Obstetrical and Neonatal Outcomes Following Unsuccessful External Cephalic Version: A Stratified Analysis amongst Failures, Successes, and Controls

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ORIGINAL ARTICLE

Obstetrical and neonatal outcomes following unsuccessful external cephalic version: a stratified analysis amongst failures, successes, and controls

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Abstract

Objective: Though on average one out of every two external cephalic versions (ECV) fails to rotate the breech fetus, little is known about the outcomes of pregnancies in which ECV is unsuccessful. The objective of the present study is to compare obstetrical and neonatal outcomes following failure of ECV, relative to cases of breech controls without an attempt at ECV.

Study design: We conducted a retrospective, population-based, cohort study using the CDC's Birth Data files from the US for the year 2006. We stratified the cohort according to fetal presentation and ECV status: success, failure, and no ECV (controls). The effect of failure of ECV on the risk of several neonatal and obstetrical outcomes was estimated using logistic regression analysis, adjusting for relevant confounders.

Results: We analyzed a total of 4 273 225 births, out of which 183 323 (4.3%) met inclusion criteria. Relative to breech controls, failed ECV occurred more frequently amongst Caucasian, college-educated, married women bearing a female fetus. Compared to no ECV, failure of ECV was associated with increased odds of PROM (aOR, 1.75; 95% CI, 1.60–1.90), elective cesarean delivery (aOR, 1.53; 95% CI, 1.36–1.72), cesarean delivery in labor (aOR, 1.38; 95% CI, 1.21–1.57), abnormal fetal heart tracing (aOR, 1.78; 95% CI, 1.50–2.11), assisted ventilation at birth (aOR, 1.50; 95% CI, 1.27–1.78), 5-min APGAR scores <7 (aOR, 1.35; 95% CI, 1.20–1.51), and NICU admission (aOR, 1.48; 95% CI, 1.20–1.82). The delayed spontaneous fetal restitution rate was 13%. When stratifying controls with regards to trial of labor status, the increased risk of failed ECV persisted for cesarean delivery, NICU admission, assisted ventilation and abnormal fetal tracing, independently of whether a trial of labor took place.

Conclusion: Relative to breech controls without attempt at ECV, failure of ECV to restitute cephalic presentation appears to be associated with an increased risk of adverse perinatal and obstetrical outcomes.

Keywords

Breech, cesarean section, external cephalic version, failure, outcomes

History

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Introduction

Breech presentation is encountered in 3 to 4% of all term pregnancies [1]. External cephalic version (ECV) is a procedure whereby the breech fetus is manipulated externally through the maternal abdomen and rotated into a cephalic presentation. ECV techniques have long been used to reverse breech presentations, and seek primarily to accomplish three goals: (1) improve a woman's chances of having a vaginal cephalic birth; (2) reduce the frequency of complications associated with breech vaginal deliveries; and (3) reduce the high rate of cesarean deliveries performed for this indication [2,3]. Although the Term Breech Trial demonstrated that elective cesarean delivery was associated with better fetal outcomes than breech vaginal delivery, the interest in ensuring the success of ECV comes from the notion that both breech vaginal and cesarean deliveries are associated with worse outcomes than cephalic vaginal births [4,5]. In addition, ECV is also associated with greater cost-effectiveness relative to a planned cesarean for breech presentation from a societal point of view [6]. Current guidelines from the American College of Obstetricians

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and Gynecologists recommend that all women with an uncomplicated breech pregnancy at 36 completed weeks without a contraindication to a vaginal birth be offered a trial of ECV [7].

Multiple studies have tried to define the predictors of success of ECV to help determine who is an adequate candidate for this technique, what results are to be expected within different populations, and how to better obtain informed consent from the patient undergoing the procedure [8,9]. Indeed, it is known that both maternal and fetal factors have a significant role to play in the rates of success of ECV. Known predictors of success include multiparity, body habitus, gestational age, the use of regional anesthesia and the use of tocolytics [10–12]. Ultrasound factors such as amniotic fluid index, fetal position and placental position (posterior) also have been linked to the reported success rates of ECV [8,9]. Even though ECV is regarded as a relatively safe procedure, immediate serious complications can occur, and need to be disclosed prior to the technique. Placental abruption occurs in about 1 in 1200 cases. Fetal death is rarely observed, with an incidence of 1 in 5000 cases [13]. Emergency caesarean delivery is necessary in about 1 per 286 to 1 per 1394 versions [8,13]. Other fetal complications reported following the procedure include abnormal cardiotocography (CTG) patterns, vaginal bleeding, feto-maternal hemorrhage and transfusion [14,15].

