

Trial of Labor After Cesarean and Amnioinfusion: A Safe Combination After Cesarean

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Abstract

Objective

Data on amnioinfusion during trial of labor after cesarean (TOLAC) are limited. We evaluated whether intrapartum amnioinfusion increases the risk of uterine rupture among individuals undergoing TOLAC.

Study Design:

Retrospective cohort of individuals undergoing TOLAC at a tertiary center (January 2013–June 2025). Per departmental protocol, amnioinfusion was used for repetitive variable decelerations. Individuals with major fetal anomalies, stillbirth, or multiple gestations were excluded. The primary outcome was uterine rupture. Secondary outcomes included unplanned cesarean delivery, postpartum hemorrhage, transfusion, hysterectomy, infectious morbidity, ICU admission, and adverse neonatal outcomes. Multivariable regression was used to estimate adjusted associations.

Results

Of 131,489 deliveries, 5,303 (4%) met inclusion criteria, of whom 315 (6.2%) underwent amnioinfusion. Individuals receiving amnioinfusion delivered at a later gestational age and had higher rates of labor induction, intrapartum fever, and meconium-stained amniotic fluid. The overall uterine rupture rate was 1%. After adjustment, uterine rupture rates did not differ between the amnioinfusion and control groups (1.2% vs. 1%; adjusted OR 1.2, 95% CI 0.4–3.3; $p = 0.7$). Amnioinfusion was associated with a higher rate of cesarean delivery (adjusted OR 3.1, 95% CI 2.5–4.0; $p < 0.01$).

Conclusion

Among individuals undergoing TOLAC, amnioinfusion was not associated with an increased risk of uterine rupture. These findings provide reassurance regarding its use during TOLAC; however, given the limited number of uterine rupture events, larger studies are needed to confirm its safety.

Introduction

The rate of cesarean deliveries has risen significantly over the past several decades, increasing from 20.7% in 1996 to 32.3% in 2023 in the United States alone. As a result, a growing proportion of pregnant individuals present with a history of prior cesarean delivery, prompting important decisions regarding the mode of delivery in subsequent pregnancies [1]. For eligible candidates, a TOLAC offers the potential for a VBAC, which is associated with a range of benefits, including shorter maternal recovery time, lower rates of infection and hemorrhage, decreased risk in future pregnancies, and higher rates of successful breastfeeding [2, 3]

Despite these advantages, TOLAC is not without risk. The most serious complication is uterine rupture, which, although rare, occurring in approximately 0.5%–0.9% of cases, and is associated with maternal and neonatal adverse outcomes [4–5]. As such, labor management in women attempting TOLAC requires careful monitoring and the avoidance of interventions that may increase intrauterine pressure.

Amnioinfusion is a well-established intrapartum intervention used primarily to alleviate recurrent variable fetal heart rate decelerations, [6–8]. By instilling isotonic fluid into the amniotic sac through an intrauterine catheter, amnioinfusion reduces variable decelerations, lowering the risk of cesarean delivery for non-reassuring fetal status. Previous studies in the general obstetric population have demonstrated that amnioinfusion is a low-risk, effective strategy to improve labor outcomes and reduce the need for operative delivery [9].

However, the safety of amnioinfusion in women with a prior cesarean delivery remains uncertain. The theoretical concern is that infusion of additional intrauterine fluid may lead to uterine overdistension, elevated intrauterine pressure, or increased mechanical stress on the uterine scar, factors that could heighten the risk of uterine rupture in the setting of TOLAC [10]. To date, only one small study from the mid-1990s has examined this question, with limited outcome data and unclear clinical applicability [11].

Given the clinical importance of balancing safe labor practices with strategies to avoid unnecessary cesarean delivery, a better understanding of the risks and benefits of amnioinfusion during TOLAC is urgently needed. The objective of this study was to evaluate whether intrapartum amnioinfusion is associated with an increased risk of uterine rupture in those undergoing TOLAC. Secondary outcomes included maternal and neonatal complications to provide a comprehensive assessment of the intervention's safety profile in this high-risk population.

Material and method

We conducted a retrospective cohort study at a single tertiary medical center between January 2013 and June 2025. Data was obtained through a comprehensive review of electronic medical record. All individuals with a history of one prior cesarean delivery who labored during the study period were screened for eligibility. Exclusion criteria included known major fetal anomalies, stillbirth and multiple gestations. The study was approved by the Institutional Review (0342-23-SMC), which waived the requirement for informed consent due to the retrospective nature of the study.

