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Induction of labor versus spontaneous labor in twin pregnancies undergoing trial of labor at ≥34 weeks of gestation: a retrospective cohort study (2012–2022)

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Abstract

Background

Evidence on the safety and efficacy of labor induction in twin pregnancies remains scarce. This study compared maternal and neonatal outcomes between induction of labor and spontaneous labor in twin pregnancies at ≥ 34 weeks of gestation attempting vaginal delivery.

Methods

In this single-center retrospective cohort study, women with twin pregnancies at ≥ 34 weeks of gestation who attempted vaginal delivery at the Third Affiliated Hospital of Guangzhou Medical University between January 2012 and December 2022 were enrolled. A total of 324 women were divided into a spontaneous labor group (n = 210) and an induction group (n = 114); the latter was classified by cervical condition into cervical ripening with a balloon catheter followed by artificial rupture of membranes and/or oxytocin (group A, n = 12), artificial rupture of membranes and/or oxytocin (group B, n = 30), and oxytocin alone (group C, n = 72). Maternal and neonatal outcomes were compared, and risk factors for conversion to cesarean delivery were analyzed.

Results

Of the 324 women, 251 (77.5%) achieved vaginal delivery. The conversion rate to cesarean delivery was higher in the induction group (36.8% vs 14.8%, *P < 0.001*), whereas the incidence of postpartum hemorrhage was lower (14.9% vs 24.8%, *P = 0.039*). Birthweights of both twins were higher in the induction group, whereas neonatal intensive care unit (NICU) admission of both twins and respiratory distress syndrome of twin 1 were less frequent (all *P < 0.05*). No significant differences were found among groups A, B and C. Multivariable logistic regression identified admission cervical dilatation as a protective factor (odds ratio [OR] 0.47, 95% confidence interval [CI] 0.22–0.99), and gestational age (OR 1.51, 95% CI 1.06–2.15) and pregnancy complications (OR 3.20, 95% CI 1.27–8.04) as independent risk factors.

Conclusions

Vaginal delivery is safe and feasible for selected twin pregnancies at ≥ 34 weeks of gestation. Although induction is associated with a higher conversion rate to cesarean delivery, it does not increase adverse maternal and neonatal outcomes. Individualized assessment is warranted for women with gestational age > 37 weeks, unfavorable cervices or pregnancy complications.

Background

With the widespread use of assisted reproductive technology and adjustments in fertility policy, twin pregnancies have increased markedly.[1,2] In 2019, the twin pregnancy rate in China was 3.69%,[3] and twins account for approximately 2%–3% of all deliveries worldwide.[4] Twin pregnancies are high-risk pregnancies, with higher risks of maternal perinatal morbidity and mortality than singleton pregnancies,[5,6] as well as markedly increased incidences of preterm birth, hypertensive disorders of pregnancy, gestational diabetes mellitus, fetal growth restriction and intrauterine fetal death.[7] Although cesarean delivery has traditionally been preferred for twins, current evidence does not support superior maternal or neonatal outcomes of cesarean over vaginal delivery.[8] Both Chinese and international guidelines recommend that, apart from indications for cesarean delivery such as conjoined twins, monochorionic monoamniotic twins and non-cephalic presentation of the first twin, eligible twin pregnancies may attempt vaginal delivery.[9,10] However, studies on labor induction in twin pregnancies remain scarce both in China and elsewhere, and high-quality evidence is lacking; clinicians and pregnant women still have concerns about the safety and feasibility of induction in twins. Recent cohort studies addressing this question have yielded divergent conclusions: a Swiss cohort of 267 twin pregnancies found that induction of labor approximately doubled the cesarean delivery rate,[48] whereas a United States cohort of 497 dichorionic twin pregnancies found that induction was not associated with a reduced likelihood of vaginal delivery of both twins,[49] indicating that the safety and efficacy of labor induction in twin pregnancies remain actively debated. Importantly, induction in this setting is undertaken for maternal or fetal indications or within guideline-recommended planned delivery windows rather than as an elective procedure; the clinically relevant question is therefore whether induction, once indicated, remains safe for both the mother and her neonates. We therefore retrospectively analyzed the clinical data of 324 women with twin pregnancies attempting vaginal delivery in late pregnancy, comparing maternal and neonatal outcomes between spontaneous labor and different induction protocols. Given that the available evidence derives predominantly from European and North American cohorts, the findings of this large Chinese single-center cohort may provide complementary population-based evidence for safeguarding maternal and neonatal safety in twin pregnancies and for the standardized practice of vaginal delivery and labor induction in twins.

Methods

Study population

This was a single-center retrospective cohort study. Clinical data were obtained from the perinatal database of the Third Affiliated Hospital of Guangzhou Medical University. Women with twin pregnancies at ≥ 34 weeks of gestation who attempted vaginal delivery at the hospital between January 1, 2012 and December 31, 2022, and their neonates, were included. The inclusion criteria were: (1) delivery at ≥ 34 weeks of gestation; (2) dichorionic diamniotic or monochorionic diamniotic twins; (3) cephalic presentation of twin 1, with twin 2 in cephalic, breech or transverse presentation; (4) both twins alive before delivery; (5) no evident cephalopelvic disproportion; and (6) voluntary choice of vaginal delivery after full counseling on the benefits and risks of cesarean and vaginal delivery, with written informed

consent. The exclusion criteria were: (1) monochorionic monoamniotic twins; (2) non-cephalic presentation of twin 1; (3) miscarriage or intrauterine death of either twin; (4) severe cardiac, hepatic or renal dysfunction; (5) genital tract malformations; (6) contraindications to cervical ripening balloon or oxytocin; (7) refusal of vaginal delivery; and (8) incomplete clinical data. A total of 324 women were included and divided by the mode of labor onset into a spontaneous labor group (n = 210) and an induction group (n = 114). After comprehensive assessment of cervical conditions before induction, the induction group was further divided into three subgroups: group A (n = 12) underwent cervical ripening with a cervical ripening balloon, followed by artificial rupture of membranes, intravenous oxytocin, or both, according to the Bishop score after balloon removal; group B (n = 30) directly underwent artificial rupture of membranes, intravenous oxytocin, or both; and group C (n = 72) received intravenous oxytocin alone.

Between January 2012 and December 2022, 74 569 deliveries occurred at our center, including 5099 twin pregnancies (6.8%); 3879 twin pregnancies (76.1%) were delivered at ≥ 34 weeks of gestation, of whom 324 women (8.4%) were willing to attempt vaginal delivery, and 251 (77.5%) delivered vaginally. Cesarean delivery has long been the predominant mode of delivery for twin pregnancies in China, and most institutions hold a cautious attitude toward vaginal delivery of twins; therefore, the proportion of women choosing a trial of labor remained limited. The flow of participant enrollment is shown in Fig. 1.

