review and meta-analyses. BMC Pregnancy Childbirth 2021;21:449.

41. Dayan N, Pilote L, Opatrny L, et al. Combined impact of high body mass index and in vitro fertilization on preeclampsia risk: a hospital-based cohort study. Obesity (Silver Spring) 2015;23:200–6.

42. Tandberg A, Klungsoyr K, Romundstad LB, Skjaerven R. Pre-eclampsia and assisted reproductive technologies: consequences of advanced maternal age, interbirth intervals, new partner and smoking habits. BJOG 2015;122:915–22.

43. Stern JE, Luke B, Tobias M, Gopal D, Hornstein MD, Diop H. Adverse pregnancy and birth outcomes associated with underlying diagnosis with and without assisted reproductive technology treatment. Fertil Steril 2015;103:1438–45.

44. Lalani S, Choudhry AJ, Firth B, et al. Endometriosis and adverse maternal, fetal and neonatal outcomes, a systematic review and meta-analysis. Hum Reprod 2018;33:1854–65.

45. Bosch E, De Vos M, Humaidan P. The future of cryopreservation in assisted reproductive technologies. Front Endocrinol (Lausanne) 2020;11:67.

46. Maheshwari A, Pandey S, Raja EA, Shetty A, Hamilton M, Bhattacharya S. Is frozen embryo transfer better for mothers and babies? Can cumulative meta-analysis provide a definitive answer? Hum Reprod Update 2018;24:35–58.

47. Ernstad EG, Wennerholm U-B, Khatibi A, Petzold M, Bergh C. Neonatal and maternal outcome after frozen embryo transfer: increased risks in programmed cycles. Am J Obstet Gynecol 2019;221:126.e1–18.

48. von Versen-Höynck F, Schaub AM, Chi YY, et al. Increased preeclampsia risk and reduced aortic compliance with in vitro fertilization cycles in the absence of a Corpus luteum. Hypertension 2019;73:640–9.

49. von Versen-Höynck F, Narasimhan P, Selamet Tierney ES, et al. Absent or excessive Corpus luteum number is associated with altered maternal vascular health in early pregnancy. Hypertension 2019;73:680–90.

50. von Versen-Höynck F, Strauch NK, Liu J, et al. Effect of mode of conception on maternal serum Relaxin, creatinine, and sodium concentrations in an infertile population. Reprod Sci 2019;26:412–9.

51. Luke B, Brown MB, Eisenberg ML, et al. In vitro fertilization and risk for hypertensive disorders of pregnancy: associations with treatment parameters. Am J Obstet Gynecol 2019;222:350.e1–13.

52. Hack KEA, Vereycken MEMS, Torrance HL, Koopman-Esseboom C, Derks JB. Perinatal outcome of monochorionic and dichorionic twins after spontaneous and assisted conception: a retrospective cohort study. Acta Obstet Gynecol Scand 2018;97:717–26.