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Abnormal umbilical cord insertion and birth weight discordancy in monochorionic diamniotic twins

A retrospective study

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Abstract

To investigate the relationship between abnormal umbilical cord insertion and birthweight discordance in monochorionic diamnionic (MCDA) twins. A total of 137 pairs of MCDAs were retrospectively analyzed who delivered and survived in Hangzhou Women's Hospital from January 2016 to December 2021. According to different insertion methods, they were divided into normal cord insertion group (n = 57), marginal cord insertion (MCI) group (n = 34) and velamentous cord insertion (VCI) group (n = 46). The correlation was analyzed between different insertion methods of umbilical cord and the discordant birth weight of MCDAs. The gestational age of delivery with velamentous cord insertion was significantly earlier than those with normal and marginal insertion ($P < .05$). There were significant differences in birthweight between large fetus (F1) and small fetus (F2) with different umbilical insertion methods ($P < .05$). The birthweight of F1 and F2 in normal insertion group was significantly higher than those in MCI and VCI group ($P < .05$). Logistic regression analysis showed that VCI was significantly associated with birth weight in F1/F2, birthweight discordance ≥ 20%, and birthweight discordance ≥ 25%, however MCI and VCI were not an independent factor for discordance in birthweight of MCDAs ($P > .05$). Umbilical cord insertion method can lead to inconsistency in birthweight of MCDA twins, however they were not an independent factor for discordance in birthweight.

Keywords: birthweight, discordance, monochorionic diamnionic, umbilical cord insertion

1. Introduction

With the liberalization of the fertility policy and the widespread application of assisted reproductive technology, the incidence of twin pregnancies has gradually increased, which is considered to be 1 of the main factors that increase the incidence of maternal complications including hypertensive disorders, anemia, postpartum hemorrhage, and maternal death.[1] Twin pregnancies are universally considered to be "high risk." Compared to singleton pregnancies, twins are also more likely to be born preterm and to have restricted growth in utero, thereby increasing their risk for intrauterine demise and neonatal mortality.[1] Higher risk of fetal death, preterm delivery and growth restriction in monochorionic diamniotic twins (MCDAs) is occured compared with dichorionic diamniotic twins (DCDAs).[2] Birth weight discordance (BWD) is 1 of the major determinants of perinatal outcomes in twins, with an associated increased risk of perinatal mortality and morbidity.[3]

Abnormal insertion of the umbilical cord in the placenta may reduce blood flow and lead to hemodynamic instability as a result of unequal division of the fetal circulation between vascular anastomosis and ordinary placenta, largely resulting in inconsistent fetal birth weights.[4] Most previous studies have focused on postnatal placental examination to assess the site of umbilical cord insertion. However, many of these cohort studies have inherent selection biases, such as preterm birth or singleton death, which prevent accurate localization of the site of umbilical cord insertion into the placenta.[4,5] This study assessed the relationship between umbilical cord insertion pattern and birthweight (BW) discordance in MCDAs by prenatal ultrasonography, aiming to explore whether prenatal ultrasound of placental insertion site could further predict the growth restriction in MCDAs, providing a diagnostic basis for antenatal consultation and clinical decision-making.

2. Methods

This was a retrospective study of 137 MCDA twins who received first-trimester ultrasonography in the ultrasound department and delivered in our hospital from January 2016 to December

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All data generated or analyzed during this study are included in this published article [and its supplementary information files].

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2021.The exclusion criteria included fetuses with severe structural malformations or chromosomal abnormalities, pregnant women with severe organ diseases, and severe perinatal complications. This study was conducted with the informed consent of the patients and reviewed by ethics committee approval at our institution.

For the purposes of the examination of the placenta, twins may be categorized as either dichorionic (each twin having its own amniotic cavity, chorion, and placenta) or monochorionic (twins sharing a chorion and placenta but having separate amniotic cavities [diamniotic] or a common amniotic cavity [monoamniotic]). In a MCDA pregnancy, the line of attachment of the dividing membrane along the placental disc has back-to-back amnion and been referred to as the T-zone, which was confirmed the chorionicity.[6]

According to different insertion methods, they were divided into normal cord insertion (NCI) group (n = 57), marginal cord insertion (MCI) group (n = 34) and velamentous cord insertion (VCI) group (n = 46).[7] The correlation was analyzed between different insertion methods of umbilical cord and the discordant BW of MCDAs. MCI was diagnosed when the cord attachment site was less than 2 cm to the nearest margin of the placental disc and VCI when the umbilical cord was attached to the membrane before reaching the placental disc, with clear evidence of vessels traversing the membranes to connect with the placental disc. All other cord insertion sites (e.g. central, paracentral, eccentric) which were more than 2 cm from the nearest edge of the placental disc, were considered as normal.[7]