Data collection

The following data were collected: (1) maternal baseline characteristics: age, obstetric history, gestational age at delivery, pre-pregnancy body mass index, mode of conception, chorionicity, and pregnancy complications and comorbidities [eg, hypertensive disorders of pregnancy, gestational diabetes mellitus, fetal growth restriction, prelabor rupture of membranes]; (2) perinatal variables: timing and method of labor induction and the presentations of the twins; (3) delivery-related data: duration of labor, birthweights and intertwin delivery interval; and (4) maternal and neonatal outcomes: conversion to cesarean delivery, blood loss and incidence of postpartum hemorrhage, placental abruption, umbilical cord prolapse, infection, neonatal asphyxia, Apgar scores, NICU admission and neonatal hospitalization.

Definitions and diagnostic criteria

The diagnostic criteria for postpartum hemorrhage, hypertensive disorders of pregnancy, gestational diabetes mellitus, prelabor rupture of membranes and other conditions, as well as the determination of gestational age, followed the 10th edition of the Chinese textbook of Obstetrics and Gynecology. Severe postpartum hemorrhage was defined as blood loss ≥ 1000 ml within 24 hours after delivery. Combined delivery is a special type of conversion to cesarean delivery, defined as vaginal birth of twin 1 followed by cesarean delivery of twin 2; in this study, combined deliveries were counted as conversions to cesarean delivery. Failure of labor induction was judged according to the Chinese guideline on cervical ripening and labor induction in late pregnancy (2024)[11]: women in whom labor was not achieved after 18 hours of

intravenous oxytocin with effective uterine contractions (> 3 contractions per 10 minutes accompanied by pain) after membrane rupture (including artificial rupture of membranes and prelabor rupture of membranes) were diagnosed with failed induction and delivered by cesarean; if the Bishop score remained < 6 after 3 days of cervical ripening, the decision to continue ripening or proceed with cesarean delivery was made after comprehensive maternal and fetal assessment. The timing of induction followed the Chinese expert consensus on the timing of delivery for pregnancy complications and comorbidities.[10]

Induction protocols

Before induction, obstetric ultrasound was performed by a senior sonographer, and pelvic assessment and Bishop scoring by an obstetrician at or above the attending level. A Bishop score ≥ 6 indicated a favorable (ripe) cervix, and a score < 6 indicated an unfavorable (unripe) cervix requiring cervical ripening: women without contraindications received a cervical ripening balloon (80 ml of normal saline injected into each of the intrauterine and vaginal balloons, indwelling for no more than 12 hours), whereas those with contraindications received low-dose intravenous oxytocin. Women with a ripe cervix but without labor received intravenous oxytocin, artificial rupture of membranes or both, according to individual conditions; if regular contractions did not occur within 2 hours after membrane rupture, intravenous oxytocin was administered. For women with spontaneous prelabor rupture of membranes without labor, early induction with low-dose oxytocin was recommended after counseling, regardless of cervical status.

Statistical analysis

Statistical analyses were performed using SPSS 24.0 (IBM Corp.). Normally distributed continuous variables were expressed as mean ± standard deviation and compared using the t test; skewed continuous variables were expressed as median (interquartile range) and compared using rank-sum tests; categorical variables were expressed as frequencies and percentages and compared using the chi-square test or Fisher's exact test. Risk factors for conversion to cesarean delivery were analyzed by multivariable logistic regression, and receiver operating characteristic (ROC) curves were plotted to evaluate the predictive value of gestational age and admission cervical dilatation. A two-sided $P < 0.05$ was considered statistically significant.

Results

Maternal baseline characteristics

No significant differences were found between the spontaneous labor and induction groups in age, gravidity and parity, chorionicity, mode of conception, pre-pregnancy body mass index or presentation of twin 2 (all $P > 0.05$). Gestational age at delivery was greater in the induction group than in the

spontaneous labor group [37 (36, 38) vs 36 (35, 37) weeks], and the rate of spontaneous membrane rupture was higher in the spontaneous labor group (78.1% vs 38.6%) (both *P < 0.05*). The data are shown in Additional file 1: Table S1.

Mode of delivery

Of the 324 women attempting vaginal delivery, 251 (77.5%) delivered vaginally and 73 (22.5%) were converted to cesarean delivery, including 10 combined deliveries (13.7% of conversions). The conversion rate was higher in the induction group than in the spontaneous labor group (36.8% vs 14.8%, *P < 0.001*), whereas the combined delivery rate did not differ significantly between groups (4.4% vs 2.4%, *P > 0.05*). The data are shown in Table 1.

Table 1
Mode of delivery in the spontaneous labor and induction groups

Vaginal delivery	**Spontaneous labor group (n = 210)**	**Induction group (n = 114)**	**χ^2**	***P***
	179 (85.2%)	**72 (63.2%)**	**20.639**	**< 0.001**
Conversion to cesarean delivery	31 (14.8%)	42 (36.8%)	20.639	< 0.001
of which: combined delivery	5 (2.4%)	5 (4.4%)	0.436	0.509

Note: Combined delivery is a special type of conversion to cesarean delivery, defined as vaginal birth of twin 1 followed by cesarean delivery of twin 2; combined deliveries are included among conversions to cesarean delivery.

Maternal outcomes

The incidence of postpartum hemorrhage was higher in the spontaneous labor group than in the induction group (24.8% vs 14.9%, *P < 0.05*), whereas the incidence of severe postpartum hemorrhage did not differ significantly (6.7% vs 2.6%, *P > 0.05*). No significant differences were found between the two groups in the durations of the first, second and third stages of labor, total labor duration, operative vaginal delivery, placental abruption, umbilical cord prolapse, infection or maternal hospital stay (all *P > 0.05*). The intertwin delivery interval was shorter in the induction group [8 (1, 17) vs 11 (5, 19) min, *P < 0.05*]. The data are shown in Table 2.

Table 2
Maternal outcomes in the spontaneous labor and induction groups

First stage of labor (min)	Spontaneous labor group (n = 210)	Induction group (n = 114)	Z/χ²	*P*
	300 (190, 540)	**272 (158, 653)**	**-0.196**	**0.845**
Second stage of labor (min)	26 (15, 48)	25 (15, 55)	-0.656	0.512
Third stage of labor (min)	21 (15, 30)	23 (16, 30)	-0.833	0.405
Total labor duration (min)	390 (240, 618)	382 (248, 753)	-0.253	0.800
Intertwin delivery interval (min)	11 (5, 19)	8 (1, 17)	-2.003	0.045
Operative vaginal delivery			—	0.134
Forceps	10 (4.8%)	1 (0.9%)		
Vacuum extraction	1 (0.5%)	1 (0.9%)		
Postpartum blood loss (ml)	399 (310, 518)	424 (339, 579)	-1.624	0.104
Postpartum hemorrhage	52 (24.8%)	17 (14.9%)	4.227	0.039
Severe postpartum hemorrhage	14 (6.7%)	3 (2.6%)	2.420	0.120
Placental abruption	9 (4.3%)	2 (1.8%)	1.200	0.230
Umbilical cord prolapse	3 (1.4%)	2 (1.8%)	0.230	0.820
Infection	5 (2.4%)	6 (5.3%)	1.096	0.295
Maternal hospital stay (days)	2 (2, 3)	3 (2, 3)	-1.508	0.132

Note: Skewed continuous variables are expressed as median (interquartile range).

