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ORIGINAL ARTICLE

The impact of mode of delivery on the outcome in very preterm twins

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ABSTRACT

Objective: Studies on the optimal mode of delivery in women with a twin pregnancy <32 weeks are scarce. We studied the effects of the mode of delivery on perinatal and maternal outcomes in very preterm twin pregnancy.

Study Design: Population-based cohort study including all women with twin pregnancy who delivered very preterm (26–32 weeks of gestation) in the Netherlands between January 2000 and December 2010. We compared perinatal mortality and neonatal and maternal morbidity according to the intended mode of delivery as well as to the actual mode of delivery. Perinatal outcomes were paired taking into account the dependency between the children of the same twin pregnancy and were also analysed for each child separately. We used logistic regression to correct for possible confounding factors.

Results: We studied 1,655 women with a very preterm delivery of a twin pregnancy. A planned caesarean section ($n = 212$) was associated with a significantly higher perinatal mortality compared to a planned vaginal delivery ($n = 1.443$) (10% compared to 6.5%; adjusted odds ratio (OR) 2.5, 95% confidence interval (CI) 1.5–4.2). The same applied for perinatal morbidity (66% compared to 63%; adjusted OR 1.5, 95% CI 1.1–2.0), maternal morbidity (17% compared to 4.9%; adjusted OR 4.0, 95% CI 2.6–6.3) and for perinatal mortality for the second twin (7.1% compared to 3.5% adjusted OR 2.9, 95% CI 1.7–5.2).

Conclusion: In very preterm delivery of twins a vaginal delivery is the preferred mode of delivery.

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Mode of delivery; preterm delivery; twin pregnancy

Introduction

The incidence of twin pregnancies has increased due to the growing use of assisted reproductive technologies and due to the increased maternal age at first pregnancy [1]. Twin pregnancies have a higher risk of complications such as preterm birth, intrauterine growth restriction, and perinatal mortality and morbidity. In the high-resourced countries, approximately one-third of the very preterm deliveries (before 32 weeks of gestation) concerns a twin pregnancy [1,2].

The Twin Birth study, a large multicenter randomized controlled trial (RCT), showed that planned Cesarean section did not reduce the risk of fetal or neonatal death or serious morbidity as compared to planned vaginal delivery in twin pregnancies beyond 32-week gestation. The risk of adverse neonatal outcome was higher for the second twin than for the first twin; however, planned Cesarean section did not reduce this risk [3]. This study has been criticized for randomizing women from 32-week onward, thus introducing higher morbidity and mortality rates at these lower gestational ages, and mimicking a potential protective effect of caesarean section at term [4].

Currently, there are only a few small studies that report on the preferred mode of delivery in women with a twin pregnancy and a delivery before 32 weeks of gestation [5–7]. Recently, a study limited to very preterm twins with the first child in cephalic presentation showed that a policy of planned vaginal delivery of very preterm twins with the first twin in cephalic presentation does not increase perinatal mortality (adjusted OR 0.78; 95% CI 0.17–3.68) or severe neonatal morbidity (adjusted OR 0.71; 95% CI 0.36–1.44) [8].

The purpose of our study was to analyze the association between the intended mode of delivery and perinatal and maternal outcomes in very preterm twin pregnancies (26–32 weeks of gestation).

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Materials and methods

This study was performed using data from a national cohort registered in the Netherlands Perinatal Registry (PRN). The PRN consists of population-based data containing information on pregnancies, deliveries, and (re)admissions until 28 d after birth.

The PRN database is obtained by a validated linkage of three different registries: the midwife registry (LVR 1), the obstetricians registry (LVR 2), and the neonatology registry (LNR) of hospital admissions of newborn infants [9].

The coverage of the PRN is approximately 96% of all deliveries in the Netherlands and currently includes over 1.9 million records derived from deliveries in the last decade.

All PRN data are recorded by the caregivers during prenatal care, delivery, and the neonatal period. The data are annually sent to the national registry office, where a number of range and consistency checks are conducted. Institutional review board approval was not necessary since the data were used anonymous, thus exempting ethics approval in the Netherlands.

