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Original Research Article

Differential Association of Fetal Surveillance Parameters with Mode of Delivery and NICU Admission in Pregnancies with Oligohydramnios: A Prospective Cohort Analysis

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Abstract

Background: Umbilical artery Doppler, cerebroplacental ratio (CPR), and biophysical profile (BPP) are commonly used to assess fetal condition in pregnancies at risk of placental insufficiency, but their relationship with clinical decisions and short-term neonatal outcomes may not be identical.

Aim: To compare the associations of umbilical artery Doppler pattern, CPR, and BPP with mode of delivery and neonatal intensive care unit (NICU) admission in pregnancies with low amniotic fluid volume.

Methods: This prospective cohort included 80 women beyond 28 weeks of gestation with low amniotic fluid volume (AFI <8 cm as defined in the present study) at Sri Chamarajendra Maternity Hospital, Hassan. Umbilical, uterine and middle cerebral artery Doppler examinations were performed; CPR was calculated as MCA-PI/UA-PI, with <1.08 considered abnormal. BPP and delivery outcomes were recorded. NICU analysis used the 72 live births. Categorical associations were assessed with the chi-square test.

Results: Umbilical artery Doppler was normal in 60/80 (75.0%); reduced diastolic flow, absent end-diastolic flow (AEDF), and reversed end-diastolic flow (REDF) occurred in 8 (10.0%), 8 (10.0%), and 4 (5.0%), respectively. CPR was <1.08 in 39/80 (48.8%). BPP was <4 in 4 (5.0%), 4-6 in 15 (18.8%), and 6-8 in 61 (76.3%). Umbilical artery Doppler pattern and BPP were associated with the four-category mode of delivery (p=0.004 for each), whereas CPR was not (p=0.805). Among 72 live births, NICU admission was required in 49 (68.1%). Umbilical artery Doppler (p=0.597), CPR (p=0.564), and BPP (p=0.775) were not significantly associated with NICU admission.

Conclusion: In this cohort, Doppler pattern and BPP were more closely related to the distribution of delivery modes than to NICU admission. CPR did not show a significant association with either endpoint. These findings support interpreting fetal surveillance results within the complete clinical context rather than as isolated predictors.

Keywords: Umbilical artery Doppler; cerebroplacental ratio; biophysical profile; oligohydramnios; mode of delivery; NICU admission; fetal surveillance.

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Introduction

Doppler ultrasonography provides a non-invasive assessment of blood-flow resistance in the maternal-fetal circulation and is an established component of fetal surveillance when placental insufficiency or fetal growth restriction is suspected.[1-5] Umbilical artery Doppler reflects downstream placental vascular resistance, while middle cerebral artery Doppler captures fetal cerebral vasodilatation that may occur during redistribution of cardiac output. The cerebroplacental ratio (CPR), calculated from middle cerebral artery and umbilical artery pulsatility indices, integrates placental resistance and fetal cerebral adaptation. Although CPR is biologically attractive, large pooled analyses have shown that its incremental prognostic value over umbilical artery Doppler alone may be limited in heterogeneous pregnancy populations.[2,6,9] This is particularly relevant when a single fixed CPR threshold is used rather than gestational-age-specific centiles. Biophysical profile (BPP) combines acute and chronic markers of fetal condition. It remains widely used in high-risk obstetric practice, although randomized evidence has not demonstrated uniform improvement in perinatal outcomes and its results often influence the timing and route of delivery.7 Contemporary ultrasound guidance therefore emphasizes integration of amniotic fluid assessment, fetal growth, Doppler findings, and the broader clinical picture rather than reliance on a single surveillance result.[1-4] The present study enrolled women with low amniotic fluid volume and collected Doppler, CPR, BPP, delivery, and neonatal data prospectively. The present analysis was designed to compare how three commonly used fetal surveillance markers - umbilical artery Doppler pattern, CPR, and BPP - related to mode of delivery and NICU admission. The objective was not to label any single marker as a causal predictor, because the same surveillance findings were available to clinicians and could influence management decisions.

Materials and Methods

Ethical approval: The present study was initiated after approval from the Institutional Ethics Committee/Review Board of Hassan Institute of Medical Sciences, Hassan. Written informed consent was obtained before enrolment.

