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Does breech delivery in an upright position instead of on the back improve outcomes and avoid cesareans? ☆

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Synopsis: Upright maternal positions for vaginal breech delivery shortened the second stage and reduced numbers of maneuvers, maternal/neonatal injuries, and cesareans compared with a dorsal position.

ABSTRACT

Objective: To compare breech outcomes when mothers delivering vaginally are upright, on their back, or planning cesareans.

Methods: A retrospective cohort study was undertaken of all women who presented for singleton breech delivery at a center in Frankfurt, Germany, between January 2004 and June 2011.

Results: Of 750 women with term breech delivery, 315 (42.0%) planned and received a cesarean. Of 269 successful vaginal deliveries of neonates, 229 in the upright position were compared with 40 in the dorsal position. Upright deliveries were associated with significantly fewer delivery maneuvers (OR 0.45, 95% CI 0.31–0.68) and neonatal birth injuries (OR 0.08, 95% CI 0.01–0.58), second stages that were on average shorter (1 vs 1.75 hours), and nonsignificantly decreased serious perineal lacerations (OR 0.34, 95% CI 0.05–3.99). When upright position was used almost exclusively, the cesarean rate decreased. Serious fetal and neonatal morbidity potentially related to birth mode was low, and similar for upright vaginal deliveries compared with planned cesareans (OR 1.37, 95% CI 0.10–19.11). Three neonates died; all had lethal birth defects. Forceps were never required.

Conclusion: Upright vaginal breech delivery was associated with reductions in duration of the second stage of labor, maneuvers required, maternal/neonatal injuries, and cesarean rate when compared with vaginal delivery in the dorsal position.

1 INTRODUCTION

For several decades, research on breech birth has centered on whether cesarean or vaginal delivery produce better neonatal/maternal outcomes, with minimal focus on how to improve vaginal breech birth.[1–3] Since 2000, large registry studies have found increased neonatal mortality and/or morbidity in vaginal versus cesarean breech deliveries,[4–6] but most cohort studies in high-resource countries using targeted screening and skilled practitioners report little difference in neonatal mortality,[2,3,7–11] and follow-up neonatal morbidity is rarely long term.[7,10–12] Meanwhile, concern is growing internationally about maternal morbidity and mortality due to planned cesareans, irrespective of fetal presentation.[13] Dutch clinicians have, in particular, highlighted the consequences of cesarean deliveries for breech births.[14–16]

Practitioners are now performing cesarean deliveries for breech births[3,5] rather than improving vaginal breech maneuvers designed for mothers on their backs that have changed little since the 1930s,[17,18] and before that, had not changed since the 1700s.[19] In 2004, we realized the Bracht maneuver for breech[17] could be eliminated by turning the mother over onto her knees. Because fewer manipulations of the fetus seemed required than when the mother was on her back, it was postulated that maternal movement and gravity were facilitating fetal descent, reducing the need for intervention and potentially affecting outcomes (Video S1).

Indeed, a Cochrane meta-analysis[20] suggested some outcomes are improved with vaginal delivery in upright or lateral positions compared with supine or lithotomy positions. Furthermore, a magnetic resonance imaging (MRI) study[21] demonstrated that maternal transverse pelvic measurements widen significantly in a kneeling crouch compared with the supine position, providing anatomical rationale for getting a woman up and moving in second stage. Therefore, the aim of the present study was to compare outcomes with vaginal breech delivery in an "upright" position—leaning over the back of the hospital bed on the knees, on all fours, or occasionally standing—with those in a dorsal position (on the back) and those in planned cesareans.

2 MATERIALS AND METHODS

A retrospective cohort study was undertaken using data for all women who presented for singleton breech delivery at the Johann Wolfgang Goethe University Hospital, Frankfurt, Germany, between January 1, 2004, and June 30, 2011. Preterm births (<37 weeks) were excluded from analysis. Ethics approval was received in November 2011 from the Ethics Committee of the Department of Obstetrics and Gynaecology at the study center. Informed consent was not needed from individual patients because we are reporting on standard care provided at the hospital on the basis of routinely collected data.

The state database—Perinatalerhebung Hessen—was used to identify breech births starting from January 2004, and basic data were extracted for each mother and neonate. Additional breech-specific items not collected in the state database were extracted from the hospital charts and added to create the breech database. In the

course of the analysis, further details required for clarification of care and outcomes were sought via the charts. In particular, details about the neonates with birth defects or negative sequelae, who were in the neonatal intensive care unit (NICU) for more than 4 days after birth, or who were in need of follow-up were extracted from the maternal and pediatric charts and discharge letters.

