Published in final edited form as:
BJOG. 2014 August ; 121(9): 1137–1144. doi:10.1111/1471-0528.12642.

The effects of labor and delivery on maternal and neonatal outcomes in term twins: a retrospective cohort study

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Abstract

Objective—To compare maternal and neonatal outcomes in twins undergoing a trial of labor vs. pre-labor cesarean.

Design—Retrospective cohort study.

Setting—19 U.S. hospitals from the Consortium on Safe Labor.

Population—2,225 twin sets ≥ 36 weeks gestation.

Methods—Maternal (abruption, estimated blood loss, postpartum hemorrhage, transfusion, chorioamnionitis, hysterectomy, ICU admission, death) and neonatal outcomes (birth injury, 5-minute Apgar <7, NICU admission, RDS, TTN, sepsis, asphyxia, NICU length of stay, death) were compared between the trial of labor and pre-labor cesarean groups with univariate and multivariate logistic and linear regression analyses. Similar analyses were performed for actual delivery modes.

Main Outcome Measures—Maternal and neonatal outcomes.

Results—Among the 2,225 twin sets, 1,078 had a trial of labor, and 65.9% of those delivered vaginally. There was an increased risk for postpartum hemorrhage (OR 2.5, 95% CI 1.4–4.5) and blood transfusion (OR 1.9, 95% CI 1.2–3.2) for the trial of labor compared to pre-labor cesarean groups. Birth injury only occurred in the trial of labor group, 1% Twin A, 0.4% Twin B. Both

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Disclosure of Interests
The authors report no conflicts of interest.

Contribution to Authorship
Dr. Wenckus was the primary author of this paper and was responsible for design, acquisition of data, analysis and interpretation, writing and final approval. Ms. Gao was responsible for aid in the design and analysis of data, revision of the methods section of the paper and final approval. Dr. Kominiarek contributed to the conception and design, acquisition of data, analysis and interpretation, critical revisions of the paper and final approval. Dr. Wilkins contributed to the conception and design, critical revisions of the paper, and final approval.

Details of Ethics Approval
IRB #2007-0656, date of approval 9/22/2008

twins had a higher risk of 5-minute Apgar <7 with trial of labor compared to pre-labor cesarean (A: OR 3.9, 95% CI 1.05–14.5; B: OR 3.9, 95% CI 1.3–12.3).

Conclusion—Term twins undergoing a trial of labor have increased maternal hemorrhage and transfusions along with neonatal birth trauma and lower Apgar scores, but these absolute neonatal occurrences were rare. Trial of labor in twins remains a safe and reasonable option in appropriately selected cases.

Keywords

Twins; Trial of Labor; Cesarean

Introduction

The optimal delivery mode for twin gestations remains controversial. The American College of Obstetricians and Gynecologists (ACOG) practice bulletin on multiple gestations, states that fetal position, ability to monitor fetal heart rate, and maternal and fetal status should determine delivery mode for twins.[1] In 1989, 50% of twin gestations were delivered by cesarean, and this number increased to 75% by 2008.[2,3] This high cesarean delivery rate for twin gestations begs the question of whether a trial of labor for twins has unacceptable risks for the mother and neonate.

In singletons, pre-labor and elective repeat cesarean deliveries increase the risk for several adverse maternal and neonatal outcomes over vaginal delivery despite the controlled circumstances in which they are performed, and these risks increase with each subsequent cesarean delivery.[4–6] A trial of labor is generally the safest option for singletons, but increased maternal and neonatal morbidity and mortality exists when cesarean delivery occurs after a trial of labor or when conducted in an emergent fashion.[7–9] It is unknown whether the risks and benefits of a trial of labor also apply to twin gestations.

