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Original Research Article

Delivery Mode and Neonatal Outcomes in Pregnancies with Fetal Growth Restriction: A Prospective Cohort Study

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Abstract

Background: Fetal growth restriction (FGR) affects 5-10% of pregnancies and remains a leading cause of perinatal morbidity and mortality. The optimal delivery mode for FGR pregnancies remains controversial with conflicting evidence regarding the safety of trial of labor versus elective cesarean delivery.

Objective: To prospectively compare neonatal outcomes between elective cesarean, successful vaginal delivery, and emergency cesarean sections in FGR pregnancies delivering at or beyond 34 weeks of gestation.

Methods: This prospective cohort study enrolled 90 singleton pregnancies with FGR diagnosed by Delphi consensus criteria, delivering at ≥34 weeks between January 2025 and June 2025. Patients were categorized by delivery mode: elective cesarean section, successful vaginal delivery, or emergency cesarean section. The primary outcome was a composite adverse neonatal outcome including NICU admission, respiratory distress syndrome, birth asphyxia, neonatal hypoglycemia, and low Apgar scores. Statistical analysis employed chi-square tests and multivariable logistic regression.

Results: Of 90 patients, 30 underwent elective cesarean delivery, 28 had successful vaginal delivery, and 32 required emergency cesarean section. Emergency cesarean delivery was associated with 3.45-fold increased odds of adverse neonatal outcomes compared to elective cesarean (95% CI: 1.42-8.38, p=0.006). Successful vaginal delivery demonstrated comparable outcomes to elective cesarean (p=0.68). Non-reassuring fetal heart rate was the primary indication for emergency cesarean and associated with the highest adverse outcome rates.

Conclusion: Emergency cesarean delivery in FGR pregnancies ≥34 weeks is associated with significantly increased neonatal morbidity. Successful vaginal delivery outcomes are comparable to elective cesarean when appropriately selected, suggesting that trial of labor may be reasonable for carefully selected FGR patients with close monitoring.

Keywords: Fetal growth restriction; Cesarean section; Vaginal delivery; Neonatal outcomes; Perinatal morbidity; Emergency cesarean; Delivery mode.

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Introduction

Fetal growth restriction (FGR) represents one of the most significant obstetric challenges worldwide, affecting approximately 5-10% of all pregnancies and contributing substantially to perinatal morbidity and mortality.[1] Defined as the failure of a fetus to achieve its full genetically determined growth potential due to pathologic etiologies, FGR is primarily caused by placental insufficiency that leads to chronic undersupply of oxygen and nutrients to the developing fetus.[2] The condition remains a leading cause of stillbirth, accounting for nearly 40% of non-malformed stillborn fetuses, and is associated with a 10-fold increase in late fetal deaths among very small fetuses.[3,4] The pathophysiology of FGR centers on placental dysfunction, which creates a chronically hypoxemic and undernourished intrauterine environment.[5] This compromised state triggers a cascade of fetal adaptations, including redistribution of blood flow to vital

organs, particularly the brain, heart, and adrenal glands, at the expense of other organ systems.[6] While these compensatory mechanisms may initially sustain fetal survival, they predispose the fetus to significant short-term and long-term complications. In the immediate neonatal period, FGR infants face elevated risks of perinatal asphyxia, respiratory distress, hypoglycemia, polycythemia, hypothermia, and neonatal sepsis.[7,8]

The optimal timing and mode of delivery for pregnancies complicated by FGR remains one of obstetrics' most debated topics. Clinical management must balance the risks of continued in utero growth restriction against the hazards of iatrogenic prematurity.[9] Current guidelines from the American College of Obstetricians and Gynecologists (ACOG) and the Society for Maternal-Fetal Medicine recommend individualized delivery timing based on gestational age, severity of growth restriction, and Doppler findings.[10] However, consensus is lacking regarding the preferred mode of delivery once the decision to deliver has been made.

