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Original Article

Vibroacoustic Stimulation and Modified Fetal Biophysical Profile for Early Intrapartum Fetal Assessment

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Abstract

Objectives: To evaluate the efficacy of vibroacoustic stimulation (VAS) and modified fetal biophysical profile (mFBP) for early intrapartum fetal assessment and prediction of adverse perinatal outcome. *Methods:* In this prospective study, 210 women who were in latent phase of labor at the time of admission to the labor unit were subjected to VAS/mFBP, in which fetal startle response and fetal heart acceleration under combined B/M mode ultrasonography following VAS were observed. The results of VAS/mFBP were correlated with adverse perinatal outcome. Standard "fourfold" format was used to calculate various diagnostic values. *Results:* Mean testing time was 4.86+0.72 min. Of the 210 fetuses subjected to VAS/ mFBP, 200 (95.2%) were reactive and 10 (4.8%) nonreactive. There were 198 (94.3%) favorable and 12 (5.7%) adverse perinatal outcomes. VAS/mFBP had: sensitivity 66.7%, specificity 99.0%, positive predictive value 80.0%, negative predictive value 98.0%, and accuracy 97.2%. *Conclusions:* Because of its simplicity, ease of administration, short testing time, noninvasiveness, and high accuracy VAS/mFBP for early intrapartum fetal assessment is a reliable diagnostic approach.

Keywords: vibroacoustic stimulation, modified fetal biophysical profile, intrapartum fetal assessment

Introduction

Early intrapartum fetal assessment is aimed at identifying the fetuses that may be either already compromised in early labor or are at the increased risk of compromise during late labor. An early identification of such fetuses may help in instituting close surveillance to reduce perinatal morbidity and mortality. This may also help in utilizing the available resources optimally in the resource-constraint setting.

Various means for early intrapartum fetal assessments have been used at the time of admission in labor. Admission cardiotocography is widely used as labor admission test to identify pregnancies that might benefit from continuous fetal electronic monitoring, but it has low sensitivity and positive predictive value and does not improve neonatal outcome in routine use[1,2]. Addition of fetal vibroacoustic stimulation (VAS) has been reported to increase the sensitivity and decrease false-positive results[3]. Amniotic fluid assessment in the form of amniotic fluid index (AFI),

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single largest pocket technique, and quantitative distribution has been used for early intrapartum fetal assessment; however, the results from various studies have been conflicting[4,5,6,7].

Fetal biophysical profile (FBP), which combines the nonstress test (NST) and several ultrasonographic parameters, is reliably accurate in predicting perinatal outcomes[8]. But the classical profile with all parameters takes a long time to perform, especially if a fetus with decreased biophysical activity is being examined. Various modifications have been proposed to obviate this difficulty, which take less time to perform without compromising the diagnostic efficiency[9,10,11]. VAS has been reported to shorten the biophysical profile testing time and improve the biophysical profile scores[12,13].

A rapid biophysical profile, which combines sound provoked fetal movement (SPFM) detected ultrasonographically and AFI, has been reported for early intrapartum fetal assessment[14]. In our study we have used a new modified biophysical profile with only two components: ultrasonographic observation of fetal startle response to VAS and simultaneous observation of fetal heart acceleration. This combines advantage of VAS with modified biophysical profile and NST .The present study was carried out with the aim to evaluate the efficacy of VAS and modified FBP (VAS/mFBP) for early intrapartum fetal assessment and prediction of adverse perinatal outcome.

Methods

This prospective study was carried out at Military Hospital Jhansi, Uttar Pradesh, India, and was approved by institutional authority. Women admitted to the labor unit of the hospital, who met the inclusion criteria were eligible for the study. Women were recruited after taking informed consent. Inclusion criteria were: gestational age ≥35 weeks, singleton pregnancy, cephalic presentation, and latent phase of labor (cervical dilatation <4 cm). Exclusion criteria were: delivery >24 hours after the VAS/mFBP test and emergency cesarean delivery because of placental abruption, placenta previa, or cord prolapse. Women were subjected to VAS/mFBP at the time of admission. Wipro GE LOGIQ α V4 (Wipro GE Medical Systems, Bangalore, India) machine with C36 (3.5 MHz) convex array probe was used. VAS was done with EMCO vibroacoustic stimulator (EMCO Health Care Pvt Ltd, Sion, Mumbai, India) with 75 db sound intensity at 1.0 meter and frequency of 75 Hz.