Previous investigations found no significant differences in maternal and first twin outcomes when comparing planned trial of labor to planned cesarean delivery, though few studies directly addressed maternal outcomes.[10–12] In light of the increased morbidity and mortality in the second twin after a planned trial of labor in larger population studies, some investigators have recommended a planned cesarean delivery.[13–16] Two recent reports found no significant differences in neonatal outcomes for the second twin according to planned delivery mode. As such, they recommended a trial of labor for twins with the goal of vaginal delivery.[17,18]

We compared maternal and neonatal outcomes for twin gestations delivered after a trial of labor to those who had a pre-labor cesarean. Our hypothesis was that increased maternal and neonatal morbidity exists in the trial of labor group. Additionally, we compared actual delivery mode after trial of labor to pre-labor cesarean to search for the presence of an outcome so catastrophic that it would preclude offering a particular delivery mode in twins. Our secondary hypothesis was that maternal and neonatal morbidity would not increase for vaginal deliveries and any additional morbidity would be limited to cesareans after labor.

Methods

This is a retrospective cohort study from the Consortium on Safe Labor (CSL). The complete database contained 233,730 deliveries from 2002–2008, acquired from electronic obstetrical databases. Twelve clinical centers from 19 distinct hospitals across nine ACOG districts participated in the CSL. Detailed description of the study is provided elsewhere.[19,20] Institutional Review Boards of all participating institutions approved the study.

The entire CSL database included 4,864 twin sets, encompassing 2.1% of all deliveries. For the current cohort study, the inclusion criteria were twins that were both liveborn and ≥ 36 weeks gestation, for a total of 2,225 twin sets. Antepartum stillbirths were excluded because the aim of the study was to measure the effects of labor. There were no intrapartum stillbirths. Comparison groups were determined based on their exposure to labor. A trial of labor (TOL) was defined as a vaginal delivery or at least two cervical examinations documented in the obstetrical database during the labor admission. The TOL group was further separated into vaginal deliveries (TOL:vaginal) and cesarean deliveries (TOL:cesarean). The pre-labor cesarean group (PLC) was defined as a cesarean delivery and ≤ 1 cervical examination documented.

Characteristics of the cohort recorded included age, race, parity, prior cesarean, admission body mass index (BMI), diabetes, hypertensive disorders, gestational age at delivery, and birthweight. Maternal outcomes included abruption, estimated blood loss (EBL), postpartum hemorrhage, blood transfusion, chorioamnionitis, hysterectomy, ICU admission, and death prior to discharge. Neonatal outcomes included birth injury (brachial plexus injury, skull fracture, facial nerve injury, laceration, clavicular fracture, shoulder dislocation), 5-minute Apgar <7, neonatal intensive care unit (NICU) admission, respiratory distress syndrome (RDS), transient tachypnea of the newborn (TTN), neonatal sepsis, asphyxia, NICU length of stay, and death prior to discharge.

Maternal and neonatal characteristics were compared with chi-square and student's t-tests for categorical and continuous variables, respectively for the TOL vs. PLC groups. Maternal and neonatal outcomes were compared for the TOL vs. PLC groups. These outcomes were also compared between the TOL:vaginal vs. PLC groups, and the TOL:cesarean vs. PLC groups to further delineate where morbidity occurs. Combined vaginal-cesarean deliveries remained within the TOL:vaginal delivery group for analysis because the intent was to deliver vaginally. Median and interquartile ranges (IQR) were reported for continuous outcome variables as none were normally distributed. The medians were compared with the Wilcoxon Rank Sum Test. Univariate analysis with simple logistic regression calculated unadjusted odds ratios with 95% confidence intervals (CI) for each of the maternal and neonatal outcomes. Multivariate analyses were conducted with logistic regression calculating adjusted odds ratios with 95% CI, after controlling for age, parity, admission BMI, prior cesarean, and diabetes. A p-value < 0.05 was considered statistically significant for all comparisons. SAS software (version 9.2; SAS Institute Inc, Cary, NC) was used for all analyses.

Results

Of the 2,225 twins studied, 1,078 had a TOL. In the TOL group 710 (65.9%) had a vaginal delivery, 311 (28.9%) had a cesarean delivery, and 57 (5.3%) had a combined vaginal-cesarean delivery. There were 1,147 women (51.6% of the cohort) who had a PLC. Overall, cesarean deliveries occurred in 68.1% of this twin study cohort.