Historically, many clinicians have advocated for elective cesarean delivery in FGR pregnancies, driven by theoretical concerns that the chronically hypoxemic fetus may not tolerate the additional stress of labor.[11] This concern is not unfounded, as FGR fetuses exhibit baseline physiological compromise with reduced glycogen stores, limited oxygen reserves, and altered cardiovascular function that may predispose them to decompensation during labor.[12] The Growth Restriction Intervention Trial (GRIT) demonstrated that FGR pregnancies carry inherent risks regardless of delivery timing, with significant rates of adverse perinatal outcomes even with optimal management.[13]

However, emerging evidence challenges the assumption that cesarean delivery is universally safer for growth-restricted fetuses. Several recent studies have suggested that appropriately selected FGR patients can safely undergo trial of labor with outcomes comparable to elective cesarean delivery.[14,15] A retrospective cohort study by Baalbaki and colleagues found that in preterm FGR pregnancies between 23 and 34 weeks, planned cesarean was not associated with decreased risk of composite adverse neonatal outcomes after adjusting for gestational age and antenatal steroids, even when considering critical umbilical artery Dopplers.[16] Similarly, Ben-Haroush et al. reported that in selected cases of suspected FGR with reassuring fetal heart rate patterns and normal antenatal testing, induction of labor with prostaglandin E2 yielded cesarean section rates and immediate fetal outcomes similar to uncomplicated pregnancies.[17] The distinction between elective and emergency cesarean delivery is particularly relevant in the FGR population. Emergency cesarean sections performed during labor are associated with significantly increased maternal and neonatal complications compared to planned deliveries, including higher rates of postpartum hemorrhage, wound infection, prolonged hospital stay, and neonatal respiratory distress.[18,19] In one large tertiary center study, emergency cesarean sections were associated with 27.6% NICU admission rates compared to 11.2% for elective procedures, with nearly doubled rates of neonatal respiratory distress (18.2% versus 7.6%).[20] The mechanisms underlying these disparities likely include the acute physiological stress of labor followed by urgent surgical intervention, incomplete lung fluid clearance, and the underlying indication necessitating emergency delivery.

For FGR pregnancies specifically, the interplay between chronic fetal compromise and acute intrapartum stress may amplify these risks. Malnutrition and low birth weight predispose FGR infants to multiple transient neonatal morbidities including hypothermia, altered glucose metabolism, hypocalcemia, polycythemia, and increased infection risk.[21] Approximately 33% of small-for-gestational-age infants develop hypoglycemia due to reduced glycogen stores and fat reserves.[22] Perinatal stress, including birth asphyxia and fetal distress, can induce a state of hyperinsulinemic hypoglycemia that may persist for days to weeks postnatally.[23] When FGR infants undergo emergency cesarean delivery for non-reassuring fetal status, they may experience compounded metabolic and respiratory complications.

Despite the clinical importance of this issue, prospective data comparing outcomes across different delivery modes in FGR pregnancies remain limited. Most existing studies are retrospective, include heterogeneous populations with varying gestational ages, or fail to differentiate between spontaneous labor, induced labor, and elective cesarean delivery. Furthermore, few studies have specifically examined outcomes in late preterm and early term FGR pregnancies (≥34 weeks gestation), a population that comprises the majority of FGR deliveries and where the decision between trial of labor and elective cesarean delivery is most clinically relevant.

Understanding the impact of delivery mode on neonatal outcomes in FGR pregnancies is crucial for appropriate patient counseling and evidence-based management decisions. Cesarean delivery carries significant maternal risks including surgical complications, prolonged recovery, and increased risks in subsequent pregnancies.[24] If trial of labor can be shown to be safe for appropriately selected FGR patients, it could reduce unnecessary cesarean

deliveries while maintaining optimal neonatal outcomes. Conversely, if emergency cesarean delivery is associated with substantially worse neonatal outcomes compared to elective cesarean, this would support a more liberal threshold for planned cesarean delivery in the FGR population.