Neonatal outcomes

The birthweights of twin 1 and twin 2 and the combined birthweight were higher in the induction group than in the spontaneous labor group ($P < 0.05$). The rates of NICU admission of twin 1 and twin 2 (51.9% and 56.2% vs 28.1% and 30.7%) and the incidence of respiratory distress syndrome of twin 1 (10.5% vs 3.5%) were higher in the spontaneous labor group, and the hospital stay of twin 1 was longer (all $P < 0.05$). No significant differences were found between the two groups in 1-minute Apgar score ≤ 7, assisted ventilation, birthweight discordance or necrotizing enterocolitis (all $P > 0.05$). The data are shown in Table 3.

Table 3
Neonatal outcomes in the spontaneous labor and induction groups

Twin 1	Spontaneous labor group (n = 210)	Induction group (n = 114)	t/χ²	*P*
Birthweight (g)	2395.00 ± 406.69	2557.11 ± 363.39	-3.554	< 0.001
1-min Apgar score ≤ 7	3 (1.4%)	1 (0.9%)	—	0.063
NICU admission	109 (51.9%)	32 (28.1%)	17.077	< 0.001
Respiratory distress syndrome	22 (10.5%)	4 (3.5%)	4.860	0.027
Assisted ventilation required	18 (8.6%)	4 (3.5%)	2.992	0.084
Necrotizing enterocolitis	2 (1.0%)	0 (0.0%)	0.092	0.762
Hospital stay (days)	4 (2, 12)	3 (2, 6)	-2.417	0.016
Twin 2				
Birthweight (g)	2347.31 ± 405.24	2445.46 ± 453.50	-1.996	0.047
1-min Apgar score ≤ 7	26 (12.4%)	7 (6.1%)	—	0.075
NICU admission	118 (56.2%)	35 (30.7%)	19.261	< 0.001
Respiratory distress syndrome	25 (11.9%)	10 (8.8%)	0.753	0.386
Assisted ventilation required	21 (10.0%)	13 (11.4%)	0.155	0.694
Necrotizing enterocolitis	6 (2.9%)	0 (0.0%)	1.933	0.164
Hospital stay (days)	3 (2, 12)	4 (2, 11)	-0.631	0.528
Birthweight discordance (g)	277.83 ± 311.85	306.54 ± 273.86	-0.825	0.410
Combined birthweight (g)	4747.19 ± 697.95	5002.58 ± 719.87	-3.175	0.002

Note: Normally distributed continuous variables are expressed as mean ± standard deviation; the 1-min Apgar score ≤ 7 was compared using Fisher's exact test.

Outcomes according to induction method

No significant differences were found among groups A, B and C in the rate of labor onset, labor duration, cesarean delivery rate, operative vaginal delivery, postpartum hemorrhage (including severe postpartum

hemorrhage), intertwin delivery interval or neonatal outcomes (1-min Apgar score ≤ 7, NICU admission of either twin, respiratory distress syndrome, assisted ventilation, hospital stay) (all $P > 0.05$). The data are shown in Table 4.

Table 4
Maternal and neonatal outcomes according to induction method

Maternal outcomes	**Group A (n = 12)**	**Group B (n = 30)**	**Group C (n = 72)**	**χ^2/Z**	***P***
Labor onset achieved	10 (83.3%)	26 (86.7%)	62 (86.1%)	0.079	0.961
First stage of labor (min)	305 (206, 585)	300 (150, 506)	272 (150, 720)	0.133	0.936
Second stage of labor (min)	33 (23, 105)	25 (16, 41)	24 (12, 67)	1.386	0.500
Third stage of labor (min)	23 (19, 33)	26 (16, 38)	23 (13, 37)	0.640	0.726
Total labor duration (min)	385 (282, 720)	350 (199, 589)	382 (241, 806)	0.380	0.827
Mode of delivery				—	0.522
Vaginal delivery	6 (50.0%)	20 (66.7%)	46 (63.9%)		
Conversion to cesarean delivery	6 (50.0%)	10 (33.3%)	26 (36.1%)		
Operative vaginal delivery				—	1.000
Forceps	0 (0.0%)	0 (0.0%)	1 (1.4%)		
Vacuum extraction	0 (0.0%)	0 (0.0%)	1 (1.4%)		
Postpartum hemorrhage	2 (16.7%)	5 (16.7%)	10 (13.9%)	—	0.787
Severe postpartum hemorrhage	0 (0.0%)	0 (0.0%)	3 (4.2%)	—	0.679
Intertwin delivery interval (min)	5 (1, 13)	11 (2, 24)	8 (1, 17)	1.555	0.460
Neonatal outcomes					
1-min Apgar score ≤ 7	0 (0.0%)	2 (6.7%)	6 (8.3%)	—	0.867
NICU admission of either twin	2 (16.7%)	8 (26.7%)	27 (37.5%)	2.826	0.243

Note: Skewed continuous variables are expressed as median (interquartile range). Note: "NICU admission of either twin" was recorded per woman: a woman was counted when either twin (twin 1 or twin 2) was admitted to the NICU; hence the number of women (n = 37) exceeds the numbers of admissions of twin 1 and twin 2 counted separately in the induction group in Table 3 *(n = 32 and n = 35, respectively).*

Maternal outcomes	Group A (n = 12)	Group B (n = 30)	Group C (n = 72)	χ^2/Z	*P*
Respiratory distress syndrome	0 (0.0%)	3 (10.0%)	9 (12.5%)	—	0.655
Assisted ventilation required	0 (0.0%)	3 (10.0%)	13 (18.1%)	—	0.202
Necrotizing enterocolitis	0 (0.0%)	0 (0.0%)	0 (0.0%)	—	—
Hospital stay of twin 1 (days)	3 (2, 4)	3 (2, 6)	3 (2, 7)	0.056	0.973
Hospital stay of twin 2 (days)	4 (3, 15)	3 (2, 9)	4 (2, 12)	1.061	0.588

Note: Skewed continuous variables are expressed as median (interquartile range). Note: "NICU admission of either twin" was recorded per woman: a woman was counted when either twin (twin 1 or twin 2) was admitted to the NICU; hence the number of women (n = 37) exceeds the numbers of admissions of twin 1 and twin 2 counted separately in the induction group in Table 3 *(n = 32 and n = 35, respectively).*

Factors associated with conversion to cesarean delivery

Univariable analysis showed that gestational age at delivery, admission cervical dilatation, pre-induction Bishop score, mode of labor onset, birthweights of twin 1 and twin 2, combined birthweight and pregnancy complications were associated with conversion to cesarean delivery ($P < 0.05$), whereas age, gravidity and parity, pre-pregnancy body mass index, chorionicity, presentation of twin 2, intrapartum oxytocin use, birthweight discordance and pregnancy comorbidities were not ($P > 0.05$). The data are shown in Table 5.