Though the immediate risks of ECV have been well described, there is currently a paucity of literature regarding the fetal, neonatal and obstetrical outcomes in the perinatal period amongst fetuses that have undergone ECV. Furthermore, the vast majority of studies on ECV have focused on predictors of success [10], as well as outcomes following a successful version relative to cephalic controls [16]. Indeed, the literature on outcomes following failure of ECV is reserved to anecdotal reports [17–20], which is surprising given that on average, one out of every two ECV fails to turn the fetus into a cephalic presentation. Therefore, using population-based data, the purpose of this study was three-fold: first, to elucidate fetal, neonatal and obstetrical outcomes in the perinatal period following ECV; secondly, to compare these outcomes amongst cases of failed versions relative to breech controls without an attempt at ECV, and finally, to determine if these outcomes differed whether a trial of labor amongst breech cases with no ECV took place.

Materials and methods

We conducted a retrospective, population-based, cohort study using vital statistics data from the ‘‘Birth Data Files’’ from the National Center for Health Statistics (Centers for Disease Control and Prevention). The birth cohort file contains information on approximately 4 million annual live births of residents and non-residents in US, and includes a number of obstetrical, perinatal and infant variables. These databases have been validated, and numerous studies have been published with their data [21–23].

We assembled a cohort using data for the year 2006 and selected from this database all records for the contiguous US, Hawaii and Alaska. The territories of Puerto Rico, Guam and the Virgin Islands were excluded from our final aggregate file because of coding differences related to the birth certificate. Births of US citizens outside of the US were not included. We restricted the analysis to singleton breech pregnancies at delivery after either failure of ECV or not having undergone ECV, and included for comparative purposes all cephalic pregnancies following successful ECV. Finally, we excluded all entries with recorded malplacentation, congenital anomalies, chromosomal abnormalities, and all those below 35 completed weeks of gestation.

We conducted our analysis in three steps. First, once all exclusion criteria were applied, we selected and divided our cohort into three subgroups: successful ECV, failed ECV and breech controls, without a trial of ECV. Following, we described each subgroup ($n = 3$) with respect to different common baseline demographic and gestational characteristics, and used Chi-Square and ANOVA statistical testing to determine within-group variability. We then examined the incidence of several fetal, neonatal and obstetrical outcomes in each group, and used binary logistic regression analysis to evaluate the adjusted effect of ECV failure or success on their risk, using the breech control group as reference. Finally, using the failed ECV group as controls, we stratified the ‘‘no ECV’’ cohort to determine whether a trial of labor taking place affected some of the outcomes in question.

We adjusted our analysis for maternal age, race, parity (number of prior births), adequacy of prenatal care, marital status, maternal education, smoking, alcohol, prior obstetric and delivery history (number of prior cesarean and preterm births), gestational age at delivery, birth weight, mode of delivery (where indicated), and maternal medical comorbidities (renal, cardiac, diabetic and hypertensive disorders) when calculating the adjusted odds ratio (aOR) for ECV outcome on the risk of the several obstetrical, fetal and neonatal outcomes. These outcomes include premature rupture of membranes (PROM), trial of labor, induction of labor, augmentation of labor, mode of delivery, precipitous labor, non-vertex presentation at birth, cord prolapse, antibiotic use, chorioamnionitis, meconium staining, abnormal tracing during labor, ventilation requirements, 5-minute APGAR scores, neonatal seizures, and Neonatal Intensive Care Unit (NICU) admission. We made the distinction between elective and cesarean in labor based upon whether a trial of labor was undertaken. Binary outcomes were analyzed as either being present or absent (‘‘yes’’ or ‘‘no’’). For categorical variables included in our analysis, we chose the following subcategories as references: ‘‘Caucasian’’ for ethnicity, ‘‘High School’’ for education, ‘‘married’’ for marital status, ‘‘adequate’’ for adequacy of prenatal care, ‘‘0’’ for number of prior gestations, and ‘‘no’’ for alcohol consumption, cigarette smoking and maternal co-morbidities. Because these de-identified data are publicly available, our study is not considered as ‘‘human subjects research’’, and therefore did not require approval from the institutional ethics review board [23]. All analyses were conducted using IBM SPSS Statistics 20.0.0 (Chicago, IL).

