Predictive value of biophysical profile in determining the immediate postpartum neonatal outcomes in preterm premature rupture of membranes (PPROM)

Shabnam Jafari Zareh[1], Shamsi Abbasalizadeh[1], Fatemeh Abbasalizadeh[1], Amirreza Jahanshahi[2]

1-Women's Reproductive Health Research Center, Department of Obstetrics & Gynecology, Faculty of Medicine, Tabriz University of Medical Sciences, Tabriz, Iran.
2-Assistant professor of Radiology, Department of Radiology, Faculty of Medicine, Tabriz University of Medical Sciences, Tabriz, Iran.
sabbasalizadeh@yahoo.com

Abstract: Evaluating predictive value of BPP and Non-stress test (NST) in determining immediate postpartum neonatal outcomes in PPROM patients. In an analytic-descriptive study on 156 PPROM singleton pregnancies at gestational age of 34-37 weeks in Al-Zahra Center, Tabriz, during a 13-month period, BPP and NST were conducted on all patients before pregnancy termination. ABG analysis was conducted in all newborns, categorizing them into two groups: normal or abnormal (acidosis or alkalosis). Abnormal BPP was considered as total score ≤6. Predictive value of BPP and NST was evaluated accordingly. In predicting immediate postpartum neonatal outcome based on ABG results, sensitivity, specificity, positive/negative predictive values, and accuracy of BPP was 52.9%, 91.1%, 62.1%, 87.4% and 81.1%, respectively. There was a significant positive correlation between total BPP score and Apgar scores on minutes 1, 3 and 5. In the same circumstances, sensitivity, specificity, positive predictive/negative predictive values, and accuracy of NST was 50%, 89.3%, 56.7%, 86.5% and 80.8%, respectively. Mean Apgar scores on minutes 1, 3 and 5 were significantly higher in cases with reactive NST result. Based on our results, although there was a significant relationship between fetal outcome of mothers with PPROM, and BPP and NST results, these two modalities may not be efficient in predicting final fetal outcome due to low sensitivity.

1. Introduction

Premature Rupture of Membranes (PROM) is a condition in which the curtains are torn at any time before the beginning of labor contractions. If this occurs before 37 weeks of pregnancy, it is defined as preterm PROM (PPROM) (Martin, 2005).

In such situation, 85% of neonatal morbidity and mortality is due to prematurity. PPROM is associated with 30 to 40 percent of preterm deliveries and known as the main detectable factor of this condition. Other factors threatening the fetus in PROM or PPROM include infection, torn placenta, fetal distress, deformity, pulmonary hyperplasia and death. Fetal death is observed in 1% of followed up expectant PROM cases (Mercer, 1998).

When PPROM occurs far after the term, the rate of maternal and neonatal morbidity and mortality significantly increase. Therefore, careful medical care in women with PPROM is of great importance (Kirpalani, 2006).

Biophysical profile (BPP) is a non-invasive method to assess the health of the fetus before birth. In this method, the possibility of asphyxia and risk of fetal death are investigated (Manning, 1999).
Evaluation of PPROM patients using BPP has been mostly performed for predicting the risk of maternal or fetal infection; yet, there is no unanimity about the efficacy of this method for this purpose (Del Valle, 1992; Lewis, 1999; Vintzileos, 1987; Miller, 1990; Devoe, 1994; Hovick, 1989; Romero Arauz, 2005).
Few studies have addressed the relationship between PPROM and BPP, according to which, contradictory results have been reported (Vintzileos, 1985; Ghidini, 2000; Vintzileos, 1986).

Regarding this fact, and given the importance of early prediction of neonatal outcome in PPROM pregnancies using a noninvasive test, we intended to evaluate the efficacy of BPP in predicting the outcome of such pregnancies.

2. Material and Methods

In a descriptive - analytical study, 156 pregnant women with preterm premature rupture of membranes (PPROM) were studied.

Non-stress Test (NST) and Biophysical Profile (BPP) and their value in predicting pregnancy outcome were determined in these patients. Place of research was Al-Zahra medical training of Tabriz. Study duration was 13 months from October 22, 2008 to November 21, 2009 and basic data collection and data analysis has been done.

Ratio estimation formula was used to determine the sample size. Given α= 0.05, d=0.04 and p=5% and the study power of 80%, the number of patients were estimated to be 150.

Mothers were selected using numbers randomly generated by a computer (simple random sampling). In this study, 156 women with singleton pregnancies, gestational age of 37-34 weeks and confirmed PPROM were studied.

Immediately before the decision to terminate the pregnancy, biophysical profile (BPP) and non-stress test (NST) was done in all women; and after the termination of pregnancy, Umbilical Cord ABG was determined for all infants.

In this study, Abnormal BPP is considered as profile ≤ 6/10. According to the results of ABG of umbilical cord, infants were divided into two groups of normal and abnormal (with acidosis or alkalosis). Predictive value of the BPP and NST were separately calculated in this field. The correlation between infants' Apgar score and BPP score was also determined. Predictive value of the BPP and NST in the prognosis during hospitalization of infants was determined.