Table 5
Univariable analysis of factors associated with conversion to cesarean delivery in twin pregnancies attempting vaginal delivery

Parous	**Vaginal delivery group (n = 251)**	**Conversion to cesarean delivery group (n = 73)**	**χ^2/Z**	***P***
	114 (45.4%)	**33 (45.2%)**	**0.001**	**0.974**
Age (years)	30 (28, 33)	31 (29, 33)	-1.920	0.055
Gravidity	2 (1, 3)	2 (1, 3)	-0.045	0.964
Parity	0 (0, 1)	0 (0, 1)	-0.037	0.970
Gestational age at delivery (weeks)	36.2 (35.0, 37.3)	37.2 (36.2, 38.0)	-4.126	< 0.001
Pre-pregnancy body mass index (kg/m²)	20.40 (18.95, 22.59)	20.90 (19.03, 23.55)	-1.063	0.288
Admission cervical dilatation (cm)	0 (0, 2)	0 (0, 0)	-3.974	< 0.001
Pre-induction Bishop score	6 (6, 9)	6 (4, 7)	-2.548	0.011
Chorionicity			2.580	0.108
Dichorionic diamniotic	191 (76.1%)	62 (84.9%)		
Monochorionic diamniotic	60 (23.9%)	11 (15.1%)		
Presentation of twin 2			1.088	0.297
Cephalic	200 (79.7%)	54 (74.0%)		
Non-cephalic	51 (20.3%)	19 (26.0%)		
Mode of labor onset			20.639	< 0.001
Spontaneous labor	179 (71.3%)	31 (42.5%)		
Induction	72 (28.7%)	42 (57.5%)		
Intrapartum oxytocin use	100 (39.8%)	36 (49.3%)	2.084	0.149
Birthweight of twin 1 (g)	2414.55 ± 394.03	2588.49 ± 380.71	-3.345	0.001
Birthweight of twin 2 (g)	2343.61 ± 417.74	2504.70 ± 432.24	-2.877	0.004
Birthweight discordance (g)	288.26 ± 318.62	286.81 ± 219.89	0.037	0.971

Note: Skewed continuous variables are expressed as median (interquartile range) and normally distributed variables as mean ± standard deviation.

Parous	Vaginal delivery group (n = 251)	Conversion to cesarean delivery group (n = 73)	χ^2/Z	*P*
	114 (45.4%)	**33 (45.2%)**	**0.001**	**0.974**
Combined birthweight (g)	4758.15 ± 693.51	5093.19 ± 734.10	-3.585	< 0.001
Pregnancy comorbidities			0.473	0.491
No	227 (90.4%)	64 (87.7%)		
Yes	24 (9.6%)	9 (12.3%)		
Pregnancy complications			6.110	0.013
No	200 (79.7%)	48 (65.8%)		
Yes	51 (20.3%)	25 (34.2%)		
Note: Skewed continuous variables are expressed as median (interquartile range) and normally distributed variables as mean ± standard deviation.				

Multivariable logistic regression showed that admission cervical dilatation was a protective factor (OR 0.47, 95% CI 0.22–0.99, *P = 0.046*), and that gestational age at delivery (OR 1.51, 95% CI 1.06–2.15, *P = 0.021*) and pregnancy complications (OR 3.20, 95% CI 1.27–8.04, *P = 0.014*) were independent risk factors for conversion to cesarean delivery. The data are shown in Table 6.

Table 6
Multivariable logistic regression analysis of factors associated with conversion to cesarean delivery in twin pregnancies attempting vaginal delivery

Variable	B	SE	Wald χ^2	*P*	OR	95% CI
Mode of labor onset	-0.679	0.604	1.265	0.261	0.51	0.16–1.66
Gestational age at delivery (weeks)	0.414	0.180	5.312	0.021	1.51	1.06–2.15
Admission cervical dilatation (cm)	-0.764	0.384	3.967	0.046	0.47	0.22–0.99
Pre-induction Bishop score	-0.013	0.090	0.022	0.883	0.99	0.83–1.18
Birthweight of twin 1 (g)	0.001	0.001	1.699	0.192	1.001	1.000–1.002
Birthweight of twin 2 (g)	0.000	0.001	0.005	0.946	1.000	0.999–1.001
Pregnancy complications	1.162	0.471	6.097	0.014	3.20	1.27–8.04
Note: SE, standard error.						

ROC curve analysis showed that the area under the curve for gestational age at delivery in predicting conversion to cesarean delivery was 0.658 (95% CI 0.59–0.72, *P < 0.001*), with an optimal cut-off of 37.05 weeks (sensitivity 60.3%, specificity 69.7%) at the maximum Youden index; the risk of conversion was

increased beyond 37.05 weeks of gestation. The area under the curve for admission cervical dilatation was 0.628 (95% CI 0.56–0.69, *P = 0.001*), with an optimal cut-off of 0.25 cm (sensitivity 37.8%, specificity 86.1%); the risk of conversion was increased when admission cervical dilatation was ≤ 0.25 cm (Fig. 2).

Discussion

The choice of delivery mode for twin pregnancies should be individualized according to chorionicity, presentation, maternal comorbidities, obstetric history and fetal status. Apart from conjoined twins and monochorionic monoamniotic twins, which are absolute indications for cesarean delivery, no other twin pregnancy is contraindicated for vaginal delivery.[12,13] Some studies, however, have reported different findings: Hu et al.[14] reported greater postpartum blood loss and a higher rate of neonatal asphyxia after vaginal delivery of twins, and the two-center study by Bevilacqua et al.[15] found higher rates of NICU admission and birth-related respiratory distress among neonates delivered vaginally. The multicenter randomized controlled trial by Barrett et al.[16] (the Twin Birth Study), which enrolled 2804 twin pregnancies at 32–38 weeks of gestation, found no significant difference in neonatal mortality or serious neonatal morbidity between planned cesarean and planned vaginal delivery, which supports the safety of vaginal delivery for near-term twins; other studies have likewise shown maternal and neonatal outcomes of vaginal delivery comparable with those of cesarean delivery in eligible twin pregnancies.[17] In our cohort of 324 women attempting vaginal delivery, the overall success rate was 77.5%, with 11 cases of placental abruption and 5 cases of umbilical cord prolapse; there were no uterine ruptures, no maternal admissions to the intensive care unit and no maternal or neonatal deaths, indicating that vaginal delivery of twins is safe when indications are strictly observed and labor is managed according to protocol. Combined delivery (vaginal birth of twin 1 followed by cesarean delivery of twin 2) requires particular vigilance because it carries increased risks of adverse outcomes for the second twin and of postpartum hemorrhage.[13,18] Among the 10 combined deliveries in our cohort, the main indications were transverse or compound presentation of twin 2 (4 cases) and fetal distress (3 cases); only one neonate had a 1-min Apgar score ≤ 7 and one developed respiratory distress syndrome, and none of the mothers experienced adverse outcomes. Of note, during the study period, 74 569 deliveries occurred at our center, including 5099 twin pregnancies (6.8%) and 3879 twins delivered at ≥ 34 weeks, yet only 324 women (8.4%) were willing to attempt vaginal delivery. This proportion accords with the predominance of cesarean delivery for twin pregnancies in China; with the wider adoption of standardized perinatal management and improved intrapartum care, the acceptance of a trial of labor in twins is expected to increase gradually.

