The worst of both worlds—combined deliveries in twin gestations: a subanalysis of the Twin Birth Study, a randomized, controlled, prospective study

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OBJECTIVE: The reported incidence of combined twin delivery (vaginal delivery of twin A followed by cesarean delivery for twin B) ranges between 5% and 10%. These estimates are based mostly on small studies or retrospective data. We aimed to evaluate to incidence and risk factors for and outcomes of combined twin deliveries, using a subanalysis of the Twin Birth Study, a randomized, controlled, prospective study.

STUDY DESIGN: The Twin Birth Study included women with twin gestation between 32+0 and 38+6 weeks, with the first twin in vertex presentation at randomization. Women were randomized to planned cesarean delivery or planned vaginal delivery. For the purpose of this subanalysis, we included women who had a vaginal delivery of twin A. Women who had a combined delivery (cesarean delivery for twin B) were compared with women who had a vaginal delivery of both twins. Our primary objective was to identify risk factors for combined twin deliveries. Our secondary objective was to assess the rate of fetal/neonatal death or serious neonatal morbidity in combined deliveries.

RESULTS: Of the 2786 women included in the original study, 842 women delivered twin A by a vaginal delivery and were included in the current analysis, of whom 59 (7%) had a combined delivery. Women in the combined delivery group had a lower rate of nulliparity (22.0% vs 34.7%, $P = 0.047$) and higher rates of noncephalic presentation of twin B at delivery (61.0% vs 27.3%, $P < 0.001$) and spontaneous version from presentation at randomization of twin B (72.9% vs 44.3%, $P < 0.0001$). In a multivariable model, the only risk factor significantly associated with a combined delivery was transverse/oblique lie of twin B following delivery of twin A (adjusted odds ratio, 47.7; 95% confidence interval, 15.4—124.5). Twins B in the combined delivery group had a higher rate of fetal/neonatal death or serious neonatal morbidity (13.6% vs 2.3%, $P < 0.001$), 5-minute Apgar score <7, neonatal intensive care unit admission, abnormal level of consciousness, and assisted ventilation.

CONCLUSION: Transverse/oblique lie of twin B following vaginal delivery of twin A is a risk factor for combined delivery. Combined delivery is associated with higher risk of adverse neonatal outcomes of twin B. These data may be used to better counsel women with twin gestation who consider a trial of labor.

Key words: cesarean delivery for the second twin, combined delivery, perinatal outcomes, twins, vaginal delivery

Twin gestations, which account for 3% of all births,[1] carry a different risk profile from singleton gestations.[2] Intrapartum management and mode of delivery in twin gestations have been a matter of debate along the decades.[3–5] According to the literature, vaginal delivery (VD) of twin A followed by a cesarean delivery (CD) of twin B (combined delivery) occurs at a rate of 5—10%. However, these estimates are based mostly on scarce or retrospective data.[6–9]

Several studies addressed the issue of combined deliveries in the past.[10–14] Their main findings were that malpresentation of the second twin is associated with a higher rate of combined delivery. In 1 study, the rate of twin B malpresentation was 70%,[10] whereas in another study, noncephalic presentation of the second twin conveyed a 2-fold risk for combined delivery.[11] A large retrospective analysis found similar results.[12] As for neonatal outcomes, combined deliveries were found to be associated with a higher incidence of maternal and neonatal infectious morbidity.[13]

All of these studies were retrospective, included pregnancies with complications such as birthweight <1500 g, excluded a substantial number of cases because of missing data, spanned several decades of changing practices, technologies, and concepts, and more. Thus, it is challenging to truly assess, in a reliable and reproducible manner, the risk of combined deliveries in order to provide proper consultation to patients.

The Twin Birth Study (TBS) was an international, multicenter, randomized, controlled trial that compared planned VD to planned CD in twin pregnancies between $32^{0/7}$ and $38^{6/7}$ weeks' gestation, in which the first twin was in a cephalic presentation at the time of randomization.[14] This trial demonstrated no difference in perinatal or maternal outcomes between the 2 groups. An interesting finding of the study was that among women assigned to the VD group, 4.2% had a combined delivery.