Patients were categorized into two groups according to intrapartum exposure to amnioinfusion: those who received amnioinfusion during TOLAC and those who did not.

Maternal, obstetrics, labor and neonatal records were retrieved using the MDCIone ADAMS platform, a self-service query tool that enables access to patient-level healthcare data. Maternal demographic variables including age, body mass index, smoking status, and use of infertility treatments. Obstetric characteristics collected included polyhydramnios, oligohydramnios, hypertensive disorders of pregnancy, gestational diabetes, and fetal growth restriction (defined as estimated fetal weight < 10th

percentile for gestational age). Labor and delivery variables included gestational age at delivery, induction of labor using either a cervical balloon catheter or oxytocin, presence of meconium-stained amniotic fluid, use of amnioinfusion, intrapartum fever, mode of delivery, operative complications. Postpartum variables included postpartum hemorrhage, blood product transfusion, endometritis, surgical site infection, and intensive care unit admission. Neonatal outcomes assessed included birth weight, gender, Apgar score, neonatal intensive care unit admission, meconium aspiration syndrome (MAS, defined as respiratory distress in the presence of meconium-stained amniotic fluid without an alternative explanation), hypoglycemia (capillary blood glucose < 40 mg/dL or need for oral/IV glucose), hyperbilirubinemia, respiratory distress syndrome, intraventricular hemorrhage, sepsis, hypoxic-ischemic encephalopathy, mechanical ventilation, necrotizing enterocolitis, and neonatal death within 28 days.

Demographic data, labor and neonatal outcomes were compared between individuals who had amnioinfusion during labor and those that did not.

The primary outcome was uterine rupture, defined as a complete disruption of all uterine layers (endometrium, myometrium, and perimetrium [11]. Secondary outcomes included unplanned cesarean delivery, postpartum hemorrhage, blood transfusion, hysterectomy, surgical site infection, endometritis ICU admission, and adverse neonatal outcomes.

Per department protocol at our institution, amnioinfusion is performed for recurrent variable fetal heart rate decelerations. The protocol includes the administration of normal saline (0.9%) via a Koala intrauterine pressure catheter, with a maximum volume of 1 liter infused at a slow rate. The decision to perform amnioinfusion was made at the discretion of the treating obstetric team based on clinical indications

Statistical analysis: Continuous variables were compared using the non-parametric Mann-Whitney test. The chi-squared test was employed to compare categorical variables. Multivariate logistic regression was used to evaluate the association between the use of amnioinfusion and primary and secondary outcomes. The models included induction of labor and intrapartum fever as confounders. Adjusted Odds ratios (aOR) with a 95% confidence interval (CI) were reported. All statistical tests were 2-tailed, and $p < 0.05$ was considered statistically significant. All calculations were performed using IBM SPSS statistics, version 25.

Results

During the study period, a total of 131,489 deliveries were recorded, of which 5,303 (4%) met the inclusion criteria. Among these, 315 women (6.2%) underwent amnioinfusion during labor (Fig. 1).

The maternal and delivery characteristics of the study population are summarized in Table 1, with no significant differences observed in demographic characteristics between the groups.

Table 1
Demographic and obstetric data

Age (years)	Amnioinfusion (N = 315)	No Amnioinfusion (N = 4,988)	P-Value
	33.2 (30.1–36.4)	33.7 (30.3–36.7)	0.13
35 or more	237 (75.2)	3851 (77.2)	0.42
Body mass index (kg/m ²)	36.7 (36.6–36.9)	36.7 (36.6–36.9)	0.41
≥ 30	204 (64.76)	3379 (67.7)	0.27
Grand multipara	32 (10.1)	444 (8.9)	0.44
Smoking	6 (1.9)	130 (2.6)	0.44
ART	6 (1.9)	54 (1.1)	0.18
PPROM	6 (1.9)	91 (1.8)	0.91
Polyhydramnios	7 (2.2)	136 (2.7)	0.59
Oligohydramnios	16 (5.1)	159 (3.2)	0.06
Hypertensive disorders*	14 (4.4)	203 (4.1)	0.74
GDM	38 (12.1)	524 (10.5)	0.38
Pregestational diabetes	6 (1.9)	62 (1.2)	0.31
Fetal growth restriction [#]	11 (3.5)	188 (3.8)	0.8
Cesarean delivery ^a	131 (41.6)	854 (17.1)	< 0.01
Arrest disorder ^{a,b}	13 (10)	74 (9)	0.63
NRFHR ^{a,b}	103 (78.6)	462 (54.1)	< 0.01
PPH	13 (4.1)	181 (3.6)	0.64

