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Macharey, Georg

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Georg Macharey\*, Mervi Väisänen-Tommiska, Mika Gissler, Veli-Matti Ulander, Leena Rahkonen, Mika Nuutila and Seppo Heinonen

# Neurodevelopmental outcome at the age of 4 years according to the planned mode of delivery in term breech presentation: a nationwide, population-based record linkage study

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## Abstract

**Purpose:** To evaluate whether a trial of planned vaginal breech labor affects neurologic development in children.

**Methods:** This is a nationwide, Finnish, population-based record linkage study. An odds ratio with 95% confidence intervals was used to estimate the relative risk that a child delivered by planned vaginal breech labor would be diagnosed with adverse neurodevelopmental outcome (cerebral palsy, epilepsy, intellectual disability, sensor neural developmental outcome, hyperactivity, speech and language problems) at the age of 4 years. The reference group were children born by planned cesarean section.

**Results:** During a study period of 7 years, 8374 infants were delivered in breech position. Among them, 3907 (46.7%) had an attempted labor and 4467 (53.3%) infants were delivered by planned cesarean section. There were no differences in the neurodevelopmental outcome. In the planned vaginal labor group, 133 (3.4%) children had an abnormal neurodevelopmental outcome at the age of 4 years compared to 142 (3.2%) in the planned cesarean section group.

**Conclusion:** The absolute risk of abnormal neurological outcome in breech deliveries at term was low, regardless of planned mode of birth. Planned vaginal breech labor did not increase the risk for abnormal neurological outcome compared to planned cesarean section.

**Keywords:** Adverse perinatal outcome; breech delivery; cerebral palsy; epilepsy; neonatal morbidity; neurodevelopmental outcome.

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\*Corresponding author: **Georg Macharey**, MD, Department of Obstetrics and Gynecology, Helsinki University Hospital, University of Helsinki, Haartmaninkatu 2, Helsinki 00029 HUS, Finland, E-mail: [georg.macharey@hus.fi](mailto:georg.macharey@hus.fi)

**Mervi Väisänen-Tommiska, Veli-Matti Ulander, Leena Rahkonen, Mika Nuutila and Seppo Heinonen:** Department of Obstetrics and Gynecology, Helsinki University Hospital, University of Helsinki, Helsinki, Finland

**Mika Gissler:** National Institute for Health and Welfare (THL), Helsinki, Finland

## Introduction

Breech presentation at term occurs in 2%–3% of all singleton pregnancies [1–3]. Neonates born vaginally in breech position at term have been reported to have a higher perinatal morbidity and mortality rate [4, 5]. Several studies have been conducted to determine whether vaginal breech delivery at term is safe for the mother and the child in settings where women have been carefully selected and labor management takes place in an adequate obstetric facility [6–8]. The effect of vaginal breech labor on the neonate's long-term neurodevelopment is unclear, since some studies, but not all, have shown an association between vaginal breech delivery and cerebral palsy, epilepsy or a low examination achievement [9–15]. Few studies have shown that cesarean section reduces long-term adverse outcome [11, 16]. On the other hand, some data have shown that adverse neonatal long-term outcome was not related to intrapartum events [17–20], but to obstetric risk factors, which are known to be associated with breech presentation at term [17, 18]. The aim of the present study was to determine whether a trial of singleton vaginal breech labor at term is associated with an adverse neurodevelopmental outcome in children at the age of 4 years.

## Methods

### Study design and data sources

We conducted a population-based, record linkage study, using the National Medical Birth Register and the hospital discharge register, maintained by the National Institute for Health and Welfare. The data for the National Medical Birth Register are collected by all maternity hospitals in Finland. It collects baseline data on pregnancies, deliveries, and the newborn's outcome during the first days of life, by using the maternal prenatal records. Reporting to the National Medical Birth Register is obligatory. The data include all live births and stillbirths with a birth weight of 500 g or beyond or with a gestational age of 22 weeks or older. Less than 0.1% of the data concerning all newborns is missing, but missing data are supplemented by the central population register for live births and the cause of death register for stillbirths and neonatal deaths. The hospital discharge register

contains information on all inpatient periods in all Finnish hospitals and all outpatient visits. The collected information includes demographic data, maternal information before and after the delivery, data regarding intrapartum procedures and complications, as well as neonatal outcome. The information is coded according to the International Statistical Classification of Diseases and Related Health Problems 10<sup>th</sup> Revision (ICD-10).

We used anonymized data of the mothers and infants recorded on the National Medical Birth Register and the hospital discharge register for this study. Authorization to use the data was obtained from the National Institute for Health and Welfare as required by the national data protection legislation law in Finland (Reference number THL/1200/5.05.00/2012).

