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Original Research Article

Comparison of multi vessel doppler velocimetry and biophysical PROFILE for antenatal assessment in high risk pregnancies

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Abstract

Background: Numerous fetal surveillance tests have been developed to identify the fetus at risk of intrauterine injury or death but there exists limited evidence to guide their appropriate application. There are few studies that have compared Doppler velocimetry with BPP in growth restricted fetuses. Similar comparative studies are lacking for high risk pregnancies.

Aim & Objective: This study was planned to study whether BPP in high risk pregnancies offers any benefit over multi vessel Doppler velocimetry in predicting adverse perinatal outcome.

Materials and Methods: It was a prospective observational study done over 2 years in a tertiary care center in Delhi. 186 women with high risk pregnancies who met the inclusion criteria were enrolled for the study. They were divided into 2 groups – group 1, those with growth restricted fetus and group 2- those without growth restricted fetus. Fetal monitoring was done with weekly Biophysical profile and Doppler velocimetry of the fetal umbilical artery and middle cerebral artery. The S/D, PI and RI were measured for the umbilical artery and middle cerebral artery. These were then correlated with neonatal outcomes and complications.

Results: A total of 186 women were enrolled for the study. The sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) for BPP in growth restricted fetus was 93.3%, 88.2%, 87.5%, 93.7% as compared to 81.8%, 70.5%, 78.2%, 75% for doppler. 12 were lost to follow up. The NcNemar Bowker Chi square test showed that the results of doppler and BPP for predicting adverse perinatal outcome in fetus with growth restriction was concordant. On comparing the test results of doppler with BPP in group II using McNemar Bowker Chi square test, the results were not found to be concordant (p=0.001).

Conclusion: In growth restricted fetus, doppler may replace BPP for antenatal survelliance but in other high risk fetus, they do not show a consistent relation with one another and can complement each other for antenatal survelliance.

Keywords: Biophysical profile, Doppler velocimetry, Fetal survelliance.

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1. Introduction

High risk pregnancies are complex as they place the mother and fetus at risk for complications. They are associated with increased perinatal morbidity and mortality. They include maternal conditions such as hypertensive disorders, diabetes, cardiac, renal, autoimmune disorders, thrombophilias[1-5] and obstetrical conditions such as fetal growth restriction, multiple pregnancy, oligohydramnios, antepartum hemorrhage and prolonged pregnancy.[3,6]

The aim of antenatal monitoring is to identify the fetus at risk of intrauterine injury or deathand give time to initiate measures so that the adverse outcomes can be prevented.

Numerous fetal surveillance tests have been developed for this purpose but there existslimited evidence to guide their appropriate application.

Antenatal fetal monitoring techniques include – fetal movement count, cardiotocographic assessment including non stress test and contraction stress test, Biophysical profile and amniotic fluid measurement and Doppler velocimetry.

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The Biophysical profile was first proposed in 1980 by Manning et al.[7] According to an observational study by Begum et al,[8] the sensitivity of BPP for determining fetal outcome was 12.5% and specificity 99.23% when a score of ≤4 was taken as cut-off. At a cut off of ≤8, sensitivity increased to 70.83% and specificity was 91.53%. The false negative rate of BPP was

0.8 per 1000, negative predictive value was 99.9% and the false positive rate was 40-50% for adverse perinatal outcome in high risk pregnancies.[9] According to Manning et al, the perinatal mortality within one week of biophysical profile without any intervention strongly correlated with the score, indicating the BPP was an accurate method of assessing fetal compromise.[10]

The Cochrane review 2009, however, did not find sufficient evidence to support the use of BPP as a test of well being in high risk pregnancies. The review mentions that the size of study group was small (2964 women) and further studies are required for testing the efficacy.[11]

