MAK HILL Publications Research Journal of Medical Sciences

Research Article
doi: 10.36478/makrjms.2024.10.97.101

OPEN ACCESS

Key Words
Prospective, malformations, subsequently , ultrasonography

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Received: 18 July 2024
Accepted: 04 September 2024
Published: 06 September 2024

Citation: S. Ramesh Babu, Lakshmisree Umeshan and P. Sri vidya 2024. Doppler Based Management Decisions of FGR Fetuses-An Analytical Study. Res. J. Med. Sci., 18: 97-101, doi: 10.36478/makrjms.2024.10.97.101

Doppler Based Management Decisions of FGR Fetuses-An Analytical Study

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ABSTRACT
This was a prospective cohort study of all singleton, non-anomalous pregnancies undergoing ultrasound doppler to assess fetal growth restriction at a single centre from 2023-2024. After excluding patients with fetal structural malformations, chromosomal abnormalities, or identified infection etiologies. After clinical suspicion of growth lag , routine growth scan was done at 30-32 weeks gestation. Whichever cases having growth >10th percentile or abnormal doppler velocimetry indices were followed subsequently by structural ultrasonography. Subsequent scan were structured after following the stage based management protocols as recommended by Figueras and Gratacos group from Barcelona study. 46 cases thus analysed showed favourable perinatal outcomes by doppler indices driven time line.

INTRODUCTION

Fetal growth restriction (FGR) is a complex and multifactorial disorder affecting fetal development, which represents currently one of the leading causes of perinatal mortality and morbidity, including iatrogenic preterm delivery. It is also known to be associated with an increased risk of suboptimal neurodevelopmental outcome and long-term morbidity, including cardiovascular disease. According to the Delphi consensus criteria, FGR is differentiated into early and late-onset phenotypes, depending on whether it is identified before or after 32 weeks gestation. Uteroplacental insufficiency is acknowledged to represent the major determinant of impaired fetal growth across gestation[1-3]. However, available evidence has shown that early and late-onset FGR types are characterized by different clinical presentation. The former is a rare condition, associated commonly with hypertensive disorders of pregnancy (HDP) and a high risk of preterm delivery[4-6]. Early-onset FGR represents 20-30% of all FGR and is associated with gestational hypertension and/or pre-eclampsia in up to 70%. On the other hand, late-onset FGR, which represents approximately 70-80% of cases of FGR, shows a weaker association with hypertensive disorders of the pregnancy, roughly 10%. Except for delivery, there is no effective treatment to reverse the course of FGR. The Trial of Randomized Umbilical and Fetal Flow in Europe (TRUFFLE) of management of preterm FGR between 26-32 weeks has been published since these SGA guidelines were submitted or published. TRUFFLE was a study of early FGR where mothers were allocated to 1 of 3 monitoring strategies to indicate timing of delivery: reduced fetal heart rate short-term variability on CTG., early changes in fetal ductus venosus (DV) waveform., or late changes in fetal DV waveform. Many infants were delivered because of safety-net criteria for maternal or other fetal indications, or >32 weeks of gestation when the protocol was no longer applied[7]. Early screening to predict the likelihood of a FGR fetus include medical and obstetric history, uterine artery Doppler and maternal serum parameters. Uteroplacental Doppler is the most powerful predictor of the clinical deterioration and the circumstances surrounding delivery. The systematic review and meta-analysis conducted by Cnossen *et al.* in 2008 established uterine artery Doppler ultrasonography as a predictor of FGR, providing a more accurate prediction when performed in the second trimester than in the first trimester[8].

Umbilical artery flow identifies different degrees of impaired placental function. Absent or reversed end diastolic flow (AEDF or REDF) indicates an important reduction of blood flow and severe fetal deterioration. Nevertheless, in early-onset FGR, up to 30-32 weeks' gestation, umbilical artery Doppler is usually not part of management protocols and the clinician relies on other parameters of fetal condition, such as Doppler velocimetry of the ductus venosus (DV), fetal heart rate (FHR) tracing or biophysical profile[8].