Results

Our cohort consisted of 4 273 225 births, of which 183 323 (4.3%) met the inclusion criteria. We analyzed 4470 cases of

Table 1. Baseline demographics by cohort according to external cephalic version status and outcome.

Variables	Successful ECV $n = 4470$	Failed ECV $n = 1695$	Breech – no ECV $n = 177\,158$	p value*
Maternal age at delivery, mean ± SD	27.2 ± 6.0	28.0 ± 6.2	28.4 ± 6.2	<0.0001
Ethnicity, n (%)				<0.0001
Caucasian	3129 (70.0)	1116 (65.8)	98 571 (55.6)	
African-American	411 (9.2)	129 (7.6)	16 896 (9.5)	
Hispanic	760 (17.0)	335 (19.7)	50 099 (28.3)	
Other	170 (3.8)	115 (6.8)	11 592 (6.5)	
Education, n (%)				<0.0001
Elementary School	299 (6.7)	85 (5.0)	9001 (5.1)	
High School	2020 (45.2)	624 (36.8)	46 592 (26.3)	
College and University	2114 (47.3)	963 (56.8)	55 991 (31.6)	
Unknown/Missing	37 (0.8)	23 (1.4)	65 574 (37.0)	
Marital status, n (%)				<0.0001
Married	2856 (63.9)	1187 (70.0)	117 432 (66.3)	
Adequacy of prenatal care, n (%)				<0.0001
Inadequate	644 (14.4)	207 (12.2)	24 853 (14.0)	
Intermediate	362 (8.1)	117 (6.9)	8814 (5.0)	
Adequate	1551 (34.7)	463 (27.3)	57 334 (32.4)	
Adequate +	1095 (24.5)	473 (27.9)	27 896 (15.7)	
Unknown	818 (18.3)	435 (25.7)	58 261 (32.9)	
Number of prior gestations, n (%)				<0.0001
0	1372 (30.7)	679 (40.1)	63 055 (35.6)	
1	1202 (26.9)	400 (23.6)	47 518 (26.8)	
>2	1896 (42.4)	616 (36.3)	66 585 (37.6)	
Cigarette smoking, n (%)	679 (15.2)	170 (10.0)	13 988 (7.9)	<0.0001
Alcohol consumption, n (%)	192 (4.3)	69 (4.1)	7440 (4.2)	<0.0001
Weight gain (lb.), mean ± SD	41.6 ± 28.6	49.1 ± 32.1	45.5 ± 29.9	<0.0001
Gestational age at delivery (w), mean ± SD	38.7 ± 1.4	38.8 ± 1.3	38.6 ± 1.7	<0.0001
Birth weight (g), mean ± SD	3275 ± 605.6	3221 ± 654.3	3257 ± 626.7	0.007
Sex of newborn, n (%)				0.109
Male	2234 (50.0)	802 (47.3)	86 340 (48.7)	
Female	2236 (50.0)	893 (52.7)	90 818 (51.3)	

*Chi-Square Test or ANOVA according to categorical or continuous variable nature.