Study design and setting: This was a prospective cohort study conducted over 18 months in the Department of Obstetrics and Gynaecology, Sri Chamarajendra Maternity Hospital, Hassan Institute of Medical Sciences, Hassan, Karnataka. Eighty newly diagnosed pregnant women with low amniotic fluid volume were included.

Eligibility Criteria: Women were eligible when gestational age was more than 28 weeks, low amniotic fluid volume/oligoamnios was diagnosed, and written informed consent was provided. Exclusion criteria were multiple gestation, intrauterine death at hospital admission, hemodynamic instability, known fetal anomaly, chorioamnionitis, antepartum haemorrhage, or a need for immediate emergency intervention at presentation.

Clinical and ultrasound assessment: After enrolment, demographic details, obstetric history, general examination, symphysis-fundal height, abdominal circumference, routine hematological investigations, admission testing, coagulation profile, and relevant evaluation of maternal comorbidities were recorded. Ultrasound assessment included amniotic fluid index (AFI), BPP, and obstetric Doppler examination. In the present study, AFI <8 cm was used to define the low-fluid cohort.

Doppler examinations were performed using a Mindray 35C50EA duplex Doppler scanner with a 2.5-MHz convex transducer. Umbilical artery indices were obtained from a free-floating loop of the cord during fetal apnoea, and approximately three technically satisfactory readings were averaged. Middle cerebral artery Doppler was obtained in an axial view of the fetal head at the level of the cerebral peduncles after visualization of the circle of Willis; the sample volume was placed within 1 cm of the vessel origin.

Uterine artery Doppler was assessed near the internal cervical os using colour flow mapping. Pulsatility index (PI) and resistance index (RI) were recorded. These acquisition principles are consistent with contemporary Doppler technique recommendations.[1]

CPR was calculated as MCA-PI divided by UA-PI. A CPR <1.08 was classified as abnormal in the present study. BPP was grouped as <4, 4-6, and 6-8. Umbilical artery Doppler waveform categories were normal flow, reduced diastolic flow, AEDF, and REDF.

Clinical management and outcomes: Timing and mode of delivery were decided according to AFI, BPP, gestational age, Doppler findings, non-stress testing, and obstetric indications. Therefore, delivery mode was treated as a management-associated outcome rather than as an outcome independent of the surveillance tests.

Mode of delivery was categorized as full-term vaginal delivery (FTVD), instrumental delivery, lower-segment caesarean section (LSCS), or preterm vaginal delivery (PTVD). Neonatal outcomes included live birth status, Apgar scores, NICU admission, and recorded reasons for NICU transfer.

Statistical Analysis: Data were entered in Microsoft Excel and analyzed using IBM SPSS version 20. Categorical variables were summarized as frequencies and percentages. Associations between categorical surveillance variables and outcomes were assessed using the chi-square test as reported in the present study; $p \leq 0.05$ was considered statistically significant.

For clinical interpretation of NICU admission, crude risk ratios with 95% confidence intervals were additionally calculated from the reported contingency counts after dichotomizing selected surveillance variables. No multivariable adjustment was performed because individual-level analytic data were not available for the present secondary analysis.