The current study was designed to address these knowledge gaps by prospectively comparing neonatal outcomes among three groups: elective cesarean delivery, successful vaginal delivery, and emergency cesarean delivery in singleton FGR pregnancies at or beyond 34 weeks of gestation. By examining this relatively homogeneous population with standardized outcome measures, we aimed to provide clinically actionable data to guide delivery planning in this high-risk obstetric population.

Aims and Objectives

Primary Objective: To prospectively compare neonatal outcomes between elective cesarean section, successful vaginal delivery, and emergency cesarean section in pregnancies complicated by fetal growth restriction at or beyond 34 weeks of gestation.

Secondary Objectives

1. To identify risk factors associated with adverse neonatal outcomes across different delivery modes in FGR pregnancies
2. To determine the indications for emergency cesarean delivery in FGR pregnancies and their association with neonatal outcomes
3. To assess the safety of trial of labor in appropriately selected FGR pregnancies

Materials and Methods

Study Design and Setting: This was a prospective cohort study conducted at a tertiary care referral center between January 2025 and June 2025. The study protocol was approved by the Institutional Ethics Committee, and written informed consent was obtained from all participants prior to enrollment. The study adhered to the principles of the Declaration of Helsinki and Good Clinical Practice guidelines.

Study Population and Sample Size: A total of 90 consecutive singleton pregnancies with fetal growth restriction were enrolled in the study. Sample size calculation was based on an expected 20% difference in composite adverse neonatal outcomes between delivery modes, with 80% power and 5% significance level. Accounting for potential attrition, a sample size of 90 patients (30 per group) was determined to be adequate for detecting clinically meaningful differences.

Inclusion Criteria

Patients were eligible for inclusion if they met all of the following criteria:

1. Singleton pregnancy
2. Fetal growth restriction diagnosed according to Delphi consensus criteria (estimated fetal weight or abdominal circumference <10th percentile for gestational age)
3. Gestational age ≥34 weeks at delivery
4. Availability for follow-up and complete data collection
5. Willingness to provide informed consent

Exclusion Criteria

Patients were excluded if any of the following conditions were present:

1. Multiple gestation (twins, triplets, or higher-order multiples)
2. Preterm delivery <34 weeks of gestation
3. Major fetal congenital anomalies detected on antenatal ultrasound
4. Intrauterine fetal demise prior to onset of labor
5. Maternal refusal to participate in the study
6. Incomplete medical records or loss to follow-up

Diagnostic Criteria for Fetal Growth Restriction: Fetal growth restriction was diagnosed using the Delphi consensus criteria, which includes estimated fetal weight or abdominal circumference below the 10th percentile for gestational age based on standard growth curves. Ultrasound biometry was performed by trained sonographers using standardized techniques. Gestational age was confirmed by first-trimester ultrasound dating or reliable last menstrual period when early ultrasound was not available.

Study Groups: Patients were categorized into three groups based on their actual mode of delivery:

Group 1: Elective Cesarean Section: Patients who underwent planned cesarean delivery without trial of labor. Indications included previous cesarean delivery, suspected cephalopelvic disproportion, breech presentation, maternal request, or physician recommendation based on severe FGR with abnormal Doppler findings.

Group 2: Successful Vaginal Delivery: Patients who attempted vaginal delivery (either spontaneous labor or induction of labor) and successfully delivered vaginally without requiring cesarean section.

Group 3: Emergency Cesarean Section: Patients who attempted vaginal delivery but required emergency cesarean section due to intrapartum complications. This group was further subdivided based on whether labor was spontaneous or induced.

Data Collection

Comprehensive maternal and neonatal data were collected using standardized case report forms. Maternal demographic data included age, parity, body mass index, gestational age at delivery, presence of pregnancy complications (hypertensive disorders, gestational diabetes, oligohydramnios), and previous obstetric history. Intrapartum data included mode of labor onset (spontaneous versus induced), duration of labor, indication for emergency cesarean section when applicable, and any intrapartum complications.

Neonatal data were meticulously recorded immediately after delivery and during the hospital stay. This included birth weight, Apgar scores at 1 and 5 minutes, umbilical cord arterial pH and base deficit, need for neonatal resuscitation, NICU admission and duration of stay, and specific neonatal morbidities.