The PLC group was more likely to be older, have a prior cesarean, diabetes, and a higher admission BMI, $p<0.05$(Table 1). The mean gestational age at delivery was 37.3 weeks for both groups. The most common indication for cesarean was “failure to progress” in the TOL group and “breech” in the PLC group. It could not be determined to which birth order fetus the term “breech” belonged.

Table 2 details the univariate and multivariate analyses of maternal and neonatal outcomes for the TOL group compared to the PLC group. The median EBL for the TOL group was 500 mL (IQR 400–800 mL) and the median EBL for the PLC group was 800 mL (IQR 700–1000 mL), $p<0.001$. The TOL group required more blood transfusions than the PLC group, (aOR 1.9, 95% CI 1.2–3.2). Postpartum hemorrhage increased for TOL (aOR 2.5, 95% CI 1.4–4.5) compared to PLC. There were no differences in ICU admissions and postpartum hysterectomies for TOL vs PLC. One maternal death occurred in the TOL group. She was a 26 year old gravida 1 with a history of depression and pre-eclampsia admitted at 37 weeks for delivery, given a beta-blocker for blood pressure management and delivered via vacuum assisted vaginal delivery of Twin A and Twin B, with an estimated blood loss of 500 mL. No further information is available in the database on this event.

For neonatal outcomes (Table 2), birth injuries (brachial plexus injury, skull fracture, facial nerve injury, laceration, clavicular fracture, shoulder dislocation) only occurred in the TOL group-1% of Twin A, and 0.4% of Twin B, and this was statistically significant for Twin A and B, p-values <0.001 and <0.05, respectively. Both twins had a higher risk of 5-minute Apgar < 7 in the TOL group (Twin A aOR 3.9, 95% CI 1.05–14.5; Twin B aOR 3.9, 95% CI 1.3–12.3). TOL was protective for TTN (Twin A aOR 0.6, 95% CI 0.3–0.9; Twin B aOR 0.5, 95% CI 0.3–0.9). For twins admitted to the NICU, the median length of stay for Twin A in the TOL and the PLC groups were 4.0 days (IQR 2.0–8.0 days) and 4.3 days (IQR 3.0–8.5 days), respectively, $p=0.53$. For twin B, the median length of stay for the TOL and PLC groups were 5.0 days (3.0–9.0 days) and 5.0 days (IQR 2.0–8.0), respectively, $p=0.56$.

Of the six cases of neonatal asphyxia, five occurred in the TOL group. The difference was not statistically significant compared to the PLC group, $p>0.05$. There were four neonatal deaths in the TOL group and two in the PLC group. The causes of death in the TOL group included GBS sepsis, congenital heart defect, hypoplastic lungs, and congenital anomaly. The causes of death in the PLC group (Twin B only) included perinatal asphyxia and congenital heart disease with sepsis.

Table 3 shows the univariate and multivariate analyses of maternal and neonatal outcomes for the TOL:vaginal group compared to the PLC group as well as analyses for the TOL:cesarean group compared to the PLC group. The median EBL was lower for the TOL:vaginal group (400 mL; IQR 300–600 mL), but similar for the TOL:cesarean group

(800 mL; IQR 700–1000 mL), compared to the PLC group (800 mL; IQR 700–1000 mL), p<0.001 and p=0.92, respectively. Both TOL:vaginal (aOR 2.7, 95% CI 1.4–5.1) and TOL:cesarean (aOR 2.6, 95% CI 1.2–5.7) had increased postpartum hemorrhage compared to PLC; however, only TOL:cesarean had increased blood transfusions compared to PLC (aOR 3.2, 95% CI 1.8–5.9).

