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Research Paper

The Relationship Between the Full Biophysical Profile and Rapid Biophysical Profile in Antepartum Fetal Surveillance

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ABSTRACT

Background: One of the best tests for the assessment of a fetus is the biophysical profile test which has a significant effect on the fetus's health and the outcome of pregnancy. The present study was designed to determine the relationship between the full biophysical profile (FBP) and the rapid biophysical profile (RBP) tests in antepartum fetal surveillance.

Methods: In this prospective study, Singleton pregnancies (n=209) with more than 34 weeks of gestational age were chosen. Both FBP and RBP tests were performed for all the patients. The main outcome is the Apgar score and neonatal intensive care unit admission analyzed by SPSS software, version 24. The sensitivity, specificity, positive predictive value, and negative predictive value of RBP were calculated.

Findings: Out of 209 people who entered the study, 48 women (23.0%) had gestational diabetes, 84 women (40.2%) had hypertension pregnancy (preeclampsia), 45 people (21.5%) had intrauterine growth restriction, and 45 women (21.5%) had post-date pregnancy. For predicting adverse fetal outcomes of pregnancy, the sensitivity, specificity, positive predictive value, and negative predictive value of RBP were 95%, 73%, 52%, and 98%, respectively.

Conclusion: According to the statistically significant positive correlation between RBP and FBP and its simple and rapid application, RBP might be an acceptable alternative method for primary antepartum fetal screening tests in overcrowded obstetrics centers.

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1. Introduction

Every day, many pregnant women around the world give birth to their children. One of the important issues is that these babies are born healthy because the birth of disabled babies has dire consequences for both the baby and society [1]. Some of these consequences are psychological effects on babies and their parents, as well as the high costs of treating these newborns.

The assessment of fetal health, which aims to diagnose high-risk fetuses and prevent complications and neonatal mortality, typically consists of the non-stress test (NST), and the contraction stress test (CST), which are the response of the fetal heart rate to uterine contractions and fetal movements [2]. CST is a complex method that requires prescribing oxytocin, which is contraindicated in many cases such as abruption placenta, preterm delivery, and twin gestation [3]. Although the CST method has a lower false-negative result than NST, it is a test with high false-positive results that is now obsolete [4].

Currently, the stress-free test (NST), which is a simple and non-invasive method based on accelerating the fetal heart rate in response to fetal movements during uterine relaxation, is the most widely used primary method to assess fetal health with a few limitations [5]. Abnormal results of this test indicate fetal problems such as acute hypoxia. Some of its limitations include a high rate of false-positive results, lack of experienced interpreters, disagreement on its interpretation, and considerable length of time, which can make this test a non-ideal method [6].

Full biophysical profile test (FBP) first developed by Manning et al., examines 5 criteria for fetal health: Fetal respiration, fetal tone, fetal gross body movements, NST, and amniotic fluid index (AFI) [7]. In addition to the cost, time (about 30 minutes), and depreciation of the device, it also requires a skilled ultrasound specialist. In contrast, the rapid biophysical profile test (RBP), described by AFI measurement besides sound-provoked fetal movement (SPFM), is more cost and time-effective not requiring an experienced radiologist in high-risk pregnancies. So far, limited studies have compared these two tests [8, 9]. Considering the significance of diagnosing and assessing prenatal fetal health and the widespread use of prenatal screening tests, we decided to investigate the relationship between these two tests in high-risk pregnancies.

2. Materials and Methods

This study is a diagnostic descriptive-analytical study that was approved by the ethics committee of Qazvin University of Medical Sciences. At first, informed consent was obtained from the participants who met the inclusion criteria.

In the present study, 209 pregnant women with a gestational age of 34 to 42 weeks and high-risk pregnancies were included. An accessible sampling method was used to complete the select the participants. If any sample was removed, she was replaced by another pregnant woman. The inclusion criteria were defined as preeclampsia, intrauterine growth restriction (IUGR), gestational diabetes, and postdate who were admitted to the High-Risk Pregnancies Ward of Kosar Hospital in Qazvin. The exclusion criteria were defined as lack of consent to enter the study and satisfaction to cooperate, multifetal pregnancies, and fetal anomaly. First, the NST test was performed under the same conditions for all patients by the Medical Econet device. To perform NST, the patient was first placed in a supine position and a transducer was placed on her abdomen, and fetal heart rate (FHR) was tracked and recorded. If the heart rate was not accelerated by 20 minutes, the FHR recording time was increased to 40 minutes. Reactive NST was reported if the fetal heart rate accelerated to two or more beats. Non-reactive NST was reported if FHR was not accelerated after 40 minutes. Then, the patients underwent an FBR. Ultrasound with the UGEO w580a ultrasound device was performed by an expert radiologist, and the results were announced according to the criteria of Table 1. The score of each parameter was 0 or 2. If the total scores are more than or equal to 8, it will be normal; and if they are less than or equal to 6, it will be abnormal [1]. A rapid biophysical profile test was performed for all patients including two AFI parameters and the fatal movement response to the acoustic stimuli. AFI, previously measured at full BPP, was performed by the same radiologist and the same device after 5 minutes of rest after the full BPP, to examine the other parameter, i.e. fetal movement in response to the acoustic stimulus of SPFM. It was considered abnormal if it was less than or equal to 2, and if it was 4, it was considered normal. If the AFI parameter is reported as less than 5 cm, the condition is normal, and if it is greater or equal to 5 cm, it is abnormal.