## Study population

The studied population included all breech deliveries from January 1, 2004, to December 31, 2010. Exclusion criteria were multiple gestations, preterm deliveries, infants with intrauterine growth restrictions (defined as birth weight <2 SD), infants with congenital malformations and pregnancies with a placental abruption (ICD-10 code O45.-). Comparisons were made between children born by planned cesarean section and children born vaginally or by emergency cesarean section after a trial of labor. Criteria used for a trial of vaginal breech delivery in Finland are based on International Obstetrics and Gynecology Guidelines [21–23]. These criteria include: (a) the mother is motivated to deliver vaginally; (b) adequate maternal pelvis confirmed by magnetic-resonance pelvimetry (obstetrical conjugata vera >11.5 cm, interspinous diameter >10 cm, diameter transversa >12.5 cm); (c) estimated fetal weight is <4000 g evaluated by ultrasound; (d) fetus is in frank, complete or incomplete breech position with the head in flexed position; (e) fetus does not suffer from intrauterine growth restrictions; (f) absence of fetal anomaly that may cause dystocia. All breech deliveries are handled or guided by a consultant and occur in a hospital with access to emergency cesarean section.

A comparison of outcomes was made between planned cesarean deliveries and planned vaginal deliveries. Planned cesarean delivery was defined as an elective cesarean delivery in mothers where cesarean delivery was planned. Planned vaginal delivery comprised cases with spontaneous or induced start of delivery regardless of cesarean delivery along the course of delivery. The intended mode of delivery was collected from the maternal records.

## Outcomes

The main outcome was adverse neurodevelopment in children at the age of 4 years. Neurodevelopment outcome includes cerebral palsy, epilepsy, intellectual disability and sensor neural defects, including visual impairment and deafness, speech or language problems and hyperactivity. These data were received from the hospital discharge register using the ICD-10 (1996–2008) codes for neurologic diagnoses (Table 1). In Finland, the diagnosis of cerebral palsy, epilepsy, autism, intellectual disability, sensor neural defects, speech or language problems and hyperactivity is based on medical history, ultrasonography, and MRI data as required, and multidisciplinary evaluations in secondary or tertiary pediatric neurology units. Cerebral palsy is usually evident within the first 2 years of life and

**Table 1:** Diagnose codes for adverse neurological outcome.

	ICD-10 code
Cerebral palsy	G 80.-, G81.-, G82.- G83.-
Epilepsy	G40.-
Intellectual disability	F70.-, F71.-, F72.-, F73.-, F74.-, F78.-, F79.-
Autism	F84.-
Speech or language problems	F80.-
Visual defects	H53.-
Auditory defects	H90.-
Hyperactivity	F90.-

practically always by the age of 3–4 years [24]. The diagnosis of cerebral palsy is added to the hospital discharge register immediately after diagnosis. The Finnish public health care system calls for all children to undergo annual physical examinations; thus, the neurologic diagnoses are consistently recognized by the age of 4 years [25]. The following covariates were collected from the medical birth register: umbilical artery pH, 5-min Apgar score <7, nulliparity, maternal age, smoking, gestational age at delivery, gestational diabetes, diabetes mellitus type I, preeclampsia, neonatal sex (male), birth weight, infertility, history of cesarean section and body mass index (BMI) >30.

## Statistical analysis

Statistical differences in categorical variables were evaluated with the  $\chi^2$ -test and differences in continuous variables by the Mann-Whitney *U*-test as appropriate. Characteristics of the children and their mothers were given as means with standard deviation score (SDs) in case of normally distributed continuous variables, by medians with interquartile range in skewed distributed variables, and by number of values as percentages if variables were categorical. Differences were deemed to be significant if  $P < 0.05$ . In addition, we calculated odds ratios (OR) with 95% confidence intervals (CI) as estimates of the relative risk that a neonate with a planned vaginal breech labor would be diagnosed with adverse neurodevelopmental outcome, using neonates with planned cesarean section as mode of delivery as the reference group. For the assessment of possible confounders, we used multivariate analysis. The data were analyzed using SPSS for Windows V.19.0 (Chicago, IL, USA). The reporting of this study conforms to the STROBE statement [26].

## Results

During the study period covering 7 years, 415,526 deliveries were observed. After the exclusion of stillbirths, preterm pregnancies, multiple gestations, infants with congenital malformations or intrauterine growth restrictions and deliveries with placental abruption, 356,010

deliveries were analyzed. Of these, n = 8374 (2.4%) infants were delivered in breech position. Among them, 4467 (53.3%) infants were delivered by planned cesarean section. The trial of vaginal labor group consisted of 3907 (46.7%) attempted labors, of which 1723 (44.1%) deliveries had an intrapartum cesarean section (Figure 1).

