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Unequal placental sharing and birth weight discordance in monochorionic diamniotic twins

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Objective: The purpose of this study was to define the association between unequal placental sharing and birth weight discordance in monochorionic/diamniotic twin pregnancies.
Study design: The study comprised a prospective cohort of monochorionic/diamniotic twin pregnancies who were delivered in Kaiser Permanente–Northern California, 1997-2003. Dye injection studies of fresh postpartum placentas were performed. Placental sharing, cord insertion combinations, vascular anastomoses, gestational age, and birth weights were recorded. Statistical comparisons of birth weight and gestational age were made with the Student *t* test. Rates of birth weight discordance were compared with the chi-square test. Multivariate logistic regression models analyzed the relationship between variables of interest.
Results: Mean birth weights for larger and smaller twins were 2400 g and 2109 g, respectively. Twenty-two percent of the monochorionic/diamniotic twin pairs had birth weight discordance $\geq$20%, and 8% of these pairs had twin-twin transfusion syndrome. Monochorionic/diamniotic twin pairs with unequal placental sharing had a 9.8 times greater likelihood of birth weight discordance (95% CI, 5.4-17.9) as compared with those pairs with equal placental sharing.
Conclusion: Unequal placental sharing is a significant risk factor for birth weight discordance in monochorionic/diamniotic twins. Antenatal diagnosis of unequal placental sharing would enable improved counseling in the setting of monochorionic/diamniotic twins.

Monochorionic placentation occurs in approximately one quarter of all twin gestations, the majority are diamniotic. Monochorionic twins are at greater risk for perinatal morbidity and mortality than dichorionic twins.[1-3] Increases in morbidity and mortality rates are due to complications of growth discordance, twin-twin transfusion syndrome (TTTS), fetal anomalies, and subsequent preterm delivery. To date, it has been difficult to identify those monochorionic twin pregnancies that are at greatest risk for such complications and the resultant poorer outcomes.

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Previous studies of discordant twins have included mixed cohorts of dichorionic and monochorionic twins and were not stratified consistently by chorionicity.[1,2] Birth weight discordance in these twin studies has been associated with increased risk of perinatal complications, which include neonatal death, 5-minute Apgar <7, newborn intensive care unit admission, neonatal oxygen requirement, and hyperbilirubinemia.[1-4] Most studies of twin pregnancy complications have used referral populations. These factors limit the clinical usefulness of these investigations, because the cause of the birth weight discordance is likely to differ between monochorionic and dichorionic twins. Growth discordance in dichorionic twins probably represents constitutional genetic differences and/or uteroplacental insufficiency,[5] whereas, in monochorionic twins, it may be due to vascular complications of the shared placenta.[2,3] Thus, the population prevalence and underlying causes of complications in monochorionic twins are unknown.[6]

In monochorionic twins, a single placenta that was designed originally for 1 fetus is shared between 2 fetuses.[7] The cause of growth discordance in monochorionic/diamniotic (MC/DA) twins is unknown, but it is theorized to be the vascular architecture of the monochorionic placenta.[2] The sites of umbilical cord insertion; the presence, type, and number of intertwin vascular anastomoses; and the degree of placental sharing between twins are the determining variables of monochorionic placental angioarchitecture. Abnormalities of umbilical cord insertion sites,[8] intertwin anastomoses,[3] and/or degree of placental sharing[3,7] have been associated with growth discordance.

TTTS is reported to occur in 10% to 35% of MC/DA twins.[9-11] Although growth discordance in MC/DA twins is not necessarily a feature of TTTS, the donor is frequently growth-restricted.[9] When severe growth discordance with associated oligohydramnios occurs in 1 fetus of a MC/DA twin pair, this may be diagnosed incorrectly as TTTS, despite normal amniotic fluid volume in the larger twin.

Given this background, we wanted to determine the incidence of birth weight discordance and TTTS in an unselected cohort of MC/DA twins. Further, we sought to examine unequal placenta sharing as a risk factor for birth weight discordance in MC/DA twins.

Methods

This was a prospective cohort study of all monochorionic twin pregnancies that were delivered in the hospitals of Kaiser Permanente-Northern California, 1997 to 2003. Monochorionic placentas were submitted to a central pathology laboratory for confirmation of monochorionicity and pathologic investigation. Contrasting colored dyes were injected into the umbilical arteries and veins at the placental insertion of the umbilical cord to delineate placental sharing and intertwin anastomoses (arterioarterial, arteriovenous, and venovenous). The intertwin anastomoses were identified when an unpaired artery or vein from 1 twin met an unpaired vessel from the other twin at the placental vascular equator.

Placental sharing was estimated visually as the percentage of placenta on either side of the vascular equator. To confirm accuracy of visual estimates, placental areas for each twin were also mapped in 113 photographed specimens with Open Lab software (Improvision Inc, Lexington, MA). Specimens were selected randomly within cord insertion groups to ensure that the proportions of cord insertion combinations in the subset were similar to the entire cohort. A different examiner performed the computer estimates and was blinded to fetal outcome. The kappa statistic was used to calculate the level of agreement between visual placenta area estimates and calculated placenta areas. The kappa value for the comparison of visual placenta area estimates and calculated placenta areas was 0.41. This is generally considered a "fair" or "good" level of agreement.[12,13]

Gestational age and birth weights at delivery were recorded for all twins by birth order. For each pair, the larger twin was labeled "L," and the smaller twin was labeled "S." Birth weight discordance was defined as $\geq$20% and was calculated by the following formula: ([L-twin birth weight – S-twin birth weight]/L-twin birth weight) $\times$ 100. *Equal placental sharing* was defined as 40% to 60% of the placenta attributed to each twin. We chose this range because preliminary data revealed that twins with 40/60 sharing and 50/50 sharing had similar gestational ages at delivery and degree of birth weight discordance. *Unequal placental sharing* was defined as 1 twin receiving blood from >60% of the placenta. Cord insertion sites in each case were designated as central, marginal, or velamentous. *Marginal insertion* was defined as an umbilical cord that inserted into the placenta $\leq$1 cm from the placental edge (Figure) For some analyses, marginal and velamentous insertions were grouped into a single category as "peripheral" cord insertion because of small numbers in the marginal and velamentous groups and the similarity in their clinical outcomes. Data on cord insertion and birth weight discordance on the first 11 cases in this series have been published previously as part of an earlier series.[7]

Diagnosis of TTTS was made by the referring obstetrician and was designated on the pathology requisition. Quintero staging was not used for the diagnosis.[14] Two pregnancies had laser ablation of intertwin anastomoses and were excluded from analysis.

Only cases with complete records for the variable of interest were used in the statistical analyses, and the number of cases that were used in each analysis was noted. Univariate associations of placental share, vascular anastomoses, gestational age, and cord insertion