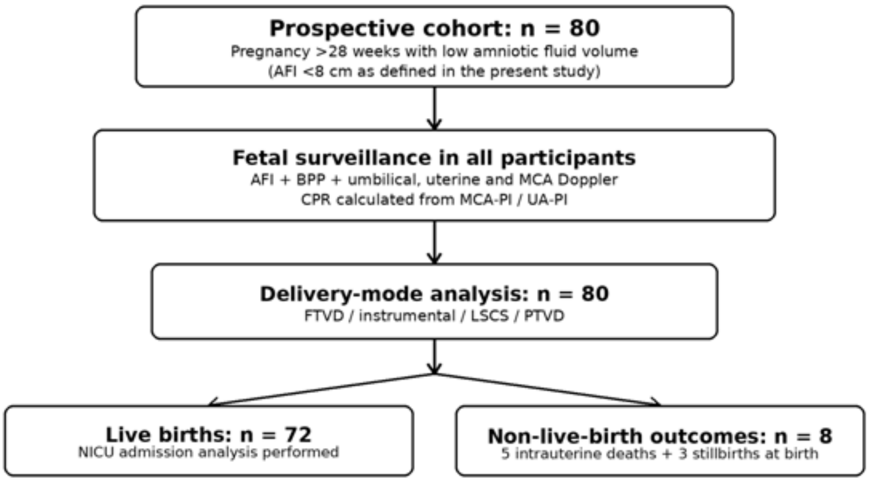

Figure 1: Study flow and denominators used for delivery-mode and NICU analyses

Results

Eighty women were included. Thirty-nine (48.8%) were aged ≤25 years, 25 (31.3%) were 26-30 years, and 16 (20.0%) were older than 30 years. Forty-eight (60.0%) were primigravidae. Fifty-seven pregnancies (71.3%) were beyond 37 weeks, 13 (16.3%) were between 34 and 37 weeks, and 10 (12.5%) were below 34 weeks. Preeclampsia and anaemia were the most common recorded comorbidities.

Table 1: Selected demographic and obstetric characteristics of the cohort (n=80)

Characteristic	Category	n (%)
Age (years)	≤25	39 (48.8)
	26-30	25 (31.3)
	>30	16 (20.0)
Parity	Primigravida	48 (60.0)
	Multigravida	32 (40.0)
Gestational age	>37 weeks	57 (71.3)
	34-37 weeks	13 (16.3)
	<34 weeks	10 (12.5)
Comorbidity	Preeclampsia	19 (23.8)
	Anaemia	12 (15.0)
	Antepartum eclampsia	4 (5.0)
	Hypothyroidism	4 (5.0)
	Hyperthyroidism	2 (2.5)
	Gestational diabetes	1 (1.3)
	No recorded comorbidity	38 (47.5)

The distribution of fetal surveillance findings is shown in Table 2 and Figure 2. Umbilical artery Doppler was normal in 60 women (75.0%). Reduced diastolic flow and AEDF were each present in 8 (10.0%), while REDF was present in 4 (5.0%). CPR was <1.08 in 39 (48.8%) and >1.08 in 41 (51.3%). Most participants had a BPP of 6-8 (61/80, 76.3%).

Table 2: Distribution of fetal surveillance parameters (n=80)

Parameter	Category	n (%)
Umbilical artery Doppler	Normal	60 (75.0)
	Reduced diastolic flow	8 (10.0)
	AEDF	8 (10.0)
	REDF	4 (5.0)
CPR	<1.08	39 (48.8)
	>1.08	41 (51.3)
BPP	<4	4 (5.0)
	4-6	15 (18.8)
	6-8	61 (76.3)

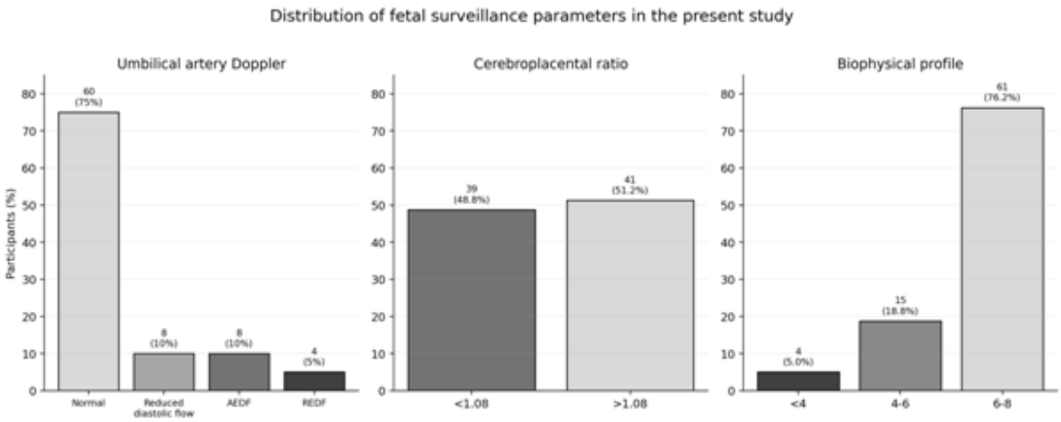

Figure 2: Distribution of umbilical artery Doppler pattern, CPR, and BPP in the present study