SPFM was created by a 110 DB and 80 MHz acoustic stimulus by the same ultrasound device by placing the probe on the abdominal surface close to the fetal head position for 3 seconds.

Table 1. Full biophysical profile scoring system (modified from Manning et al.)

Biophysical Variables	Normal (Score=2)	Abnormal (Score=0)
FBM	One or more episodes of FBM >30 sec in 30 min	Absent or no episode of FBM >30 sec in 30 min
Gross body movements	3 or more discrete body/limb movements in 30 minutes (episodes of active continuous movement considered as single movement)	2 or less episodes of body/limb movements in 30 min
Fetal tone	1 or more episodes of extremity extension and subsequent flexion: opening and closing of hand considered normal tone	Either slow extension with a return to partial flexion or movement of the limb in full extension or absent fetal movements
NST	2 or more accelerations of 15 beats per minute for 15 sec within 20-40 min	0 or 1 acceleration within 20-40 min
AFI	>5 cm	<5 cm

FBM: Fetal breathing movement; AFI: Amniotic fluid index; NST: Non-stress test

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Interpretation: Score=8-10 normal fetus; Score=6 fetal hypoxia suspicious; Score=0-4 fetal hypoxia;

Modified from Manning et al. and Voxman et al.

If the fetal movement occurs within 15 seconds of the acoustic stimulus, it is considered normal and receives a score of 2. If the movement does not occur within 15 seconds after the acoustic stimulus, the acoustic stimulus can be repeated up to three times before termination. If after repetitions, fetal movements do not occur, it receives a score of zero, and an abnormal result is reported. After the termination of pregnancy, the results were examined in the form of 1 and 5-minute neonatal Apgar scores and hospitalization in the NICU. It should be noted that fetal care for all patients was performed based on FBP, which is the gold standard.

3. Results

In this study, 209 pregnant women with a mean and standard deviation of 26.06±6.69 years were studied. The mean and standard deviation of their body mass index (BMI) were 31.05±5.59 kg/m^2. The mean and standard deviation of gestational age at the end of pregnancy were calculated as 37.11±1.9 weeks. Overall, 90 women (43.1%) gave birth by vaginal delivery and 119 mothers (56.9%) gave birth by cesarean section. Besides, 48 women (23%) had gestational diabetes, 84 (40.2%) women had gestational hypertension (preeclampsia), 45 (21.5%) women had IUGR, and 45 women (21.5%) had post-date pregnancy. Moreover, 36 women (17.2%) suffered from membrane rupture and 9 women (4.3%) had postdated pregnancies.

Among the studied pregnant women with a high-risk pregnancy, 49 (23.4%) had an abnormal FBP and 160 (76.6%) had normal results. Also, 90 women (43.1%) had abnormal RBP results and 119 women (56.9%) had normal results.

Out of 49 women with abnormal FBP, 47 (95.9%) had abnormal RBP and 2 (4.1%) had normal RBP.

Also, out of 160 women with normal FBP, 117 women (73.1%) had normal RBP and 43 women (26.9%) had abnormal RBP.

Using the kappa index, FBP and RBP tests, as well as the NST test were determined demonstrating that there is a direct and significant correlation between the scores of full and rapid biophysical profile methods and the scores of NST and FBP (Table 2).

Table 2. Study of kappa index between FBP and RBP scores

Variables	FBP Score	
	Kappa	P
RBP	0.535	<0.001
NST	0.087	<0.001

RBP: Rapid biophysical profile; NST: Non-stress test.

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Furthermore, there was a significant relationship between IUGR and FBP test results with a significance level of 0.046, and 64.4% of women with IUGR had normal FBP, while this rate was about 80% for women without IUGR.

There was no significant relationship between the rapture of the membrane and postdate with the results of the RBP test. However, there was a significant relationship between diabetes and the results of the RBP test with a significance level of 0.031, and 70.8% of women with diabetes had normal RBP test results, while this rate was 52.8% for women without diabetes. A significant relationship was found between preeclampsia and the results of the RBP test with a significance level of 0.047, and 65.5% of women with preeclampsia had normal biophysical profile test results. In women with no high blood pressure, this rate was about 51%.