successful ECV and 1695 cases of failed ECV against 177 158 breech controls. This rate corresponds to the incidence of breech presentation described in the literature [24]. Demographic baseline characteristics demonstrate inherent differences amongst the cohorts' make-up. Indeed, compared to breech fetuses not having undergone ECV, a failed ECV occurred more frequently amongst Caucasian, college-educated, married women who bore a female fetus, and had highest quality of prenatal care (Adequate +) (Table 1). Relative to breech controls, failure of ECV was associated with increased odds of premature rupture of membranes (PROM) (aOR, 1.75; 95% CI, 1.60–1.90), cesarean delivery (aOR, 2.93; 95% CI, 2.47–3.49), abnormal fetal heart tracing (aOR, 1.78; 95% CI, 1.50–2.11), assisted ventilation at birth (aOR, 1.50; 95% CI, 1.27–1.78), 5-min APGAR scores <7 (aOR, 1.35; 95% CI, 1.20–1.51) and NICU admission (aOR, 1.48; 95% CI, 1.20–1.82) ($p < 0.0001$, Tables 2 and 3). A *post-hoc* analysis demonstrates different adjusted odds of cesarean delivery depending on whether the cesarean took place during labor, or as an elective procedure: aOR, 1.38; 95% CI, 1.21–1.57, and aOR, 1.53; 95% CI, 1.36–1.72, respectively ($p < 0.0001$). Relative to controls, lower odds of trial of labor and induction of labor was noted in the failed ECV group. Following failure of ECV, we find a rate of spontaneous restitution to cephalic presentation in 13% of cases at birth (Table 2).

Alternatively, a successful ECV was also associated with increased odds of PROM (aOR, 1.54; 95% CI, 1.28–1.86). As expected, relative to the control group, rates of induction, and augmentation of labor as well as rates of trial of labor were all significantly increased in cases of ECV success, as were vaginal delivery rates (aOR, 7.84; 95% CI, 7.34–8.37) ($p < 0.0001$). Though the risk of chorioamnionitis was increased, the rates of cesarean delivery, antibiotic use and cord prolapse were decreased relative to breech controls in this group ($p < 0.0001$). Seizure rates were similar amongst all groups (Tables 2 and 3).

Finally, when using the failed ECV group as controls, and stratifying the ''no ECV'' cohort between those undergoing a trial of labor or no trial of labor, we find that relative to cases of ECV failure, the increased risk of unsuccessful ECV persisted for cesarean delivery, NICU admission, assisted ventilation and abnormal fetal tracing (Table 4).

Discussion

Though on average one out of every two external cephalic versions fails, no studies have ever addressed the outcome of pregnancies following ECV failure. Relative to breech fetuses not having undergone ECV, we find that failure of ECV appears to be associated with increased odds of PROM, elective and intrapartum cesarean delivery, abnormal heart tracing, lower APGAR scores, ventilation support at birth and NICU admission.

Numerous considerations ought to be taken into account in the interpretation and implication of our results. The first relates to the data available in the database. Though it is unclear how many versions are carried out every year in the

Table 2. Obstetric outcomes – adjusted odds ratios (aOR) and rate of outcome per 1000 live births according to ECV outcome and control group*.

	Rate	Failed ECV aOR [95% CI]	p value	Rate	Successful ECV aOR [95% CI]	p value	Rate	Breech – no ECV (Reference)
PROM	25.4	1.75 [1.60–1.90]	<0.0001	29.9	1.67 [1.36–2.05]	0.005	14.1	1.0
Trial of labor	307.6	0.65 [0.57–0.72]	<0.0001	818.9	3.36 [2.89–3.90]	<0.0001	346.9	1.0
Induction of labor	105.9	0.78 [0.66–0.92]	<0.0001	292.4	2.67 [2.48–2.86]	<0.0001	127.9	1.0
Precipitous labor	9.7	1.05 [0.64–1.73]	0.833	17.7	1.68 [1.34–2.11]	<0.0001	8.6	1.0
Augmentation of labor	89.6	0.66 [0.56–0.77]	<0.001	172.2	1.34 [1.23–1.45]	<0.0001	111.7	1.0
Mode of delivery								
Vaginal	105.9	0.34 [0.28–0.40]	<0.0001	727.7	7.84 [7.34–8.37]	<0.0001	248.0	1.0
Cesarean	894.1	2.93 [2.47–3.49]	<0.0001	272.3	0.08 [0.07-0.09]	<0.0001	752.0	1.0
Post-hoc analysis†								
Elective	692.4	1.53 [1.36–1.72]	<0.0001	181.1	0.09 [0.06-0.12]	<0.0001	653.1	1.0
Intrapartum	201.7	1.38 [1.21–1.57]	<0.0001	91.2	0.46 [0.41–0.51]	<0.0001	98.9	1.0
Non-vertex presentation	871.1	1.09 [0.90–1.28]	0.563	24.7	0.08 [0.07–0.10]	<0.0001	1000.0	1.0
Cord prolapse	14.0	0.96 [0.90–1.02]	0.781	5.0	0.07 [0.04–0.11]	<0.0001	15.0	1.0
Chorioamnionitis	51.2	1.57 [0.77–3.18]	0.209	83.4	1.58 [1.02–2.46]	0.039	49.4	1.0
Antibiotic use	140.7	1.10 [0.94–1.27]	0.213	99.3	0.69 [0.62–0.76]	<0.0001	112.0	1.0