The use of Doppler ultrasound for the umbilical artery waveforms was reported by Fitzgerald in 1977. Their systematic review of 18 randomized trials with 10,156 high-risk women, founddecreased perinatal mortality with the use of Doppler ultrasound.[12] Studies show that Interventions based on identification of abnormal umbilical artery waveform patterns have reduced the incidence of perinatal death by 38% in high risk pregnancies. Addition of fetal venous dopplers alongwith arterial assessment further helps in predicting outcomes in growth restricted fetuses.[13]

There are few studies that have compared Doppler velocimetry with BPP in growth restrictedfetuses. Soothill et al compared fetal heart rate variability, biophysical profile and umbilical artery Doppler and found that only umbilical artery Doppler had value in predicting poor perinatal outcome in SGA fetuses.[14] A comparison of computerized fetal heart rate analysis, Doppler and BPS for predicting acid-base status of growth restricted fetus revealed that multiple surveillance modalities are required and incorporation of venous Doppler provides the best prediction of acidemia.[15] Gonzalez et al compared NST, BPS and Doppler for predicting perinatal outcome in IUGR and found Doppler to be the best predictor.[16]

Similar comparative studies are lacking for high risk pregnancies. Biophysical profile is a time consuming and expensive modality. Although observational studies have suggested that BPPconfers benefit in high risk pregnancies, the financial and manpower costs involved in performing a BPP are much higher. So, this study was planned to study whether BPP in high risk pregnancies offers any benefit over multi vessel Doppler velocimetry in predicting adverse perinatal outcome. If deteriorations in both BPP and Doppler velocimetry are closelyrelated, then Doppler may replace BPP for fetal surveillance. However, if the results are discordant, then an integrated approach would benefit. This study was therefore planned to compare Doppler velocimetry with Biophysical profile for fetal surveillance in high risk pregnancies.

2. Material and Methods

It was a prospective observational study done over 2 years in a tertiary care center in Delhi. 186 women with high risk pregnancies who met the inclusion criteria were enrolled for the study. As per protocol, a detailed history, physical examination and obstetrical examination was done after an informed consent. Routine antenatal investigations were performed. Fetalmonitoring was commenced from 30 weeks onward. Weekly NST, amniotic fluid estimation, Biophysical profile and Doppler velocimetry of the fetal umbilical artery and middle cerebral artery were done. The S/D, PI and RI were measured for the umbilical artery and middle cerebral artery. In case of non reassuring results, the frequency of testing was increased. Theresult of the last Doppler and BPS within 7 days of delivery was considered for subsequent correlation with perinatal outcomes. A decision for expediting delivery was taken in case of BPP ≤ 6/10, AEDF or REDF in umbilical artery, non-reassuring fetal heart rate or on the discretion of the attending physician.

The gestational age at delivery, the mode and indication of delivery was noted. The birth weight, 5 minute apgar score and umbilical cord pH were also recorded. Umbilical cord pH<7.2 was considered abnormal. Major fetal outcome in the form perinatal death, complications such as hypoxic ischemic encephalopathy (HIE), necrotizing enterocolitis (NEC), intraventricular haemorrhage (IVH), periventricular leukomalacia (PVL), neonatal hyperbilirubinemia (NHB), retinopathy of prematurity (ROP), transient tachypnea of newborn (TTNB) were noted. Minor outcomes included 5 minute apgar < 7, cord pH <7.2 and admission to NICU.

2.1. Procedure

2.1.1. Doppler vascular technique

We used the pulsed Doppler ultrasound (LOGIQ 700-GE Medical systems, Waukesha, Wisconsin) with 3.5 MHz curvilinear probe with high pass filter for performing doppler velocimetry. The following vessels were studied with the woman in the recumbent position during period of fetal inactivity and apnea.

1. Umbilical artery
2. Middle cerebral artery

The umbilical artery measurements were made from a free loop of the cord midway between the placental and abdominal wall insertion.

The MCA was located in a transverse plane at the level of the lesser wing of the sphenoid bone with sample gate placed on proximal portion of the vessel.