Whether labor induction is appropriate for twin pregnancies remains controversial. In this study, the induction rate was 35.2% (114/324), and the conversion rate to cesarean delivery in the induction group (36.8%) was approximately 2.5-fold that in the spontaneous labor group (14.8%), consistent with the reports of Lopian et al.,[19] Mikaelsen et al.[20] and Jonsson.[21] The existing evidence, however, is not entirely consistent: in a meta-analysis pooling eight studies, Sorrenti et al.[22] found no significant difference in the risk of unplanned cesarean delivery between induced and spontaneous labor in twins

(pooled OR 0.94, 95% CI 0.36–2.45), and neonatal mortality was even lower after induction; compared with elective cesarean delivery, however, induction was associated with a higher risk of maternal complications (pooled OR 2.48). The prospective cohort study by Kjeldsen et al.[23] demonstrated comparable maternal and neonatal outcomes between planned induction and planned cesarean delivery. The higher conversion rate in our induction group is readily explained: women undergoing induction had more advanced gestational age, less cervical dilatation on admission and relatively unfavorable cervices, all of which were identified in this study as risk factors for a failed trial of labor. Induction, however, did not increase adverse maternal or neonatal outcomes: the incidence of postpartum hemorrhage was even lower in the induction group; labor duration, operative vaginal delivery, placental abruption, umbilical cord prolapse, infection and hospital stay did not differ significantly between groups; and NICU admission and respiratory distress syndrome of twin 1 were also less frequent in the induction group, consistent with the findings of Ni et al.[24] and Shi et al.[25] The better neonatal outcomes in the induction group may be related to more advanced gestational age and greater fetal maturity, which likely reflects selection bias rather than a benefit of induction itself. Theoretically, larger fetuses in the induction group would be expected to prolong labor, yet no significant differences were observed in any stage of labor, and the intertwin delivery interval was even slightly shorter, suggesting that with standardized oxytocin titration and continuous intrapartum monitoring, induction does not substantially alter labor characteristics in twins.

Regarding induction methods, most authors consider that methods used in singleton pregnancies can be safely and effectively applied to twin pregnancies.[24,26,27] Reports on the use of prostaglandins for induction in twin pregnancies are rare in China, and the guideline of the Society of Obstetricians and Gynaecologists of Canada also advises caution with these agents in twins;[28] Huber et al.[29] compared oral misoprostol with vaginal dinoprostone for induction in twins and found no significant differences in vaginal delivery rates or neonatal outcomes. In this study, using cervical ripening balloon, artificial rupture of membranes and oxytocin alone or in combination, groups A, B and C showed no significant differences in the rate of labor onset, labor course, cesarean delivery rate, postpartum hemorrhage or neonatal outcomes, consistent with the conclusions above: induction protocols selected individually on the basis of comprehensive cervical assessment are all safe and effective. A recent meta-analysis of head-to-head comparisons of different induction methods in twins (five studies) likewise found no differences in cesarean delivery rates among protocols,[22] corroborating our results. The main indication for induction in our cohort was chorionicity-specific gestational age at delivery (59.6%), followed by prelabor rupture of membranes (28.1%). Group A comprised only 12 women, limiting statistical power, and the relative merits of different induction protocols require confirmation in larger samples.

The focus of managing vaginal twin delivery lies after the birth of twin 1. Leung et al.[30] found that cord blood gas status deteriorated more rapidly during the second stage of labor in twin 2 than in twin 1, warranting more active management of the second stage for twin 2; Zhang et al.[26] reported a positive correlation between the duration of the second stage and postpartum blood loss and recommended that it be kept within 1 hour. The median third stage of labor in our cohort was 21–23 min. Current practice

generally requires the third stage to be completed within 30 min, with manual removal of the placenta as the most common intervention;[31] Whittington et al.[32] recommended that the placenta be delivered within 15 min of the birth of twin 2; the prospective study by Rabie et al.[33] showed that a third stage exceeding 15 min increased the risk of blood loss > 500 ml by 15.8-fold; and Frolova et al.[34] reported a 95th percentile third-stage duration of only 13 min. By these standards, the median third stage in our cohort was already prolonged, and more active management is warranted. The literature is inconsistent regarding the intertwin delivery interval: most studies associate a prolonged interval with higher conversion rates and increased risks of distress and acidosis in twin 2,[35,36] whereas others found no effect on neonatal outcomes;[37,38] Justman et al.[39] recommended that twin 2 be delivered within 15 min of twin 1. Owing to the long study period and the limited number of women with complete second-stage blood gas data, we were unable to determine an optimal interval threshold, which awaits clarification in large multicenter studies.

Multivariable logistic regression showed that admission cervical dilatation was a protective factor for successful vaginal delivery (OR 0.47), and gestational age at delivery and pregnancy complications were independent risk factors (OR 1.51 and 3.20); the optimal cut-offs derived from ROC analysis were 37.05 weeks for gestational age and 0.25 cm for admission cervical dilatation. These results explain the higher conversion rate in the induction group: women undergoing induction tended to have more advanced gestational age and unfavorable cervices, consistent with the findings of Lopian et al.[19] The population-based cross-sectional analysis by Davey et al.[40] also suggested that induction increases the risk of cesarean delivery; Fausett et al.[41] attributed some cesarean deliveries to decreased uterine sensitivity after prolonged intrapartum oxytocin use; and Schachter-Safrai et al.[42] reported an association between malpresentation of twin 2 and failed trial of labor in twins. The study by Mi et al.[43] likewise supports a higher likelihood of successful vaginal delivery before 37 weeks, possibly because fetuses are smaller at earlier gestational ages, whereas term twins tend to be larger and more prone to uterine atony; in addition, women presenting in labor after failed tocolysis already have regular contractions and cervices approaching the laboring state. Regarding fetal weight, the combined birthweight of the twins was associated with conversion in univariable analysis but did not enter the multivariable model, its effect likely being partly mediated by gestational age. Guo et al.[44] analyzed 137 women attempting vaginal delivery of twins and identified a combined birthweight ≥ 4735 g as a factor associated with a failed trial of labor, close to our findings, whereas reports on the effect of birthweight discordance remain inconsistent.[44,45] Therefore, women with gestational age > 37 weeks, undilated or unfavorable cervices on admission, or pregnancy complications should be thoroughly counseled about the risk of conversion to cesarean delivery before induction; strengthened antenatal nutrition and weight management and active prevention and treatment of pregnancy complications may also improve the conditions for a trial of labor.