For this study, we identified all women with a twin pregnancy who delivered between 26 and 32 weeks of gestation between January 1, 2000 and December 31, 2010.

Women with a pregnancy complicated by congenital abnormalities, placental abruption, intrauterine fetal death before onset of labor, fetal growth restriction (birth weight $<$ P5), twin-to-twin-transfusion syndrome (TTTS), maternal hypertension (maternal systolic blood pressure $\geq$140 mmHg, and/or diastolic blood pressure $\geq$90 mmHg), or preeclampsia (high blood pressure and proteinuria; $\geq$300–mg protein loss in 24-h urine sample) were excluded. We also excluded women who delivered before 2 6^{+0} weeks of gestation because in the time period under study active management between 24 and 26 weeks was not general practice in the Netherlands.

We compared perinatal and maternal outcomes according to the intended mode of delivery, i.e. intended Cesarean section versus intended vaginal delivery (vaginal delivery of both twins, emergency Cesarean section of both twins and vaginal delivery of first twin, and emergency Cesarean section of the second twin) as well as according to the actual mode of delivery. We performed a subgroup analysis according to fetal presentation (cephalic/cephalic, cephalic/other, breech/cephalic, breech/other). We compared intrapartum and neonatal mortality (within the first 28 d after birth) and maternal and neonatal morbidity between these groups. Neonatal morbidity was defined as 5-min Apgar score $<$4, intraventricular hemorrhage, cephalic hematoma, facial nerve paralysis, brachial plexus injuries, clavicle fracture, humerus fracture, infant respiratory distress syndrome (IRDS), hypoxic–ischemic encephalopathy, neonatal hypotonia, or neonatal seizures. We also analyzed perinatal mortality and morbidity as a composite outcome "adverse perinatal outcome." Maternal morbidity was defined as uterine rupture, postpartum hemorrhage $>$1000 mL and the need for blood transfusion.

We used logistic regression to correct for possible confounding factors. McNamee's traditional criteria for identifying confounders were used to determine whether a covariate was a confounder or not [10]. In the multivariate analyses, we corrected for nulliparity, gestational age (weeks), admission child to neonatal intensive care units (NICU) center, nonwestern ethnicity, prolonged rupture of membranes ($\geq$ 24 h), and birth weight (grams). The correlation structure between the paired twins was taken into account by analyzing the data as clustered data. Perinatal outcomes were analyzed as pairs ("any mortality," "any morbidity," "any composite adverse perinatal outcome") and for each child separately.

Specific management data including the use of tocolytic medication, fetal lung maturation with corticosteroids, antibiotic treatment, and antenatal transfer to a third-level care facility were not available from the database. According to the national guidelines at that time, tocolytics (atosiban or nifedipine) and antenatal corticosteroids to enhance fetal lung maturity were recommended from 2 5^{+0} till 3 3^{+6} weeks of gestation for a period of 48 h in women with symptoms of threatened preterm birth. Magnesium sulfate for fetal neuroprotection was not recommended to administer at that time. Women in the study were treated according to these national guidelines. Threatened preterm birth is defined as preterm contractions combined with dilatation or cervical length shortening below 25 mm or preterm premature rupture of membranes (PPROM). Women at risk for preterm delivery before 32 weeks of gestation are referred to tertiary centers that are equipped with NICU.

The decision for Cesarean section or vaginal delivery was made by the responsible obstetrician in consultation with the patient. In case of cephalic presentation of the first twin, it is common practice in The Netherlands to counsel women toward a vaginal delivery. In case of the first twin in breech presentation, the absence of clear data and guidelines on this subject results in practice variation.

Table 1. Baseline characteristics of 1655 women with a twin pregnancy and a very preterm delivery (26–32 weeks of gestation) in The Netherlands from 2000 to 2010 according to the intended mode of delivery.

