ORIGINAL ARTICLE

An Observational Study to Assess the Role of Modified Biophysical Profile and Doppler Ultrasound in Determining the Fetal Well-being in Low-risk Term Pregnancy

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Abstract

Aims and objectives: To determine the tests of antepartum fetal surveillance such as Doppler ultrasound, modified biophysical profile (MBP) alone, and in combination for assessing adverse neonatal outcome in term low-risk pregnancy.

Materials and methods: Prospective observational study was done in a rural tertiary care center for 1 year duration. A total of 169 term low-risk pregnant women were included in the study and fetal surveillance tests such as MBP and Doppler ultrasound were done. The sensitivity of MBP and Doppler analysis in predicting the neonatal outcome using parameters such as birth asphyxia, meconium-stained amniotic fluid (MSAF), neonatal intensive care unit (NICU) admission, and Appearance, Pulse, Grimace, Activity, and Respiration (APGAR) score were assessed.

Results: Among 169 pregnant women, MBP was normal in 66% and abnormal in 34% cases. 150 (89%) showed normal Doppler indices and 19 (11%) were found abnormal. Those with normal MBP and with normal Doppler were found to have better neonatal outcome and this was statistically meaningful (p <0.00). Doppler sensitivity was 37.5% and MBP was 62.5%. The results of combination of MBP and Doppler showed higher sensitivity of 73.5%.

Conclusion: Modified biophysical profile was found to be a more significant than Doppler analysis in determining fetal well-being and in presage of fetal distress. Together MBP and Doppler analysis has yielded a higher sensitivity to detect adverse neonatal outcome.

Clinical significance: Even if Doppler ultrasound is unavailable for surveillance, MBP alone can be the best modality to determine reassuring status in low-risk pregnancy.

Keywords: Amniotic fluid index, Antepartum fetal surveillance, Low-risk pregnancy, Modified biophysical profile, Non-stress test, Term pregnancy, Ultrasound Doppler.

Journal of South Asian Federation of Obstetrics and Gynaecology (2022): 10.5005/jp-journals-10006-2054

Introduction

The purpose of obstetric care is to optimize maternal and fetal well-being. The clinical decisions play an important role in balancing between the risks to the fetus if delivered and the risks to the mother and fetus if the pregnancy continues. A variety of screening tests are performed in an attempt to stratify risk, during the antenatal period to identify the high-risk population.[1]

Antepartum fetal evaluation is an ever-growing and changing science, whose goal is to decrease perinatal mortality and permanent neurologic damage. This can be achieved by judicious use of reliable and valid methods of fetal assessment without acting prematurely to interfere with a normal pregnancy or providing a false assurance in cases of impending morbidity. Historically the goal of antepartum fetal assessment is to identify fetuses at risk for perinatal mortality at the earliest.

In high-risk pregnancies, fetal biophysical profile is a well-established method of antepartum surveillance. Manning et al. described classical biophysical profile which includes the following five parameters: Fetal tone, breathing movements, gross body movements, amniotic fluid volume, and non-stress test (NST)—which is more complicated, not feasible, and costly.[2] Nageotte et al. first described MBP which includes amniotic fluid index (AFI) and a NST. Amniotic fluid index is an indicator of long-term placental function and NST is a marker of short-term fetal status.[3]

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How to cite this article: Sonia H, Bhavya HU, Doppa G. An Observational Study to Assess the Role of Modified Biophysical Profile and Doppler Ultrasound in Determining the Fetal Well-being in Low-risk Term Pregnancy. J South Asian Feder Obst Gynae 2022;14(2):144–147.

Source of support: Nil

Conflict of interest: None

The application of real-time ultrasonography to assess antepartum fetal condition has aided the obstetrician to examine and evaluate the dynamic functions which reflect the integrity and maturity of the fetal nervous system.[1] Doppler ultrasound, a non-invasive technique, which can be used to assess maternal and fetal hemodynamics. The fetal umbilical artery Doppler velocimetry evaluates the downstream impedance to the flow in umbilical arteries. Blood flow is most commonly measured either by pulsatility index or resistant index which reflects the downstream vascular resistance. The differences between the peak systolic and the

end-diastolic velocity within blood vessels of importance quantify the vascular resistance.