Appendix S1 outlines the obstetric protocols developed and introduced at the hospital in the first year of the study for breech delivery. Briefly, women who carried breech at 36 weeks were counseled about their options and offered external cephalic version. If a woman still presented breech at 38 weeks, wanted a vaginal delivery, and had not previously delivered vaginally a neonate weighing within 500 g of the current pregnancy, MRI was used to measure her pelvis in a supine position. Cesarean delivery was recommended when the obstetric conjugate was smaller than 12 cm and the fetus weighed less than 2000 g. or was diagnosed with intrauterine growth restriction. Unlike in other units, previous cesarean delivery, head flexion, and large estimated fetal weight were not exclusion criteria for planned vaginal birth.

We compared outcomes of women who were planning a cesarean with those planning a vaginal delivery at the time of admission for the birth. In the few cases when no obstetrician experienced in vaginal breech birth was available, the option was no longer offered. These women were put into the planned cesarean group for analysis. Then, we compared vaginal births in an upright position with those in the dorsal position. Vaginal births were being done in both dorsal and newly developing upright position in the first 5 years of the study period (2004–2008) on the basis of individual obstetrician experience and preference. By 2009, essentially all vaginal

breech births were being done in the upright position. The early dorsal births provided the control group to enable a comparison with the upright position.

Observations of upright delivery suggest two points of dystocia with fetal descent that require maneuvers. Two maneuvers were created by FL during the study period to attend to these difficulties (Figure 1).

After delivery, neonates were followed up for 3 months, or more if there were residual problems.

Two Canadian researchers (B-AD and KCJ) performed analyses and prepared the manuscript as part of an international, interdisciplinary collaboration that allowed an arm's length evaluation of the Frankfurt clinical experience.

First, the frequency of fetal and neonatal mortality, or serious morbidity was assessed using the composite outcome measure from the PREMODA study.[2] This variable included fetal or neonatal mortality (excluding that caused by lethal birth defects) at less than 28 days of age and before discharge, or at least one of six outcomes (serious birth trauma/injuries [not including cuts or bruises], seizures at <24 hours of age, 5-minute Apgar score <4, intubation for >24 h, tube feeding for ≥4 days, or >4 days in the NICU).[2]

In a second analysis, to look more specifically at which negative outcomes might be attributed to birth mode, we removed neonates from the PREMODA criteria who had birth defects or were in the NICU for more than 4 days for reasons unrelated to birth

trauma—e.g. exclusively for neonatal infections or maternal history. In a subanalysis of the second analysis, the cesarean comparison group was further restricted to the 175 low-risk cesareans planned because of mother's choice or absence of an experienced physician for vaginal birth. This minimized the effect of cesareans planned for pre-existing conditions.

Finally, neonatal injuries, maneuvers used, length of labor, cesarean rate, and perineal injuries were compared between upright and dorsal positions.

Baseline characteristics were compared using Fischer exact test for categorical data, or χ^2 test if required. Odds ratios and exact 95% confidence intervals were calculated using STATA version 12.1(StataCorp, College Station, TX, USA).

3 RESULTS

Between January 1, 2004 and June 30, 2011, 977 women with a singleton breech presentation attending the study center were offered a vaginal or cesarean delivery. Although 23 (31.5%) of 73 planned vaginal breech births for preterm neonates at 32 weeks or more did deliver vaginally, all 227 preterm births were excluded from further analysis (Figure 2).

Table 1 presents the maternal, fetal, and obstetric characteristics of the planned cesarean deliveries and the planned term vaginal births. Of 750 women admitted for singleton term breech delivery, 315 (42.0%) planned and underwent a cesarean delivery. This included 47 (13.2%) of 355 primiparous women and 1 (0.7%) of 148 multiparas who wanted a vaginal birth but who were risked out because their

obstetric conjugate was less than 12 cm on MRI. Half the planned cesareans were at the mother's request (Table 1).

Of the 435 women for whom a vaginal delivery was planned, 271 (62.3%) had a successful vaginal delivery, including 157 (54.5%) of 288 primiparas and 114 (77.6%) of 147 multiparas. Three-quarters (237 or 75.2%) of the planned cesareans and two-thirds (288 or 66.2%) of the planned vaginal births were for primiparous mothers (Table 1).