Thus, we aimed to evaluate and to report the incidence, risk factors, and outcomes for combined twin deliveries using a subanalysis of a prospective, randomized, controlled trial.

Materials and Methods

Participants

This is a secondary analysis of a prospectively collected data from the Twin Birth Study (TBS). The methodology of the TBS is detailed extensively in the original study[14] and repeated in brief here. The TBS included women with diamniotic twin gestation (regardless of

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AJOG at a Glance

Why was this study conducted?

Current literature regarding combined twin deliveries is scarce, as based on retrospective and/or small studies.

Key findings

The only significant risk factor found for combined twin deliveries was a transverse/oblique lie of the second twin. Breech presentation, chorionicity, and weight difference were not found to affect the rate of combined deliveries.

What does this add to what is known?

This study provides information regarding risk factor for combined delivery of the second twin, and data regarding the outcomes of such deliveries.

chorionicity) at $32^{0/7}$ to $38^{6/7}$ weeks' gestation, with twin A in the cephalic presentation, and estimated weight of each twin between 1500 and 4000 g. Gestations complicated by fetal reduction after 13 weeks of gestation, lethal fetal anomaly, or contraindication to vaginal delivery were excluded. Participants were randomized to planned CD or planned VD from December 2003 to April 2011. Elective delivery by means of either CD or labor induction was planned between $37^{5/7}$ and $38^{6/7}$ weeks' gestation. Perinatal and maternal outcomes were gathered and documented.

For the purpose of this subanalysis, we included all women in the planned vaginal delivery arm who had a VD of twin A. Women who had a combined delivery were compared with women who had a VD of both twins. Multivariable logistic regression analysis was used to identify factors associated with combined delivery, and to identify factor associated with adverse neonatal outcomes of twin B.

As described in the original TBS, women having a vaginal delivery were attended by a qualified obstetrician who was experienced in vaginal twin delivery, defined a priori as an obstetrician who judged himself or herself to be experienced at vaginal twin delivery and whose department head agreed with this judgment. Overall, 98.5% of women in the planned vaginal delivery arm were attended by obstetricians qualified in vaginal twin deliveries (in 95.2% of births by 1 of the obstetricians, which was assigned a code number by the administration of the trial, and in an additional 3.3% by an experience obstetrician who was not assigned with a code). The mode of delivery of twin B was at the discretion of the obstetrician.

Definitions

Chorionicity was determined by means of ultrasonography, and confirmed by pathological examination at birth. Presentation of the twins was assessed at the time of ultrasound within 7 days before randomization and later during delivery. Spontaneous version of twin B was defined as change in presentation from the time of randomization to the time of delivery.

To keep the same definitions as presented in the original TBS and for ease of patient consultation, we preferred the use of cephalic presentation (which is defined as the combination of longitudinal lie and vertex presentation) versus noncephalic presentation (which is defined as either longitudinal lie with breech presentation, or nonlongitudinal lie [oblique or transverse lie]).

Neonatal mortality or serious neonatal morbidity was defined as 1 or more of the following: birth trauma (spinal cord injury, basal or depressed skull fracture, fracture of a long bone [humerus, radius, ulna, femur, tibia, or fibula]; injury to a peripheral nerve [brachial plexus or phrenic or facial nerve] present at 72 hours of age or at discharge from the hospital; subdural or intracerebral hemorrhage confirmed by means of ultrasonography, computed tomography [CT], or magnetic resonance imaging [MRI]); Apgar score of <4 at 5 minutes; coma, stupor, or decreased response to pain; seizures on at least 2 occasions before 72 hours of age; need for assisted ventilation with the use of an endotracheal tube, inserted within 72 hours after birth and remaining in place for at least 24 hours; septicemia confirmed by means of blood culture or meningitis confirmed by means of cerebrospinal fluid culture within 72 hours after birth; necrotizing enterocolitis, defined as intestinal perforation, pneumatosis intestinalis, or air in the portal vein diagnosed by means of surgery or radiography; bronchopulmonary dysplasia, defined as the need for supplemental oxygen at a postnatal gestational age of 36 weeks and confirmed by means of radiography; grade III or IV intraventricular hemorrhage confirmed by means of ultrasonography; or cystic periventricular leukomalacia confirmed by means of ultrasonography.