Age (years)	Amnioinfusion (N = 315)	No Amnioinfusion (N = 4,988)	P-Value
	33.2 (30.1–36.4)	33.7 (30.3–36.7)	0.13
Data are presented as n (%) or average ± standard deviation			
ART- artificial reproductive technologies ,PPROM-preterm (< 37.0 weeks) premature rupture of membranes, GDM-Gestational diabetes mellitus. NRFHR- non-reassuring fetal heart rate, PPH: postpartum hemorrhage (estimated blood loss of > 1,000 mL or blood loss accompanied by signs or symptoms of hypovolemia within 24 hours from delivery)			
a. Arrest of dilatation or Arrest of descent			
b. Considered only in the subgroup of women who underwent a cesarean section			
*Hypertensive Disorder of Pregnancy (HDP)- SIPET-Superimposed preeclampsia, PET-preeclampsia, HELLP-Hemolysis, Elevated Liver enzymes and Low Platelets,			
#Estimated fetal weight < 10th percentile for gestational age			

Intrapartum characteristics are summarized in Table 2. Compared with controls, the amnioinfusion group delivered at a later gestational age (median 40.1 vs. 39.5 weeks; $p < 0.01$), with a higher rate of late-term delivery beyond 41 weeks (21.3% vs. 12.1%; $p < 0.01$). Amnioinfusion was also associated with higher rates of labor induction (34.3% vs. 14.1%; $p < 0.01$), meconium-stained amniotic fluid (5.1% vs. 2.5%; $p < 0.01$), and intrapartum fever (6.0% vs. 2.8%; $p < 0.01$).

Table 2
Intrapartum characteristics

Gestational age at delivery (weeks)	Amnioinfusion (N = 315)	No Amnioinfusion (N = 4,988)	P-Value
	40.1 (39.1–40.6)	39.5 (38.6–40.4)	< 0.01
< 37.0	10 (3.2)	201 (4)	0.45
≥ 41.0	67 (21.3)	603 (12.1)	< 0.01
Induction of labor	108 (34.3)	706 (14.1)	< 0.01
Meconium-stained amniotic fluid	16 (5.1)	126 (2.5)	< 0.01
Intrapartum fever	19 (6)	142 (2.8)	< 0.01
Data are presented as n (%)			
Bolded if significantly different			

Table 3 summarizes the primary and secondary outcomes. In multivariable regression analysis, there was no significant difference in the primary outcome of uterine rupture between the amnioinfusion and

control groups (1.2% vs. 1%, adjusted OR 1.2; 95% CI 0.4, 3.3; $p = 0.7$). Unplanned cesarean delivery occurred more frequently among patients who underwent amnioinfusion (41.6% vs. 17.1%; adjusted OR, 3.1; 95% CI, 2.5–4; $p < 0.01$). Among women who delivered by cesarean, the indication of non-reassuring fetal heart rate was significantly higher in the amnioinfusion group (78.6% vs 54.1%, adjusted OR 3.1; 95% CI 1.2–4.8; $p < 0.01$).