BWD was calculated by subtracting the weight of the smaller twin from the weight of larger twin and then dividing by the weight of larger twin, and was expressed as a percentage.[7,8]

SPSS 22.0 software (IBM Corporation, Armonk, NY, USA) was used for all statistical analysis data. All the variables were tested for normal distribution by Kolmogorov-Smirnov test, Levene's test of homogeneity of variance were further performed. They were depicted as mean ± standard deviation or number (%). The continuous variables were compared using Student's *t* test or ANOVA for multiple comparisons (SNK test was used for pairwise comparison within groups). Categorical variables were compared using chi-square or Fisher's exact test. Association with abnormal umbilical cord insertion and BWD was computed by logistic regression analysis. A *P*-value < .05 was considered statistically significant for all analyses.

3. Results

A total of 137 pregnant women with MCDA twins were enrolled and underwent ultrasonography or No-invasive Prenatal Testing at 10 to 14 weeks of gestation to determine the mode of umbilical cord insertion. According to different insertion methods, they were divided into NCI group (n = 57, 41.61%), MCI group (n = 34, 24.82%) and VCI group (n = 46, 33.57%).

Table 1 shows that the differences in age and body mass index were not statistically significant between the different cord insertion groups. In the VCI group, the gestational age of delivery was significantly earlier than those in the NCI and MCI groups (*P* < .05). BW was significantly lower in large fetus (F1) and small fetus (F2) (*P* < .05), while the birth weight difference was significantly higher than those in the NCI and MCI groups (*P* < .05). There was a statistically significant difference in BWD ≥ 20% among the 3 groups (*P* < .05), while BWD ≥ 25% was not significantly different (*P* > .05).

Table 1

Different placental insertion modes in MDCAs.

	NCI (n = 57)	MCI (n = 34)	VCI (n = 46)	F/χ^2	*P*-Value
Age	30.53 ± 4.46	30.74 ± 3.76	29.83 ± 2.79	0.589	.556
BMI	27.08 ± 3.19	27.30 ± 3.12	26.86 ± 2.42	0.211	.810
Delivery gestational age	35.40 ± 1.82	35.63 ± 1.37	34.69 ± 1.95	3.179	.045
BW in F1	2.58 ± 0.41	2.45 ± 0.39	2.27 ± 0.46	6.001	.003
BW in F2	2.34 ± 0.43	2.15 ± 0.42	1.92 ± 0.52	9.650	.000
BWD	0.10 ± 0.09	0.13 ± 0.09	0.16 ± 0.12	5.149	.007
BWD ≥ 20%	6 (10.53%)	11 (32.35%)	13 (28.26%)	7.572	.023
BWD ≥ 25%	2 (3.51%)	6 (17.65%)	6 (13.04%)	5.744	.057

BMI = body mass index, BW = birthweight, BWD = birthweight discordance, F1 = large fetus, F2 = small fetus.

Table 2

Analysis of different umbilical cord insertion methods and related indicators in MCDAs ($\bar{x} \pm s$).

	NCI (n = 57)	MCI (n = 34)	VCI (n = 46)	F/χ^2	*P*-Value
F1					
BPD (cm)	8.68 ± 0.69	8.64 ± 0.46	8.55 ± 0.43	0.544	.581
HC (cm)	31.14 ± 2.21	31.29 ± 1.36	30.87 ± 1.86	0.504	.605
AC (cm)	30.02 ± 2.85	30.08 ± 1.88	29.52 ± 2.21	0.626	.536
FL (cm)	6.49 ± 0.57	6.44 ± 0.32	6.28 ± 0.41	2.424	.092
AFV (cm)	4.78 ± 1.25	4.96 ± 1.19	5.38 ± 1.23	2.567	.081
S/D	2.31 ± 0.45	2.35 ± 0.40	2.29 ± 0.33	0.236	.790
F2					
BPD (cm)	8.57 ± 0.68	8.46 ± 0.46	8.30 ± 0.67	2.029	.135
HC (cm)	30.85 ± 2.27	31.05 ± 1.47	29.99 ± 2.20	3.014	.052
AC (cm)	29.45 ± 3.12	29.31 ± 1.88	28.00 ± 3.29	3.217	.043
FL (cm)	6.38 ± 0.67	6.35 ± 0.37	6.06 ± 0.57	3.821	.024
AFV (cm)	4.49 ± 1.23	4.92 ± 1.20	4.45 ± 1.37	1.930	.149
S/D	2.47 ± 0.66	2.53 ± 0.56	2.51 ± 0.58	0.125	.882

AC = abdominal circumference, AFV = amniotic fluid volume, BPD = biparietal diameter, F1 = large fetus, F2 = small fetus, FL = femoral length, HC = head circumference.