Of all analyzed children born in breech presentation, a total of 275 (3.3%) suffered from an abnormal neurodevelopment at the age of 4 years. Of all children delivered vaginally or by emergency cesarean section 133 (3.4%) suffered from an abnormal neurodevelopment at the age of 4 years compared to 142 (3.2%) infants delivered by planned cesarean section [OR 1.06; 95% CI (0.74–1.52)].

Five children in the planned vaginal labor group had cerebral palsy, compared to six in the planned cesarean

section group [OR 1.31; 95% CI (0.28–6.07)]. Epilepsy was diagnosed among 23 children in the planned vaginal labor group (0.59%) and in 23 in the planned cesarean section group (0.51%) [OR 1.39; 95% CI (0.62–3.14)]. No significant difference was found between vaginal breech labors and planned cesarean sections for the other variables of abnormal neurodevelopment either (Table 2).

Table 3 shows the demographics, pregnancy characteristics and reproductive factors of both groups. Significantly more infants born after a trial of vaginal delivery had an arterial pH below 7.0 (1.2 vs. 0.1%) and a 5-min Apgar below 7 (3.1 vs. 1.2%) than those born by planned cesarean section. The prevalence of perinatal mortality in planned vaginal breech delivery did not differ significantly from planned cesarean breech delivery (3 children [0.08%] vs. 0 children [0%]) (Table 3).



Figure 1: Flow of deliveries through the study period.

**Table 2:** Crude and adjusted odds ratio (OR) with 95% confidence intervals (CI) for neurodevelopment among singletons born in breech position at term.

	Planned vaginal labor (n=3907)		Planned cesarean section (n=4467)		OR (95% CI)	Adjusted <sup>b</sup> OR (95% CI)
	n	%	n	%		
Cerebral palsy	5	0.13	6	0.13	0.95 (0.29–3.12)	1.31 (0.28–6.07)
Epilepsy	23	0.59	23	0.51	1.14 (0.64–2.04)	1.39 (0.62–3.14)
Intellectual disability	11	0.28	6	0.13	2.10 (0.78–5.68)	1.26 (0.45–3.56)
Autism	5	0.13	10	0.22	0.57 (0.20–1.67)	0.20 (0.02–1.60)
Speech or language problems	42	1.07	46	1.03	1.04 (0.69–1.59)	1.21 (0.73–2.00)
Visual defects	43	1.10	50	1.12	0.98 (0.65–1.48)	0.68 (0.36–1.29)
Auditory defects	13	0.33	11	0.25	1.35 (0.61–3.02)	1.52 (0.59–3.90)
Hyperactivity	3	0.08	6	0.13	0.57 (0.14–2.29)	1.03 (0.19–5.55)
Combined adverse outcome <sup>a</sup>	13	3.40	142	3.18	1.07 (0.84–1.37)	1.06 (0.74–1.52)

<sup>a</sup>Infants with more than one diagnosis.

<sup>b</sup>Adjusted for umbilical artery pH, 5-min Apgar score <7, nulliparity, maternal age, smoking, gestational age at delivery, gestational diabetes, diabetes mellitus type I, preeclampsia, neonatal sex (male), birth weight, infertility, history of cesarean section and body mass index (BMI) >30.

**Table 3:** Neonatal baseline characteristics of singletons born in breech position at term according to mode of delivery.

	Planned vaginal labor (n=3907)		Planned cesarean section (n=4467)		P-value
Maternal age (years), mean ± SD	30.0	5.0	30.4	5.3	<0.001
Nulliparous	1686	43.2	2221	49.7	<0.001
Smoking	517	13.2	681	15.2	0.009
Diabetes mellitus type I	8	0.2	0.2	0.8	<0.79
BMI >30	318	8.1	456	10.2	0.001
History of cesarean section	254	6.5	633	14.2	<0.001
Assisted reproduction technology	73	1.9	107	2.4	0.097
Gestational diabetes	221	5.7	325	7.3	0.003
Oligohydramnios	75	1.9	83	1.9	0.835
Preeclampsia	9	0.2	19	0.4	0.123
Gestational age at delivery, mean ± SD	276.6	8.5	274.5	5.1	<0.001
Emergency cesarean section	1723	44.1	–	–	
Birth weight (g) ± SD	3399	393	3465	414	<0.001
Neonatal sex (male)	2101	53.8	2427	54.3	0.610
Umbilical artery pH, mean ± SD	7.26	0.09	7.30	0.06	<0.001
Umbilical artery pH <7.00	31	1.2	4	0.1	<0.001
5-min Apgar score <7	112	3.1	50	1.2	<0.001
Perinatal mortality 0–28 days	3	0.08	0	0	0.10
Child mortality 29–365 days	1	0.03	1	0.02	0.57

Values are n and %, unless indicated otherwise.

## Discussion

Our study shows that a trial of vaginal breech delivery is not associated with adverse neurological development in children at the age of 4 years, if conducted in women with a low-risk breech pregnancy (exclusion of cases with fetal growth restriction, congenital anomalies and placental abruption) and managed in a modern obstetric setting.