Additionally, there was a significant relationship between IUGR and the results of the RBP test with a significance level of 0.011, and 40% of women with IUGR had normal RBP test results. In women without IUGR, this rate was about 61%.

In the present study, the sensitivity of the RBP method was 95% compared to the FBP method which was 73%. Also, a positive predictive value of 52% and a negative predictive value of 98% were obtained. Finally, the diagnostic accuracy of the RBP test was calculated at 78%.

These values demonstrate that the strength of FBP in diagnosing high-risk pregnancies is 95% (sensitivity) which appears an acceptable value. However, the strength of this test in detecting normal women was 73% (specificity) which is not considered a desirable value.

Also, the percentage of women with high-risk pregnancies in women with positive results of the RBP test was 52% (positive predictive value), and the percentage of normal women in women with a negative result of the test was 98% (negative predictive value).

The accuracy of the RBP test in diabetic pregnant women was higher than other women (91.6%); while in postdate pregnant women, the accuracy was 66.6%, which was less than others.

The relationship between the RBP test result and the FBP test components was analyzed. In all cases, the relationship between the FBP test components and the results of the RBP test results was significant (P<0.001) (Table 3).

According to the t-test results, there was no significant difference between the scores of Apgar min 1 and 5 and RBP. However, there was a significant difference between admission to the NICU with the results of RBP at the significance level of 0.016. In addition, 17.8% of infants whose mothers had abnormal RBP test results were hospitalized in the NICU; while this percentage was 6.7% in infants whose mothers had normal RBP test results.

Also, 51.1% of infants whose mothers had abnormal RBP test results, weighed less than 2.5 kg at birth, while this percentage in infants whose mothers had normal RBP test results was 14.3% (considered abnormal <0.001).

Table 3. Relationship between fetal consequences and rapid biophysical profile test results in high-risk pregnant women

Variables		No. (%)/Mean±SD		P
		Abnormal RBP (n=119)	Normal RBP (n=90)	
NICU	Yes	16(17.8)	8(6.7)	0.016
	No	74(82.2)	111(93.3)	
Low birth weight (≤2500)	Yes	46(51.1)	17(14.3)	0.001>
	No	44(48.9)	10.2(85.7)	
Apgar	Min 1	8.50±0.78	8.54±1.04	0.726
	Min 5	9.54±0.62	9.63±1.04	0.488

RBP: Rapid biophysical profile; NICU: Neonatal intensive care unit.

4. Discussion

The present study investigated the relationship between FBP and RBP tests in fetal health assessment methods. This study was performed on 209 mothers with singleton pregnancies without fetal malformations and with high-risk pregnancies in 4 groups diabetes, preeclampsia, IUGR, and post-date pregnancy. Most of the studied groups were mothers with hypertension (preeclampsia) followed by diabetes (40% and 23%).

This study showed that the average age of patients, BMI, and gestational age at birth were 26.06±6.69 years, 31.05±5.59 kg/m^2, and 37.11±1.9 weeks, respectively. Besides, 39.02% of patients were nulliparous and 60.8% were multiparous. In the study conducted by Prabhu et al. [10] in 2015, both FBP and RBP were examined in India, and the mean age of mothers and time of birth was 26.63 years and 38.5 weeks, which was consistent with our study. The number of nulliparous individuals was 67.7% and the rate of vaginal delivery was 58.8%, which was more than the number of nulliparous cases and fewer cesarean deliveries compared to our study. This discrepancy may be due to differences in the structure of the studied population and the national protocol, and our study was performed in a level 3 hospital on high-risk patients, which of course increases the rate of cesarean section.

In our study, FBP had 76.6% normal results and 23.4% abnormal results. The RBP test also had 57% normal results and 43% abnormal results. The correlation coefficient of the two tests was 0.795 (P<0.001), which was statistically significant and indicated a strong relationship between the two tests. In the study conducted by Prabhu et al. [10], the correlation between FBP and RBP was 0.62, and P<0.001, which is completely consistent with the results of our study. However, in our study, this correlation was stronger.

In the study conducted by Phattanachindakun et al. [9] in Bangkok, which investigated the relationship between FBP and RBP, both tests were performed on 200 pregnant women with the gestational ages of 30 to 42 weeks. Similar to our study, abnormal results of FBP and RBP were defined as 6≥ and 2≤,1.5% of patients had abnormal results of FBP and 6% had abnormal results of RBP. In this study, which is consistent with our study and Ashkay's study, the companionship of RBP with FBP is more than that of NST with FBP (r=0.67 vs. r=0.33).

In the present investigation, the results of the RBP and FBP components were examined. In all cases, there was a significant relationship between RBP test results and FBP test components (P<0.001).