Table 3
Outcomes

Uterine rupture	Amnioinfusion (N = 315)	No Amnioinfusion (N = 4,988)	P- Value	OR	Unadjusted OR (95% CI)	aOR (95% CI)*
	4 (1.2)	50 (1)	0.7	1.2	0.4, 3.5	0.4, 3.3
Hysterectomy	0 (0)	0 (0)	NC	NC	NC	NC
CD	131 (41.6)	854 (17.1)	< 0.01	3.1	2.7,4.4	2.5, 4
Arrest of labor ^{a,b}	13 (10)	74 (9)	0.63	1.2	0.6, 2.2	0.6, 2.2
NRFHR ^b	103 (78.6)	462 (54.1)	< 0.01	3.1	2, 4.8	1.2, 4.8
PPH	13 (4.1)	181 (3.6)	0.62	1.1	0.6, 2	0.6,2.1
Blood products transfusion	7 (2.2)	73 (1.5)	0.3	1.5	0.7, 3.3	0.7, 3.4
Endometriosis	3 (0.9)	31 (0.6)	0.66	1.3	0.5, 5	0.4, 4.4
Surgical site infection ^b	3 (0.9)	6 (0.1)	0.22	2.4	0.8, 13.4	0.6, 10
Intensive Care Unit admission	0 (0)	2 (0.04)	0.99	NC	NC	NC
Data are presented as n (%)						
CD- cesarean delivery, NRFHR- non-reassuring fetal heart rate						
a. Arrest of dilatation or Arrest of descent						
b. Considered only in the subgroup of women who underwent a cesarean section						
*Adjusted for induction of labor and intrapartum fever						
Bolded if significantly different						

Neonatal outcomes are summarized in Table 4. The incidence of hypoglycemia was higher in the amnioinfusion group compared with the control group (6.7% vs. 2.8%, $p < 0.01$), while all other neonatal outcomes were comparable between the groups.

Table 4
Neonatal data

Birthweight	Amnioinfusion	No Amnioinfusion	P-Value	
	(N = 315)	(N = 4,988)		
	3280 (3018–3530)	3300 (3010–3590)	0.44	
SGA	14 (4.4)	176 (3.5)	0.4	
LGA	29 (9.2)	478 (9.6)	0.81	
Gender(F)	140 (44.4)	2481 (49.7)	0.06	
Apgar score < 7 at 5 min	2 (0.6)	9 (0.2)	0.08	
NICU admission		6 (1.9)	97 (1.9)	0.95
Meconium aspiration syndrome		9 (2.9)	0 (0)	0.45
Hypoglycemia		21 (6.7)	142 (2.8)	< 0.01
Hyperbilirubinemia		66 (20.9)	879 (17.6)	0.13
RDS		0 (0)	15 (0.3)	NC
IVH		0 (0)	1 (0.02)	NC
Sepsis		0 (0)	5 (0.1)	NC
HIE		0 (0)	1 (0.02)	NC
Mechanical ventilation		0 (0)	3 (0.06)	NC
NEC		0 (0)	1 (0.02)	NC
Neonatal death within the first 28 days of life		0 (0)	2 (0.04)	NC
Data are presented as n (%) or median (interquartile range)				
SGA, small for gestational age (birth weight < 10th percentile using Dollberg nomogram); LGA, large for gestational age (birth weight > 90th percentile using the Dollberg nomogram) NICU-neonatal intensive care unit, RDS-respiratory distress syndrome, IVH- intraventricular hemorrhage, HIE-hypoxic-ischemic encephalopathy, NEC- Necrotizing enterocolitis.				
Bolded if significantly different				

Discussion

In this cohort, intrapartum amnioinfusion was utilized in 5% of laboring patients and was not associated with an increased risk of uterine rupture, supporting its intrapartum safety in this population. Overall, patients who underwent amnioinfusion delivered at a later gestational age and exhibited higher rates of labor induction, meconium-stained amniotic fluid, intrapartum fever, and cesarean delivery.

Cesarean delivery is among the most frequently performed surgical procedures worldwide, with rates continuing to increase [1]. Consequently, an increasing number of pregnant individuals are attempting a TOLAC [1]. In a comprehensive 2022 review, Fitzpatrick et al. compared the risks and benefits of planned TOLAC versus elective repeat cesarean delivery. They reported that although planned VBAC is associated with a higher risk of certain serious maternal and neonatal complications compared with elective repeat cesarean delivery, the absolute risk of these complications remains low with either strategy [2].

As noted in the introduction, the most serious complication of TOLAC is uterine rupture. Clinical signs typically include fetal heart rate abnormalities, abdominal pain, and vaginal bleeding [12, 13]. However, some cases may be asymptomatic or present with only a subset of these features. The most frequent manifestation is severe fetal heart rate abnormality, occurring in approximately 77% of cases, most commonly as persistent bradycardia [13]. Mild variable decelerations are rarely observed in this context [14].