Healthy fetuses have the high-velocity diastolic flow, whereas the growth-restricted fetuses usually have diminished, absent; or even in severe cases, a reversed umbilical artery diastolic flow reported.[4] An abnormal umbilical artery Doppler velocimetry is an index of fetal peripheral vasoconstriction which is one of the prominent pathophysiology of the reduced fetal oxygenation.

Many studies have been conducted among high-risk pregnancy in which fetal Doppler and MBP successfully established their role. As very few studies have been conducted in low-risk pregnancy, the present study was conducted to assess antepartum fetal monitoring techniques such as Doppler ultrasound, MBP individually and in combination, for predicting adverse neonatal outcome and to assess the most reliable and valid test of fetal assessment in low-risk pregnancy.

Materials and Methods

Our study is based on a prospective observational study after taking clearance from the institutional ethical committee and informed written consent by the participants. The study was done on 169 patients who were admitted from September 2020 to September 2021 in a rural tertiary care center, South India after fulfilling the inclusion criteria.

Inclusion criteria included the following:

- Singleton pregnancy.
- Antenatal women between the age group of 18 and 35 years.
- Primigravida and multigravida.
- Gravid women with gestational age more than 37 weeks.
- Non-anomalous fetus.

Exclusion criteria included the following:

- Gravid women with gestational age less than 37 weeks.
- Fetal anomalies.
- Intrauterine death.
- Multiple pregnancies.
- Severe PIH.
- Uncontrolled diabetic.
- Systemic diseases.

Those who met the study's inclusion criteria were chosen after giving their informed consent, a complete history, clinical and obstetric examination, and routine investigations carried out. The estimated fetal weight, fetal number, intrauterine condition, and fetal cardiac activity were all assessed using a Voluson S8 USG machine and 8–15 MHz abdominal curvilinear probes. After excluding out fetal anomalies, AFI was measured. Those with an AFI sum of less than 5 cm in four quadrants in a vertical plane were considered as oligohydramnios and more than 25 as polyhydramniotic.[5]

After obtaining a minimum of three velocity waveforms during a period of no-respiration and no-fetal movements, Doppler analysis was done; Doppler indices of umbilical artery at the level of cord insertion at placental end and middle cerebral artery in the axial section of brain at the level of circle of Willis were evaluated. Following parameters such as systolic/diastolic (S/D) ratio of umbilical artery more than 3.6 suggesting a reduced diastolic flow, an absent diastolic flow, and a reversed diastolic flow, which were considered as abnormal finding.[6]

Patients underwent an NST in the semi-fowler position for at least 20 minutes using a bionet fetal care cardiotocography (CTG) device. When a non-reactive NST is detected, maternal abdominal wall stimulation was done to reduce false positivity. An absolute non-reactive NST was defined when NST showed no changes in pattern for 40 minutes irrespective of stimulation.

An MBP was formed with both AFI and NST, the former being a definitive marker of chronic hypoxia, and the latter which shows acute hypoxia. An aberrant MBP was defined as the presence of oligohydramnios and/or non-reactive NST, and its effectiveness to predict the fetal distress and pregnancy outcomes was based on these characteristics.

Patients whose labor was scheduled, the choice of vaginal delivery or cesarean section was made after careful consideration of fetal, maternal, and obstetrical indications. During the delivery of fetus, nature of amniotic fluid was assessed, and the presence of meconium-stained liquor was noted, the baby was evaluated by the pediatrician who attended the birth, and APGAR scores were estimated at the first and 5 minutes. Pregnancy outcome mainly dependent on variables such as birth asphyxia, presence of meconium, perinatal mortality, NICU admission, APGAR score at the first and 5 minutes.

Data Analysis

The data was entered on an Excel sheet and IBM SPSS25 was used for the statistical analysis. Frequencies, percentages, sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and graphical presentation were used to represent the data. The Chi-squared test was used to determine whether or not there was a significant difference between the two groups.

Results

Our study included 169 pregnant women aged 18–35 years who fulfilled the inclusion criteria, of which majority were in the age range 21–30 years and with gestational age beyond 37 weeks and were admitted to our hospital for delivery from September 2020 till September 2021.

In this present study, the relationship between the MBP and Doppler ultrasonography findings with neonatal outcome was evaluated both independently and in combination.