Statistical analysis

Our primary objective was defined as identifying risk factors for combined twin deliveries. Our secondary objective was defined as determining the rate of fetal/neonatal death or serious neonatal morbidity in combined deliveries.

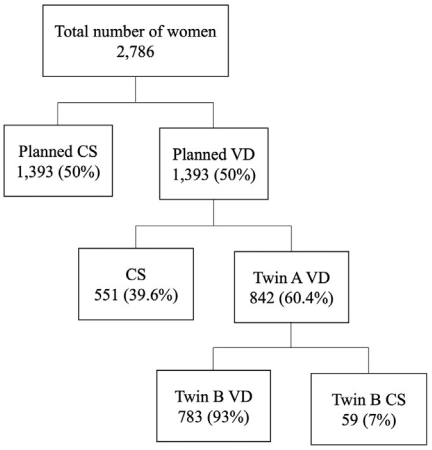
Maternal and pregnancy characteristics were compared between delivery groups. Normally distributed continuous variables were compared using the Student t test and non–normally distributed variables with the Mann–Whitney U test. Categorical variables were compared with the Fisher exact test or χ^2 test. A multivariable logistics regression model was constructed to identify factors associated with the combined delivery. A P value of <0.05 was considered significant. SAS 9.4 software was used for statistical analysis. The study was approved by the local Research Ethics Board (#364-2017, 02-Nov-2017).

Results

Rate of combined deliveries

Out of the 2786 women who were eligible for analysis in the original study,

FIGURE 1
Study population



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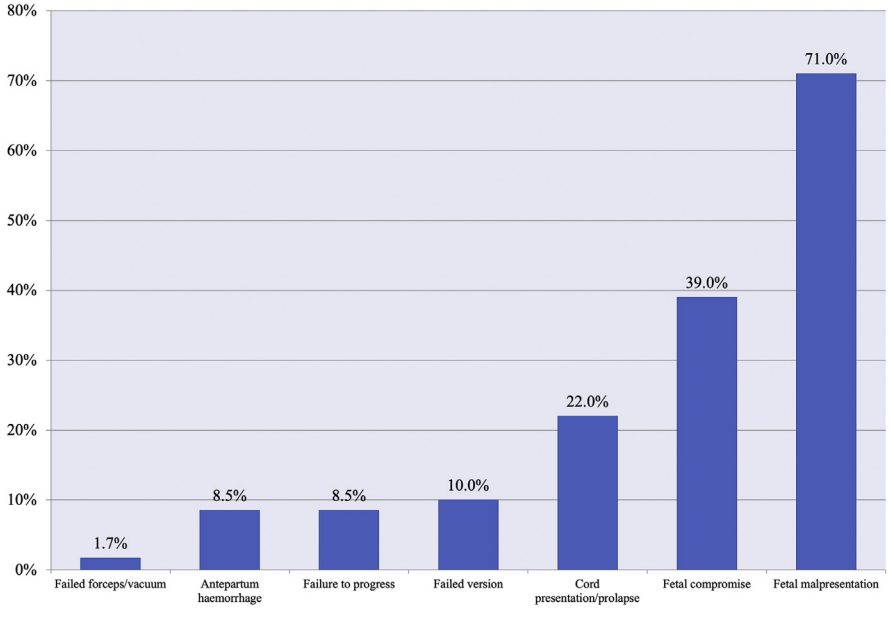
1393 (50%) were randomized for planned vaginal delivery, of which 842 (60.4%) delivered twin A by a VD and were included in the current analysis. Overall, 59 women (7.0% of 842 women who delivered twin A by a VD, or 4.2% of 1393 women randomized to planned vaginal delivery) had a combined delivery (CS for twin B) and were compared to the 783 women (93.0%) who delivered both twins vaginally (Figure 1).