The fetal vessels that are more commonly examined include umbilical artery, middle cerebral artery and ductus venosus. Early-and late-onset FGR epitomize two distinct clinical phenotypes of placental dysfunction and differ significantly in clinical progression. Early-onset FGR is associated with high impedance utero placental perfusion which in turn leads to elevated umbilical artery blood flow resistance once villous damage exceeds 30%[8]. The relationship between fetal size and growth and fetal Doppler indices in FGR is complex but in general Doppler deterioration is associated with absolute fetal size rather than growth velocity. Late-onset FGR is more common but less severe with absent or mild placental abnormalities; umbilical artery Doppler may be normal, but fetuses may react with decreased middle cerebral artery (MCA) impedance in response to hypoxemia[8]. At present there is no effective intervention for FGR except delivery and especially for early-onset FGR the timing is crucial and requires a balance between the risks of prematurity and the possibility of stillbirth and organ damage due to inadequate tissue perfusion[9], unless severe maternal complications supervene. The aim of this study was to evaluate the role of Doppler ultrasound in determining the timing of delivery for pregnancies complicated by early onset fetal growth restriction (FGR) and to assess the correlation between Doppler changes and perinatal outcomes. By examining the effectiveness of Doppler indices in guiding clinical decisions, the study sought to identify optimal management strategies that could improve the health and survival rates of both mothers and infants affected by this condition.

MATERIALS AND METHODS

Study Design: This was a prospective cohort study aimed at evaluating the role of Doppler changes in determining the timing of delivery in cases of fetal growth restriction (FGR) and its correlation with perinatal outcomes. The study was conducted from 2023-2024, encompassing a comprehensive assessment of pregnancies at a single medical institute.

Study Setting: The study was conducted at the Adichunchanagiri Medical Institute in Mandya, India. This institution served as the single centre for all the participants undergoing ultrasound Doppler assessments.

Study Participants: The participants included women with singleton non-anomalous pregnancies who underwent routine ultrasound Doppler assessments to evaluate FGR after 28 weeks of gestation.

Study Sample Size: The study included a total of 46 cases diagnosed with fetal growth restriction. These cases were meticulously followed up and monitored throughout the study period.

Study Sampling Size: Sampling was conducted using non-probability convenience sampling. Only those women who met the inclusion criteria and consented to participate in the study were included.

Study Parameters: Key parameters measured included estimated fetal weight (EFW) <10th percentile for gestational age, Doppler indices such as the systolic/diastolic ratio, resistance index, pulsatility index (PI) and peak systolic velocity for the umbilical artery and middle cerebral artery (MCA). The cerebroplacental pulsatility ratio (CPR) was also calculated.

Study Procedure: Participants underwent routine ultrasound assessments to measure fetal anatomy and growth. Serial growth ultrasounds were performed every two weeks and Doppler assessments were used to monitor fetal well-being. The timing of delivery was guided by Doppler changes, cardiotocography (CTG) findings and other fetal indicators. Management followed standard protocols, including NICHD/SMFM recommendations for antenatal surveillance and delivery timing and Figueras and Gratacos group from Barcelona study.

Stage Based Management Protocol[10]:

Stage	Pathophysiological correlate	Criteria (any of)	Monitoring*	GA/mode of delivery
I	Severe smallness or mild placental insufficiency	EFW <3rd centile CPR <p5 UA PI >p95 MCA PI <p5 UtA PI >p95	Weekly	37 weeks LI
II	Severe placental insufficiency	UA AEDV Reverse AoI	Biweekly	34 weeks CS
III	Low-suspicion fetal acidosis	UA REDV DV-PI >p95	1–2 days	30 weeks CS
IV	High-suspicion fetal acidosis	DV reverse a flow cCTG <3 ms FHR decelerations	12 h	26 weeks** CS

All Doppler signs described above should be confirmed at least twice, ideally at least 12 h apart. GA = Gestational age; LI = labor induction; CS = cesarean section. * Recommended intervals in the absence of severe preeclampsia. If FGR is accompanied by this complication, strict fetal monitoring is warranted regardless of the stage. ** Lower GA threshold recommended according to current literature figures reporting at least 50% intact survival. Threshold could be tailored according to parents' wishes or adjusted according to local statistics of intact survival.

Fig. 1: Stage based management protocol by Figueras and Gratacos group from Barcelona study[10]

Study Data Collection: Maternal and obstetric histories, antepartum complications and obstetric and neonatal outcomes were documented. Data were collected using standardized forms and entered into a database. Detailed information on each ultrasound and Doppler assessment was recorded, along with perinatal outcomes.