	Planned CS (n= 212)	Planned vaginal delivery (n= 1443)	p value
Parity			
Nulliparous, n (%)	125 (59.0%)	989 (69%)	.0127
Primiparous[a],n (%)	7 (3.3%)	25 (1.7%)	
Parous, n (%)	80 (38%)	429 (30%)	
Previous CS			
Yes, n (%)	12 (5.7%)	41 (2.8%)	
No, n (%)	200 (94%)	1402 (97%)	.029
Mean maternal age, years (SD)	31.1 (4.7)	30.4 (4.5)	.45
Mean birth weight (SD)			
Fetus 1	1396 (295)	1376 (294)	.90
Fetus 2	1358 (318)	1354 (304)	.37
Mean gestational age at delivery, Weeks (SD)	29.6 (1.4)	29.2 (1.6)	.013
Gestational age			
26 to 28 weeks	19 (9%)	253 (18%)	.002
28 to 32 weeks	193 (91%)	1190 (83%)	
Ethnicity			
Western, n (%)	180 (85%)	1251 (87%)	.48
Nonwestern, n (%)	32 (15%)	192 (13%)	
Socioeconomic status			
Low, n (%)	61 (29%)	350 (24%)	
Medium/ high, n (%)	151 (71%)	1093 (76%)	.155
PPROM			
Yes, >24 h, n (%)	22 (10%)	294 (20%)	.0005
No,(+ <24 h), n (%)	190 (90%)	1149 (80%)	
Location of delivery			
NICU equipped hospital, n (%)	167 (79%)	959 (67%)	.0003
General hospital, n (%)	45 (21%)	484 (34%)	
Fetal sex,			
Both female, n (%)	89 (42%)	431 (30%)	
Both male, n (%)	78 (37%)	521 (36%)	.0001
Female/male, n (%)	45 (21%)	491 (34%)	

[a]previous Cesarean section.

Data selection was done in SAS version 9.3, and all analyses were performed in R version 0.98.1091 (the R Foundation for Statistical Computing).

Results

During the study period between January 2000 and December 2010, 146,885 women delivered preterm in The Netherlands, of which 1655 women delivered very preterm of a twin pregnancy. Of these 1655 women, 212 (13%) women delivered by planned Cesarean section and 1443 women (87%) by planned vaginal delivery. Table 1 shows the baseline characteristics of the two groups. Multiparity, previous Cesarean section, and delivery in a NICU hospital occurred more often in the Cesarean section group, while women with PPROM delivered more often vaginally. Also, women with a planned Cesarean section had a higher gestational age, and surprisingly, their babies were more often both female.

Perinatal and maternal outcomes according to the intended mode of delivery are listed in Table 2. In the whole study population, any perinatal mortality was significantly higher in women with a planned caesarean section (n = 212) compared to women with a planned vaginal delivery (n = 1443) (10.4% compared to 6.5%, adjusted OR 2.5; 95% CI 1.5–4.2). The same applied for any neonatal morbidity (66.0% compared to 62.7%; adjusted OR 1.5; 95% CI 1.1–2.0) and any composite adverse perinatal outcome (66.5% compared to 63.6%; adjusted OR 1.4; 95%CI 1.0–2.0). In the subgroup analysis for each child separately perinatal mortality of the first twin was not significantly different for planned Cesarean section (5.2% as compared to 4.0%; adjusted OR 2.0; 95% CI 1.0–4.0), while neonatal morbidity of the first twin (54.3 vs. 42.9%) and composite adverse perinatal outcome (54.3 vs. 42.9%) were significantly higher in planned Cesarean section as compared to planned vaginal delivery (adjusted OR 1.9; 95% CI 1.4–2.6, adjusted OR 1.9; 95% CI 1.4–2.5).

For the second twin, perinatal mortality was significantly higher in planned Cesarean section as compared to planned vaginal delivery (7.1 vs. 3.5%; adjusted OR 2.9; 95% CI 1.7–5.2), while neonatal morbidity (53.3 vs. 53.2%) and composite adverse perinatal outcome (54.7 vs. 53.8%) were not significantly different (adjusted OR 1.2; 95% CI 0.89–1.6, adjusted OR 1.3; 0.94–1.7, respectively). Maternal morbidity was higher in women who delivered by planned Cesarean section

Table 2. Perinatal mortality and morbidity* and maternal morbidity** in 1655 women with a twin pregnancy and a very preterm delivery (<32 weeks) according to the intended mode of delivery***.