There were no maternal deaths. The three neonates who died all had lethal birth defects, all diagnosed before delivery. One was delivered by planned cesarean and admitted to the NICU for 30 days, but died due to a complex cardiac defect. The other two had planned vaginal deliveries: one died due to Potter syndrome, the other due to trisomy 18.

The three cases of neonatal lethal birth defects were excluded from further analysis. Among the remaining 269 women who had a successful vaginal delivery, most delivered in an upright position (Figure 2).

Using the PREMODA measure, the likelihood of fetal or neonatal mortality, or serious morbidity was similar for planned vaginal births and planned cesarean deliveries (Table 2). The criteria for mortality or serious morbidity were met by 4 (10.0%) of the 40 neonates delivered vaginally with the mother in a dorsal position, 7 (3.2%) of the 229 neonates delivered vaginally with the mother in an upright position, and 8 (4.9%) of the 164 delivered by cesarean in labor in a planned vaginal delivery.

In the second analysis, we removed neonates with non-lethal birth defects or who were in the NICU for more than 4 days for reasons unrelated to birth trauma, leaving negative sequelae more potentially associated with birth mode. This analysis showed a nonsignificant increased risk of mortality or serious morbidity for planned vaginal births in the dorsal position, but much smaller differences in risk with upright delivery, or planned vaginal birth ending in cesarean, when compared with planned cesarean (Table 2). These risks of mortality or serious morbidity were very similar in the subanalysis of negative sequelae potentially associated with birth mode, using the more restrictive 175 low-risk planned cesareans as the referent group (Table 2 footnote).

The proportion of neonates with a low 5-minute Apgar score was nonsignificantly lower for planned cesareans than for planned vaginal deliveries (Table 2). No neonates had both an Apgar score of less than 7 at 5 minutes and pH arterial blood gases of less than 7.0.

The length of second stage of vaginal delivery was significantly shorter with the mother in an upright position than in a dorsal position—42% shorter, on average an hour compared with 1.75 hours (mean difference 44.6 minutes, 95% confidence interval 18.0–71.2) (Table 3).

Comparing the first years of the study, when the dorsal position was still used almost one-third of the time, with the last 2.5 years, when virtually all vaginal breech births were done upright (Table 3), the cesarean rate decreased by 32%—from 45.8% to 31.1% (data not shown).

There were 5 (1.6%) birth injuries among the planned cesareans, which was not significantly different from the number of injuries in planned vaginal deliveries (Table 4). There were significantly fewer birth injuries among the planned vaginal births in an upright position compared with planned vaginal births in the dorsal position when birth defects were included, but the increase was no longer statistically significant once the birth defects were removed (Table 5). The likelihood of a maneuver being required was significantly lower among the 229 vaginal deliveries in an upright position compared with the 40 births in a dorsal position (Table 5). Cesarean maneuvers were not well captured although many of the same ones were used (data not shown). Forceps were not used in any of the breech deliveries. There were fewer third- and fourth-degree (serious) perineal lacerations in the upright position than in the dorsal position, but with the limited sample size it was not significant (Table 5).

Induction and augmentation were first captured in the database from January 2010, when virtually all vaginal deliveries were being done in the upright position. Of 142 births in 2010–2011, 19 (13.4%) were induced and 22 (15.5%) were augmented (including 3 of the induced). Fifteen (10.6%) women went past 41 weeks and 3 days; seven of these were induced. Seven (4.9%) went over 42 weeks; one then planned a cesarean.

Epidurals that allowed motor ability were performed for 36 (90.0%) of the 40 women delivering vaginally in the dorsal position, and 148 (64.6%) of the 229 delivering in the upright position. Dilation at time of cesarean was recorded for 124 (75.6%) of the 164 planned vaginal births ending in cesarean: 34 (27.4%) were 0–4 cm, 13 (10.5%) were 5–6 cm, 32 (25.8%) were 7–9 cm, and 45 (36.3%) were fully dilated (10 cm).

Thus, the decision to undertake a cesarean during a planned vaginal delivery occurred by full dilation approximately two-thirds of the time. When station was reported, only two cesareans were done as late as +3; none were done past the point where the presenting part was beginning to protrude.

4 DISCUSSION

The present study suggests that vaginal breech delivery in an upright position is associated with significantly reduced length of the second stage, cesarean rate, and frequency of neonatal injuries and manipulations to extract the neonate when compared with vaginal breech delivery in a dorsal position. More than half the upright births required no maneuvers at all (Video S1). There was also a trend towards fewer serious perineal injuries with upright births. Newborn morbidity potentially related to birth mode was low, but considerably higher in the dorsal position than in the upright position. The difference, however, was not statistically significant in this limited sample size for this rare outcome.