Mode of delivery was LSCS in 59/80 (73.8%), FTVD in 12 (15.0%), PTVD in 6 (7.5%), and instrumental delivery in 3 (3.8%). The overall distribution of delivery modes differed significantly across umbilical artery Doppler categories (p=0.004). Importantly, this association was not a simple monotonic increase in caesarean delivery with worsening Doppler. LSCS occurred in 48/60 (80.0%) women with normal umbilical artery Doppler, 6/8 (75.0%) with reduced diastolic flow, 4/8 (50.0%) with AEDF, and 1/4 (25.0%) with REDF; three of four REDF pregnancies resulted in PTVD. The p-value therefore reflects a difference in the overall pattern of delivery, including preterm delivery, rather than proof that abnormal Doppler independently increased the probability of LSCS.

Table 3: Umbilical artery Doppler pattern and mode of delivery (n=80)

Mode of delivery	AEDF n=8	Normal n=60	REDF n=4	Reduced flow n=8	p value
FTVD	4 (50.0)	8 (13.3)	0	0	0.004
Instrumental	0	2 (3.3)	0	1 (12.5)	
LSCS	4 (50.0)	48 (80.0)	1 (25.0)	6 (75.0)	
PTVD	0	2 (3.3)	3 (75.0)	1 (12.5)	

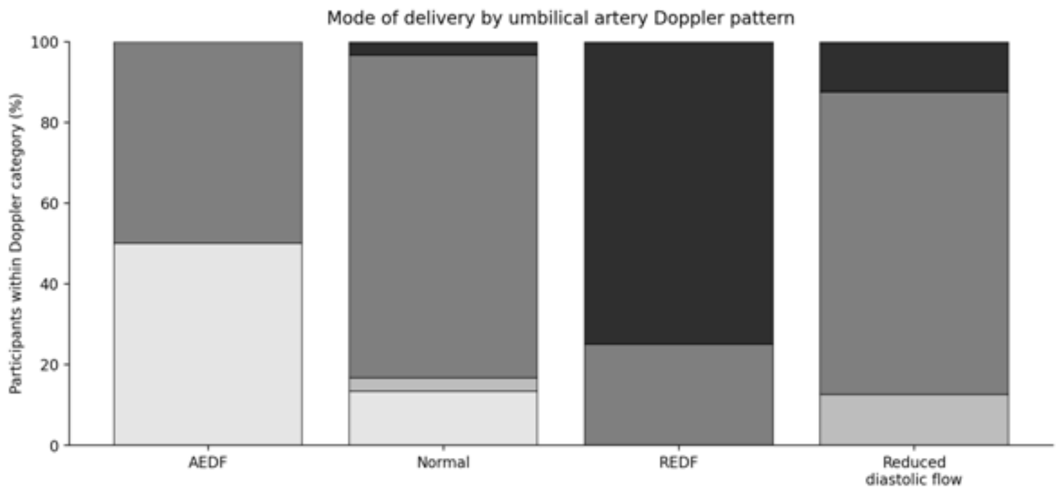

Figure 3: Mode of delivery according to umbilical artery Doppler pattern. Percentages are calculated within each Doppler category

BPP was also associated with the four-category mode of delivery (p=0.004). Among women with BPP <4, three of four (75.0%) had PTVD and one had FTVD. In the BPP 4-6 group, 13/15 (86.7%) underwent LSCS. In the BPP 6-8 group, 46/61 (75.4%) underwent LSCS. As with Doppler, the association should be interpreted in the context of gestational age and management decisions rather than as an isolated causal effect of BPP.

Table 4: Biophysical profile and mode of delivery (n=80)

Mode of delivery	BPP <4 n=4	BPP 4-6 n=15	BPP 6-8 n=61	p value
FTVD	1 (25.0)	2 (13.3)	9 (14.8)	0.004
Instrumental	0	0	3 (4.9)	
LSCS	0	13 (86.7)	46 (75.4)	
PTVD	3 (75.0)	0	3 (4.9)	

CPR did not show a significant association with mode of delivery (p=0.805). LSCS occurred in 30/39 (76.9%) women with CPR <1.08 and 29/41 (70.7%) with CPR >1.08. The distributions of FTVD, instrumental delivery, and PTVD were also similar between CPR groups.