Data Analysis: Data were analyzed using SPSS-25 software. Categorical data were presented as percentages, while continuous data were presented as means and standard deviations.

Ethical Considerations: Ethical approval for the study was obtained from the College authorities prior to its commencement. Informed consent was obtained from all participants. Confidentiality and anonymity of the participants were maintained throughout the study. There were no conflicts of interest declared and the study did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

RESULTS AND DISCUSSIONS

Table 1: Demographic Characters

Parameter	Number (%)
Age	
<20 years	2(4.3%)
20-35 years	44(95.6%)
Gravidity	
Primigravida	28(60.8%)
Multigravida	18(39.13%)
Socioeconomic status	
LSES	44(95.6%)
HSES	2(4.3%)

Table 2 : Obstetric and Perinatal Outcomes for Patients with Fetal Growth Restriction with Abnormal Doppler Changes

Characteristic	Values
Pre eclampsia	9(19.5%)
Gestational hypertension	3(6.5%)
Hypothyroidism	10(21.7%)
Oligohydrsamnios	3(6.5%)
Abruption	1(2.1%)
IUFD	1(2.1%)
Gestational diabetes mellitus	2(4.3%)
NICU admission	13(28.2%)
Need for respiratory support	13(28.2%)

Table 3: Doppler Changes

Doppler Indices	Value
Raised umbilical artery PI	**4(8.6%)**
Absent end diastolic flow	**1(2.1%)**
Reduced middle cerebral artery PI	**6(13.0%)**
Aortic isthmus reversal	**3(6.5%)**
Aortic isthmus reduced	**1(2.1%)**
CP ratio reversal	**2(4.3%)**
MUA diastolic notch	**1(2.1%)**

Table 4: Mode of Delivery

LSCS	31(67.3%)
FTVD	12(26.0%)
VAVD	2(4.3%)
PTVD	1(2.1%)

Table 5: Estimated Fetal Weight

<10th percentile	41(89.13%)
<3rd percentile	5(10.87%)

Table 6: Fetal Growth Restriction

Early onset FGR	2(4.3%)
Late onset FGR	44(95.6%)

Table 7: Birth Weight

1 1.5 kg	3(6.5%)
1.5 2 kg	14(30.4%)
2 2.5 kg	19(41.3%)

The findings of this prospective cohort study highlight the critical role of Doppler changes in determining the timing of delivery and improving perinatal outcomes in cases of fetal growth restriction (FGR). Early onset FGR, late onset FGR identified before 32 weeks of gestation, is a significant concern due to its association with increased perinatal morbidity and mortality. This study demonstrated that regular monitoring with Doppler ultrasound and timely intervention could significantly improve outcomes for affected pregnancies.

The study showed that abnormal Doppler findings were significantly associated with adverse perinatal outcomes, including low birth weight, the need for neonatal intensive care unit (NICU) admission and need for respiratory support. Specifically, cases with abnormal Doppler changes, such as increased systolic/diastolic ratio, resistance index and pulsatility index, were more likely to experience complications. These Doppler indices are crucial in assessing placental function and fetal well-being, as they provide insight into the blood flow resistance in the umbilical artery and the cerebral circulation of the fetus.

Among the participants in the current study several doppler abnormalities were observed .Raised umbilical artery pulsatility index PI was found in 4 cases (8.6%), and absent end diastolic flow was noted in 1 case (2.1%) . Reduced middle cerebral artery PI was observed in 6 cases (13.0%), Aortic isthmus reversal occurred in 3 cases (6.5%), while reduced aortic isthmus PI was noted in 1 case (2.1%), cerebroplacental CP ratio reversal was found in 2 cases (4.3%), maternal uterine artery (MUA) diastolic notch was present in 1 case (2.1%) .

One of the key findings was the correlation between Doppler changes and the timing of delivery. The study found that early delivery based on abnormal Doppler results could prevent severe complications associated with prolonged intrauterine exposure to a compromised placental environment. For instance, cases showing absent or reversed end-diastolic flow (AEDF or REDF) in the umbilical artery, or abnormal ductus venosus (DV) waveform, were delivered earlier to mitigate the risks of stillbirth and organ damage due to inadequate tissue perfusion. This finding aligns with previous research, such as the Truffle study, which emphasized the importance of monitoring fetal heart rate variability and DV Doppler changes in managing preterm FGR.