For neonatal outcomes, all of the birth injuries occurred in the TOL:vaginal group but to reiterate, the occurrence was low-1% for Twin A and 0.4% for Twin B. The 5-minute APGAR score <7, which occurred more frequently in the TOL group, was attributable to the lower Apgar scores in the TOL:vaginal group (Twin A aOR 6.4, 95% CI 1.5–27.4; Twin B aOR 6.1, 95% CI 1.7–21.4). The protective effect against TTN was only realized if TOL resulted in a vaginal delivery (Twin A aOR 0.4, 95% CI 0.2–0.6; Twin B aOR 0.3, 95% CI 0.2–0.6).

For twins admitted to the NICU, Twin A's NICU length of stay was 4.0 days (IQR 2.0–8.0 days) for the TOL:vaginal group, 4.0 days (IQR 3.0–8.5 days) for the TOL:cesarean group, and 4.3 days (IQR 3.0–8.5 days) for the PLC group, p=0.72. Twin B's NICU length of stay was 6.0 days (IQR 3.0–11.0 days) for the TOL:vaginal group, 4.0 days (IQR 3.0–8.0 days) for the TOL:cesarean group, and 5.0 days (IQR 2.0–8.0 days) for the PLC group, p=0.14.

For the combined vaginal-cesarean delivery group, the mean blood loss was 814 mL, range 150–2100 mL. Blood transfusions occurred in 7/57 (12.3%). The mean birthweight was 2710 gm for Twin A and 2800 gm for Twin B. Twin A neonatal outcomes included one birth injury, seven NICU admissions (12.3%), and a NICU mean length of stay of 3.6 days. Twin B neonatal outcomes included one birth injury, 11 NICU admissions (19.3%), one 5-minute APGAR < 7, two cases of RDS, and NICU mean length of stay of 4.6 days. There was no asphyxia or neonatal deaths in this group.

Discussion

Main Findings

In this cohort study of twins at term and their delivery mode, the majority of women attempting TOL delivered vaginally. The morbidities associated with TOL included postpartum hemorrhage, blood transfusions, birth trauma, and risk of 5-minute Apgar score < 7. These outcomes were countered by less TTN in TOL. Overall, the burden of morbidity was greater for the maternal outcomes over the neonatal outcomes. Although neonatal findings were statistically significant, the overall occurrences of trauma and 5-minute Apgar score < 7 were low.

Strengths and Limitations

The strengths of this investigation include the large sample size, the scope of this multicenter study, and the number of maternal and neonatal outcomes available for analysis. To our knowledge, this is the largest study to evaluate the planned mode of delivery in term twins, rather than only the actual delivery mode. The large sample size also limits the interpretations when specific aspects of delivery events are not detailed. The decision for TOL vs. PLC was at the discretion of the provider and likely varied among different sites,

however it is known that all the sites did allow for twin trials of labor. As the TOL and PLC groups had dissimilar maternal characteristics, the effects of selection bias were mediated by controlling for confounders, such as prior cesarean. Finally, many of the outcomes occurred infrequently and a much larger cohort would be required to have the power to detect a significant difference if one truly exists.

Misclassification bias is also a potential source of bias relating to the creation of the TOL group. The definition of TOL used for this study was a vaginal delivery or having at least two cervical examinations documented in the database for that admission. It is possible that women who were to undergo a planned PLC, but who presented for a labor evaluation and therefore had two cervical exams may be incorrectly classified to the TOL group. If these were women who experienced postpartum hemorrhage or blood transfusions, which were significant findings in the TOL:cesarean group compared to the PLC group, then the results would have been biased towards a significant finding that may not actually be significant, or a type 1 error. Or the magnitude of the misclassification could have been so great that the results may be significant in the opposite direction, with greater risk for hemorrhage and blood transfusions associated with PLC compared to TOL. The inclusion criteria of the "term" twin likely lessened the number of labor evaluations for those with planned PLC at admission and thereby supports the correct classification of women. In addition, the percentage of twins undergoing a trial of labor was similar compared to other studies, as was the rate of vaginal deliveries.[17,18,21]