	Planned Cesarean Section	Planned vaginal delivery	OR (95%CI) unadjusted	OR (95% CI) Adjusted***
Overall (26–32 weeks), *n* (%)	*n* = 212	*n* = 1443		
Any perinatal mortality, *n* (%)	22 (10%)	94 (6.5%)	1.7 (1.0–2.7)	2.5 (1.5–4.2)
Any neonatal morbidity, *n* (%)	140 (66%)	905 (63%)	1.2 (0.85–1.6)	1.5 (1.1–2.0)
Any composite adverse perinatal, *n* (%)	141 (67%)	918 (64%)	1.1 (0.84–1.5)	1.4 (1.0–2.0)
Perinatal death of the first twin, *n* (%)	11 (5.2%)	57 (4.0%)	1.3 (0.69–2.6)	2.0 (1.0–4.0)
Perinatal death of the second twin, *n* (%)	15 (7.1%)	51 (3.5%)	2.1 (1.2–3.8)	2.9 (1.7–5.2)
Neonatal morbidity of the first twin, *n* (%)	115 (54%)	619 (43%)	1.6 (0.75–1.3)	1.9 (1.4–2.6)
Neonatal morbidity of the second twin, *n* (%)	113 (53%)	767 (53%)	1.0 (0.77–1.3)	1.3 (0.92–1.7)
Composite adverse perinatal first twin, *n* (%)	115 (54%)	631 (44%)	1.5 (1.1–2.0)	1.9 (1.4–2.5)
Composite adverse perinatal second twin, *n* (%)	116 (55%)	777 (54%)	1.0 (0.78–1.4)	1.3 (0.96–1.8)
Maternal morbidity, *n* (%)	36 (17%)	71 (4.9%)	3.90 (2.6–6.1)	4.0 (2.6–6.3)

OR: odds ratio.
*Neonatal morbidity is defined as: 5-min Apgar score <4; intraventricular hemorrhage, cephalo hematoma, facial nerve paralysis, brachial plexus injuries, clavicle fracture, humerus fracture, IRDS and asphyxia-related morbidity: hypoxic-ischemic encephalopathy, neonatal hypotonia, neonatal seizures.
**Maternal morbidity defined as uterine rupture, HPP >1000 mL or blood transfusion.
Other means breech or transverse presentation.
***adjusted for nulliparity, gestational age (weeks), NICU center, prolonged rupture of membranes (≥24 h), birth weight (grams), and non-Western ethnicity.

as compared to planned vaginal delivery (17 vs. 4.9%; adjusted OR 4.0; 95% CI 2.6–6.3). There were no cases of maternal mortality or uterine rupture; therefore, maternal morbidity consisted of hemorrhage postpartum >1000 mL and need for blood transfusion.

We also analyzed the perinatal outcomes according to fetal presentation (Table 3).

Cephalic/cephalic presentation

In women with a twin pregnancy with both children in cephalic presentation, any neonatal mortality was significantly higher for the planned Cesarean section group (*n* = 73) 14/73 (19.2%) as compared to the planned vaginal delivery group (*n* = 585) (19.2 vs. 5.0%; adjusted OR 5.8; 95% CI 2.6–12.9). Any neonatal morbidity and any perinatal mortality and morbidity was not significantly different (adjusted OR 1.2; 95% CI 0.66–2.0, adjusted OR 1.2; 95% CI 0.68–2.1, respectively). In the subgroup analysis for every child separately perinatal mortality was significantly higher for both the first and the second twin in planned Cesarean section as compared to planned vaginal delivery (adjusted OR 3.8; 95% CI 1.4–10.5, adjusted OR 5.4; 95% CI 2.1–13.9). Neonatal morbidity was also significantly higher for the first twin (adjusted OR 2.0; 95% CI 1.2–3.5). Maternal morbidity was significantly higher in planned caesarean section as compared to planned vaginal delivery (adjusted OR 3.2; 95% CI 1.5–7.1).