The MBP was normal in 111 (66.00%) of the patients, but abnormal in 58 (34.00%) of the cases (Table 1). The normal MBP was found to be associated with a better neonatal outcome, which was highly statistically significant (p <0.00). The relation between MBP and neonatal outcome is as shown in Table 2.

In our study, when the findings of umbilical and middle cerebral artery Doppler analysis were evaluated, 150 (89.00%) showed normal Doppler indices and 19 (11.00%) were found abnormal (Table 1). The normal Doppler analysis had a better neonatal outcome than the abnormal group, and the results were statistically significant (p <0.00). The relation between Doppler and neonatal outcome is as shown in Table 3.

Among 169 pregnant women, majority of them, i.e., a total of 98 (58.00%) had normal vaginal delivery, followed by 65 (38.46%) who underwent lower segment cesarean section (LSCS) and 6 (3.54%) delivered with an assistance of ventouse. Out of 111 cases with normal MBP, 76(68.46%) had normal delivery, 2 (1.80%) with assistance of ventouse, and around 33 (29.72%) cases underwent LSCS. Those 58 cases with abnormal MBP, majority around 32 (55.17%) cases underwent LSCS which was high when compared to

Table 1: Antepartum fetal surveillance tests

Parameter	*Number (n = 169)*	*%*
Modified biophysical profile (*n* = 169)		
AFI		
Normal	135	79.88
Abnormal	34	20.11
NST		
Reactive	128	75.73
Non-reactive	41	24.26
Doppler parameter (*n* = 169)		
Normal	150	88.75
Raised S/D ratio	7	4.14
Reversal diastolic flow	1	0.59
Absent end-diastolic flow	4	2.36
Reversal of cerebroplacental ratio	7	4.14

Table 2: Relationship between MBP and neonatal outcome

	Neonatal outcome		
	Good	*Adverse*	*Total*
MBP			
Abnormal	33 (19.5)	25 (12.75)	58 (34.31)
Normal	96 (56.80)	15 (8.87)	111 (65.68)
Total	129 (76.33)	40 (23.66)	169

Chi-squared test = 18.46, $p = 0.000$; Statistically significant when $p < 0.05$

Table 3: Relationship between Doppler and neonatal outcome

	Neonatal outcome		
	Good	*Adverse*	*Total*
Doppler			
Abnormal	4 (2.36)	15 (8.87)	19 (11.24)
Normal	125 (73.96)	25 (14.92)	150 (88.75)
Total	129 (76.33)	40 (23.66)	169

Chi-squared test = 36.270, $p = 0.000$; Statistically significant when $p < 0.05$

normal group and the remaining 26 (44.82%) had vaginal delivery. This correlation was again statistically significant with $p = 0.00$.

In our study, it was found that among 150 cases with normal Doppler, majority of them, i.e., a total of 92 (61.33%) had normal vaginal delivery, 5 (3.33%) cases with an assistance of ventouse, and about 53 (35.33%) cases underwent LSCS. Those who showed abnormal Doppler (19), 13 underwent LSCS, only 6 delivered vaginally. With $p = 0.046$, the association was shown to be highly significant.

Among 169 cases, 76% (129) showed good and 24% (40) had adverse perinatal outcome. The birth weight of neonate ranged between 2 and 3.6 kg. When analyzing the neonatal outcome, admission to the NICU is a major factor, among 40 neonates with adverse neonatal outcome admitted in NICU, 26 were admitted for MSAF and 14 in view of respiratory distress, as depicted in Table 4.

The validity tests such as sensitivity, specificity, PPV, and NPV, accuracy of diagnosis in predicting the neonatal outcome applying MBP and Doppler analysis independently and as a combination are shown in Figure 1.

Doppler sensitivity was 37.50% while MBP was 62.50% in predicting an adverse outcome. The sensitivity increased to 73.52%

Table 4: Neonatal outcome in the study

Variables (N = 169)	*Levels*	*Number of cases*	*%*
Perinatal outcome	Good	129	76.31
	Adverse	40	23.66
APGAR score at 1 min	7–8	28	14.79
	9–10	141	83.43
APGAR score at 5 min	8–9	44	26.03
	10	125	73.96
Birth weight	2–2.5	30	53.25
	2.6–3.6	138	81.65
	>3.6	1	0.59
Admission to NICU (40)	Respiratory distress	14	8.28
	MSAF	26	15.97