Interpretation

Two retrospective cohort studies evaluated outcomes based on planned mode of delivery in twin gestations, both of which employed protocols for active second-stage management. Schmitz et al evaluated 758 consecutive sets of twins greater than 35 weeks with a cephalic presenting first twin, and controlled for pregnancy complications such as hypertension, pre-eclampsia, diabetes, twin-to-twin transfusion syndrome, and placenta previa. Similar to our study, they also found increased postpartum hemorrhage in the planned vaginal delivery group, but no difference in transfusions between the groups.[18] They found no difference in neonatal composite morbidity for either twin when comparing outcomes in planned vaginal delivery to planned cesarean delivery. Fox et al reported only neonatal outcomes in 287 twin gestations and found no difference in Apgar scores or umbilical artery pH<7.2 in the planned vaginal versus planned cesarean group.[17]

Both of the aforementioned study findings are consistent with the only randomized controlled trial of the management of a nonvertex second twin which randomized 60 twin gestations to vaginal delivery or cesarean delivery and found no significant differences in Apgar scores or other neonatal morbidity in the second twins.[12] In addition, a meta-analysis of four studies also noted no evidence to support planned cesarean delivery of twins, unless twin A was breech.[11] However, many of the outcomes still occurred infrequently, making it difficult for the studies to have enough statistical power to detect a difference.

Finally, Peaceman et al, reported neonatal morbidities and death in the first year of life in 450,504 twin gestations from a Matched Multiple Birth dataset that compared twins delivering at ≥ 30 weeks by actual delivery mode for vertex/vertex and vertex/nonvertex

pairs.[22] A sub-analysis of neonatal outcomes for infants born ≥ 34 weeks gestation found lower Apgar scores and increased birth injuries as well as an increased overall composite neonatal morbidity score in the vaginal compared to the cesarean group, similar to the findings for the entire cohort ≥ 30 weeks gestation. However, they concluded that these statistically significant differences were not clinically important and that neonatal morbidity and mortality were similar for vaginal and cesarean deliveries of twin gestations ≥ 30 weeks gestation.

Combined vaginal-cesarean delivery occurred in 5.3% of our TOL cohort. This is similar to the 6–16% rate published in other reports, though the denominator in these publications may vary between a TOL group or a vaginal delivery of the first twin group.[23–25] This percentage may increase to 22–23% with vertex/non-vertex pairings after the first twin delivers vaginally.[22,23] Our database was not able to delineate between our vertex/vertex, and vertex/non-vertex pairings.

Conclusion

This study reflects on contemporary practices of twin delivery modes in the United States. In the entire cohort, 68.1% of all twins at term were delivered via cesarean. For those women who had a TOL, 65.9% had a vaginal delivery, a relatively high degree of success. In concordance with our original hypothesis we have demonstrated increased maternal and neonatal morbidity in the TOL group. Specifically, the maternal morbidity in the form of increased transfusions was related to cesarean delivery after a trial of labor. The neonatal morbidity, in the form of birth trauma and 5-minute Apgar score < 7, was rare overall, and related to vaginal delivery rather than cesarean delivery after TOL, in contrast to our secondary hypothesis. It is important to note the absolute increase in birth asphyxia in the TOL group, though this finding was not statistically significant. These rare neonatal outcomes must be balanced against the lack of difference in NICU admissions and decreased TTN in the TOL group. Increased birth trauma suggests that vaginal delivery of twins may be a technically difficult procedure that requires a skilled provider. This study supports that a TOL is a reasonable and safe option that should be strongly considered after counseling women regarding the maternal and neonatal risks and benefits for twin gestations at term.