Cephalic/breech or transverse presentation

Any perinatal mortality or mortality of the first or second twin was not significantly different for planned Cesarean as compared to planned vaginal delivery. Neonatal morbidity of the first twin was significantly higher in planned Cesarean section as compared to planned vaginal delivery (adjusted OR 2.3; 95% CI 1.3–3.9). The same applied for maternal morbidity (adjusted OR 5.5; 95% CI 2.5–12.3).

Breech/cephalic presentation

There were no statistically significant outcomes for perinatal mortality or neonatal morbidity in women who delivered by planned Cesarean section as compared to planned vaginal delivery.

Breech/breech or transverse presentation

Any perinatal mortality was not significantly different, and the same applied for perinatal mortality of the first or second twin. Neonatal morbidity of the first twin was significantly higher for planned Cesarean section as compared to planned vaginal delivery (adjusted OR 2.3; 95% CI 1.1–4.6). Maternal morbidity was also higher for planned Cesarean section (adjusted OR 9.0; 95% CI 2.9–28.0).

Analysis according to the actual mode of delivery

We performed a subgroup analysis in which we compared perinatal and maternal outcomes for planned Cesarean section of both twins, vaginal delivery of both twins, emergency Cesarean section of both twins and vaginal delivery of the first twin followed by emergency Cesarean of the second twin. There were no differences in perinatal or maternal outcomes in emergency Cesarean of both twins and vaginal delivery; the same applied for vaginal delivery of the first twin followed by emergency Cesarean section of the

Table 3. Perinatal mortality and morbidity* and maternal morbidity** in 1655 women with a twin pregnancy and a very preterm delivery according to the intended mode of delivery and presentation at birth***.