As shown in Table 2, the MCDAs were routinely ultrasounded before delivery and the twin indicators were measured, including biparietal diameter, head circumference, abdominal circumference (AC), femoral length (FL), amniotic fluid volume, S/D ratio. There was no significantly different in the biparietal diameter, head circumference, amniotic fluid volume and S/D ratio between F1/F2 fetuses with 3 groups in MCDAs ($P > .05$). The differences in AC and FL in F1 were not statistically significant ($P > .05$), while AC and FL in F2 showed statistically significant differences ($P < .05$).

The results of the uni- and multivariate analysis were shown in Tables 3 and 4. VCI was significantly correlated with F1 (OR: 0.998, 95% CI: 0.997–0.999) and F2 birth weight (OR: 0.998, 95% CI: 0.997–0.999), BWD ≥ 20% (OR: 5.023, 95% CI: 1.691–14.922), BWD ≥ 25% (OR: 5.69, 95% CI: 1.079–29.993) of MCDA twins ($P < .05$). MCI was significantly correlated with F2 birth weight (OR: 0.999, 95% CI: 0.998–1.000) of MCDA twins ($P < .05$), but not with F1 birth weight, BWD ≥ 20%, BWD ≥ 25% ($P > .05$). Multiple logistic analysis showed that umbilical cord insertion include MCI and VCI were not independent factors affecting the BWD of MCDAs ($P > .05$).

4. Discussion

Twin pregnancies leads to an increasingly risk of perinatal and maternal mortality and morbidity due to unique complications such as discordance of size between twins, selective fetal growth restriction (sFGR), twin anemia–polycythemia sequence and twin-to-twin transfusion syndrome (TTTS). MDCAs are associated with a higher risk of these complications compared with DCDAs.[9] It has been reported[10] that abnormal umbilical cord insertion has observed in approximately 12% of MCDAs and 7% of DCDAs, which were higher than about 2% of singlet pregnancies. The underlying mechanisms are thought to be caused by vascular anastomoses and unequal placental sharing.[11] However, the correlation between abnormal umbilical cord insertion and twin birth weight differences is still controversial.

Kalafat et al[7] pointed out that in pregnancies with BWD of 25% or more, the smaller fetuses in MCDA twins were more likely to have abnormal cord insertion, with VCI being the most common. It was thought that VCI might be more likely to present with compression symptoms, leading to reduced blood flow and haemodynamic instability, which in turn lead to fetal birth weight discrepancies. However, no significant correlation was found between MCI and BWD. Cambiaso et al[12] assessed the relationship between different combinations of placental umbilical cord insertion and inconsistent birth weight in MCDAs. The reasons of BWD in MCDAs might be related to placental abnormalities caused by unequal placental sharing and abnormal cord insertion. Smaller fetuses in twins had smaller placental sharing accompanied by VCI or MCI, whereas larger fetuses had larger placental sharing with central or paracentral cord insertion. Most studies have focused on abnormal insertion of 1 fetal umbilical cord without considering the type of other fetal cord insertion up till now. This study suggested that the inconsistent insertion of umbilical cord in MCDAs was associated with differences in birth weight, mainly due to unequal placental sharing, which might be an important indicator of adverse outcomes in MCDAs.[12] Castro-Costa et al[5] found that abnormal umbilical cord insertion was not associated with the occurrence of TTTS in MCDAs. However, it was significantly associated with small gestational age status and severe birth weight inconsistency. VCI was noted as an important indicator of adverse perinatal outcome of MCDAs.

A large number of studies[5,7,9,13] have shown a high correlation between VCI and adverse pregnancy outcomes (e.g. sFGR, TTTS, and BWD) in MCDAs. However, some studies with relatively large sample sizes have drawn conflicting conclusions

Table 3

Correlation between VCI and birth weight of MCDAs.

Factors	Univariate analysis OR (95% CI)	Univariate analysis P-Value	Multivariate analysis OR (95% CI)	Multivariate analysis P-Value
Delivery gestational age	1.092 (0.854–1.396)	.483	1.743 (1.184–2.568)	.005
BWD (kg)	41.46 (0.492–3496.601)	.100	0.000 (0.000–13752.339)	.372
BW in F1 (kg)	0.999 (0.998–1.000)	.125	1.001 (0.996–1.007)	.647
BW in F2 (kg)	0.999 (0.998–1.000)	.029	0.996 (0.989–1.003)	.223
BWD ≥ 20%	2.671 (0.904–7.896)	.076	1.775 (0.259–12.153)	.559
BWD ≥ 25%	4.125 (0.791–21.507)	.093	4.101 (0.361–46.619)	.255

BW = birthweight, BWD = birthweight discordance, F1 = large fetus, F2 = small fetus.