Acknowledgments

The data included in this paper were obtained from the Consortium on Safe Labor, which was supported by the Intramural Research Program of the Eunice Kennedy Shriver National Institute of Child Health and Human Development, National Institutes of Health, through Contract No. HHSN267200603425C. Institutions involved in the Consortium include, in alphabetical order: Baystate Medical Center, Springfield, MA; Cedars-Sinai Medical Center Burnes Allen Research Center, Los Angeles, CA; Christiana Care Health System, Newark, DE; Georgetown University Hospital , MedStar Health, Washington, DC; Indiana University Clarian Health, Indianapolis, IN; Intermountain Healthcare and the University of Utah, Salt Lake City, Utah; Maimonides Medical Center, Brooklyn, NY; MetroHealth Medical Center, Cleveland, OH.; Summa Health System, Akron City Hospital, Akron, OH; The EMMES Corporation, Rockville MD (Data Coordinating Center); University of Illinois at Chicago, Chicago, IL; University of Miami, Miami, FL; and University of Texas Health Science Center at Houston, Houston, Texas. The named authors alone are responsible for the views expressed in this manuscript, which does not necessarily represent the decisions or the stated policy of the NICHD.

Funding

This study was supported by the Intramural Research Program of the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development, National Institutes of Health, through a contract (Contract No. HHSN267200603425C), by Grant Number K12HD055892 from the NICHD and NIH office of Research on Women's Health (ORWH), and the University of Illinois at Chicago (UIC) Center for Clinical and Translational Science (CCTS), Award Number UL1RR029879 from the National Center for Research Resources.

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Table 1

Maternal Characteristics

Variable (SD or %)	Trial of Labor (TOL) n=1078	Prelabor Cesarean (PLC) n= 1147	P-value
Mean Age (years)	29.4 (± 6.1)	31.4 (± 6.6)	<0.001
Race			0.11
Caucasian	610 (59.0)	663 (60.3)	
African American	234 (22.6)	210 (19.1)	
Hispanic	143 (13.8)	158 (14.4)	
Other	47 (4.6)	68 (6.2)	
Nullipara	426 (39.5)	497 (43.3)	0.07
Prior cesarean	54 (5.5)	289 (25.9)	<0.001
Diabetes	60 (5.6)	96 (8.4)	0.01
Hypertensive Disorders	150 (13.9)	135 (11.8)	0.13
Mean Admission BMI (kg/m^2)	32.3 (± 6.7)	33.4 (± 7.1)	0.001
Cesarean Delivery	311 (28.9)		
Mean Gestational Age (weeks)	37.3 (± 1.0)	37.3 (± 0.9)	0.86
Birthweight (gm)			
Twin A	2687 (± 358)	2716 (± 387)	0.07
Twin B	2659 (± 392)	2661 (± 405)	0.89

Table 2

Maternal and Neonatal Outcomes for TOL vs PLC

Maternal Outcomes	**TOL n=1078 (%)**	**PLC n=1147 (%)**	**Unadjusted OR (95% CI)**	**Adjusted OR (95% CI)**
Abruptio Placentae	10 (1.2)	1 (0.1)	10.9 (1.4–85.1)	8.6 (1.1–69.7)
Estimated Blood Loss ≥ 1000 mL	120 (14.7)	264 (29.1)	0.4 (0.3–0.5)	0.5 (0.4–0.7)
Postpartum Hemorrhage	53 (6.6)	20 (2.7)	2.5 (1.5–4.3)	2.5 (1.4–4.5)
Blood Transfusion	55 (5.7)	38 (3.7)	1.6 (1.02–2.4)	1.9 (1.2–3.2)
Chorioamnionitis	38 (4.5)	2 (0.2)	21.3 (5.1–88.8)	23.1 (5.3–99.7)
Hysterectomy	1 (0.1)	2 (0.2)	0.5 (0.05–5.9)	*
ICU Admission	1 (0.1)	6 (0.6)	0.2 (0.02–1.5)	0.3 (0.03–2.4)
Maternal Death	1 (0.1)	0	*	*
Neonatal Outcomes			Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Birth Injury				
Twin A	11 (1.0)	0	*	*
Twin B	4 (0.4)	0	*	*
5 minute APGAR < 7				
Twin A	13 (1.2)	7 (0.6)	2.0 (0.8–5.0)	3.9 (1.05–14.5)
Twin B	17 (1.6)	7 (0.6)	2.6 (1.1–6.4)	3.9 (1.3–12.3)
NICU Admission				
Twin A	154 (14.3)	164 (14.3)	1.0 (0.8–1.3)	1.1 (0.8–1.4)
Twin B	170 (15.8)	162 (14.1)	1.1 (0.9–1.4)	1.0 (0.8–1.4)
Respiratory Distress Syndrome				
Twin A	22 (2.0)	23 (2.0)	1.0 (0.6–1.8)	1.0 (0.5–2.0)
Twin B	31 (2.9)	26 (2.3)	1.3 (0.8–2.2)	1.2 (0.6–2.2)
Transient Tachypnea of the Newborn				
Twin A	34 (3.2)	71 (6.2)	0.5 (0.3–0.7)	0.6 (0.3–0.9)
Twin B	42 (3.9)	67 (5.8)	0.7 (0.5–0.97)	0.5 (0.3–0.9)
Neonatal Sepsis				
Twin A	25 (2.3)	16 (1.4)	1.7 (0.9–3.2)	1.8 (0.8–4.1)
Twin B	19 (1.8)	13 (1.1)	1.6 (0.8–3.2)	1.2 (0.5–2.8)
Neonatal Asphyxia				
Twin A	3 (0.3)	1 (0.1)	3.2 (0.3–30.8)	5.0 (0.4–55.7)
Twin B	2 (0.2)	0	*	*
NICU LOS ≥ median				
Twin A ≥ 4.0 days	79 (59.0)	99 (65.1)	0.8 (0.5–1.2)	1.0 (0.5–1.9)
Twin B ≥ 5.0 days	76 (50.7)	78 (53.1)	0.9 (0.6–1.4)	0.6 (0.3–1.1)