Outcome Measures

Primary Outcome: The primary outcome was a composite adverse neonatal outcome defined as the presence of one or more of the following:

- NICU admission for >24 hours
- Respiratory distress syndrome requiring respiratory support
- Birth asphyxia (5-minute Apgar score <7 and/or umbilical artery pH <7.1)
- Neonatal hypoglycemia requiring intravenous glucose therapy
- Perinatal death (stillbirth or neonatal death within 7 days of birth)

Secondary Outcomes: Individual components of the composite outcome were analyzed separately, along with:

- Mean birth weight
- Mean Apgar scores at 1 and 5 minutes
- Umbilical cord arterial blood gas parameters
- Duration of NICU stay
- Need for mechanical ventilation
- Neonatal seizures
- Neonatal sepsis
- Hyperbilirubinemia requiring phototherapy

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation or median with interquartile range depending on distribution. Categorical variables were presented as frequencies and percentages.

Comparisons between groups were performed using appropriate statistical tests. Chi-square test or Fisher's exact test (when expected cell frequency was <5) was used for categorical variables. One-way ANOVA or Kruskal-Wallis test was employed for continuous variables depending on normality of distribution.

Multivariable logistic regression analysis was performed to identify independent predictors of adverse neonatal outcomes, adjusting for potential confounders including gestational age at delivery, birth weight, presence of oligohydramnios, maternal hypertensive disorders, and mode of delivery. Adjusted odds ratios with 95% confidence intervals were calculated. A p-value <0.05 was considered statistically significant for all analyses.

Results

Baseline Characteristics: A total of 90 patients with singleton pregnancies complicated by fetal growth restriction delivering at or beyond 34 weeks of gestation were enrolled during the six-month study period.

The mean maternal age was 26.8 ± 4.2 years, and the mean gestational age at delivery was 37.2 ± 1.6 weeks. Distribution across delivery modes was as follows: 30 patients (33.3%) underwent elective cesarean section, 28 patients (31.1%) achieved successful vaginal delivery, and 32 patients (35.6%) required emergency cesarean section.

Baseline demographic and clinical characteristics were comparable across the three groups, with no statistically significant differences in maternal age, parity, body mass index, or gestational age at delivery. However, patients in the emergency cesarean group had a higher prevalence of oligohydramnios (43.8% versus 26.7% in elective cesarean and 21.4% in vaginal delivery groups, p=0.04) and were more likely to have undergone labor induction (68.8% versus 0% in elective cesarean and 46.4% in vaginal delivery groups, p<0.001).

Table 1: Baseline Maternal and Pregnancy Characteristics

Characteristic	Elective Cesarean (n=30)	Vaginal Delivery (n=28)	Emergency Cesarean (n=32)	p-value
Maternal age (years), mean ± SD	27.2 ± 4.5	26.1 ± 3.8	27.1 ± 4.4	0.62
BMI (kg/m²), mean ± SD	24.3 ± 3.1	23.8 ± 2.9	24.6 ± 3.3	0.65
Gestational age at delivery (weeks), mean ± SD	37.4 ± 1.5	37.3 ± 1.4	36.9 ± 1.8	0.38
Hypertensive disorders, n (%)	12 (40.0)	11 (39.3)	15 (46.9)	0.78
Gestational diabetes, n (%)	4 (13.3)	3 (10.7)	5 (15.6)	0.85
Oligohydramnios, n (%)	8 (26.7)	6 (21.4)	14 (43.8)	0.04
Labor induction, n (%)	0 (0.0)	13 (46.4)	22 (68.8)	<0.001
Previous cesarean, n (%)	18 (60.0)	2 (7.1)	4 (12.5)	<0.001

BMI: Body mass index; SD: Standard deviation

Individual Neonatal Outcomes by Delivery Mode: Analysis of individual neonatal outcomes revealed significant differences across delivery modes. Mean birth weight was similar among groups (elective cesarean: 2156 ± 324 g, vaginal delivery: 2189 ± 298 g, emergency cesarean: 2098 ± 356 g, p=0.52). However, emergency cesarean delivery was associated with significantly lower 5-minute Apgar scores, higher rates of birth asphyxia, increased respiratory distress syndrome, and elevated neonatal hypoglycemia compared to both elective cesarean and vaginal delivery groups.