Researchers in Salzburg, Austria, did a matched-pair analysis limited to 41 breech deliveries with the mother on her hands and knees and a retrospective cohort of classic vaginal delivery, and concluded that upright delivery seemed to be “safe for the fetus with reduced maternal morbidity.”[23] In an Australian study of 243 planned vaginal upright births,[7] morbidity was low and short term, indicating good outcomes. However, there was no dorsal comparison group.

A strength of the present study is that it is the first with a large cohort of vaginal breech deliveries in upright positions and a comparison cohort of women who delivered in the standard dorsal position. Second, it introduces a new understanding of cardinal movements of the descending breech and maneuvers to rectify problems (Figure 1), avoiding traditional, potentially damaging maneuvers required in dorsal position and from which cesarean delivery does not necessarily escape.[17–19] Third, unlike registry studies, the present investigation provides detailed clinical information about each birth for assessment and comparisons.

As with all observational studies, selection bias cannot be ruled out, but the main limitation is the small size of the referent group of women delivering vaginally in the dorsal position; the upright approach has become increasingly favored in Frankfurt since its introduction in 2004. This results in low power to find statistical differences in the rare neonatal outcomes of interest.

The two newborns born in the upright position with negative sequela potentially related to the mode of delivery were born in the first 2 years of the 6.5-year study period. Both had perinatal asphyxia, but no follow-up was required after discharge from the NICU at 7 and 12 days. It is possible that at the time of these deliveries, the obstetricians were in the process of learning the new maneuvers that were being developed for upright delivery. At the same time, even though the maneuvers for the dorsal position were well practiced, they still resulted in more injuries.

At the Frankfurt hospital, small neonates are considered more vulnerable and less maneuverable in delivery. It has been demonstrated that they have poorer outcomes.[1] Internationally, there is also fear of a large breech neonate,[24] but upper limitation restrictions are not imposed in Frankfurt. We argue that the bigger the fetus, the more robust, and that the abdominal circumference and legs create the required wider opening for the arms and head that follow. We are not convinced MRI pelvimetry is required,[25] but it helps to reassure practitioners and mothers.

Less focus has been placed on time limits to reach full dilation than with the cephalic neonate, because the turning and descent is considered more important for decision making in the breech. The present data provide a counterpoint to jurisdictions that offer vaginal birth under greater eligibility restrictions or curtailed lengths of first and second stage of labor.[2,24]

Half the planned cesareans at the study hospital were at the mother's request, suggesting a perception of fear around breech, even in a hospital environment where vaginal breeches are considered safe and common. It is important to point out that the cesarean solution has been driven by research comparing cesarean with women delivering vaginally only in the dorsal position.

We concur with Goffinet et al.[2] that registry studies "are difficult to interpret because of the questionable validity and sparseness of the antenatal and postnatal information," including difficulties in distinguishing planned mode of birth and undiagnosed breeches. The 2-year follow-up of the International Randomized Term Breech Trial[12] and cohort studies similar to the present one[2,3,7–11] demonstrate that,

with experience and better screening,[26] vaginal and cesarean delivery can provide similar safety for the neonate. Vaginal breech birth avoids the increased maternal morbidity and mortality associated with cesareans.[13]

Using liberal criteria when compared with other centers, more than 60% of term breeches screened for vaginal delivery avoided cesarean surgery and forceps, with newborn morbidity potentially related to birth mode that was low, short term, and not significantly different between cesarean and vaginal birth, irrespective of position. However, vaginal breech in the upright position was associated with shorter second stages, fewer cesareans during labor, reduced maneuvers and neonatal injuries, and fewer serious perineal lacerations than was the dorsal position, suggesting potential advantages of maternal upright position over dorsal position for vaginal breech delivery.

Author contributions

B-AD and KCJ were the principal investigators and were responsible for study design and data analysis. B-AD wrote the article, with major input from KCJ. AR applied for ethical approval, created the database, retrieved the necessary chart data, and provided input for manuscript writing. FL, as head of obstetrics at Johann Goethe-University Klinikum, Frankfurt, Germany, created the two maneuvers and the management approach adopting an upright position that was evaluated in the present study, contributed to the study concept and provided input for manuscript writing.

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Conflict of interest

The authors have no conflicts of interest.