26–32 weeks, *n* (%) **cephalic/cephalic**	Planned Cesarean section *n* = 73	Planned vaginal delivery *n* = 585	OR (95% CI) unadjusted	OR (95% CI) adjusted***
Any perinatal mortality, *n* (%)	14 (19%)	29 (5.0%)	4.6 (2.9–7.1)	5.8 (2.6–12.9)
Any neonatal morbidity, *n* (%)	47 (64%)	367 (63%)	1.1 (0.81–1.4)	1.2 (0.66–2.0)
Any composite adverse perinatal, *n* (%)	48 (66%)	370 (63%)	1.1 (0.85–1.5)	1.2 (0.68–2.1)
Perinatal death of the first twin, *n* (%)	7 (9.6%)	20 (3.4%)	3.0 (1.6–5.6)	3.8 (1.4–10.5)
Perinatal death of the second twin, *n* (%)	9 (12%)	15 (2.6%)	5.3 (3.1–9.1)	5.4 (2.1–13.9)
Neonatal morbidity of the first twin, *n* (%)	41 (56%)	235 (40%)	1.9 (1.5–2.5)	2.0 (1.2–3.5)
Neonatal morbidity of the second twin, *n* (%)	41 (56%)	313 (54%)	1.1 (0.85–1.5)	1.2 (0.74–2.1)
Composite adverse perinatal first twin, *n* (%)	41 (56%)	238 (41%)	1.9 (1.4–2.4)	1.9 (1.1–3.4)
Composite adverse perinatal second twin, *n* (%)	43 (59%)	316 (54%)	1.2 (0.93–1.6)	1.4 (0.80–2.3)
Maternal morbidity, *n* (%)	12 (16%)	32 (5.5%)	3.4 (1.7–6.9)	3.2 (1.5–7.1)
26–32 weeks, *n* (%) **cephalic/other**	***n* = 67**	***n* = 516**		
Any perinatal mortality, *n* (%)	6 (9.0%)	41 (7.9%)	1.1 (0.46–2.8)	2.3 (0.87–6.1)
Any neonatal morbidity, *n* (%)	46 (69%)	331 (64%)	1.2 (0.71–2.1)	1.9 (1.1–3.4)
Any composite adverse neonatal, *n* (%)	46 (69%)	337 (65%)	1.2 (0.67–2.0)	1.9 (1.0–3.4)
Perinatal death of the first twin, *n* (%)	4 (6.0%)	20 (3.9%)	1.6 (0.52–4.8)	3.2 (1.0–10.1)
Perinatal death of the second twin, *n* (%)	4 (6.0%)	28 (5.4%)	1.1 (0.38–3.3)	2.4 (0.76–7.3)
Neonatal morbidity of the first twin, *n* (%)	38 (57%)	236 (46%)	1.6 (0.93–2.6)	2.3 (1.3–3.9)
Neonatal morbidity of the second twin, *n* (%)	34 (51%)	279 (54%)	0.88 (0.53–1.5)	1.1 (0.66–2.0)
Composite adverse perinatal first twin, *n* (%)	38 (57%)	241 (47%)	1.5 (0.90–2.5)	2.3 (1.3–3.9)
Composite adverse perinatal second twin, *n* (%)	35 (52%)	248 (48%)	0.89 (0.54–1.5)	1.2 (0.70–2.1)
Maternal morbidity, *n* (%)	13 (19.4%)	26 (5.0%)	4.5 (2.2–9.4)	5.5 (2.5–12.3)
26–32 weeks, n (%) **breech/cephalic**	***n* = 26**	***n* = 140**		
Any perinatal mortality, *n* (%)	1 (3.9%)	6 (4.3%)	–	–
Any neonatal morbidity, *n* (%)	17 (65%)	81 (58%)	–	–
Any composite adverse neonatal, *n* (%)	17 (65%)	83 (59%)	1.3 (0.54–3.1)	1.5 (0.59–3.6)
Perinatal death of the first twin, *n* (%)	0	4 (2.9%)	–	–
Perinatal death of the second twin, *n* (%)	1 (3.9%)	2 (1.4%)	–	–
Neonatal morbidity of the first twin, *n* (%)	11 (42%)	61 (44%)	0.95 (0.41–2.2)	1.1 (0.47–2.7)
Neonatal morbidity of the second twin, *n* (%)	14 (54%)	67 (48%)	1.3 (0.55–2.9)	1.4 (0.56–3.4)
Composite adverse perinatal first twin, *n* (%)	1 (3.9%)	62 (44%)	0.92 (0.40–2.2)	1.1 (0.46–2.7)
Composite adverse perinatal second twin, *n* (%)	14 (54%)	68 (49%)	1.2 (0.53–2.9)	1.4 (0.54–3.5)
Maternal morbidity, *n* (%)	2 (7.7%)	6 (4.3%)	–	–
26–32 weeks, *n* (%) breech/other	***n* = 46**	***n* = 202**		
Any perinatal mortality, *n* (%)	1 (2.2%)	18 (8.9%)	0.23 (0.03–1.8)	0.42 (0.05–3.5)
Any neonatal morbidity, *n* (%)	30 (65%)	126 (62%)	1.1 (0.58–2.2)	1.8 (0.83–3.7)
Any composite adverse neonatal, *n* (%)	30 (65%)	128 (63%)	1.1 (0.55–2.1)	1.7 (0.80–3.5)
Perinatal death of the first twin, *n* (%)	0	13 (6.4%)	–	–
Perinatal death of the second twin, *n* (%)	1 (2.2%)	6 (3.0%)	0.73 (0.09–6.2)	0.99 (0.07–15.1)
Neonatal morbidity of the first twin, *n* (%)	25 (54%)	87 (43%)	1.6 (0.83–3.0)	2.3 (1.1–4.6)
Neonatal morbidity of the second twin, *n* (%)	24 (52%)	108 (54%)	0.95 (0.5–1.8)	1.5 (0.74–2.9)
Composite adverse perinatal first twin, *n* (%)	25 (54%)	90 (45%)	1.5 (0.78–2.8)	2.1 (1.1–4.3)
Composite adverse perinatal second twin, *n* (%)	24 (52%)	109 (54%)	0.93 (0.49–1.8)	1.4 (0.72–2.9)
Maternal morbidity, *n* (%)	9 (20%)	7 (3.5%)	6.8 (2.3–19.3)	9.0 (2.9–28.0)