This study has several strengths. The sample comprised consecutive cases from a single delivery center over 11 years, and 324 twin pregnancies attempting vaginal delivery constitute one of the larger

controlled studies of this kind in China. The induction group was stratified by cervical condition, enabling a head-to-head comparison of balloon cervical ripening, artificial rupture of membranes and oxytocin, alone or in combination; such direct comparisons are uncommon in the literature on induction in twins. Furthermore, multivariable logistic regression showed that the mode of labor onset itself was not an independent predictor of conversion after adjustment for gestational age and admission cervical dilatation, suggesting that the higher conversion rate in the induction group is largely attributable to case selection, information directly relevant to clinical counseling before induction in twins.

In line with the recommendations of Zou et al.,[46] Luo et al.[47] and Yuan and Zhao,[27] vaginal delivery and induction in twin pregnancies should be undertaken at tertiary institutions capable of critical care of mothers and neonates, with collaborative management by experienced obstetricians, midwives and neonatologists; continuous dual fetal heart rate monitoring should be combined with bedside ultrasound to dynamically assess presentation and labor progress; operative vaginal delivery, emergency cesarean delivery and the management of severe postpartum hemorrhage should be immediately available in the delivery room; and indications and contraindications should be strictly observed before induction to avoid non-indicated induction. This study also has limitations: owing to the single-center historical design, selection bias was unavoidable; group A was small, with limited statistical power; the 11-year study span means that changes in obstetric management strategies over time may have affected the results; and neonatal blood gas data were missing, precluding analysis of the relationship between the intertwin delivery interval and acidosis.

Conclusions

Vaginal delivery in late pregnancy is safe and feasible for women with twin pregnancies who meet the indications for vaginal delivery; the various induction protocols, used alone or in combination, are all safe and effective; and although induction increases the risk of conversion to cesarean delivery, it does not increase adverse maternal or neonatal outcomes. For women with gestational age > 37 weeks, unfavorable cervices or pregnancy complications, thorough assessment and individualized selection of the delivery route are warranted before induction.

Abbreviations

CI, confidence interval; NICU, neonatal intensive care unit; OR, odds ratio.

Declarations

Ethics approval and consent to participate

This study was approved by the Ethics Committee of the Third Affiliated Hospital of Guangzhou Medical University (approval number YL-20260923000654), and the requirement for informed consent was waived owing to the retrospective design.

Consent for publication

Not applicable.

Availability of data and materials

The data that support the findings of this study are not publicly available owing to patient privacy protection, but de-identified summary data are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

L.L.: study design and implementation, data analysis, and manuscript drafting. X.L.: data collection and curation, statistical analysis, and manuscript writing and revision. X.W.: study protocol design and oversight. B.C.: data collection and verification. C.K.: study supervision, funding acquisition and manuscript revision. All authors read and approved the final manuscript.

References

1. Xiao HY, Kong SM, Yu J, et al. Trends in twin pregnancies and perinatal outcomes in Guangzhou, Guangdong Province, 2011–2020 (in Chinese). Chin J Women Child Health. 2022;13(5):10–3.
2. Martin JA, Hamilton BE, Osterman MJK. Births: final data for 2019. Natl Vital Stat Rep. 2021;70(2):1–51.
3. Committee of Twin Pregnancy, Chinese Association of Maternal and Child Health. Guidelines for the diagnosis, treatment and healthcare of preterm birth in twin pregnancies (2020 edition) (in Chinese). Chin J Practical Gynecol Obstet. 2020;36(10):949–59.
4. Ochsenbein-Kölble N. Twin pregnancies. Ultraschall Med. 2021;42(3):246–69.
5. Santana DS, Cecatti JG, Surita FG, et al. Twin pregnancy and severe maternal outcomes: the World Health Organization multicountry survey on maternal and newborn health. Obstet Gynecol. 2016;127(4):631–41.
6. Rissanen AS, Jernman 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(1):337.

7. Gong JJ, Huang CJ, Liu SL, et al. Clinical characteristics and risk factors for preterm birth in twin pregnancies (in Chinese). J Practical Obstet Gynecol. 2019;35(11):841–5.
8. Rossi AC, Mullin PM, Chmait RH. Neonatal outcomes of twins according to birth order, presentation and mode of delivery: a systematic review and meta-analysis. BJOG. 2011;118(5):523–32.
9. Fetal Medicine Group, Society of Perinatal Medicine, Chinese Medical Association. Obstetrics Group, Society of Obstetrics and Gynecology, Chinese Medical Association. Guidelines for clinical management of twin pregnancies (part 1): antenatal care and management (in Chinese). Chin J Obstet Gynecol. 2015;50(8):561–7.
10. Society of Perinatal Medicine, Chinese Medical Association; Obstetrics Group, Society of Obstetrics and Gynecology, Chinese Medical Association. Expert consensus on the timing of delivery for pregnancy complications and comorbidities (in Chinese). Chin J Perinat Med. 2020;23(11):721–32.
11. Obstetrics Group, Society of Obstetrics and Gynecology, Chinese Medical Association. Guideline for cervical ripening and labor induction in late pregnancy (2024) (in Chinese). Chin J Obstet Gynecol. 2024;59(11):819–28.
12. American College of Obstetricians and Gynecologists. ACOG Practice Bulletin 144: multifetal gestations: twin, triplet, and higher-order multifetal pregnancies. Obstet Gynecol. 2014;123(5):1118–32.
13. Vayssiere C, Benoist G, Blondel B, et al. Twin pregnancies: guidelines for clinical practice from the French College of Gynaecologists and Obstetricians (CNGOF). Eur J Obstet Gynecol Reprod Biol. 2011;156(1):12–7.
14. Hu L. Clinical study on different delivery methods of twin pregnancy. Am J Perinatol. 2023;40(12):1306–10.
15. Bevilacqua E, Torcia E, Melia F, et al. Maternal and fetal outcomes after planned cesarean or vaginal delivery in twin pregnancy: a comparison between 2 third level birth centers. J Matern Fetal Neonatal Med. 2024;37(1):2350676.
16. Barrett JF, Hannah ME, Hutton EK, Twin Birth Study Collaborative Group, et al. A randomized trial of planned cesarean or vaginal delivery for twin pregnancy. N Engl J Med. 2013;369(14):1295–305.
17. Smith GCS. Mode of delivery of twins at term. Best Pract Res Clin Obstet Gynaecol. 2022;84:194–204.
18. Ylilehto E, Palomäki O, Huhtala H, Uotila J. Term twin birth - impact of mode of delivery on outcome. Acta Obstet Gynecol Scand. 2017;96(5):589–96.
19. Lopian M, Kashani-Ligumsky L, Cohen R, et al. Induction of labor in twins: double trouble? J Clin Med. 2023;12(5):2041.
20. Mikaelsen I, Johansen AN, Tappert C, Eggebø TM. Induction of labor in twin pregnancies - a retrospective cohort study. Sex Reprod Healthc. 2022;32:100724.