NICU admission rates differed substantially between groups, with 40.0% of elective cesarean neonates, 35.7% of vaginally delivered neonates, and 71.9% of emergency cesarean neonates requiring NICU admission (p=0.005). The duration of NICU stay was also longest in the emergency cesarean group (median 5 days, IQR 3-8) compared to elective cesarean (median 3 days, IQR 2-5) and vaginal delivery (median 3 days, IQR 2-4), p=0.02.

Table 2: Individual Neonatal Outcomes by Delivery Mode

Outcome	Elective Cesarean (n=30)	Vaginal Delivery (n=28)	Emergency Cesarean (n=32)	p-value
Birth weight (g), mean ± SD	2156 ± 324	2189 ± 298	2098 ± 356	0.52
1-minute Apgar score, median (IQR)	7 (7-8)	7 (7-8)	6 (5-7)	0.003
5-minute Apgar score, median (IQR)	9 (8-9)	9 (8-9)	8 (7-8)	<0.001
Birth asphyxia (5-min Apgar <7), n (%)	2 (6.7)	1 (3.6)	9 (28.1)	0.008
NICU admission, n (%)	12 (40.0)	10 (35.7)	23 (71.9)	0.005
Duration of NICU stay (days), median (IQR)	3 (2-5)	3 (2-4)	5 (3-8)	0.02
Respiratory distress syndrome, n (%)	4 (13.3)	3 (10.7)	12 (37.5)	0.01
Mechanical ventilation required, n (%)	1 (3.3)	0 (0.0)	6 (18.8)	0.01
Neonatal hypoglycemia, n (%)	3 (10.0)	2 (7.1)	11 (34.4)	0.007
Hyperbilirubinemia requiring phototherapy, n (%)	8 (26.7)	7 (25.0)	14 (43.8)	0.21
Neonatal sepsis, n (%)	1 (3.3)	1 (3.6)	3 (9.4)	0.51
Perinatal death, n (%)	0 (0.0)	0 (0.0)	1 (3.1)	0.42

IQR: Interquartile range; NICU: Neonatal intensive care unit; SD: Standard deviation

Composite Adverse Neonatal Outcome: The primary outcome of composite adverse neonatal outcome occurred in 13 patients (43.3%) in the elective cesarean group, 11 patients (39.3%) in the vaginal delivery group, and 25 patients (78.1%) in the emergency cesarean group (p=0.002). Compared to elective cesarean delivery, emergency cesarean was associated with significantly increased odds of adverse neonatal outcome (unadjusted OR 4.63, 95% CI 1.72-12.45, p=0.002). Successful vaginal delivery showed no significant difference compared to elective cesarean (unadjusted OR 0.85, 95% CI 0.30-2.38, p=0.68).

After adjusting for potential confounders including gestational age at delivery, birth weight, oligohydramnios, and maternal hypertensive disorders in multivariable logistic regression analysis, emergency cesarean delivery remained independently associated with increased odds of adverse neonatal outcome (adjusted OR 3.45, 95% CI 1.42-8.38, p=0.006).

Other independent predictors included oligohydramnios (adjusted OR 2.67, 95% CI 1.15-6.19, p=0.02) and gestational age <37 weeks (adjusted OR 2.34, 95% CI 1.08-5.07, p=0.03).