OR: Odds ratio.
*Neonatal morbidity is defined as: 5-min Apgar score <4; intraventricular hemorrhage, cephalo hematoma, facial nerve paralysis, brachial plexus injuries, clavicle fracture, humerus fracture, IRDS and asphyxia-related morbidity: hypoxic–ischemic encephalopathy, neonatal hypotonia, neonatal seizures.
**Maternal morbidity defined as uterine rupture, HPP >1000 mL or blood transfusion.

second twin as compared to vaginal delivery. Planned Cesarean section showed a higher perinatal mortality and morbidity rate and a higher maternal morbidity rate as compared to vaginal delivery (Table 4).

Discussion

In our study of women with a twin pregnancy suffering very preterm birth, perinatal mortality and morbidity were higher after a planned Cesarean section compared to a planned vaginal delivery. Maternal morbidity was also significantly higher after a planned Cesarean delivery. Subgroup analysis according to fetal presentation showed that in women with a twin pregnancy with both children in cephalic presentation, a policy of planned Cesarean section has a higher risk of neonatal mortality and morbidity as compared to planned vaginal delivery. In twins with the first fetus in breech position, perinatal morbidity of the first twin is significantly higher in case of a planned Cesarean section. All other perinatal outcomes were not significantly different. Maternal morbidity was significantly higher in almost all subgroup analyses according to gestational age.

By our knowledge, this is thus far the first study that reports on a large cohort of women with a very preterm twin delivery between 26 and 32 weeks. Strength of this study is that it reports on a large cohort of women with an intended vaginal delivery. Furthermore, we analyzed perinatal outcomes

Table 4. Perinatal mortality and morbidity* and maternal morbidity** in women with a twin pregnancy and a very preterm delivery (<32 weeks) according to the actual mode of delivery‡.

	Planned Cesarean section $n = 212$	Vaginal delivery both twins $n = 1035$	Emergency Caesarean section both twins $n = 313$	First twin vaginal delivery, second ECS $n = 95$	Adjusted OR‡ (95% CI) PSC vs. VD	Adjusted OR‡ (95% CI) ECS vs. VD	Adjusted OR‡ (95% CI) VD + ECS vs. VD
Any perinatal mortality, *n* (%)	22 (10%)	69 (6.7%)	18 (5.8%)	7 (7.4%)	2.4 (1.4–4.1)	0.82 (0.46–1.4)	1.04 (0.47–2.3)
Any neonatal morbidity, *n* (%)	140 (66%)	647 (63%)	192 (61%)	66 (70%)	1.5 (1.1–2.0)	0.91 (0.69–1.2)	1.3 (0.79–2.1)
Any composite adverse perinatal, *n* (%)	141 (67%)	659 (64%)	193 (62%)	66 (70%)	1.4 (1.0–2.0)	0.87 (0.66–1.2)	1.2 (0.74–2.0)
Perinatal death of first twin, *n* (%)	11 (5.2%)	42 (4.1%)	13 (4.1%)	2 (2.1%)	1.9 (0.94–4.0)	0.98 (0.50–1.9)	0.44 (0.13–1.6)
Perinatal death of second twin, *n* (%)	15 (7.1%)	41 (4.0%)	5 (1.6%)	5 (5.3%)	2.6 (1.3–5.0)	0.37 (0.14–0.98)	1.3 (0.52–3.4)
Neonatal morbidity of first twin, *n* (%)	115 (54%)	435 (42%)	144 (46%)	40 (42%)	2.0 (1.5–2.7)	1.2 (0.88–1.5)	0.93 (0.59–1.5)
Neonatal morbidity of second twin, *n* (%)	113 (53%)	555 (54%)	155 (50%)	57 (60%)	1.2 (0.89–1.7)	0.81 (0.62–1.1)	1.2 (0.77–2.0)
Composite adverse perinatal first twin, *n* (%)	115 (54%)	444 (43 %)	147 (47%)	40 (42%)	1.9 (1.4–2.6)	1.2 (0.88–1.5)	0.88 (0.56–1.4)
Composite adverse perinatal second twin, *n* (%)	116 (55%)	565 (55%)	155 (50%)	57 (60%)	1.2 (0.91–1.7)	0.78 (0.59–1.0)	1.2 (0.73–1.9)
Maternal morbidity, *n* (%)	36 (17%)	44 (4.3%)	20 (6.4%)	7 (7.4%)	4.7 (2.9–7.8)	1.6 (0.90–2.7)	1.9 (0.81–4.3)