FIGURE 2
Indications for cesarean delivery (CD) of twin B. The total number of indications exceed the number of CD, as some CD were performed for more than 1 indication



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The main indication for CD for twin B was malpresentation, followed by suspicion of fetal compromise (Figure 2).

Risk factors for combined deliveries

Women in the combined delivery group were less likely to be nulliparous. At the time of delivery, the rate of noncephalic presentation of twin B was more than 2-fold higher in the combined delivery group (Table 1). In addition, the likelihood of spontaneous version of twin B (a different presentation at delivery compared to the presentation at randomization) was also higher in the combined delivery group (Table 1). The inter-twin delivery interval was longer in the combined delivery group. No other significant differences, including in weight differences or chorionicity, were found between the groups.

To better evaluate the risk factors associated with combined delivery, we calculated a multivariable logistic regression model. The model included maternal age, gestational age at delivery, parity, presentation of twin B (cephalic vs noncephalic), and spontaneous version of twin B. Only noncephalic presentation remained significantly associated with a combined delivery (adjusted odds ratio [OR], 3.3; 95% confidence interval [CI], 1.4−7.6) (Table 2). As we wanted to characterize this risk factor, we tested a second multivariable regression model, in which noncephalic presentation was further subcategorized to breech presentation and transverse/oblique lie (with cephalic presentation as the reference). In this model, breech presentation was no longer significantly associated with combined delivery (adjusted odds rati [aOR], 0.99; 95% CI, 0.36−2.67), in contrast to transverse/oblique lie (aOR, 43.74; 95% CI, 15.37−124.49) (Table 3).

Outcomes of combined deliveries

Combined deliveries of twins B had a higher rate of fetal/neonatal death or serious neonatal morbidity (13.6% vs 2.3%, $P < 0.001$), 5-minute Apgar score <7, neonatal intensive care unit admissions, abnormal level of consciousness, and prolonged (≥24 hours) assisted

TABLE 1
Maternal and pregnancy characteristics

Variable	Vaginal delivery (n = 783)	Combined delivery (n = 59)	*P* value
Maternal age, y[a]	28.97±5.83	28.98±6.35	0.99
Maternal age ≥35 y, n (%)	141 (18.0)	14 (23.7)	0.27
Nulliparity, n (%)	272 (34.7)	13 (22.0)	0.047
Chorionicity, n (%)			
Dichorionic	574 (73.3)	44 (74.6)	0.37
Monochorionic	197 (25.2)	13 (22.0)	
Unknown	12 (1.5)	2 (3.4)	
Twin B presentation at randomization, n (%)			
Cephalic	492 (62.8)	31 (52.5)	0.12
Breech	182 (23.2)	14 (23.7)	
Transverse/oblique	109 (13.9)	14 (23.7)	
Gestational age at randomization[a]	34.6±1.9	34.7±1.9	0.73
Twin B presentation at delivery, n (%)			
Cephalic	569 (72.7)	23 (39.0)	<0.001
Breech	202 (25.8)	10 (16.9)	
Transverse/oblique	12 (1.5)	26 (44.1)	
Presentation at delivery vs at randomization, n (%)			
Same	436 (55.7)	16 (27.1)	<0.001
Different	347 (44.3)	43 (72.9)	
Inter-twin delivery interval, min[a]	8.0 [10.0]	33.0 [25.0]	<0.001
Gestational age at delivery, wk[a]	36.7±1.6	36.9±1.5	0.38
Twin B BW > Twin A BW, n (%)	365 (46.6)	24 (40.7)	0.52

BW, birthweight.

[a] Data are presented as mean ± SD or as median [interquartile range]

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ventilation (Table 4). On multivariable logistic regression model, including twin B presentation and inter-twin delivery interval, transverse/oblique lie was not found to be associated with fetal/neonatal death or serious neonatal morbidity (aOR, 1.46; 95% CI, 0.33 −6.50). In addition, when considering mode of delivery of twin B and inter-twin delivery interval in the multivariable analysis, combined delivery itself, rather than inter-twin delivery interval, was found to be associated with fetal/neonatal death or serious neonatal morbidity (combined delivery: aOR, 5.14; 95% CI, 1.95−13.53; inter-twin delivery interval: aOR, 1.01; 95% CI, 1.00−1.02).