Table 5: Cerebroplacental ratio and mode of delivery (n=80)

Mode of delivery	CPR <1.08 n=39	CPR >1.08 n=41	p value
FTVD	6 (15.4)	6 (14.6)	0.805
Instrumental	1 (2.6)	2 (4.9)	
LSCS	30 (76.9)	29 (70.7)	
PTVD	2 (5.1)	4 (9.8)	

There were 72 live births and 49 neonates (68.1%) required NICU admission. NICU admission was not significantly associated with the four-category umbilical artery Doppler pattern (p=0.597), CPR category (p=0.564), or BPP category (p=0.775). When umbilical artery Doppler was dichotomized for descriptive effect-size estimation, NICU admission occurred in 12/15 (80.0%) live-born neonates with an abnormal waveform category and 37/57 (64.9%) with normal flow (crude RR 1.23, 95% CI 0.90-1.69). For CPR <1.08 versus >1.08, the crude RR was 0.91 (95% CI 0.66-1.25). For BPP ≤6 versus BPP 6-8, the crude RR was 1.05 (95% CI 0.73-1.50). None of these crude estimates demonstrated a precise clinically independent association.

Table 6: Fetal surveillance parameters and NICU admission among live births (n=72)

Marker	Category	NICU not required	NICU required	Reported p value
Umbilical artery Doppler	AEDF	2 (8.7)	5 (10.2)	0.597
	Normal	20 (87.0)	37 (75.5)	
	REDF	0	2 (4.1)	
	Reduced diastolic flow	1 (4.3)	5 (10.2)	
CPR	<1.08	12 (52.2)	22 (44.9)	0.564
	>1.08	11 (47.8)	27 (55.1)	
BPP	<4	1 (4.3)	1 (2.0)	0.775
	4-6	4 (17.4)	11 (22.4)	
	6-8	18 (78.3)	37 (75.5)	

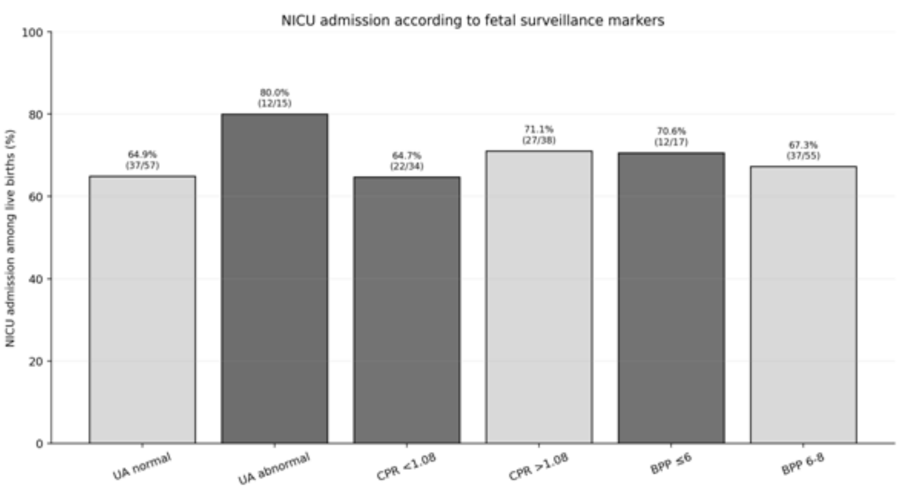

Figure 4: NICU admission proportions after clinically useful dichotomization of selected surveillance markers. These bars are descriptive; reported study p values used the original categorical groupings

Among the 49 NICU admissions, the recorded reasons were low birth weight in 18 (36.7%), preterm birth in 10 (20.4%), acute respiratory distress syndrome in 9 (18.4%), meconium aspiration syndrome in 7 (14.3%), the category recorded as “TTP” in 3 (6.1%), and fetal anomaly in 2 (4.1%). The abbreviation “TTP” should be expanded from the original case records before final submission. These data suggest that prematurity and low birth weight were major contributors to NICU use and could dilute the apparent association of any single surveillance marker with NICU admission.