Moreover, the study underscored the importance of a multidisciplinary approach in managing early onset FGR. Regular follow-up with serial growth ultrasounds and Doppler assessments allowed for timely identification of fetal compromise and guided clinical decision-making. The collaboration between obstetricians, maternal-fetal medicine specialists and neonatologists was crucial in optimizing the timing of delivery and ensuring the best possible outcomes for both the mother and the fetus.

In this study , the mode of delivery was predominantly lower segment caesarean section (LSCS) , accounting for 31 cases (67.3%). This was followed by full -term vaginal delivery (FTND) in 12 cases (26%), vacuum -assisted vaginal delivery (VAVD) in 2 cases (4.3%) and preterm vaginal dlivery (PTVD) in 1 case (2.1%).

The data also indicated that the majority of cases with early onset FGR were associated with hypertensive disorders of pregnancy, such as gestational hypertension and pre-eclampsia. This finding is consistent with existing literature, which highlights the strong link between placental insufficiency and hypertensive disorders. Effective management of these maternal conditions is essential in mitigating the risk of FGR and improving perinatal outcomes.

The birth weight distribution of fetuses shows that 3 fetuses (3.6%) fall within 1-1.5kg range. A larger proportion , 14 fetuses (30.4%), have weights between 1.5-2 kg. The majority 19 fetuses (41.3%) weigh between 2-2.5kgs.

In terms of neonatal outcomes, the study found that early intervention and delivery based on Doppler findings resulted in a high rate of NICU admissions, yet overall good perinatal outcomes. While preterm delivery and low birth weight were common, the majority of neonates required only short-term respiratory support and had favorable long-term prospects. This highlights the balance that clinicians must achieve between the risks of prematurity and the potential for adverse outcomes due to continued intrauterine growth restriction.

In conclusion, this study provides valuable insights into the management of early onset FGR. It reinforces the importance of Doppler ultrasound as a tool for monitoring fetal well-being and guiding the timing of delivery. By identifying pregnancies at risk for adverse outcomes and intervening appropriately, healthcare providers can significantly improve perinatal outcomes. Future research should focus on refining these monitoring techniques and exploring additional interventions that could further enhance the care of pregnancies complicated by early onset FGR.

This study included cases of fetal growth restriction with early onset FGR occurring in 2 cases (4.3%) and Late onset FGR with 44 cases (95.6%) additionally fetal weight was below the 10th percentile with 41 cases (89.1%) and 3rd percentile 5 cases (10.8%). Furthermore, our findings demonstrate an independent association between an abnormal doppler changes and obstetric intervention in fetal

growth restriction by Gratacos stage wise management and early delivery in these cases had better perinatal outcome.

CONCLUSION

To pick up few cases of FGR fetuses from larger pool of normally growing fetus. Clinical methods should be used robustly. Once subnormally grown fetus is tracked the frequent structuring of the ultrasound doppler and growth evaluation should be delicately balanced. In that view analysis of fetal size, fetal activity in general and doppler indices of umbilical artery, middle cerebral artery and their CP ratio in particular give valuable objective directions to time line the delivery decisions. The utilization of diastolic reversal data in aortic isthmus appeared as a valuable tool to push the intrauterine life to avoid prematurity when it is not expected to be robust before 32-34 weeks of gestation. In few fetuses when subnormal growth and CP ratio reversal with umbilical artery PI >95th centile (absent end diastolic flow reversal persist) still not appeared diastolic flow reversal in aortic isthmus , doppler was viewed as benign situation as hypoxia but not acidosis. Delivery decision was delayed till diastolic reversal flow was seen in aortic isthmus on weekly doppler analysis for such fetuses without absent end diastolic flow but with reversal of CP ratio. On an average up to 1 weeks time could be bought as a valuable intrauterine safe shelter amidst urgency of delivery in such fetuses. In segregated small fetuses by SFH guided clinical methods, ultrasound estimation of fetal size, blood flow pattern doppler studies and NST gives objective clear ideas for delivery time line. But over dependence and over utilization of ultrasound and less use of cute clinical observations needs to be balanced for the overall benefit of the society.

Declarations:

Funding: This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Conflict of Interest: None to declare

Ethical Approval: Permission for the study was obtained from the College authorities prior to commencement.

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