Flow velocity waveforms were obtained using pulsed wave Doppler ultrasound. The indices used to describe the resistance to flow in the uteroplacental circulation included S/D, PI and RI. MCA-PSV was also measured.

2.1.2. Biophysical profile

Using real time ultrasound, the fetal breathing movements, fetal tone, gross body movements, amount of liquor and non stress test were assessed. Each parameter was scoredas 0 or 2 depending on absence or presence respectively. A maximum score of 10 was given.[10]

3. Results

A total of 186 women were enrolled for the study. 12 were lost to follow up. The remaining 174 women were divided into 2 groups – group I, those with growth restricted fetuses (N=81)and group II, those without growth restricted fetuses (N=93).

In group I, the mean gestational age at delivery was 35.20±2.94 weeks and it was 35.9±2.28 weeks in group II. The difference in mean birth weight of the two groups was statistically significant (p=0.001) with mean birth weight of 1.56 ± 0.49 Kg in group I and 2.26 ± 0.44 Kg ingroup II. The fetal outcome in terms of 5 min apgar <7 was seen in 16% cases in group I as compared to 1.07% in group II. NICU admissions were 22 (27.15) in group I and 7 (7.5%) in group II. 46.9% of group I and 8.6% of group II had birth weight < 1.5 Kg.

Doppler velocimetry result in group I was normal in 16 (19.7%), raised S/D in 42 (51.8%), AEDF in 12(14.8%) and REDF in 11 (13.5%). The fetal outcome parameters were correlated with the doppler test results (**Table 1**). Fetuses with doppler showing A/REDF were delivered at significantly lesser gestational age and with lower birth weight at delivery as compared to those with normal result or only raised S/D in umbilical artery. Similarly, the duration of hospital stay (34.6 days) and the number of nursery admissions (78.2%) were also significantly high in this sub group.

Biophysical profile in group I was normal (>8/10) in 16 (19.7%), 8/10 in 49 (60.4%), ≤6/10 in16 (19.7%). The mean gestational age at delivery and birth weight along with other fetal outcome parameters were correlated with BPP score. Again, the sub group showing the worst result i.e score ≤ 6/10 had significantly low birth weight and gestational age at delivery (**Table 2**).

Table 3 shows the risk stratification in growth restricted fetuses by doppler and BPP had similar results. Accordingly, doppler subgroup A has results concordant with BPP normal, doppler subgroup B with BPP 8/10 and doppler subgroup C with BPP ≤6/10. In **Table 6**, we have compared the two testing modalities. In 42/81 (51.8%) the results were concordant. In cases with discordant result, 16 had a higher BPP grade. The fetal outcome was compromised in 50% of these. 23 showed a higher doppler grade and 11 of these fetus had compromised outcome.

The NcNemar Bowker Chi square test showed that the difference in the test results was not significant (Mc Nemar chi-square=0.05; P-Value= 0.8231). That is, the results of doppler and BPPfor predicting adverse perinatal outcome in fetus with growth restriction was concordant. The 2 cases with BPP ≤6/10 and normal doppler results had meconium passage in utero which explained the poor biophysical profile.

The sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) for doppler and BPP with different cut-offs for abnormal in group I are given in **Table 4** and **Table 5**. If we include raised S/D as abnormal doppler result, the sensitivity increases to 90% but the specificity falls to 29.27%. Similarly, for BPP, the sensitivity is 34% and specificity 95% if cut off for abnormality is a score ≤ 8/10.

A more balanced combination of sensitivity and specificity is obtained on including only caseswith A/REDF in umbilical artery doppler as abnormal and for BPP, a score ≤ 6/10 as cut off forabnormal result.

In group II, the doppler changes preceeded changes in BPP or delivery in cases with normal BPP on an average of 13.37 days in group I and 11.8 days.

The adverse perinatal outcomes in the two groups are shown in **Table 6**. There was no perinatal mortality. The adverse perinatal outcomes were more in group I as compared to group II.