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Figure legends

Figure 1 Maneuvers created by Dr. Frank Louwen to assist during vaginal breech delivery with mother in an upright position (on knees, all fours, or standing). The top left image shows what should be seen during a normal vaginal breech delivery, whereas the top right image shows a sign of shoulder dystocia. The middle three images show the “180 degree torque” maneuver. When shoulder dystocia occurs, the practitioner grasps the shoulders and turns the fixed shoulder away from the maternal symphysis (the opposite direction to the Loveset), and back 90 degrees. The bottom two diagrams show “the Frank Nudge” maneuver, in which the practitioner pushes the neonate’s shoulders up against the pubic bone to flex the head to enable it to emerge. For further information, please see Appendix S1 under “Standard Care During the Antenatal and Intrapartum Period.” Figure published with the permission of the artist, Chloe Aubert.

Figure 2 Flow of patients through the study.

Supporting information legends

Appendix S1 Protocols for breech delivery at the Johann Wolfgang Goethe University Hospital in Frankfurt, Germany.

Appendix S2 Maneuvers Described in Table 5.

Video S1 Video of a mother delivering a Frank breech neonate in a hands and knees position (all fours) in Frankfurt.

Table S1 Maternal, obstetric, and fetal characteristics by planned mode of delivery at admission.

Table S2 Body mass index and maternal age for vaginal births in upright or dorsal position.

Table 1 Maternal, obstetric, and fetal characteristics by planned mode of delivery (cesarean or vaginal) at admission.[a,b]

Characteristic	**Planned cesarean delivery (n=315)**	**Planned vaginal delivery (n=435)**	***P* value**
Parity			0.078
1 (this pregnancy)	237 (75.2)	288 (66.2)	
2 (1 previous delivery)	64 (20.3)	110 (25.3)	
>2	14 (4.4)	37 (8.5)	
Type of breech			<0.001
Frank	220 (69.8)	293 (67.4)	
Complete	30 (9.5)	59 (13.6)	
Incomplete	14 (4.4)	47 (10.8)	

Footling	6 (1.9)	17 (3.9)	
Oblique Lie	14 (4.4)	8 (1.8)	
Missing data	31 (9.8)	11 (2.5)	
Reason for cesarean before/during labor [c]			<0.001
Mother's wish	168 (53.3)	15 (3.4)	
Delay in stage 1	0	46 (10.6)	
Delay in stage 2	0	47 (10.8)	
Abnormal electronic fetal monitoring/Doppler	14 (4.4)	30 (6.9)	
Uterine scar or pathology	32 (10.2)	4 (0.9)	
Placental (e.g. placenta previa, accreta)	5 (1.6)	2 (0.5)	
Cord prolapse [d]	1 (0.3)	13 (3.0)	
Bleeding, cervical dilation, or contractions before date of planned cesarean	13 (4.1)	8 (1.8)	
Maternal reason [e]	18 (5.7)	1 (0.2)	
Obstetric conjugate ≤12 cm	48 (15.2)	0	
Other perceived cephalopelvic disproportion	7 (2.2)	6 (1.4)	
Chorioamnionitis	3 (1.0)	3 (0.7)	
Birth defects identified through ultrasonography	5 (1.6)	0	
Intrauterine growth restriction	2 (0.6)[f]	0	
Other fetal reasons	3 (1.0)[g]	1 (0.2)	
Obstetrician not available for vaginal breech	17 (5.4)	0	
Birthweight percentiles [h]			<0.001
<10th	41 (13.0)	52 (11.9)	
> 90th	25 (7.9)	17 (3.9)	

[a] Values are given as number (percentage) unless indicated otherwise. Note: some distributions do not add up to the total because of small numbers of missing values

[b] For a version of this table including other characteristics, see Table S1.

[c] >1 reason can be recorded.

[d] None of the 14 neonates were admitted to the neonatal intensive care unit.

[e] Present/previous disease or problem (e.g. pre-eclampsia, HELLP syndrome [hemolysis, elevated liver enzymes, low platelet count], HIV, hepatitis B/C virus infection, history of embolism, or other severe systemic disease.

[f] 1 removed from primary composite outcome in the second analysis because of the severity; 1 died.

[g] 2 for oblique lie (1 with spontaneous rupture of membranes) and 1 for oligohydramnios and cord round the neck.