Women were positioned for the ultrasonographic examination in 15 degrees left lateral position. Fetal body was scanned in combined B/M mode and the depth of the field was adjusted to bring the fetal heart, chest, and abdomen into the same section. Location of the marker on the fetal heart was selected to get the optimal waveform and the fetal heart rate was calculated. Fetal VAS was done for 3 sec by placing the stimulator on abdominal wall over fetal head. Fetal startle response and fetal heart acceleration were observed. Fetal startle response was defined as a sudden movement of fetal extremities in response to vibroacoustic stimulus ≤2 sec after the cessation of the stimulus. Fetal heart acceleration was defined as acceleration of ≥15 beats, lasting for ≥15 sec. If there was no fetal startle response, the stimulus was repeated at 1 min intervals for a total of three stimuli.

Presence of startle response accompanied by fetal heart acceleration was considered reactive (negative) test. Absence of either or both after three stimulations was considered nonreactive (positive) test. Test results were not available to the care providers. All women underwent continuous electronic fetal monitoring during active labor. Adverse perinatal outcomes were assessed and recorded immediately after delivery. Results of VAS/mFBP in women delivering ≤24 hours were correlated with adverse perinatal outcome. Perinatal morbidity was defined as presence of at least two of the following variables of adverse perinatal outcome: cesarean delivery for fetal distress, 5 min Apgar score <7, and admission to NICU >24 hours. Various diagnostic values in predicting perinatal morbidity and mortality were calculated.

Standard 'fourfold' format was used to calculate various diagnostic values. Statistical software Epi Info Version 3.2.2 (Center for Disease Control and Prevention Atlanta, Georgia, USA) was used for statistical analysis of data.

Results

From June 2005 to July 2006, a total of 210 women were recruited for the study. None were excluded. All completed the study protocol and were included in the analysis. Mean maternal age was 25.9+4.5 years, 135 (75%) were multipara, and mean gestational age was 37.3+2.01 weeks (Table 1). A total of 124 (59%) women had some high risk factor (Table 2). Mean testing time was 4.86+0.72 min. Of the 210 fetuses subjected to VAS/mFBP, 200 (95.2%) were reactive and 10 (4.8%) nonreactive. There were 198 (94.3%) favorable and 12

Table 1
Maternal demographics[a]

Characteristic	No.	(%)
Maternal age (years)	25.9	±4.5[b]
Parity		
1	53	(25.2)
2	112	(53.3)
3	36	(17.2)
4	9	(4.3)
Gestational age (weeks)	37.3	±2.01[b]

[a]N=210
[b]Mean±SD

Table 2
High risk factors[a]

Characteristic	No.	(%)
Fetal growth restriction	40	(19.0)
Pregnancy induced hypertension	31	(14.7)
Bad obstetric history	20	(9.5)
Post term pregnancy	12	(5.7)
Gestational diabetes	10	(4.8)
Others	11	(5.3)
Nil	86	(41.0)

[a]N=210.

(5.7%) adverse perinatal outcomes with 2 (0.95%) perinatal deaths (Table 3). These were two false-positive and four false-negative test results.

Various diagnostic values in terms of perinatal morbidity were: sensitivity 66.7%, specificity 99.0%, positive predictive value 80.0%, negative predictive value 98.0%, and accuracy 97.1% (Table 4). Diagnostic values in terms of perinatal deaths were sensitivity 100%, specificity 96.2%, positive predictive value 20%, negative predictive value 100%, and accuracy 96.2% (Table 5).