Table 4

Correlation between MCI and birth weight of MCDAs.

Factors	Univariate analysis OR (95% CI)	Univariate analysis P-Value	Multivariate analysis OR (95% CI)	Multivariate analysis P-Value
Delivery gestational age	0.818 (0.650–1.028)	.085	1.360 (0.940–1.967)	.103
BWD (kg)	441.590 (5.16–37793.395)	.007	0.000 (0.000–2617.224)	.258
BW in F1 (kg)	0.998 (0.997–0.999)	.003	1.003 (0.997–1.009)	.368
BW in F2 (kg)	0.998 (0.997–0.999)	.000	0.994 (0.987–1.001)	.110
BWD ≥ 20%	5.023 (1.691–14.922)	.004	2.298 (0.318–16.619)	.410
BWD ≥ 25%	5.69 (1.079–29.993)	.04	1.375 (0.105–17.981)	.808

BW = birthweight, BWD = birthweight discordance, F1 = large fetus, F2 = small fetus.

about the relationship between abnormal umbilical cord insertion in MCDAs and BWD and sFGR. Lee et al[14] evaluated the prevalence of VCI in twins and the actual association between pathologically proven VCI and perinatal outcomes based on choriostomy. Nine hundred and forty-one twins were included in the study, and the prevalence of VCI in DCDAs and MCDAs was 5.8% and 7.8%, respectively. Birth weight, 1- and 5-minute Apgar scores were significantly lower in MCDA twins with VCI than in DCDA twins. However, there was no significant correlation between velamentous placenta and selective fetal growth restriction, twin transfusion syndrome, and inconsistent birth weight of MCDA twins (≥20% and ≥ 25%).

Our findings indicated a significant correlation between abnormal umbilical cord insertion (MCI, VCI) and BWD in MCDA twins, with VCI significantly associated with BWD (25% or 20%). This is consistent with the results of Kalafat et al[7] The birth weight of fetuses in the NCI group was significantly higher than that in the VCI and MCI groups in MCDAs, and the difference of birth weight of smaller fetuses was more significant. BWD of up to 20% was still statistically significant. However, when the BWD was exceeded 25%, no significant abnormalities were seen between abnormal and normal cord insertion groups. It was considered that VCI in MCDAs might lead to reduced placental share, vulnerable to external pressure, resulting in a reduced blood supply to the corresponding fetus and a relative imbalance in blood circulation pressure between the twins, leading to a birth weight difference in MCDAs. However, we found that MCI was not an independent risk factor for birth weight differences in MCDAs, which is consistent with Lee.[14]

Previous studies have shown that the incidence of MCI is about 8.5% in all pregnancies, 6.3% in singleton pregnancies and 10.9% in twin pregnancies, which is more common than VCI.[15] It is thought to be associated with different risk factors, such as pregnancy hemorrhage, advanced maternal age, pregnancies conceived with the aid of artificial reproductive technology, maternal chronic diseases and substance abuse during pregnancy.[16,17] Marginal umbilical cord insertion resulted in intrauterine growth retardation, low birth weight, preterm labor, etc. and is also a known risk factor for the occurrence of congenital abnormalities, compression of fetal vessels, stillbirth, and excessive hemorrhage.[18] Ismail et al[19] showed that MCI was associated with an increased risk of adverse outcomes, such as placenta praevia, placental abruption, pre-eclampsia, preterm birth, low birth weight and fetal malformations, suggesting that abnormal cord insertion is associated with an increased risk of adverse perinatal outcomes; while cord sail insertion caused a greater risk than marginal insertion. The results of this study showed that MCI was significantly associated with differences in birth weight in MCDAs. In contrast, there was no significant difference in BWD ≥ 25%. The results of retrospective analysis showed that MCI was not the main factor affecting the difference of BW in MCDAs, which was similar to the conclusions of some studies.[7,12]

In conclusion, abnormal umbilical cord insertion was an influencing factor for the difference in birth weight of MCDAs. VCI was significantly associated with BW of F1/F2, BWD ≥ 20%, and BWD ≥ 25% of MCDAs. However, VCI and MCI were not independent factors affecting the inconsistency of birth weight in MCDAs. Antenatal assessment of the cord insertion combination was a proxy for placenta sharing, and as such it might be useful for risk stratification and diagnostic management of MCDAs. Large sample, multicenter prospective studies are still needed to determine the relationship between umbilical cord insertion site in early pregnancy and perinatal outcomes in MCDAs, to provide a diagnostic basis for predicting birth weight in MCDAs.

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Author contributions

YG and CY designed the study. LZ, YW and QY acquired the data. FZ and YG analyzed the data.

YG and CY were responsible for methodology and wrote the draft manuscript. QY and HZ reviewed and edited the manuscript.

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