[h] Compared with birthweights from Voight et al.[22]

Table 2 Outcomes by planned mode of delivery (cesarean or vaginal) at admission (PREMODA composite variable measures other than birth injuries).[a,b]

Outcome	Planned cesarean delivery (n=314)	Planned vaginal delivery (n=433)	Odds ratio (95% confidence interval)
5-min Apgar score			
<4 [c]	0	1 (0.2)[d]	–
4 to <7	1 (0.3)	10 (2.3)	7.25 (1.02–315)
Intubation	3 (1.0)	3 (0.7)	–
Intubation >24 h [c,e]	1	0	–
Seizures at <24 h [c]	0	1 [f]	–
Parenteral/tube feeding >4 d [c]	0	0	–
NICU >4 d [c]	15 (4.8)	18 (4.2)	0.86 (0.40–1.87)
NICU >4 d excluding birth defects [c]	7 (2.2)	10 (2.3)	1.03 (0.35–3.25)
Vaginal delivery in dorsal position	–	2	
Vaginal delivery in upright position	–	6	
Cesarean in labor	–	2	
Birth defects and syndromes [g]	13 (4.1)[h]	20 (4.6)[i]	1.12 (0.52–2.50)
Vaginal delivery in dorsal position		5	
Vaginal delivery in upright position		6	
Cesarean in labor		9	
Fetal and neonatal deaths, excluding lethal birth defects [c]	0	0	–
Fetal and neonatal mortality, or serious morbidity (defined by PREMODA composite variable)[j]	15 (4.8)[k]	19 (4.4)[l]	0.91 (0.43–1.97)
Fetal and neonatal mortality, or serious morbidity potentially related to delivery mode [m]	2 (0.6)[n]	6 (1.4)	2.19 (0.39–22.32)
Vaginal delivery in dorsal position [o]	–	2/40 (5.0)[p]	8.21 (0.57–115.00)
Vaginal delivery in upright position [o]	–	2/229 (0.9)[q]	1.37 (0.10–19.08)
Cesarean in labor [o]	–	2/164 (1.2)[r]	1.93 (0.14–26.75)

Abbreviation: NICU, neonatal intensive care unit; MRI, magnetic resonance imaging.

[a] 3 cases of lethal anomaly excluded.

[b] Values are given as number (percentage), number, or number/total number (percentage), unless indicated otherwise.

[c] Included in the composite variable of fetal and neonatal mortality and serious morbidity taken from the PREMODA study.

[d] Cesarean delivery in labor.

[e] The only case for which it seems that the decision about mode of birth was unclear before the mother was at the unit and thus was made primarily because of questionable fetal heart tracing. A cord was found around the neck as the neonate was lifted out, there was severe asphyxia and "moderate HIE," but the neonate was discharged to the normal pediatric unit at 5 days. This illustrates the importance of categorization; this newborn was in the group that had severe morbidity but was removed with the others whose births were deemed unrelated to the mode of birth.
[f] Diagnosed by chance during a ward round; follow-up electrocardiogram and postnatal brain MRI showed several lesions of different ages, which were therefore deemed to be the result of intrauterine events before labor. The neonate had been delivered spontaneously and quickly, requiring no maneuvers with the mother in an upright position. There is coagulopathy in the family, but undiagnosed in the neonate. At 8-month follow-up, MRI showed defects in the brain areas where the suspected bleeding had been, but clinical examination identified no motor or other abnormality, no neurological symptoms, and no seizures; the infant was still being given antiepileptic drugs (phenobarbital) as a precaution. The infant was deemed to have a birth defect with long-term problems.
[g] Not all in the NICU >4 d.
[h] Prader–Willi syndrome, gastroschisis known before birth, cleft palates and/or lip (n=3), pituitary deficiency, atrial defect with aneurysm, microcephaly with cystic brain lesions, anal atresia and fistula with cardiac defect and pulmonary stenosis, ventricular septal defect, a hemangioma on the chest wall, and adrenogenital syndrome. Five were known ahead of time, leading to a cesarean delivery.
[i] A muscular disease (unnamed), Potter syndrome, cleft palate and/or lip (n=5), a chromosomal microdeletion found after delivery, ventricular septal defect, a club foot, Turner syndrome, a brain lesion found on MRI to have been present before labor, trisomy 21 (n=2), trisomy 18, triple X, hydrocephaly, and cystic fibrosis. Most cleft palates were known ahead of time.
[j] Includes birth defects and neonates in the NICU >4 d for reasons unrelated to birth trauma.
[k] 1 neonate who had only hyperbilirubinemia, 2 in good health but being observed for maternal concerns (with maternal McAlbright bone deformation and maternal drug abuse; both women had pre-eclampsia), 1 severe intrauterine growth restriction of 1750 g at 37 wk, and 2 who presented with concerns about the fetal heart before cesarean (1 already planned before the mother came to the unit, the other with the unclear decision about mode of delivery).
[l] Among neonates delivered with maternal upright position, 3 had antibiotics exclusively for neonatal infections, and 1 was in the NICU for observation because of family history of a mitochondrial disease. Among neonates delivered with maternal dorsal position, there were no other reasons for being in the NICU other than birth defects and reasons that are more likely related to the mode of birth. Among neonates delivered by cesarean during labor, only 1 was being observed because the mother had chicken pox.
[m] Evaluated the negative sequela that could potentially be related to birth mode. Neonates who had birth defects or were in the NICU >4 d for reasons unrelated to birth trauma (e.g. exclusively for neonatal infections or maternal history) were removed.
[n] 1 respiratory distress, 1 adoption to life not well specified.
[o] In the subanalysis of negative sequelae potentially associated with birth mode, using the 175 low-risk planned cesareans as the reference group, the risks of mortality or serious morbidity were very similar to the risk when all 314 planned cesareans were used as the reference group (odds ratio for upright position 1.53, for dorsal position 9.16, and for cesarean in labor 2.14).
[p] 1 intracranial bleed, 1 asphyxia.
[q] 1 apparent asphyxia and at first labelled as hypoxic ischemic encephalopathy but needed no follow-up at 3 months, 1 with initial asphyxia.
[r] 1 mild asphyxia with respiratory distress, 1 with Apgar <4 at 5 minutes.