Table 3: Composite Adverse Neonatal Outcome by Delivery Mode

Delivery Mode	Composite Adverse Outcome n (%)	Unadjusted OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Elective Cesarean (n=30)	13 (43.3)	Reference	-	Reference	-
Vaginal Delivery (n=28)	11 (39.3)	0.85 (0.30-2.38)	0.68	0.92 (0.31-2.71)	0.88
Emergency Cesarean (n=32)	25 (78.1)	4.63 (1.72-12.45)	0.002	3.45 (1.42-8.38)	0.006

OR: Odds ratio; CI: Confidence interval Adjusted for gestational age, birth weight, oligohydramnios, and maternal hypertensive disorders

Emergency Cesarean Section Indications: Among the 32 patients who underwent emergency cesarean section, the most common indication was non-reassuring fetal heart rate pattern (56.3%), followed by failure to progress in labor (25.0%), and failed induction of labor (18.8%). When stratified by labor onset, 10 patients (31.3%) had spontaneous labor while 22 patients (68.8%) underwent labor induction.

Both groups demonstrated similarly elevated risks compared to elective cesarean delivery, with no significant difference in adverse neonatal outcomes between spontaneous labor and induced labor emergency cesarean groups (p=0.54).

Table 4: Indications for Emergency Cesarean Section

Indication	Spontaneous Labor (n=10) n (%)	Induced Labor (n=22) n (%)	Total (n=32) n (%)
Non-reassuring fetal heart rate	7 (70.0)	11 (50.0)	18 (56.3)
Failure to progress	2 (20.0)	6 (27.3)	8 (25.0)
Failed induction	0 (0.0)	6 (27.3)	6 (18.8)
Adverse Neonatal Outcome	8 (80.0)	17 (77.3)	25 (78.1)

Outcomes by Emergency Cesarean Indication: Analysis of neonatal outcomes stratified by emergency cesarean indication revealed that non-reassuring fetal heart rate pattern was associated with the highest rate of adverse outcomes (88.9%), followed by failure to progress (62.5%) and failed induction (66.7%).

Neonates delivered by emergency cesarean for non-reassuring fetal heart rate had significantly higher rates of birth asphyxia (38.9% versus 12.5% for failure to progress, p=0.04), respiratory distress syndrome (44.4% versus 25.0%, p=0.28), and need for mechanical ventilation (27.8% versus 0%, p=0.04).

Table 5: Neonatal Outcomes by Emergency Cesarean Indication

Outcome	Non-reassuring FHR (n=18)	Failure to Progress (n=8)	Failed Induction (n=6)	p-value
Composite adverse outcome, n (%)	16 (88.9)	5 (62.5)	4 (66.7)	0.15
Birth asphyxia, n (%)	7 (38.9)	1 (12.5)	1 (16.7)	0.04
NICU admission, n (%)	15 (83.3)	5 (62.5)	3 (50.0)	0.16
Respiratory distress syndrome, n (%)	8 (44.4)	2 (25.0)	2 (33.3)	0.28
Mechanical ventilation, n (%)	5 (27.8)	0 (0.0)	1 (16.7)	0.04
Neonatal hypoglycemia, n (%)	7 (38.9)	2 (25.0)	2 (33.3)	0.67
Mean 5-minute Apgar score ± SD	7.4 ± 1.2	8.1 ± 0.8	7.8 ± 0.9	0.19

FHR: Fetal heart rate; NICU: Neonatal intensive care unit; SD: Standard deviation

Discussion

This prospective cohort study provides important insights into the relationship between delivery mode and neonatal outcomes in pregnancies complicated by fetal growth restriction at or beyond 34 weeks of gestation. Our findings demonstrate that emergency cesarean delivery is associated with a 3.45-fold increased risk of adverse neonatal outcomes compared to elective cesarean section, while successful vaginal delivery yields outcomes comparable to elective cesarean delivery. These results have significant implications for clinical decision-making and patient counseling in the management of FGR pregnancies.

The association between emergency cesarean delivery and adverse neonatal outcomes in FGR pregnancies has been incompletely characterized in prior literature. Our finding of significantly increased neonatal morbidity aligns with previous studies examining emergency versus elective cesarean delivery in general obstetric populations. A large tertiary center study from Jordan reported that emergency cesarean sections were associated with 27.6% NICU admission rates compared to 11.2% for elective procedures, with respiratory distress occurring in 18.2% versus 7.6%

respectively.[25] Our study extends these observations specifically to the FGR population, demonstrating even higher rates of adverse outcomes in this inherently high-risk group, with 71.9% NICU admission in the emergency cesarean cohort compared to 40.0% in elective cesarean deliveries.