*Analysis adjusted for maternal age, race, parity, prenatal care, marital status, maternal education, smoking, alcohol, prior obstetric history, mode of delivery (where indicated), gestational age, birth weight and maternal medical co-morbidities (renal, cardiac, diabetic and hypertensive disorders).
†Status inferred from whether a trial of labor was undertaken.

Table 3. Neonatal outcomes – aOR and rate of outcome per 1000 live births ECV outcome and control group*.

	Rate	Failed ECV aOR [95% CI]	p value	Rate	Successful ECV aOR [95% CI]	p value	Rate	Breech – no ECV (Reference)
Meconium staining	28.3	0.85 [0.61–1.19]	0.370	40.1	1.32 [1.12–1.55]	0.002	35.8	1.0
Abnormal fetal tracing	83.4	1.78 [1.50–2.11]	<0.0001	30.9	0.62 [0.52–0.73]	<0.0001	39.0	1.0
5-minute APGAR <7	28.5	1.35 [1.20–1.51]	0.499	23.2	1.08 [0.87–1.33]	0.464	18.9	1.0
Assisted ventilation	90.1	1.50 [1.27–1.78]	<0.0001	27.8	0.40 [0.33–0.47]	<0.0001	53.8	1.0
Neonatal seizure	0.5	1.24 [0.16–2.33]	0.833	0.8	1.98 [0.68–3.28]	0.209	0.4	1.0
NICU admission	89.0	1.48 [1.20–1.82]	<0.0001	39.8	0.69 [0.58–0.82]	<0.0001	49.9	1.0

*Analysis adjusted for maternal age, race, parity, prenatal care, marital status, maternal education, smoking, alcohol, prior obstetric history, birth weight, mode of delivery and maternal medical comorbidities (renal, cardiac, diabetic and hypertensive disorders).

Table 4. Neonatal and obstetrical outcomes according to TOL status in the group with no ECV against failed ECV cases (rate per 1000).

	No ECV						Failed ECV	
	Rate	TOL $n=61\,456$ aOR [95% CI]	p value	Rate	No TOL $n=115\,702$ aOR [95% CI]	p value	Rate	$n=1695$ aOR [95% CI]
Chorioamnionitis	70.1	1.80 [0.84–3.88]	0.129	30.0	0.44 [0.19–0.98]	0.046	51.2	1.0
Antibiotic use	145.2	1.03 [0.90–1.17]	0.650	87.1	0.76 [0.65–0.90]	0.002	140.7	1.0
Cesarean delivery	363.4	0.70 [0.59–0.82]	0.0001	1000.0	*	*	894.1	1.0
Meconium staining	52.2	2.32 [1.59–3.13]	0.0001	26.7	0.93 [0.71–1.23]	0.646	28.3	1.0
Abnormal fetal tracing	57.1	0.66 [0.56–0.78]	0.0001	31.2	0.34 [0.28–0.41]	0.0001	83.4	1.0
5-minute APGAR <7	27.7	0.77 [0.55–1.07]	0.246	15.3	0.93 [0.64–1.36]	0.740	28.5	1.0
Assisted ventilation	48.7	0.75 [0.62–0.91]	0.017	57.5	0.81 [0.67–0.99]	0.040	90.1	1.0
Neonatal seizure	0.5	1.04 [0.12–8.32]	0.964	0.7	1.10 [0.56–1.64]	0.915	0.5	1.0
NICU admission	35.2	0.51 [0.42–0.62]	0.0001	59.3	0.85 [0.69–1.04]	0.129	89.0	1.0