Discussion

The present study provides a clinically important contrast between fetal surveillance markers and two different types of outcomes. Umbilical artery Doppler pattern and BPP were associated with the distribution of delivery modes, whereas neither marker showed a statistically significant association with NICU admission. CPR was not significantly associated with either endpoint. This separation is important because a surveillance test may influence the decision to deliver without necessarily functioning as an independent predictor of neonatal morbidity. Umbilical artery Doppler is one of the best-established tools for surveillance of placental insufficiency and fetal growth restriction. Guidelines recommend closer surveillance as end-diastolic flow decreases, with AEDF and REDF representing progressively concerning placental vascular abnormalities.[1,2,4,5] In the present study, 25% of women had a non-normal umbilical artery waveform category. The statistically significant association with mode of delivery (p=0.004) was driven by differences across the full delivery distribution. REDF, for example, was accompanied by PTVD in three of four cases. It would therefore be inaccurate to summarize the present data simply as “abnormal Doppler caused more caesarean deliveries.” The more defensible interpretation is that Doppler severity was associated with a different pattern and timing of delivery. This distinction is biologically and clinically plausible. Doppler abnormalities are not passive observations in high-risk pregnancy; they are actionable information. Contemporary FGR guidance links deteriorating umbilical artery flow to intensified monitoring and, depending on gestational age and the overall clinical picture, earlier delivery.[2,4] Consequently, management is an intermediate pathway between the test result and mode of delivery. The present study was not designed to separate the intrinsic prognostic value of Doppler from the effect of management decisions triggered by Doppler.

CPR <1.08 was present in almost half of the cohort, yet CPR was not associated with mode of delivery (p=0.805) or NICU admission (p=0.564). This finding is compatible with the individual-participant-data meta-analysis by Vollgraff Heidweiller-Schreurs and colleagues, in which CPR added very little discrimination beyond umbilical artery PI for a composite adverse perinatal outcome.6 It is also relevant that the present study used a fixed threshold of 1.08. Modern guidance and much of the contemporary literature favour gestational-age-adjusted centiles or standardized thresholds when CPR is used for risk stratification.[2,3,9]

BPP showed a significant association with mode of delivery but not NICU admission. The pattern was again non-linear: the very small group with BPP <4 was dominated by PTVD, whereas the 4-6 and 6-8 groups were dominated by LSCS. BPP is intended to reflect fetal well-being, but it also directly informs obstetric management. The Cochrane evidence base has not demonstrated a consistent improvement in major perinatal outcomes from BPP surveillance alone, underscoring the importance of interpreting BPP alongside other clinical and ultrasound findings.[7]

The absence of statistically significant associations with NICU admission should not be interpreted as evidence that fetal surveillance is clinically unimportant. More than two-thirds of live-born neonates required NICU admission, and the leading recorded reasons were low birth weight and prematurity. These determinants are themselves strongly related to gestational age, placental disease, fetal growth, and the decision to deliver. In a cohort of only 72 live births, such competing determinants can substantially reduce the ability of a single Doppler or BPP category to discriminate NICU use.

The present findings therefore support a multi-parameter approach. Third-trimester ultrasound guidance emphasizes fetal biometry, amniotic fluid volume, fetal and uterine Doppler where appropriate, and integration with maternal disease and gestational age.[3] A clinically abnormal test should be interpreted as one part of a longitudinal fetal assessment rather than as a stand-alone trigger detached from the rest of the pregnancy.

Strengths and Limitations

The strengths of the present study include prospective enrolment, concurrent recording of multiple fetal surveillance measures, documentation of clinically relevant delivery outcomes, and linkage to early neonatal care requirements. The cohort also reflects real-world tertiary-care practice in which low amniotic fluid volume frequently coexists with hypertensive disease, anaemia, fetal growth concerns, and referral from peripheral centres. Several limitations should be considered. The sample size was small, particularly for AEDF, REDF, and BPP <4 categories, producing sparse contingency cells. The present study was single-centre and included a mixed-risk population rather than isolated low amniotic fluid volume. Doppler examinations were performed by different radiologists and obstetricians, introducing potential interobserver variation. The fixed CPR cut-off of 1.08 does not account for gestational-age-dependent reference ranges. Most importantly, clinicians had access to AFI, BPP, and Doppler findings and used them in management; this creates confounding by indication when mode of delivery is analyzed as an outcome. No multivariable adjustment was available in the present secondary analysis, and only short-term neonatal outcomes were recorded.