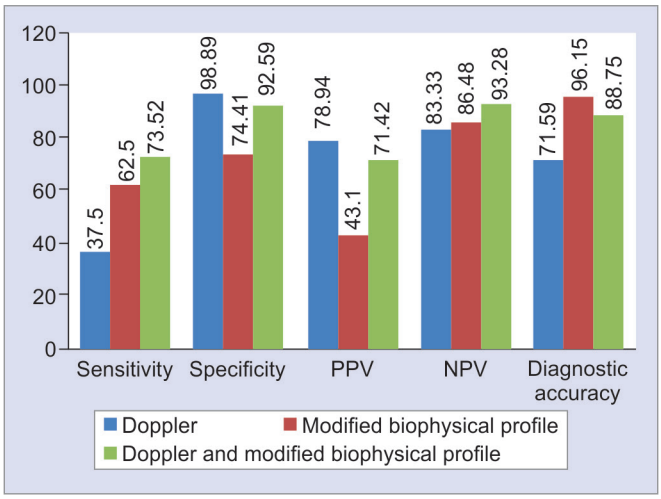

Fig. 1: Graph showing sensitivity, specificity, PPV, NPV, and diagnostic accuracy of Doppler and MBP alone and in combination

once the MBP and Doppler data were combined. The MBP alone yielded maximum of 96.15% accuracy of diagnosis followed by combined MBP and Doppler, i.e., 88.75%, and Doppler alone with 71.59%.

Discussion

The goal of obstetric care is to ensure the safety of both the mother and the fetus. Clinical judgments are usually a balance between the hazards to the fetus if the pregnancy is terminated and the risk to the mother and fetus if the pregnancy continues. A variety of screening tests are being used to identify the high-risk individuals during the prenatal and intrapartum period in an attempt to stratify risk. According to the data acquired, those with abnormal MBP and Doppler analysis had a significant negative outcome and the difference between the normal and abnormal groups in the current study was statistically significant.

Mehmet et al. studied MBP and Doppler in predicting neonatal outcome at/over 36 weeks gestation and concluded that in the prediction of non-reassuring fetal status and perinatal outcome, MBP (sensitivity, 60%) was found to be more significant than

Doppler analysis (sensitivity, 40%), and sensitivity rose when both were combined (70%).[7] These results were similar to our study results where Doppler sensitivity was 37.5%, MBP was 62.5%, when findings of MBP and Doppler were combined, the sensitivity enhanced to 73.5%.

In a similar study by Bakay et al., who studied MBP with Doppler analysis in assessing the fetal well-being in the third trimester among 99 pregnant patients, had similar findings to our study. They discovered that when MBP was paired with uterine/umbilical artery Doppler ultrasonography to detect acute fetal distress, the approach had a sensitivity of 100% and a specificity of 89.2%, making it the most sensitive test in the study. The MBP alone showed a sensitivity of 94.12 % and a specificity of 98.78 %.[8]

Borade et al., who studied the role of MBP in predicting perinatal outcome in high-risk pregnancies among 100 ANC patients, found that in cases with abnormal MBP, the rate of LSCS, intrapartum fetal distress, meconium-stained fluid, APGAR score, neonatal resuscitation, and perinatal morbidity were mostly increased. These findings were similar to our study results. They also found that MBP is a simple, inexpensive, and time-saving test that can be used as a major antepartum fetal surveillance test to predict perinatal outcomes and provide timely intervention in high-risk pregnancies.[9]

A clinical study by Talukdar et al., regarding the significance of MBP and Doppler in the management of postdated pregnancy among 300 patients, concluded that the use of combined cerebroplacental ratio and MBP has better sensitivity in postdated pregnancy to predict adverse perinatal outcome.[10]

Conclusion

Modified biophysical profile was found to be more significant in predicting an adverse neonatal outcome than Doppler, but the sensitivity was increased when both were combined. In terms of affordability and feasibility, the MBP can be considered as test of antenatal assessment as it has better diagnostic accuracy than Doppler in term low-risk pregnancy.

Clinical Significance

Even if Doppler ultrasound is unavailable for surveillance, MBP alone can be the best modality to determine fetal well-being in low-risk pregnancy.

Limitations

- The NST component of MBP usually have high false positive rate.
- Prior MBP had no effect on perinatal morbidity caused by intrapartum fetal distress due to uterine hyperstimulation.

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