Table 3 Characteristics and length of labor stages for term breeches with successful vaginal delivery, comparing dorsal and upright maternal positions.[a,b,c]

Characteristic	Dorsal position (n=40)	Upright position (n=229)	*P* value
Year			<0.001
2004	9	6	
2005	5	21	
2006	8	17	
2007	11	14	
2008	5	32	
2009	1	45	
2010	1	63	
2011 (to June 30)	0	31	
Parity			
1 (this pregnancy)	20 (50.0)	136 (59.4)	0.412
2 (1 previous delivery)	14 (35.0)	69 (30.1)	
>2	6 (15.0)	24 (10.5)	
Maternal breech delivery position			–
Dorsal	40 (100.0)	–	
Kneeling or on hands and knees	–	222 (96.9)	
Standing	–	7 (3.1)	
Length of 1st stage, h			<0.001
≤2	2 (4.9)	44 (19.1)	
>2 to 6	22 (53.7)	87 (37.8)	
>6 to 10	9 (22.0)	52 (22.6)	
>10	7 (17.1)	41 (17.8)	
Length of 2nd stage, h	106.1 [d]	61.5 [d]	<0.001
<0.25	9 (22.0)	82 (35.7)	
>0.25 to 0.5	5 (12.2)	43 (18.7)	
>0.5 to 1	4 (9.8)	33 (14.4)	
>1 to 2	8 (19.5)	34 (14.8)	
>2 to 3	7 (17.1)	17 (7.4)	
>3 to 4	4 (9.8)	12 (5.2)	
>240 to 300	1 (2.4)	3 (1.3)	
>300	2 (4.9)	2 (0.9)	

[a] 3 cases of lethal anomaly excluded. Note: some distributions do not add up to the total because of small numbers of missing values.
[b] Values are given as number or number (percentage), unless indicated otherwise.
[c] See Table S2 for body mass index and maternal age.
[d] Mean. Mean difference (44.6 minutes, 95% confidence interval 18.0–71.2).

Table 4 Outcomes by planned mode of delivery (cesarean or vaginal birth) at admission (birth injuries, including those in the PREMODA category, and cord outcome difficulties).[a,b]

Outcome	Planned cesarean delivery (n=314)	Planned vaginal delivery (n=433)	Odds ratio (95% confidence interval)
Cord entanglement (around the neck or body, or in a knot)	31 (9.9)	81 (18.7)	2.11 (1.33–3.39)
In NICU >4 days when cord entanglement present	2 (0.6)	3 (0.7)	1.21 (0.23–7.87)
Birth injuries among neonates with birth defects [c]			
Fracture of clavicle and brachial plexus injury	0	1 [d]	–
Humerus fracture	0	1 [d]	–
Neurological deficit [e]	1	0	–
Birth injuries among neonates without birth defects [c]			
Humerus fracture	0	2 [f]	–
Brachial plexus irritation	0	1 [g]	–
Parietal and basal skull fracture	0	0	–
Sternocleidomastoid injury	0	0	–
Cutaneous cut	3	2 [h]	2.08 (0.24–25.00)
Neurological deficit [e]	0	1 [d]	–
Hip dislocation	1	0	–
Total no. of neonates with birth injuries [c]	5 (1.6)	8 (1.8)	1.16 (0.33–4.6)
Vaginal delivery in dorsal position	–	4/40 (10.0)	7.0 (1.31–33.74)
Vaginal delivery in upright position	–	2/229 (0.9)	0.55 (0.05–3.42)