21. Jonsson M. Induction of twin pregnancy and the risk of caesarean delivery: a cohort study. BMC Pregnancy Childbirth. 2015;15(1):147.
22. Sorrenti S, Ulusoy CO, Mohammed D, Di Mascio D, D'Antonio F, Khalil A. Induction of labor in twin pregnancies: systematic review and meta-analysis. Best Pract Res Clin Obstet Gynaecol. 2026;107:102746.
23. Kjeldsen MH, Højlund M, Andreasen E, Khalil MR. Neonatal and maternal outcomes with elective cesarean section compared to induction of labor in twin pregnancies: a prospective cohort study. Eur J Obstet Gynecol Reprod Biol. 2023;286:85–9.
24. Ni P, Huang L, Peng J, et al. Clinical analysis of vaginal delivery after labor induction in twin pregnancies (in Chinese). Progress Obstet Gynecol. 2025;34(2):131–4.
25. Shi DD, Zhang QY, Cheng Y. Effect of mode of labor on delivery outcomes in twin pregnancies beyond 36 weeks of gestation (in Chinese). Chin J Birth Health Heredity. 2022;30(2):255–8.
26. Zhang L, Yu YY, Wu JN, et al. Labor characteristics and maternal and neonatal outcomes of trial of labor in twin pregnancies (in Chinese). Fudan Univ J Med Sci. 2023;50(1):80–6.
27. Yuan PB, Zhao YY. Vaginal delivery in twin pregnancies (in Chinese). Chin J Obstetric Emerg (Electronic Edition). 2016;5(3):165–8.
28. Leduc D, Biringer A, Lee L, Dy J. Induction of labour. J Obstet Gynaecol Can. 2013;35(9):840–57.
29. Huber G, Schütz H, Seelbach-Göbel B. Induction of labor in twin pregnancies with oral misoprostol versus vaginal dinoprostone: is it effective and safe? J Matern Fetal Neonatal Med. 2015;28(9):1043–6.
30. Leung TY, Lok IH, Tam WH, Leung TN, Lau TK. Deterioration in cord blood gas status during the second stage of labour is more rapid in the second twin than in the first twin. BJOG. 2004;111(6):546–9.
31. Cummings K, Doherty DA, Magann EF, Wendel PJ, Morrison JC. Timing of manual placenta removal to prevent postpartum hemorrhage: is it time to act? J Matern Fetal Neonatal Med. 2016;29(24):3930–3.
32. Whittington JR, Pagan M, Daugherty K, et al. Duration of the third stage of labor and estimated blood loss in twin vaginal deliveries. Am J Perinatol Rep. 2020;10(3):e330–4.
33. Rabie NZ, Ounpraseuth S, Hughes D, Lang P, Wiegel M, Magann EF. Association of the length of the third stage of labor and blood loss following vaginal delivery. South Med J. 2018;111(3):178–82.
34. Frolova AI, Stout MJ, Tuuli MG, Lopez JD, Macones GA, Cahill AG. Duration of the third stage of labor and risk of postpartum hemorrhage. Obstet Gynecol. 2016;127(5):951–6.
35. Lindroos L, Elfvin A, Ladfors L, Wennerholm UB. The effect of twin-to-twin delivery time intervals on neonatal outcome for second twins. BMC Pregnancy Childbirth. 2018;18(1):36.
36. Stein W, Misselwitz B, Schmidt S. Twin-to-twin delivery time interval: influencing factors and effect on short-term outcome of the second twin. Acta Obstet Gynecol Scand. 2008;87(3):346–53.

37. Suzuki S. What is the effect of intertwin delivery interval on the outcome of the second twin delivered vaginally? J Matern Fetal Neonatal Med. 2020;33(10):1758.
38. Algeri P, Callegari C, Mastrolia SA, et al. What is the effect of intertwin delivery interval on the outcome of the second twin delivered vaginally? J Matern Fetal Neonatal Med. 2019;32(20):3480–6.
39. Justman N, Goldfriend R, Rosh B, et al. Exploring the optimal intertwin delivery interval for vaginal delivery. Reprod Sci. 2024;31(6):1551–7.
40. Davey MA, King J. Caesarean section following induction of labour in uncomplicated first births: a population-based cross-sectional analysis of 42 950 births. BMC Pregnancy Childbirth. 2016;16(1):92.
41. Fausett MB, Barth WH Jr, Yoder BA, Satin AJ. Oxytocin labor stimulation of twin gestations: effective and efficient. Obstet Gynecol. 1997;90(2):202–4.
42. Schachter-Safrai N, Karavani G, Haj-Yahya R, Ofek Shlomai N, Porat S. Risk factors for cesarean delivery and adverse neonatal outcome in twin pregnancies attempting vaginal delivery. Acta Obstet Gynecol Scand. 2018;97(8):845–51.
43. Mi X, Zou LY, Hou L, et al. Factors associated with successful trial of labor in twin pregnancies (in Chinese). Progress Obstet Gynecol. 2024;33(11):850–3.
44. Guo XY, Wei Y, Zhao YY, et al. Clinical characteristics of women with twin pregnancies undergoing trial of labor and factors associated with failed trial of labor (in Chinese). Natl Med J China. 2022;102(20):1512–7.
45. Christopher D, Robinson BK. An evidence-based approach to determining route of delivery for twin gestations. Rev Obstet Gynecol. 2011;4(3–4):109–16.
46. Zou XY, Li C, Wei J. Pregnancy management and delivery of twin pregnancies (in Chinese). Chin J Practical Gynecol Obstet. 2025;41(2):133–8.
47. Luo YH, Liu HS. Management of vaginal delivery in twin pregnancies (in Chinese). Chin J Obstetric Emerg (Electronic Edition). 2018;7(3):162–5.
48. Rüegg L, Vonzun L, Wawrla-Zepf J, et al. Twin delivery: does induction of labor make a difference? Arch Gynecol Obstet. 2025;312(1):99–106.
49. Rao MG, DeBolt CA, Wang K, et al. Mode of delivery outcomes of induced versus spontaneous labor in individuals with dichorionic twins. Am J Perinatol. 2025;42(14):1875–84.