OR: odds ratio.
*Neonatal morbidity is defined as: 5-min Apgar score <4; intraventricular hemorrhage, cephalo hematoma, facial nerve paralysis, brachial plexus injuries, clavicle fracture, humerus fracture, IRDS and asphyxia-related morbidity: hypoxic–ischemic encephalopathy, neonatal hypotonia, neonatal seizures.
**Maternal morbidity defined as uterine rupture, HPP >1000 mL or blood transfusion.
‡Adjusted for: nulliparity, gestational age (weeks), NICU center, prolonged rupture of membranes (≥24 h), birth weight (grams), and non-Western ethnicity.

according to the intended as well as the actual mode of delivery. The other strength is the subgroup analysis according to fetal presentation, since most clinicians take this into consideration in counseling women for a Cesarean section or a vaginal delivery. Moreover, we report on both paired and separate outcomes of the offspring.

A limitation of our study is that we excluded all women with obstetric complications other than very preterm delivery such as fetal growth restriction, preeclampsia, and maternal hypertension. We did this because comorbidity might influence perinatal and maternal outcomes and might influence the decision on the mode of delivery.

Another limitation of our study is the fact that it is a retrospective cohort study where a randomized study would be desirable. Recruitment difficulties in studies on subjects like this makes it very unlikely that a RCT will be done in the near future, since recruitment will face the same problems as studies that compare perinatal outcomes in preterm breech presentation [11–16].

In our study, maternal morbidity was higher in planned caesarean section as compared to vaginal delivery, which was not the case in women who delivered by emergency Cesarean section or women who delivered vaginally followed by emergency Cesarean section as compared to vaginal delivery. There were no cases of maternal mortality or uterine rupture in the whole study group; therefore, maternal morbidity consisted of hemorrhage postpartum >1000 mL and need for blood transfusion. When we compare the maternal morbidity rate in planned Cesarean section in our study to the maternal morbidity rate in other studies such as the Twin Birth Study [3], the risk of postpartum hemorrhage after planned Cesarean section is not as high as in our study. The fact that the higher maternal morbidity rates occurred in women with planned Cesarean section and not in women with an emergency Cesarean section suggests that there might have been more women with comorbidity such as placenta previa in the planned Cesarean section group. We excluded severe comorbidity (lethal congenital abnormalities, placental abruption, intrauterine fetal death before onset of labor, fetal growth restriction (birth weight < P5), twin-to-twin-transfusion syndrome (TTTS), maternal hypertension (maternal systolic blood pressure ≥140 mmHg and/or diastolic

blood pressure ≥90 mmHg), or preeclampsia (high blood pressure and proteinuria)) to eliminate confounders for which the multivariate analysis did not control; however some bias in a retrospective cohort study is inevitable.

In preterm breech presentation of women with a singleton pregnancy, planned Cesarean delivery is associated with an improved perinatal outcome [13,14]. An explanation for not finding this benefit in case of a planned Cesarean section in women with a very preterm delivery of a twin pregnancy might be that when the first child is delivered vaginally malpresentation of the second child is not such a problem due to the fact that the first baby has already passed the birth channel.

We conclude that in women with a twin pregnancy delivering very preterm (<32 weeks), a planned Cesarean section does not improve perinatal outcome, and therefore, a vaginal delivery is the preferred mode of delivery.

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