No ECV – TOL = No external cephalic version followed by a trial of labor.
No ECV – No TOL = No external cephalic version followed by an elective cesarean delivery.
*Odds ratio non-determinable as it approaches infinity, given that there is division over 0 on the contingency table calculations (100%. Cesarean rate versus 0% vaginal rate).
Analysis adjusted for maternal age, race, parity, prenatal care, marital status, maternal education, smoking, alcohol, prior obstetric history, birth weight and maternal medical comorbidities (renal, cardiac, diabetic and hypertensive disorders).

US, it is evident that there is an underreporting of pregnancies that underwent ECV in the database, as we only had 3.4% of breech fetuses undergoing ECV in our study. Numerous studies have demonstrated a success rate of 49–70% depending on certain ultrasound factors and maternal parity [8]. The discrepancy observed in this study (72.5% success) is likely due to an ascertainment bias, with probable contamination of the breech control group. In other words, breech pregnancies with failed ECV are coded simply under the ''breech'' category, but not under the ''failed ECV'' category. This assumption stemmed from two different notions. Firstly, given that the rate of success reported in the literature is lower, it is more likely that there might be an underreporting of cases that failed ECV, which artificially tilts the balance towards higher success. Secondly, a breech baby that fails ECV remains a breech baby; in other words, it has an unchanged presentation to that prior to ECV. On the other hand, a change in the pregnancy course and management follows a successful ECV, which may incline a healthcare professional to report such change. Though the ascertainment bias is likely as we have described it, we have no way to validate this suspicion, and it may be that the misclassification would blunt the differences found in this study as well. Should our suspicion be correct, as it pertains to the findings of this study, a true ascertainment would draw the results farther away from the null hypothesis, favoring the alternate hypothesis, thereby increasing the magnitude of the risk associated with failure of ECV that we find. All in all, though this poses a limitation with regards to the true incidence of ECV in our cohort, it does not preclude statistical analyses to be carried out amongst confirmed cases and controls.

Other important points relate to the findings of this study; in particular, the cesarean delivery odds amongst failed ECV cases. The higher elective cesarean delivery rates amongst the failed ECV group may point towards an underlying mechanism, which may not be related to maternal or fetal factors. Indeed, the practice of pelvimetry in the US is not widespread, as it has been shown not to be a successful predictor of neither vaginal nor operative delivery [25]. Thus, deciding to undergo elective cesarean delivery is unlikely due to inadequate pelvimetry measurements. Since any contraindication to labor is a contraindication to perform ECV, we infer that there is no contraindication to vaginal delivery amongst failed ECV cases. However, it is more likely that both patient preference and a center's experience with breech vaginal births may contribute to the high rates of elective cesarean delivery upon ECV failure. Indeed, a study has shown that only 54% of patients carrying breech fetuses were willing to consider ECV, and 65% preferred planned caesarean section if the breech presentation persisted [26], indicating that patient preference may play an important role in the higher rate of elective cesarean delivery. We hypothesize that this phenomenon may not be observed as often in the breech control group given that as many as 21 to 26% of breech presentations are either discovered in labor or enter labor spontaneously prior to elective surgical intervention [27,28]. In addition, as we have shown in this study, the total rate of ''adequate'' and ''adequate +'' care is higher in the failed version cohort than in the breech control group, indicating that perhaps a closer, more rigorous follow-up allows for the screening of breech pregnancies, the proposal of ECV, and the eventual arrangement for elective cesarean delivery upon ECV failure. In our model, higher levels of maternal education remained significant in the elective cesarean cohort amongst the failed versions. This may further support our hypothesis. Nonetheless, it remains that with careful selection, cases where version has failed can be allowed to labor and be delivered vaginally [29], and that amongst carefully managed cases of breech presentation, induction of labor seems a safe and reasonable option [30]. Otherwise, when an attempted ECV fails, a repeat attempt under epidural anesthesia may be successful, resulting in a lower cesarean delivery rate [19]. Of note, this study finds a spontaneous version rate of 13% following ECV failure (Table 2). As it is commonly done, practitioners should therefore always verify the fetal presentation prior to undertaking a surgical approach for delivery.