In group II, 75.3% fetus had a normal doppler followed by 23.7% having raised S/D and only 1fetus with A/REDF. The BPP was normal in 70 (75.2%), 8/10 score in 17 (18.2%) and ≤6/10 in6 cases (0.06%). With worsening doppler result, the fetus were delivered at earlier gestational age but the birth weight and duration of hospital stay were not associated with test result. The BPP result also did not show an association with gestational age at delivery, birth weightand duration of hospital stay.

On comparing the test results of doppler with BPP in group II using McNemar Bowker Chi square test, the results were not found to be concordant (p=0.001). There were 4 fetus having BPP ≤6/10 and normal doppler. 1 of these had meconium passage in utero while one had cholestasis of pregnancy. No cause was found in the remaining two cases for poor biophysicalprofile. The apgar score for all 4 was >7.

In group II, the sensitivity of doppler for adverse perinatal outcome was 74.32% and specificitywas 21.05% when raised s/D was the cut off. On including only cases with A/REDF as abnormal, the sensitivity increased to 98.2% but specificity decreased to 0. Similarly, for BPP results, the sensitivity increases to 93.3% and specificity fell to 12.5% when score ≤6/10 was the cut off used.(**Table 7** and **Table 8**)

Table 1: Doppler and fetal outcomes in group 1

	Doppler N N=16	**Doppler Raised S/D N=42**	**Doppler A/REDF N=23**
Mean GA	35.1 + 1.36	34.34 + 1.36	31.2+2.39
Mean BW	1.56 + 0.551`	1.54 + 0.551	1.16+0.38
Duration of hosp stay	13.83	13.8	34.6
Nursery adm	4 (25%)	20 (47.6%)	18 (78.2%)
Apgar score <7	2(12.5%)	4 (9.5%)	7 (30.4%)
Birth wt <1.5	0	21 (50%)	17 (73.9%)
Perinatal mortality	0	0	0

Table 2: BPP and fetal outcome in group 1

	BPP N N=16	**BPP 8/10 N=49**	**BPP<=6/10 N=16**
Mean GA	36.7+2.95	35.1+2.67	33.1+3.55
Mean BW	1.89+0.48	1.56+0.48	1.20+0.51
Duration of hosp stay	12.18	15.2	39
Nursery adm	11 (68.7%)	24 (48.9%)	15 (93.7%)
Apgar score <7	0	3 (6.1%)	11 (68.7%)
Birth wt <1.5	3 (18.7%)	23 (46.9%)	13 (81.2%)
Perinatal mortality	0	0	0

Table 3: Doppler and BPP in group 1

	Doppler N	**Doppler Raised S/D**	**Doppler A/REDF**
BPP N	6	8	2
BPP 8/10	8	28	13
BPP <= 6/10	2	6	8
	16	42	23

Table 4: Doppler as a screening tool in group 1 for different cut offs

Doppler	**Abnormal includes raised SD**	**Abnormal includes AEDF/REDF only**
Sensitivity	90 (76.95, 96.04)	81.8 (61.48, 92.69)
Specificity	29.27 (17.61, 44.48)	70.5 (46.87, 86.72)
PPV	75.0 (50.5, 89.82)	75.0 (50.5, 89.82)
NPV	55.38(43.34, 66.83)	78.26% (58.1, 90.34[1])

Table 5: BPP as screening tool for different cut offs in group 1

	Abnormal <=8/10	**Abnormal <=6/10**
Sensitiity	34.1 (21.56, 49.45)	93.3 (70.18, 98.81)
Specificity	95 (83.5, 98.62)	88.2 (65.66, 96.71)
PPV	87.5 (63.98, 96.5)	87.5 (63.98, 96.5)
NPV	58.4 (46.34, 69.64)	93.7 (71.67, 98.89)

Table 6: Adverse perinatal outcome

Adverse PO	FGR	NON- FGR
Respiratory Distress Syndrome	7	1
Necrotizing Entero Colitis	8	4
Neonatal Hyper bilirubinemia	10	6
Retinopathy Of prematurity	04	0
Asphyxia	6	1
Transient Tachypnea of newborn	6	5
Bronchopulomnary dysplasia	5	0
Hyaline membrane disease	1	1
Hypoxic ischemic encephalopathy	2	0