Figures

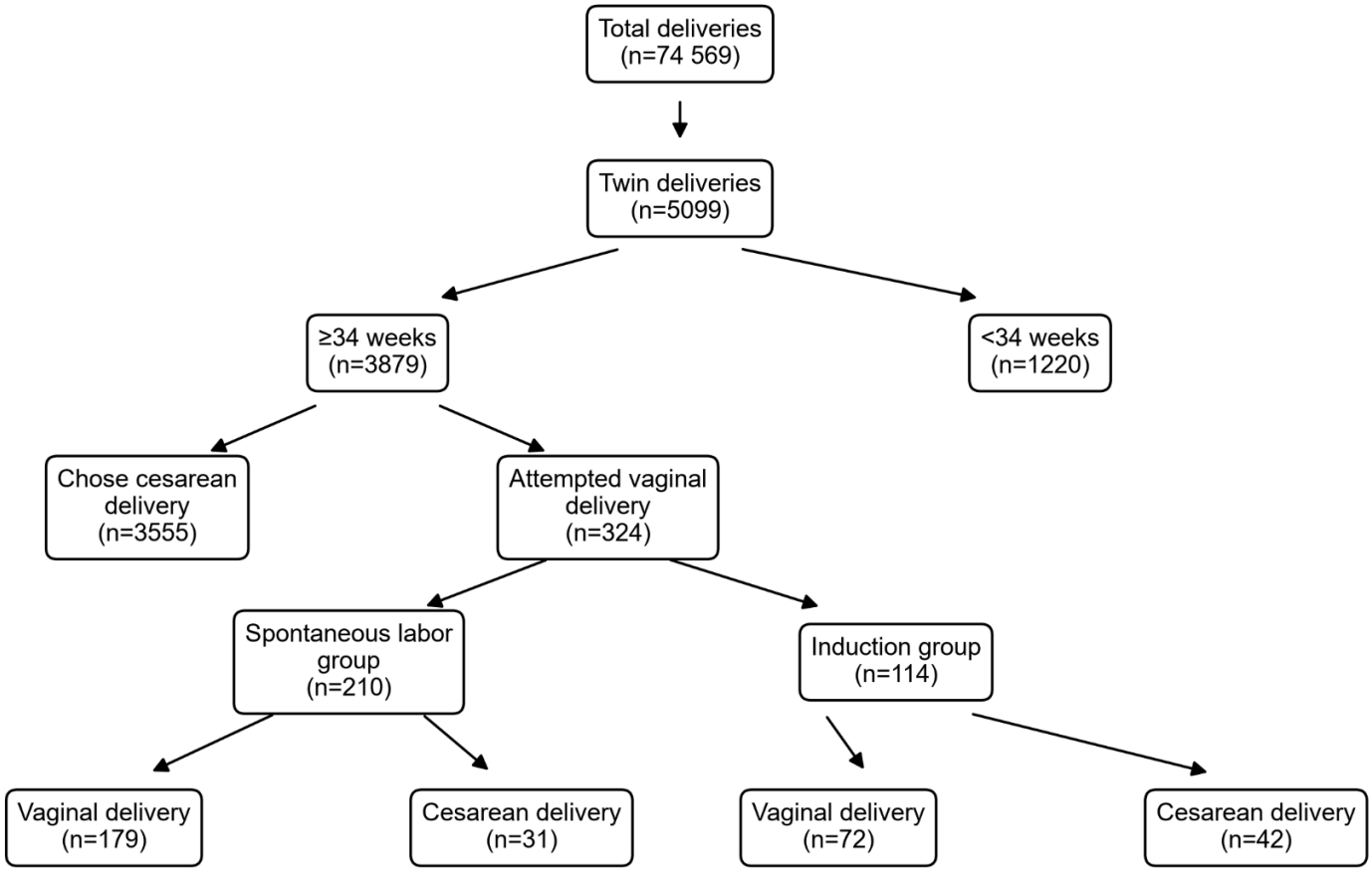


Figure 1

Flow chart of participant enrollment.

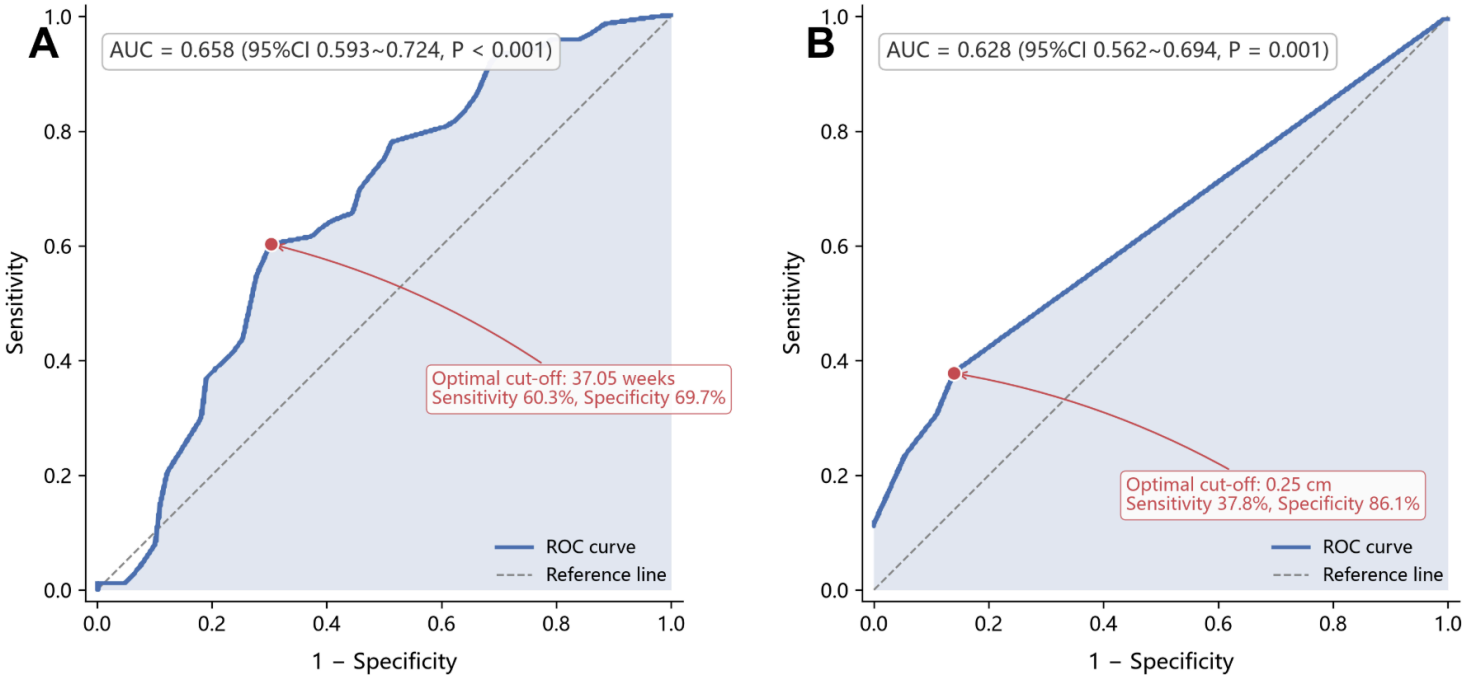


Figure 2

Receiver operating characteristic curves of gestational age at delivery (A) and admission cervical dilatation (B) for predicting conversion to cesarean delivery in twin pregnancies attempting vaginal delivery (shaded areas indicate the areas under the curves, AUC=0.658 and 0.628).

Supplementary Files

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