In the study conducted by Prabhu et al., only NST and RBP were statistically significant, and there was no significant relationship between the other components. This discrepancy may be due to the larger sample size in our study and the difference in the interpretation of the radiologist performing the test [10].

Using the Chi-square method, the relationship between the groups of diabetes, preeclampsia, IUGR, and postdate was examined by RBP and FBP tests. The FBP test showed a statistically significant relationship only in the IUGR and preeclampsia groups [11]. However, in the RBP test, in addition to the IUGR and preeclampsia groups, the diabetes group was also statistically significant. The results of mothers with postdate were not significantly associated with any of the FBP or RBP test results. However, it was consistent in patients with preeclampsia, IUGR, and postdate, which indicates that the BPP test is compatible with the RBP test.

In this study, the sensitivity of the RBP test compared to the FBP test was 95% and its feature was 73%. Also, the positive predictive value was 52% and the negative predictive value was 98%. Finally, the diagnostic accuracy of RBP was 78%. These values indicate that the strength of RBP in the correct diagnosis of high-risk embryos was 95% (sensitivity), which is an acceptable value. However, the ability of this test to diagnose the health of pregnant women with no high-risk pregnancies was 73% (specificity), which is not very desirable.

In the study conducted by Prabhu et al. [10], the sensitivity, feature, positive predictive value, and negative predictive value were 71.4, 87.1, 35.7, and 96.8%, respectively. In comparison, our study had lower specificity but higher sensitivity, positive predictive value, and negative predictive value than Prabhu et al.'s study. Also, the positive likelihood ratio was 3.51. According to this value, the ratio of patients with positive test results to the ratio of women with the same positive test is approximately 3.5 times. The sensitivity, specificity, positive predictive value, and negative predictive value of RBP were examined and analyzed separately for each group of RBP. Results demonstrated that, in our study, the diagnostic accuracy of RBP was highest in diabetes patients (91.6%) and lowest in postdate patients (66.6%). To the best of our knowledge, no study has ever examined and analyzed two tests of FBP and RBP in various subgroups.

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Pregnancy outcome in our study was measured by NICU admission criteria, weight less than 2500 g, and Apgar 1 and 5. It indicated that the RBP did not have a significant relationship with Apgar; however, it had a significant relationship with the rate of hospitalization in the NICU and the weight of less than 2500g. In a study conducted in 2013 by J. Czeresnia et al. [5] in Brazil to examine the applicability and usage of RBP for the evaluation of fetal health in high-risk pregnancies, RBP results were compared with neonatal Apgar scores. This cross-sectional study was conducted on 37 high-risk pregnant women. RBP was performed 24 hours before delivery. Finally, results showed a significant relationship between the results of RBP and Apgar.

In the study conducted by Prabhu, the outcomes of pregnancy were examined at minutes 1 and 5 Apgar and the NICU. In this study, the relationship between both RBP and FBP with 1 and 5 Apgar was significant. The results showed that the relationship between RBP and Apgar 1 and 5 was stronger than that of FBP. In this study, there was also a significant relationship between FBP and RBP with hospitalization in the NICU.

As a result, Prabhu and Buraya's studies on the relationship between RBP and Apgar scores are consistent with each other but inconsistent with our study. This discrepancy can be due to the differences in the way of evaluating the neonatal Apgar scores in this hospital. However, considering the relationship between NICU and RBP, our study was consistent with Prabhu's study and was significant. Also, the relationship between RBP and a weight less than 2500g was examined, which was not investigated in other studies, and was significant in this study.

5. Conclusion

Given the obtained data and the positive correlation between RBP and FBP, and its ability to predict adverse outcomes, RBP can be used as a fetal health screening test for high-risk pregnancies in crowded maternity centers with no experienced staff or advanced monitoring equipment [12]. Particularly, simplicity, shorter duration, and no need for an experienced NST interpreter make RBP a good choice for obstetrics and gynecology centers with limited equipment and without experienced NST interpreters. In addition, RBP does not need high-resolution ultrasound equipment. However, the accuracy of the RBP test (in terms of sensitivity, specificity, false positive, and false-negative rates) needs to be widely validated, a larger number of the population should be examined, and more tests should be performed, including abnormal tests [13]. For high-risk pregnancies with abnormally rapid BPP, we recommend that patients undergo NST followed by an FBP. However, because only a few patients have an abnormal RBP score, it saves considerable time and energy.

Ethical Considerations

Compliance with ethical guidelines

The present study was approved by the Ethics Committee of Qazvin University of Medical Sciences with an ethical code of IR.QUMS.REC.1398.113.

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Authors' contributions

All the authors contributed equally to the preparation of this work.

Conflict of interest

The authors declared no conflict of interest.

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