Comment

In this subanalysis, we aimed to evaluate the incidence and risk factors for and to assess the outcomes of combined twin deliveries, using data from the TBS, a randomized, controlled, prospective study.

Principal findings

Our main results show that the prevalence of combined delivery among patients who delivered twin A vaginally was 7%, that transverse/oblique lie of twin B is a risk factor for combined delivery, and that twin B delivered in a combined delivery is more prone to adverse neonatal outcomes. We also found that this adverse outcome of twin B is not associated with the presentation of twin B or with the inter-twin delivery interval, but rather with the combined delivery itself.

Results

Previous publications support the prevalence of combined twin deliveries found in our study, between 4% and 10%.[6,7,9,10,12,15]

We found that only transverse/oblique lie was associated with combined delivery, whereas breech presentation was not. Naturally, all vaginal deliveries of twin B occurred with the fetus in a longitudinal lie, whether in cephalic or in breech presentation. Although some of these fetuses (1.5%) were coded by the obstetrician as transverse/oblique lie, this is clearly a coding issue rather than a clinical issue. In the combined delivery arm, however, all those undelivered vaginally because of transverse/oblique lie were clearly those cases in which the obstetrician thought that external or internal versions were unfeasible, may be associated with harm, or tried to perform a version but failed. Thus, it is important to make the following distinction: the methodology of the TBS allows us to conclude only that transverse/oblique lie following the delivery of twin A is a risk factor for combined delivery. The available data precludes drawing conclusions regarding transverse/oblique lie in other scenarios, such as in antepartum ultrasound. Nonetheless, we assume that it is safe to extrapolate that antepartum transverse/oblique twin B is likely at higher risk for combined delivery than a longitudinal twin B, notwithstanding the fact the even longitudinal twins may be found to be

transverse or oblique following delivery of twin A.

There is a dispute in the literature regarding noncephalic presentation of the second twin as a risk factor for combined delivery. Some studies have shown similar results. In 1 study, noncephalic twin B at admission or after delivery of twin A were associated with increased risk of combined delivery (aOR, 11.5 and 17.7, respectively).[9] Another study reported that presentation of twin B was found to be significantly associated with combined delivery.[15] Yet, although the investigators did find a significant association of transverse lie of twin B to be a significant risk factor for combined delivery, with an odds ratio of approximately 180, they also reported an odds ratio of 2.4 for breech presentation. The difference may lie in the different methodology of the studies: their study was a retrospective, single-center study, whereas ours is a subanalysis of a multicenter, prospective, randomized trial. Furthermore, only centers in which the personnel were skilled in breech deliveries of the second twin were allowed to participate in our study. As such, the likelihood of successful breech delivery was probably higher in our cohort, which is another explanation for the lack of association between breech presentation and combined delivery. Our results are also in accordance with those of Breathnach et al, who found that 10 of 14 (71%) combined deliveries were indicate by malpresentation of the second twin (defined in their cohort as transverse, shoulder, brow, or compound presentation).[10] Persad et al found that a nonvertex presentation of the second twin was associated with a 2-fold higher risk of cesarean delivery (relative risk, 2.3; 95% CI, 1.3–3.8).[11] Finally, in their case-control study of 206 vaginal deliveries of first twins, Suzuki et al reported that the incidence of CD for twin B was significantly greater in cases with nonvertex presentation.[16] Conversely, other studies reported different results, such as those of Easter et al, who found that patients with non-presenting twins in non-cephalic presentation had comparable, if not higher, rates of vaginal delivery than cephalic-presenting second twins.[17] Nonetheless, in this study, the actual presentation twin B at the time of delivery was not reported in full, but only as vertex vs nonvertex. Of note, the authors stated that of the 18 combined deliveries, 10 involved operation for breech delivery, which was actually vertex in a prelabor ultrasound.