The children born vaginally in breech position were as healthy as the children born by planned cesarean section at the age of 4 years. Vaginal labor was not associated with cerebral palsy, epilepsy, intellectual disability, autism, speech or language problems, visual or auditory defects or hyperactivity.

Adverse neurodevelopmental outcome like cerebral palsy can be caused by preconceptional factors (both

hypo- and hyperthyroidism), antenatal risk factors (congenital anomalies, preterm delivery, fetal growth restriction, placental changes, placental abruption, infections and maternal diseases like heart diseases, seizures and preeclampsia) and intrapartum factors/birth asphyxia (meconium aspiration, prolonged labor, instrumental deliveries and fetal presentation) [27]. The aim of this study was to evaluate whether a trial of vaginal delivery with the fetus in breech position itself has a higher risk for adverse neurodevelopment. Therefore, other risk factors for adverse neurodevelopment, like cerebral palsy, fetal growth restriction [28, 29], multiple pregnancies [30], placental abruption and preterm delivery [11] were excluded. After the exclusion of pregnancies with other risk factors for adverse neurodevelopment, no correlation between vaginal breech delivery and the risk of adverse neurological development like cerebral palsy or epilepsy, as shown by Krebs et al. [17, 18], was identified. Our results regarding the lack of excess risk for adverse neurological development associated with vaginal breech labor are consistent with the results of a recently published large Norwegian population based cohort study [31] and with the follow-up study of the term breech trial [14], which reviewed the children from the term breech trial at 2 years of age and could not find a difference regarding the risk of death or risk of neurodevelopmental delay between the planned cesarean birth group (3.1%) and the planned vaginal birth group (2.8%) [14].

We confirm that a trial of vaginal breech labor is associated with adverse short-term outcomes. Our findings regarding the perinatal mortality rate are consistent with earlier studies [21, 31] that have shown that the perinatal mortality rate in planned vaginal breech delivery is higher than in planned cesarean breech delivery. The infants from the trial of vaginal labor group had a lower 5-min Apgar score and a lower umbilical artery pH, as shown before [4, 5, 32, 33]. Birth asphyxia is known to be a strong risk factor for adverse neurodevelopment [27], due to which vaginal breech delivery at term is quite often linked as an individual risk factor to cerebral palsy and other adverse neurodevelopmental outcome itself [11, 12, 15, 25, 27]. Those studies, however, did not exclude systematic bias for cerebral palsy like placental abruption, preterm delivery, multiple pregnancies, small birth weight and congenital malformations, or the studies compared breech with vertex deliveries [11, 12, 15, 25].

The main strength of our study is the large number of births and the prospective recording of the data in the registers. Another strength of our study is that we were able to exclude other risk factors for adverse neurodevelopment outcome to evaluate the pure risk for adverse

long-term outcome of a trial of vaginal breech delivery itself. The main limitation of the present study is the potential loss of follow-up. The main cause for losses in follow-up in Finland is possible migration abroad, as otherwise all serious illnesses are treated by state hospitals, which report to the hospital discharge register. Another possible limitation is a potential misclassification, but as other studies have shown too, the data from the National Medical Birth Register and the hospital discharge register are valid and give good, nationwide coverage [34]. A further limitation of the study was that the variables were restricted to databank availability. The Finnish birth register lacks for example information on the socioeconomic class of the women and records of neonatal cord arterial base deficit. Finally, the results regarding perinatal mortality should be interpreted with caution: due to the small number of perinatal deaths, a type II error cannot be ruled out.

We showed that a trial of vaginal breech labor is not associated with an adverse neurodevelopmental outcome in children at the age of 4 years. These facts should be taken into account when counseling women for vaginal breech delivery, as a primary cesarean section is associated with a higher maternal morbidity especially for later pregnancies [21, 35, 36]. We confirm that neonates often suffer from significant respiratory acidosis after a trial of vaginal breech labor. The most common reason for this is umbilical cord compression during the delivery of the fetal head. The selection of women eligible for vaginal labor is important, as breech presentation itself is in some cases an indicator of obstetric risk factors [3] and thus for adverse neurodevelopmental outcome as well.

## Conclusion

A trial of vaginal labor at term with the fetus in breech presentation is not associated with a disorder of the brain function in children at the age of 4 years.

### Author's statement

**Conflict of interest:** The authors have no conflicts of interest. The authors state that they have full control of all primary data and they agree to allow the journal to review their data if requested.

**Material and methods:** Informed consent: Informed consent has been obtained from all individuals included in this study.

**Ethical approval:** The research related to human subject use has complied with all the relevant national



regulations, and institutional policies, and is in accordance with the tenets of the Helsinki Declaration, and has been approved by the authors' institutional review board or equivalent committee.

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