On the other hand, should the breech fetus that failed ECV enter the laboring process, this study finds an increased risk of intrapartum cesarean delivery as well. Though correlations cannot be ascertained with absolute confidence, it is plausible that fetal or pelvic factors exist, which impede both the success of ECV as well as the success of vaginal delivery. Other studies have concluded that the cesarean section rate is increased amongst successful ECV cases relative to the baseline risk for cephalic fetuses, implying that successful ECV may not have a major impact on the overall cesarean birth rate [31,32]. In keeping with this notion, other studies have demonstrated that the incidence of operative delivery and other obstetric interventions are higher in pregnancies after successful ECV as well [33]. It is therefore not unlikely that breech fetuses undergoing ECV, independent of outcome, are inherently ''different'', and at higher risk for cesarean delivery for labor dystocia. Whether this hypothesis contributes to the higher rate of elective cesarean delivery in patients that failed ECV requires further investigation. Given that ours is the first study to demonstrate an increased risk of cesarean in labor amongst failed ECV cases relative to breech controls, the decision to undergo surgical delivery unlikely based on proven risks, but is likely due to physician and patient preference, as well as a center's experience with breech vaginal birth.

Other salient outcomes like abnormal heart tracings, lower APGAR scores, ventilator requirement at birth, and NICU admission are known concerns amongst neonates born from cesarean section [4]. Though these outcomes may be interrelated, we have shown that even after adjusting for mode of delivery and doing sub-analysis stratification, fetuses that failed to rotate following ECV are at an increased risk of these complications relative to breech controls. With regards to other pertinent findings, we hypothesize that mechanical manipulation of the amnio-chorionic membranes may weaken their tensile force, and explain why both cases of failure and success of ECV yield a higher rate of PROM relative to breech controls [34].

The limitations and drawbacks posed by the nature of the data used in this study are several and worth mentioning. Information pertaining to the technical aspects of ECV, the method of selection used, the use of tocolytics, the application of regional anesthetics, amniotic fluid index, and the capacity of a given center to perform ECV and carry out breech vaginal births would have provided greater depth to our analysis. Additionally, the ECV-to-delivery time interval would have provided us with another interesting angle to this association, as would have the knowledge of the indication for elective cesarean delivery. Finally, data on stillbirths was not available on this dataset. This would have provided another interesting perinatal perspective following the intervention in question. As with all retrospective, population-based databases, we had no way to confirm each diagnosis. In particular, the information about ECV attempt might be missing in many cases, which could explain the low rate of ECV in this cohort (less than 4%).

On the other hand, this study has numerous strengths. First and foremost, to the best of our knowledge, this is the first population-based study in the literature addressing the outcomes following failure of ECV. We were able to adjust for several relevant confounders, with sufficient power to detect differences in outcome measures. The data is therefore unlikely biased with respect to our study question. Furthermore, by comparing cases of failed ECV to breech controls, and stratifying cesarean deliveries as either elective or in labor, we point at an underlying mechanism to the higher cesarean rate, which may be directly related to physician's attitudes and patient preference following early detection of breech presentation. These factors may be potentially modifiable, and may theoretically help decrease cesarean deliveries for breech presentation. Finally, as this study elucidates some of the important risks associated with failure of ECV, it raises the question whether proposed prediction models that discriminate between women with poor chance of successful ECV from those with high chance should be used to screen ECV candidates [35].

In conclusion, relative to breech controls without attempt at ECV, and regardless of trial of labor undertaking, failure of ECV to restitute fetal cephalic presentation appears to be associated with an increased risk of adverse perinatal and obstetrical outcomes. Given these results, this study raises the question whether we should reserve ECV to women in whom it is likely to succeed based on predetermined, validated criteria. In the mean time, prospective trials are warranted to validate these findings. In particular, studies comparing patients desiring a trial of labor despite failed ECV to those who desire a trial of labor and decline ECV should be undertaken.

Declaration of interest

The authors disclose no conflicts of interest.

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