Although we found that nonvertex presentation is a risk factor for combined delivery, further subcategorization revealed that breech presentation was no longer associated with combined delivery, which may explain the dissimilarity between this study and ours. We speculate that although breech extraction is relatively not complicated to perform and is often part of the routine training in labor and delivery suites because of the relatively higher incidence, a transverse or oblique lie, especially when the back of the fetus is pointing down, presents a greater challenge to the obstetric staff. Because it is more scarce in reality, training is minimal, and one can go through training without actually encountering such a case, let alone practice in the management of it.

Surprisingly, although we did find a difference in the univariable analysis between the groups in the rate of spontaneous version of twin B, it did not emerge as a significant factor contributing to combined delivery in the multivariable analysis. A previous study found that in labors in which twin B changed presentation from vertex to nonvertex between admission to labor and delivery, the rate of spontaneous vaginal delivery was lower than if twin B was nonvertex both on admission and delivery.[10] The difference in findings may stem from the difference in design. In our study, we did not have the results of the sonogram performed at admission to labor, but rather the results of the

TABLE 2
Multivariable logistic regression model for combined delivery

Variable	OR	95% CI
Maternal age ≥35 y (vs maternal age <35 y)	1.14	0.59–2.18
Gestational age at delivery (each additional wk)	1.10	0.89–1.28
Nulliparity (vs multiparity)	0.59	0.31–1.14
Spontaneous version of twin B (vs same presentation)	1.33	0.53–3.32
Noncephalic presentation (vs cephalic presentation)	3.28	1.41–7.63

CI, confidence interval; *OR*, odds ratio.

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TABLE 3
Multivariable logistic regression model for combined delivery, with subcategorization of presentation of twin B

Variable	OR	95% CI
Maternal age ≥35 y (vs maternal age <35 y)	0.82	0.37–1.82
Gestational age at delivery (each additional wk)	1.10	0.87–1.32
Nulliparity (vs multiparity)	0.63	0.30–1.31
Spontaneous version of twin B (vs same presentation)	1.33	0.53–3.32
Breech presentation (vs cephalic presentation)	0.99	0.37–2.67
Transverse/oblique lie (vs cephalic presentation)	47.74	15.37–124.49

CI, confidence interval; *OR*, odds ratio.

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TABLE 4
Neonatal outcomes of twin B

Variable	Vaginal delivery (n = 783)	Combined delivery (n = 59)	*P* value
Fetal/neonatal death or serious neonatal morbidity,[a] n (%)	18 (2.3)	8 (13.6)	<0.001
5-min Apgar score <7, n (%)	16 (2.1)	12 (20.7)	<0.001
NICU admission, n (%)			
≥48 h	41 (5.27%)	7 (12.07%)	<0.001
<48 h	11 (1.41%)	4 (6.90%)	
Abnormal level of consciousness, n (%)			
Coma	0 (0.00%)	1 (1.72%)	0.02
Stupor or decreased response to pain	0 (0.00%)	0 (0.00%)	
Hyperalert, drowsy, or lethargic	3 (0.39%)	1 (1.72%)	
Assisted ventilation, n (%)			
≥24 h	7 (0.90%)	3 (5.17%)	<0.001
<24 h	9 (1.16%)	5 (8.62%)	

NICU, neonatal intensive care unit.

[a] Fetal/neonatal death or serious neonatal morbidity: neonatal death was defined as death during the period from 0 to 27 days after birth. Serious neonatal morbidity was defined as 1 or more of the following: birth trauma present at 72 h of age or at discharge from the hospital; subdural or intracerebral hemorrhage; Apgar score of <4 at 5 min; coma, stupor, or decreased response to pain; seizures on at least 2 occasions before 72 h of age; need for assisted ventilation with the use of an endotracheal tube, inserted within 72 h after birth and remaining in place for at least 24 h; septicemia or meningitis within 72 h after birth; necrotizing enterocolitis; bronchopulmonary dysplasia; grade III or IV intraventricular hemorrhage; or cystic periventricular leukomalacia.