Amnioinfusion has been described in the literature as a therapeutic intervention during labor, primarily aimed at reducing the frequency of recurrent variable decelerations and the likelihood of cesarean delivery. [6–8]. A Cochrane review by Hofmeyr et al. evaluated the effects of amnioinfusion for suspected or potential umbilical cord compression and demonstrated a significant reduction in caesarean section rates (13 trials, 1,493 women; RR 0.62, 95% CI 0.46–0.83). These findings are consistent with a reduction in variable decelerations, which probably contributes to the observed decrease in caesarean delivery rates. [6].

The combined use of amnioinfusion during TOLAC has been infrequently addressed in the literature, with an early report by Joseph et al. in 1995. In that study, 122 patients who underwent intrapartum amnioinfusion during TOLAC were compared with 1,314 patients who underwent TOLAC without amnioinfusion, and no significant difference in the rate of uterine rupture was observed between the groups. However, that study did not evaluate perinatal or obstetric outcomes [10]. In contrast, our study includes the largest reported cohort of patients undergoing intrapartum amnioinfusion in the setting of TOLAC (317 patients), with comprehensive comparison of both obstetric and perinatal outcomes. Moreover, all patients in our cohort received amnioinfusion for the same indication (variable decelerations), unlike the heterogeneous indications reported in the study by Joseph et al [10].

Notably, cesarean delivery for non-reassuring fetal heart rate was more common in the amnioinfusion group. This finding likely reflects indication bias, as amnioinfusion in this study was predominantly performed in the setting of variable decelerations. The association between amnioinfusion and later gestational age, post-term delivery, and increased intrapartum interventions is consistent with existing literature demonstrating that advancing gestational age is associated with higher rates of labor induction, meconium-stained amniotic fluid, and cesarean delivery [15–18]. Joseph et al. also reported lower rates of successful VBAC in patients receiving amnioinfusion, attributed to a higher proportion of labor inductions. Furthermore, meconium-stained amniotic fluid has been linked to an increased risk of

intrapartum fever, which may further contribute to the observed increase in cesarean delivery rates [20,21].

It should be noted that the composite outcome includes uterine rupture across both induced and spontaneous labours. This may partially explain differences in rates compared with previously published literature. When focusing on women who did not undergo induction, the rates appear more consistent with prior reports; however, these subgroup analyses are limited by small numbers, particularly in the amnioinfusion group, which reduces the precision of the estimates. In the control group, uterine rupture occurred in 50/4,988 (1.0%), decreasing to 25/4,309 (0.6%) after excluding women who underwent labor induction. In the amnioinfusion group, the rate of uterine rupture was 4/315 (1.2%), decreasing to 1/208 (0.5%) after excluding women who underwent labor induction.

To the best of our knowledge, this is the largest study to date evaluating whether amnioinfusion increases the risk of uterine rupture in women undergoing TOLAC. A major limitation of our study is its retrospective design, with the inherent risk of bias. In particular, the higher rate of cesarean delivery observed in the amnioinfusion group may reflect indication bias, as amnioinfusion was administered for recurrent variable decelerations, which themselves may increase the likelihood of operative delivery. Therefore, despite multivariable adjustment, residual confounding by indication cannot be excluded, limiting our ability to establish a causal relationship between amnioinfusion and cesarean delivery. A randomized controlled trial would be needed to better determine the independent effect of amnioinfusion on mode of delivery and other clinical outcomes in women undergoing TOLAC. Moreover, we were unable to account for potential confounders, including the duration of amnioinfusion, the stage of labor at which it was initiated, and whether intrapartum fever occurred before or after the procedure. Furthermore, despite the relatively large overall cohort, the number of uterine rupture events was limited, resulting in wide confidence intervals. Thus, the possibility of a type II error cannot be entirely excluded.

In conclusion, intrapartum amnioinfusion was not associated with an increased risk of uterine rupture in women with a prior cesarean undergoing TOLAC. Our findings suggest that amnioinfusion can be safely used in this population, likely reflecting its role as a strategy to facilitate labor progress, support more favorable labor conditions, and improve the likelihood of a successful VBAC.