Table 7: DOPPLER as a screening tool in group 2 for different cut offs

Doppler	Abnormal includes raised SD	Abnormal includes AEDF/REDF only
Sensitivity	21.0 (58.508, 43.33)	98.2 (90.55, 99.68)
Specificity	74.3(63.35, 82.9)	0
PPV	17.3 (6.979, 37.14)	78.5 (67.61, 86.56)
NPV	78.5 (67.61, 86.56)	0

Table 8: BPP as screening tool for different cut offs in group 2

	Abnormal <=8/10	Abnormal <=6/10
Sensitiity	75.6 (64.79, 84.02)	93.3 (84.07, 97.38)
Specificity	26.3 (11.81, 48.79)	12.5 (3.498, 36.02)
PPV	80 (69.18, 87.7)	80 (69.18, 87.7)
NPV	21.7 (9.664, 41.9)	33.3 (9.677, 70)

4. Discussion

Antepartum fetal testing has been a matter of great concern among the obstetricians. Over the years, various methods have been devised, used, studied and critically analysed in order to get a better predictor for perinatal outcome. The modalities in modern practice include NST, amniotic fluid estimation, BPP and Doppler velocimetry of fetal blood vessels.

The present study was done to compare the two methods of fetal monitoring i.e. Doppler and BPP so as to find out which of the two is an earlier and better predictor of fetal compromise in high risk pregnancies. Whether Doppler which is a less time consuming method can replace BPP as a method of fetal monitoring in high risk pregnancies?

There were two groups of babies - those with growth restriction (group I) and without growth restriction (group II). Though the mean gestational age at delivery for both the groups was similar, there was significant difference in the birth weight, apgar score and nursery admissions. This was due to the low birth weight of the growth restricted fetus. The adverse perinatal outcomes in group I exceeded those of group II showing that the low birth weight and the complications associated with growth restriction makes this group different from other high risk fetus.

In the present study, we observe that with worsening doppler and BPP scores, the number ofdays of hospital stay and admission to nursery increases. Both doppler and BPP show a goodsensitivity and positive predictive value, so they are valuable in predicting adverse perinatal outcome in growth restricted fetus.

The sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) for BPP in growth restricted fetus was 93.3%, 88.2%, 87.5%, 93.7% as compared to 81.8%, 70.5%, 78.2%, 75% for doppler. Though BPP appears to be a better predictor of adverse outcome, but when compared by McNemar Chi square test, the results of the two are similar. That implies that one test can replace the other for antenatal survelliance in growth restricted fetuses. Also doppler changes have been shown to preceed changes in BPP scoring. Therefore, we can propose to replace BPP with doppler for antenatal survelliance of growth restricted fetus as it is less time consuming compared to BPP and is an earlier predictor of adverse perinatal outcome.

In group II, that is those with high risk but non growth restricted fetus, the sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) for doppler was 98.2%, 0, 78.5%, 0 and for BPP 93.3%, 12.5%, 80%, 33.3% . Though doppler is highly sensitive with a good PPV but specificity and NPV fall to 0. On comparing the two tests using McNemar chi square test, the results were non concordant, that is dissimilar. Therefore, in thisgroup of fetus, the cardiovascular and behavioural changes as represented by doppler and BPPappear to be independent of each other. The two test are complementary to each other.

5. Conclusion

Both Doppler and BPP results can be used to stratify fetus for prognostication. In growth restricted fetus, doppler may replace BPP for antenatal survelliance but in other high risk fetus, they do not show a consistent relation with one another and can complementeach other for antenatal survelliance.

6. Source of Funding

None.

7. Conflict of Interest

None.

8. Ethical Approval

Ethical No.: HIMSR/IEC/04/2021.

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