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sonogram at the time of randomization, which took place prior to labor. Also, the skilled personnel who were a prerequisite in our study were able to cope with breech deliveries, so spontaneous version had little or no impact, especially compared with the overwhelmingly high odds ratio of transverse/oblique lie.

We also found that twins B delivered in combined deliveries had a higher rate of adverse outcomes. Although several investigators reported the opposite,[9,10,18] others found similar results.[7,19] Rossi et al noted in their systematic review and meta-analysis that the highest morbidity rate occurred when twin B was born by caesarean delivery following vaginal delivery of twin A.[19] First, the adverse outcomes may be associated with the indication for CD, such as a non-reassuring fetal heart rate tracing or a prolapsed umbilical cord. Second, in the TBS study, no information was gathered regarding the set-up for twin delivery. Because not all institutions universally practiced a "double set-up" approach (in which delivery of twins takes place in the operating theatre to decrease the time-to-delivery interval in case of the need for CD, the time-to-delivery may be increased in combined deliveries, translating into worse outcomes. We did not find that the presentation of twin B or the inter-twin delivery interval were associated with the higher rate of adverse outcomes, but rather the combined delivery itself. Nonetheless, because the prevalence of the adverse outcome was low (overall 26 cases), great caution should be taken in interpreting these results and in drawing any practical implications from them.

Clinical implications

Our findings have several clinical implications. First, they may be used during consultation as a source of information for pregnant women regarding the planned mode of delivery and associated outcomes. Second, these results may be used by stakeholders to discuss the policy of routine "double set-up" for twin deliveries in the operating room, as a way to decrease the decision-to-incision interval. Third, as these situations are not encountered routinely, another method of staff preparedness should be encouraged, possibly through simulation. Out study did not address this issue, but further studies are needed to assess the utility of training and simulations in this scenario.

Research implications

As the TBS was the largest randomized, controlled trial regarding mode of delivery of twins, it is probably unreasonable to think that another endeavor of the same nature will take place. Nonetheless, further research may be needed to assess the utility, cost-effectiveness, and feasibility of different settings for twin deliveries (regular labor and delivery suite vs operating room). Further research may also be needed to evaluate the best possible way of training and simulation for optimal management of twin deliveries.

Strengths and limitations

The strengths of our study lie in its size, the prospective design of the original study, and the strict recruitment and follow-up protocol. To our knowledge, the TBS is the largest prospective study of its kind, strengthening the results of this subanalysis. Yet, our study is not free of limitations. First, the data collected originally were not intended to answer the questions raised by this specific analysis. The data regarding ultrasound assessments of twin B were not required in the original analysis, so we cannot address the important question of antepartum and intrapartum use of ultrasound in twin deliveries. As all twins B who were delivered vaginally had to be in vertex of breech presentation at the time of delivery, we need to assume that all of those categorized as transverse/oblique lie in the vaginal delivery arm actually represent those who ultimately turned to longitudinal lie. Similarly, all twins B who were delivered by a CD and categorized as transverse/oblique lie were the ones in which a version to longitudinal lie was not feasible, or failed. We did not have the results of recent pre-labor sonograms to verify presentation, nor

did we have updated fetal weight estimations. We also did not analyze the use intrapartum ultrasound as a risk factor for combined deliveries, as ultrasound was used in only 30% of the deliveries, so adding it to the multivariable model may have yielded results that would be neither generalizable nor reproducible. Also, 1 of the exclusion criteria of the original TBS was second twin substantially larger than the first twin, which had no clear definition. As such, we could not evaluate the contribution of size differences between the twins to the risk of a combined delivery. It is also important to emphasize that the original TBS was not powered for the outcomes presented in this subanalysis.

Conclusions

The results of this analysis demonstrate that transverse/oblique lie of the twin B is a significant risk factor for combined delivery, and that twin B delivered in a combined delivery is more prone to adverse perinatal outcomes. These data may be used to better counsel women who consider a trial of labor. ■

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