Declarations

Funding:

Not Applicable

Data availability statement:

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

Author Contribution

K.Z: Conception and design, data acquisition, data analysis and interpretation; manuscript drafting; final approval.O.M, E.S: Data acquisition, critical revision of the manuscript, final approval.S.C: Data analysis and interpretation, critical revision of the manuscript, final approval.M.B, T.C: Conception and design; data acquisition, data analysis and interpretation, critical revision of the manuscript, final approval.

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The authors report no conflict of interest.

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Figures

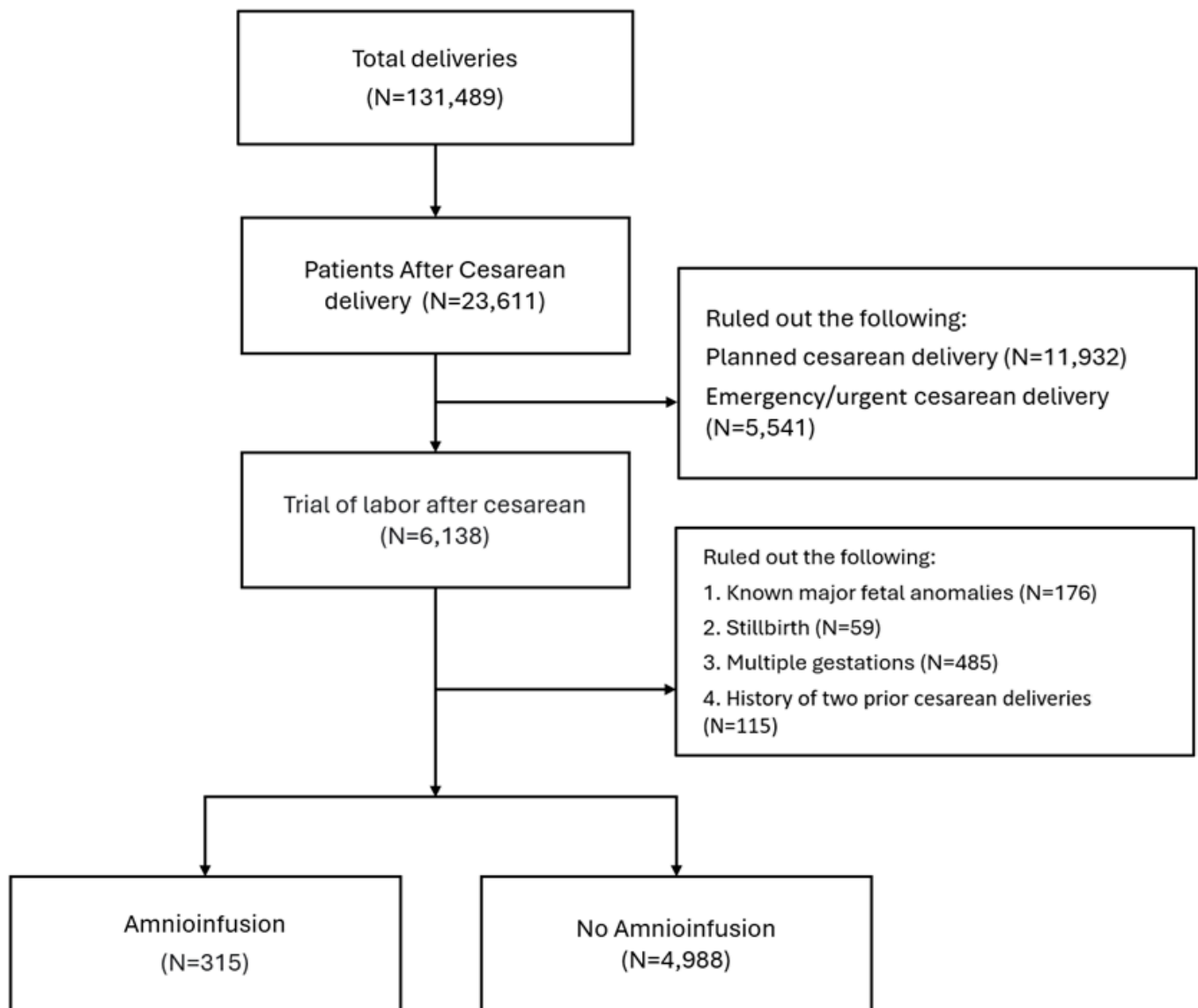


Figure 1

Flowchart of patient inclusion and exclusion criteria.