Maternal Outcomes	**TOL n=1078 (%)**	**PLC n=1147 (%)**	**Unadjusted OR (95% CI)**	**Adjusted OR (95% CI)**
Neonatal Death				
Twin A	2 (0.2)	0	*	*
Twin B	2 (0.2)	2 (0.2)	1.0 (0.1–7.3)	0.5 (0.1–3.8)

* Regression model does not fit, due to low outcome occurrence

Table 3

Maternal and Neonatal Outcomes based on Actual Delivery Mode Compared to PLC

Maternal Outcomes	**TOL: Vaginal n=767 (%)**	**Unadjusted OR (95% CI)**	**Adjusted OR (95% CI)**	**TOL: Cesarean n=311 (%)**	**Unadjusted OR (95% CI)**	**Adjusted OR (95% CI**	**PLC n=1147 (%)**
Abruptio Placentae	5 (0.8)	7.6 (0.9–65.5)	3.3 (0.4–31.9)	5 (2.0)	18.9 (2.2–162.4)	17.6 (2.0–159.0)	1 (0.1)
Estimated Blood Loss ≥ 1000 mL	47 (8.1)	0.2 (0.1–0.3)	0.2 (0.1–0.4)	73 (31.1)	1.1 (0.8–1.5)	1.2 (0.8–1.7)	264 (29.1)
Postpartum Hemorrhage	41 (6.8)	2.6 (1.5–4.5)	2.7 (1.4–5.1)	12 (5.9)	2.3 (1.1–4.8)	2.6 (1.2–5.7)	20 (2.7)
Blood Transfusion	32 (4.5)	1.2 (0.8–2.0)	1.3 (0.7–2.3)	23 (8.7)	2.5 (1.4–4.2)	3.2 (1.8–5.9)	38 (3.7)
Chorioamnionitis	23 (3.8)	18.1 (4.2–77.0)	21.2 (4.6–98.2)	15 (6.1)	29.5 (6.7–130.0)	22.6 (4.8–105.3)	2 (0.2)
Hysterectomy	0	*	*	1 (0.3)	1.8 (0.2–20.4)	*	2 (0.2)
ICU Admission	1 (0.2)	0.3 (0.03–2.1)	0.4 (0.04–3.7)	0	*	*	6 (0.6)
Maternal Death	1 (0.2)	*	*	0	*	*	0
Neonatal Outcomes	**TOL: Vaginal n=767 sets (%)**	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	**TOL: Cesarean n=311 sets (%)**	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	**PLC n=1147 sets (%)**
Birth Injury							
Twin A	11 (1.4)[A]	*	*	0	*	*	0
Twin B	4 (0.5)[A]	*	*	0	*	*	0
5 minute APGAR < 7							
Twin A	12 (1.6)	2.6 (1.02–6.6)	6.4 (1.5–27.4)	1 (0.3)	0.5 (0.1–4.3)	1.2 (0.1–11.2)	7 (0.6)
Twin B	16 (2.1)	3.5 (1.4–8.5)	6.1 (1.7–21.4)	1 (0.3)	0.5 (0.1–4.3)	1.0 (0.1–8.9)	7 (0.6)
NICU Admission							
Twin A	97 (12.7)	0.9 (0.7–1.1)	0.9 (0.6–1.3)	57 (18.3)	1.3 (0.97–1.9)	1.3 (0.9–2.0)	164 (14.3)
Twin B	115 (15.0)	1.1 (0.8–1.4)	1.0 (0.7–1.4)	55 (17.7)	1.3 (0.9–1.8)	1.0 (0.7–1.6)	162 (14.1)
Respiratory Distress Syndrome							
Twin A	18 (2.4)	1.2 (0.6–2.2)	1.2 (0.5–2.7)	4 (1.3)	0.6 (0.2–1.9)	0.7 (0.2–2.3)	23 (2.0)
Twin B	25 (3.3)	1.5 (0.8–2.5)	1.5 (0.8–3.0)	6 (1.9)	0.8 (0.3–2.1)	0.6 (0.2–1.8)	26 (2.3)
Transient Tachypnea of the Newborn							