Conclusion

Among women with low amniotic fluid volume, umbilical artery Doppler pattern and BPP were associated with the overall pattern of delivery, while CPR was not. None of the three surveillance markers showed a statistically significant association with NICU admission in the 72 live births. The results indicate that fetal surveillance findings in this cohort were more closely connected to clinical delivery decisions than to short-term NICU use. Umbilical artery Doppler, CPR, and BPP should therefore be interpreted together with gestational age, fetal growth, maternal comorbidity, AFI, and the evolving clinical picture rather than used as isolated predictors.

Declarations

Ethics approval and consent to participate: Approval was obtained from the Institutional Ethics Committee/Review Board of Hassan Institute of Medical Sciences, Hassan, and written informed consent was obtained from participants.

Funding: Self-funded study.

Conflict of interest: Nil.

Data availability: The present study data are contained in the institutional study records and master chart; any sharing should comply with ethics approval and institutional policy.

References

1. Bhide A, Acharya G, Baschat A, Bilardo CM, Brezinka C, Cafici D, et al. ISUOG Practice Guidelines (updated): use of Doppler velocimetry in obstetrics. Ultrasound Obstet Gynecol. 2021;58(2):331-339. doi:10.1002/uog.23698.
2. Lees CC, Stampalija T, Baschat AA, da Silva Costa F, Ferrazzi E, Figueras F, Hecher K, et al. ISUOG Practice Guidelines: diagnosis and management of small-for-gestational-age fetus and fetal growth restriction. Ultrasound Obstet Gynecol. 2020;56(2):298-312. doi:10.1002/uog.22134.
3. Khalil A, Sotiriadis A, D'Antonio F, Da Silva Costa F, Odibo A, Prefumo F, Papageorghiou AT, Salomon LJ. ISUOG Practice Guidelines: performance of third-trimester obstetric ultrasound scan. Ultrasound Obstet Gynecol. 2024;63(1):131-147. doi:10.1002/uog.27538.
4. Society for Maternal-Fetal Medicine (SMFM), Martins JG, Biggio JR, Abuhamad A. Society for Maternal-Fetal Medicine Consult Series #52: Diagnosis and management of fetal growth restriction. Am J Obstet Gynecol. 2020;223(4):B2-B17. doi:10.1016/j.ajog.2020.05.010.
5. Alfirevic Z, Stampalija T, Dowswell T. Fetal and umbilical Doppler ultrasound in high-risk pregnancies. Cochrane Database Syst Rev. 2017;6:CD007529. doi:10.1002/14651858.CD007529.pub4.
6. Vollgraff Heidweiller-Schreurs CA, van Osch IR, Heymans MW, Ganzevoort W, Schoonmade LJ, Bax CJ, et al. Cerebroplacental ratio in predicting adverse perinatal outcome: a meta-analysis of individual participant data. BJOG. 2021;128(2):226-235. doi:10.1111/1471-0528.16287.
7. Lalor JG, Fawole B, Alfirevic Z, Devane D. Biophysical profile for fetal assessment in high risk pregnancies. Cochrane Database Syst Rev. 2008;(1):CD000038. doi:10.1002/14651858.CD000038.pub2.
8. Figueras F, Gratacos E. Update on the diagnosis and classification of fetal growth restriction and proposal of a stage-based management protocol. Fetal Diagn Ther. 2014;36(2):86-98. doi:10.1159/000357592.
9. Di Mascio D, Rizzo G, Buca D, D'Amico A, Leombroni M, Tinari S, et al. Comparison between cerebroplacental ratio and umbilicocerebral ratio in predicting adverse perinatal outcome at term. Eur J Obstet Gynecol Reprod Biol. 2020;252:439-443. doi:10.1016/j.ejogrb.2020.07.032.
10. Novillo-Del Alamo B, Martinez-Varea A, Nieto-Tous M, Padilla-Prieto C, Modrego-Pardo F, Bello-Martinez de Velasco S, et al. Prediction of cesarean section for intrapartum fetal compromise: a multivariable model from a prospective observational approach. J Pers Med. 2024;14(6):658.
11. Sujani BK, Sushma KS. Role of modified biophysical profile and cerebroplacental ratio in fetal outcome in low risk and high-risk pregnancies. Int J Reprod Contracept Obstet Gynecol. 2018;7(3):1104-1108.