Table 3
Test results and perinatal outcome[a]

Characteristic	No.	(%)
Testing time (min)	4.86	±0.72[b]
Test results		
Reactive	200	(95.2)
Nonreactive	10	(4.8)
Perinatal outcome		
Favorable	198	(94.3)
Adverse	12	(5.7)
Perinatal deaths	02	(0.95)

[a]N=210
[b]Mean±SD

Discussion

Early intrapartum fetal assessment with some form of admission test may help in identifying the fetus at risk of developing fetal distress during labor and requiring prompt cesarean delivery. A negative or reactive test may indicate a low probability of adverse outcome and thus reassuring. On the other hand, a positive or nonreactive test may imply a significant risk of fetal compromise that may lead to prompt abdominal delivery. A reliable fetal admission test may help in accurately identifying such high-risk fetuses so that limited perinatal resources can be utilized better and fetal distress resolved expeditiously by cesarean delivery.

FBP is a reliable test for assessing fetal well-being[15]. VAS improves the biophysical profile scores and shortens testing time. Fetal startle response to vibroacoustic stimulus in a study was found to be associated with a FBP score of ≥8[16]. Intrapartum fetal acoustic stimulation has also been reported to be useful in ruling out fetal acidemia[17]. In our study we have included startle response to VAS as a component for fetal biophysical dynamic assessment. The modified biophysical profile in the present study integrates VAS, startle response, and NST as a onetime composite fetal assessment in a much shorter testing time with high accuracy. Moreover, the end point of the test as reactive or nonreactive is easier to assess and interpret than the numerical FBP score.

Table 4
Diagnostic values in predicting perinatal morbidity[a]

	Percentage (95% CI)	No. of cases (*n/n*)
Sensitivity	66.7 (35.4-88.7)	8/12
Specificity	99.0 (96.1-99.8)	196/198
Positive predictive value	80.0 (44.2-96.5)	8/10
Negative predictive value	98.0 (94.7-99.4)	196/200
Accuracy	97.1	204/210

[a]N=210

Table 5
Diagnostic values in predicting perinatal deaths[a]

	Percentage (95% CI)	No. of cases (*n/n*)
Sensitivity	100 (19.8-100)	2/2
Specificity	96.2 (92.3-98.2)	200/208
Positive predictive value	20 (3.5-55.8)	2/10
Negative predictive value	100 (97.7-100)	200/200
Accuracy	96.2	202/210

[a]N=210

In terms of perinatal morbidity, VAS/mFBP demonstrated: sensitivity 66.7%, positive predictive value 80%, specificity 99%, negative predictive value 98%, and accuracy 97%. The sensitivity and positive predictive values of VAS/mFBP in our study are higher (66.7 and 80%) as compared to those reported by Tongprasert et al.[14] (50 and 50%, respectively) in a rapid biophysical profile which combined SPFM detected ultrasonographically and AFI. Intrapartum AFI has been reported to be a poor diagnostic test for adverse perinatal outcome and not recommended as a reliable and efficacious fetal admission test[5]. Inclusion of NST rather than AFI in our test may have enhanced its sensitivity. Moreover, since AFI was not a component of VAS/mFBP, women with ruptured membranes were not excluded from our study.

VAS/mFBP had a high specificity (99%) and positive predictive value (98%), thus implying that it is a reliable diagnostic test for assessing fetal well-being, as a negative or reactive test is unlikely to be associated with adverse perinatal outcome. On the other hand, a lesser sensitivity (66.7%) and negative predictive value (80%) imply that it is relatively less reliable as a screening test for identifying a compromised fetus, as a positive or nonreactive fetus needs further evaluation for confirming fetal compromise. In terms of perinatal deaths, it showed both high sensitivity (100%) and negative predictive value (100%). The practical implication in resource-constraint setting is that it may be useful as a rapid admission test for fetal well-being, so that limited perinatal resources can be optimally utilized for compromised fetuses.

In the present study the sample size was relatively small. Fetal or neonatal acidemia by fetal scalp blood/umbilical artery blood sampling was not studied as an outcome measure as the facility for the same was not available.

Randomized controlled studies with adequate power comparing VAS/mFBP with FBP and other admission tests are needed to validate the efficacy of VAS/mFBP for early intrapartum fetal assessment.

Conclusion

Because of its simplicity, ease of administration, short testing time, noninvasiveness, and high accuracy, VAS and modified FBP for early intrapartum fetal assessment is a reliable diagnostic approach.

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