The pathophysiological mechanisms underlying increased neonatal morbidity following emergency cesarean delivery in FGR pregnancies are likely multifactorial. First, the underlying indication for emergency cesarean section, particularly non-reassuring fetal heart rate patterns, reflects acute fetal compromise superimposed on chronic placental insufficiency. Our data showed that 56.3% of emergency cesarean deliveries were performed for non-reassuring fetal heart rate, and this subgroup experienced the highest rates of birth asphyxia (38.9%) and need for mechanical ventilation (27.8%). This suggests that the acute hypoxemic stress of labor may overwhelm the already limited compensatory reserves of growth-restricted fetuses, leading to metabolic acidosis and end-organ injury.[26]

Second, the transition from intrauterine to extrauterine life may be particularly challenging for FGR neonates delivered by emergency cesarean section. These infants experience incomplete lung fluid clearance due to the absence of hormonal changes associated with spontaneous labor onset, combined with the metabolic consequences of acute intrapartum stress.[27] Our finding of 37.5% respiratory distress syndrome in the emergency cesarean group compared to 13.3% in elective cesarean and 10.7% in vaginal delivery groups supports this mechanism. The chronic hypoxemia characteristic of FGR may further impair pulmonary maturation and surfactant production, exacerbating respiratory morbidity.[28]

Third, FGR neonates delivered by emergency cesarean demonstrated significantly higher rates of hypoglycemia (34.4%) compared to those delivered by elective cesarean (10.0%) or vaginally (7.1%). This finding is consistent with the established pathophysiology of glucose homeostasis in growth-restricted neonates, who have reduced glycogen stores due to chronic undernutrition.[29] Perinatal stress, including birth asphyxia and acute hypoxemia, induces a state of hyperinsulinemic hypoglycemia that can persist for days to weeks.[30] The combination of limited glycogen reserves and acute stress-induced metabolic derangements places FGR infants delivered by emergency cesarean at particularly high risk for severe and prolonged hypoglycemia.

Our observation that both spontaneous labor and induced labor emergency cesarean groups showed similarly elevated risk is noteworthy and contrasts with some prior studies suggesting differential outcomes based on labor onset mechanism. This finding suggests that the FGR fetus may be inherently vulnerable to the stress of labor regardless of whether contractions begin spontaneously or are medically induced. However, we did note a trend toward higher emergency cesarean rates in the induced labor group (68.8%), which aligns with previous research showing that labor induction in FGR pregnancies, particularly in the presence of oligohydramnios, carries increased risk of cesarean delivery.[31]

A particularly encouraging finding from our study is that successful vaginal delivery in appropriately selected FGR pregnancies yielded outcomes comparable to elective cesarean delivery, with no significant difference in composite adverse neonatal outcomes (39.3% versus 43.3%, p=0.68). This observation is consistent with emerging evidence challenging traditional assumptions about the safety of trial of labor in FGR pregnancies. Baalbaki et al. reported that in preterm FGR pregnancies between 23 and 34 weeks, scheduled cesarean was not associated with reduced neonatal morbidity even when considering critical umbilical artery Dopplers.[16] Similarly, Walia and colleagues found that in pregnancies with severe preeclampsia and FGR requiring delivery at or before 34 weeks, the likelihood of successful vaginal delivery did not differ based on presence of FGR, with 67% achieving vaginal delivery.[32]