Maternal Outcomes	TOL: Vaginal n=767 (%)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	TOL: Cesarean n=311 (%)	Unadjusted OR (95% CI)	Adjusted OR (95% CI	PLC n=1147 (%)
Twin A	18 (2.4)	0.4 (0.2–0.6)	0.4 (0.2–0.8)	16 (5.1)	0.8 (0.5–1.4)	0.9 (0.5–1.6)	71 (6.2)
Twin B	21 (2.7)	0.5 (0.3–0.7)	0.3 (0.2–0.6)	21 (6.8)	1.2 (0.7–1.9)	1.0 (0.5–1.8)	67 (5.8)
Neonatal Sepsis							
Twin A	13 (1.7)	1.2 (0.6–2.5)	1.6 (0.6–4.1)	12 (3.9)	2.8 (1.3–6.1)	2.2 (0.9–5.7)	16 (1.4)
Twin B	12 (1.6)	1.4 (0.6–3.1)	1.3 (0.5–3.2)	7 (2.3)	2.0 (0.8–5.1)	0.9 (0.2–3.3)	13 (1.1)
Neonatal Asphyxia							
Twin A	2 (0.3)	3.0 (0.3–33.1)	6.1 (0.3–107.9)	1 (0.3)	3.7 (0.2–59.3)	5.2 (0.3–88.4)	1 (0.1)
Twin B	1 (0.1)	*	*	1 (0.3)	*	*	0
NICU LOS ≥ median							
Twin A ≥ 4.0 days	49 (57.0)	0.7 (0.4–1.2)	1.1 (0.5–2.3)	30 (62.5)	0.9 (0.5–1.7)	0.8 (0.4–2.0)	99 (65.1)
Twin B ≥ 5.0 days	58 (57.4)	1.2 (0.7–2.0)	0.7 (0.4–1.5)	18 (36.7)	0.5 (0.3–1.0)	0.3 (0.1–0.8)	78 (53.1)
Neonatal Death							
Twin A	2 (0.3)	*	*	0	*	*	0
Twin B	2 (0.3)	1.4 (0.2–10.2)	0.6 (0.1–4.4)	0	*	*	2 (0.2)

[A] $P<0.05$

[*] Regression model does not fit, due to low outcome occurrence