[a] 3 cases of lethal anomaly excluded.
[b] Values are given as number (percentage), number, or number/total number (percentage), unless indicated otherwise.
[c] Excludes bruising, because not well captured.
[d] Dorsal position.
[e] Cerebral hemorrhage and seizures. 3 affected neonates were also in the NICU >4 d. Only one case of actual seizures. Among the other two, the first neonate had an atrial defect and cleft palate, and was delivered by planned cesarean. The second was delivered vaginally with a maternal dorsal position, for whom MRI indicated intracranial bleeding that was mainly subdural around the tentorium and falx cerebri—a pattern consistent with trauma at birth. The bleeding resolved, and the neonate was discharged at 15 days.
[f] 1 dorsal position, 1 upright position.
[g] Upright position.
[h] Ended in cesarean delivery.

Table 5 Perineal injuries, maneuvers and neonatal outcomes for term breeches with successful vaginal delivery, comparing dorsal and upright maternal positions.[a,b,c]

Characteristic	Dorsal position (n=40)	Upright position (n=229)	Odds ratio (95% confidence interval)
Perineal injury			
1st-degree tear	10 (24.4)	85 (62.2)	1.84 (0.83–4.42)
2nd-degree tear	7 (17.1)	31 (13.5)	0.76 (0.30–2.23)
3rd- and 4th-degree tears	2 (4.9)	4 (1.7)	0.34 (0.05–3.99)
Episiotomies	4 (10.0)	2 (0.9)	0.08 (0.01–0.64)
Help delivering the body [d]			
Loveset or the 180° torque	1 (2.5)	18 (7.9)	3.33 (0.49–142)
Classic maneuver for release of arms	17 (42.5)	18 (7.9)	0.11 (0.05–0.28)
Bickenbach	4 (10.1)	1 (0.4)	0.04 (0.00–0.42)
Bracht (folding the fetus)	21 (52.5)	5 (2.2)	0.04 (0.02–0.10)
Total maneuvers required to deliver the body	37 (92.5)	40 (17.5)	0.19 (0.14–0.25)
Help exclusively for delivery of the head [d]			
Suprapubic pressure	4 (10.0)	3 (1.3)	0.12 (0.02–0.75)
The Frank nudge	0	45 (19.7)	–
Mauriceau-Smellie-Veit	26 (65.0)	45 (19.7)	0.13 (0.06–0.29)
Total maneuvers required exclusively for delivery of the head	31 (77.5)	88 (38.4)	0.18 (0.07–0.41)
Other maneuvers (head/body)	1 (2.5)	4 (1.7)	0.69 (0.07–35.0)
Any maneuvers used	38 (95.0)	100 (43.7)	0.45 (0.31–0.68)
Neonates with birth injuries			
Among neonates including those with birth defects	4 (10.0)	2 (0.9)	0.08 (0.01–0.58)
Among neonates without birth defects	2 (5.0)	2 (0.9)	0.17 (0.01–2.40)
5-min Apgar score			
<4	0	0	
4 to <7	1 (2.5)	5 (2.2)	0.87 (0.09–42.2)
Birth defects (not all in the NICU)	5 (12.5)	6 (2.6)	0.19 (0.04–0.83)

NICU >4 d, excluding birth defects	2 (5.0)	6 (2.6)	0.51 (0.09–5.38)
Fetal and neonatal mortality, or serious morbidity (defined by PREMODA composite variable)	4 (10.0)	7 (3.1)	0.28 (0.07–1.40)
Fetal and neonatal mortality, or serious morbidity potentially related to delivery mode [e]	2 (5.0)	2 (0.9)	0.17 (0.01–2.40)

[a] 3 cases of lethal anomaly excluded.
[b] Values are given as number (percentage) unless indicated otherwise.
[c] See Appendix S2 for explanations of maneuvers.
[d] More than one maneuver could be used. The Kristeller maneuver (fundal pressure) is sometimes used in the unit, but has not been well captured.
[e] Neonates with negative sequelae potentially related to birth mode were achieved by removing births in which birth defects, infections, and/or the mother's factors were the cause of the stay in the NICU >4 days.