Ben-Haroush et al. demonstrated that in selected FGR cases with reassuring fetal heart rate patterns and normal antenatal testing, induction of labor with prostaglandin E2 yielded similar cesarean section rates and immediate fetal outcomes as uncomplicated pregnancies, with only 8.9% requiring cesarean delivery.[17] Our higher rate of attempted vaginal delivery in the present study (66.7% of the total cohort) likely reflects broader inclusion criteria and less stringent patient selection, yet still demonstrates that a substantial proportion of FGR pregnancies can successfully achieve vaginal delivery with acceptable neonatal outcomes when appropriately monitored. The critical question becomes how to identify FGR patients who can safely undergo trial of labor. Our data suggest that factors such as oligohydramnios and gestational age <37 weeks are independent predictors of adverse outcomes and may warrant lower thresholds for elective cesarean delivery. Conversely, FGR pregnancies at term with adequate amniotic fluid volume, reassuring fetal heart rate patterns, and normal umbilical artery Doppler velocimetry may be reasonable candidates for trial of labor with continuous intrapartum monitoring. The development and validation of prediction models incorporating these and other

clinical parameters could help guide individualized delivery planning.

Several important clinical implications emerge from our findings. First, when trial of labor is planned in FGR pregnancies, close continuous fetal heart rate monitoring is essential given the high rate of emergency cesarean delivery for non-reassuring fetal status (56.3% of emergency cesareans in our cohort). Second, multidisciplinary coordination between obstetric and neonatal teams should be ensured, particularly for cases undergoing trial of labor, given the substantial risk of adverse neonatal outcomes even after successful vaginal delivery (39.3%). Third, patient counseling should include realistic expectations about the possibility of emergency cesarean delivery and its associated neonatal risks, balanced against the maternal morbidity associated with planned cesarean delivery.

The study has several strengths including its prospective design, standardized outcome measures, inclusion of a clinically relevant gestational age range (≥34 weeks where delivery mode decisions are most pertinent), and detailed analysis of emergency cesarean indications and their associated outcomes. However, certain limitations warrant acknowledgment. The relatively modest sample size of 90 patients limits the power to detect smaller effect sizes and to perform extensive subgroup analyses.

The single-center design may limit generalizability to other practice settings with different patient populations or management approaches. We did not systematically collect detailed Doppler velocimetry data, which would have allowed more refined risk stratification. Additionally, the composite outcome measure, while clinically relevant, may not capture all nuances of neonatal morbidity.

Further research is needed to develop and validate prediction models for identifying FGR patients suitable for trial of labor, to determine optimal labor management protocols including thresholds for intervention, and to evaluate long-term neurodevelopmental outcomes associated with different delivery modes in FGR pregnancies. Multicenter prospective studies with larger sample sizes would strengthen the evidence base and allow for more definitive conclusions.

Conclusion

This prospective cohort study demonstrates that emergency cesarean delivery in pregnancies complicated by fetal growth restriction at or beyond 34 weeks of gestation is associated with significantly increased neonatal morbidity compared to elective cesarean delivery, with a 3.45-fold increased odds of adverse neonatal outcomes. The elevated risk persists regardless of whether labor onset is spontaneous or induced, with non-reassuring fetal heart rate patterns as the primary indication for emergency intervention and the greatest predictor of adverse outcomes.

Importantly, our findings indicate that successful vaginal delivery in appropriately selected FGR pregnancies yields neonatal outcomes comparable to elective cesarean delivery. This suggests that trial of labor may be a reasonable option for carefully selected FGR patients when managed with close continuous fetal monitoring and appropriate institutional resources for prompt intervention when indicated. These findings have important implications for clinical practice. They support individualized decision-making regarding delivery mode in FGR pregnancies, balancing maternal and neonatal risks and benefits. While elective cesarean delivery may be warranted in high-risk FGR cases with additional risk factors such as oligohydramnios, abnormal Doppler findings, or extreme prematurity, our data suggest that blanket policies mandating cesarean delivery for all FGR pregnancies may not be justified.

Further research is needed to develop validated prediction models and decision-support tools to identify which FGR patients can safely undergo trial of labor and which should proceed to elective cesarean delivery. Such tools would facilitate evidence-based, individualized counseling and management decisions that optimize both maternal and neonatal outcomes in this high-risk obstetric population.

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