Exclusion criteria included a history of systemic diseases such as hypertension, diabetes mellitus, cardiac or renal diseases and connective tissue, fetal abnormality and intrauterine growth retardation (IUGR), any signs of infection such as fever, maternal and fetal tachycardia, pain and abdominal allergy, and symptoms of placental abruption including vaginal bleeding and abdominal pain and having active labor and discretion of fetal meconium. All women were included in this study signing a written consent.

No additional costs were charged on the people under study. For people with mental disabilities and those who were not able to read and sign the consent form, two first-degree relatives were assigned to fill the consent form.

This study has been approved by the Ethics Committee of Tabriz University of Medical Sciences. The issues studied included gestational age, overall score of biophysical profile (BPP), non-stress test (NST) result, birth weight, first minute Apgar score, third minute Apgar score, fifth minute Apgar score, the arterial blood gas (ABG) analysis result, and pregnancy outcome. The obtained data is expressed as Mean ± SD, frequency and percentage.

Statistical software used is SPSS™ ver.15. To compare quantitative data, Independent samples T-test or Mann-Whitney U-test were used. To compare qualitative data, Chi-square test or Fisher's exact test was used. Distribution of quantitative data was evaluated using Kolmogorov–Smirnov Z test. Spearman coefficient (rho) was calculated to determine the correlation. In all cases, p≤0.05 is considered significant. Sensitivity, specificity, positive predictive value, negative predictive value and accuracy of the tests are determined based on the following relationships.

3. Results

156 pregnancies with preterm premature rupture of membranes (PPROM) were studied. The mean gestational age was 35.5 ± 0.8 (34-37) weeks and the mean overall score of biophysical profile (BPP) was 7.5 ± 1.9 (2-10).

Accordingly, BPP score in 56 (35.9%) was about 8 to 10, in 71 (45.5%) cases was 6 to 8 and in 29 (18.5%) of cases was 6 or less.

The result of non-stress test (NST) was normal (reactive) in 126 (80.8) and abnormal (non-reactive) in 71 (45.5) cases. Mean birth weight was 2358.8 ± 284.8 (1959-2876) g, mean first minute Apgar score was 1.7 ± 1.8 (3-10), mean third minute Apgar score was 7.9 ± 1.6 (3-10) and mean fifth minute Apgar score was 8.8 ± 1.3 (2-10). According to the results of arterial blood gas (ABG) analysis, 122 (78.2) cases were normal and 34 (21.8) cases were abnormal. Accordingly, the cases with abnormal ABG Included: metabolic acidosis: 16 (47.1%) cases, metabolic alkalosis: 6 (17.6%) cases, respiratory acidosis: 7 (20.6%), and mixed disorder: 5 (14.7%) cases. All infants were discharged.

The relationship between infant's ABG and NST: Frequency percentage of cases with non-reactive NST was significantly higher in the group with abnormal ABG (50% vs. 10.7%;P<0.001 , OR=8.4)(Table I)

The relationship between infant's ABG and BPP: Frequency percentage of cases with BPP≤6 was significantly higher in the group with abnormal ABG (52.9% vs. 9%; P<0.001)(Table II).

The relationship between infant's Apgar score and ABG: The mean Apgar score of infants regarding their ABG condition is summarized in Table 1. Accordingly, the mean Apgar scores at minutes 1, 3 and 5 were significantly higher in the group with normal ABG(table III).

The relationship between NST and BPP: Frequency percentage of cases with BPP≤6 was significantly higher in the group with non-reactive NST (43.3% vs. 12.7%; P<0.001)(Table IV).

The relationship between NST and the Apgar score: The mean Apgar score of infants regarding their NST condition is summarized in Table 2. Accordingly, the mean Apgar scores at minutes 1, 3 and 5 were significantly higher in the group with reactive NST(Table V).

The relationship between BPP and the Apgar score: A moderate and significant positive correlation

was observed between Apgar scores of minutes 1 (rho=0.371, P<0.001), 3 (rho=0.349, P<0.001), and 5 (rho=0.305, P<0.001).

Determining the predictive value of NST based on infant's ABG, sensitivity, specificity, positive predictive value, negative predictive value and accuracy were 50, 89.3, 56.7, 86.5 and 80.8 percent respectively. Determining the predictive value of BPP based on infant's ABG, sensitivity, specificity, positive predictive value, negative predictive value and accuracy were 52.9, 91.1, 62.1, 87.4 and 81.1 percent respectively.

Table I: Result of ABG at the base of NST results

| ABG | NST | | P-value | OR |
	Reactive	Non Reactive		
Normal	109(89.3%)	13(10.7%)	<0.001	8.39
Abnormal	17(50%)	17(50%)		

Table II: Result of ABG at the base of BPP results

| ABG | BPP | | | P-value |
	≤ 6	6-8	8-10	
Normal	11(9%)	59(47.5%)	53(43.5%)	<0.001
Abnormal	18(53%)	13(38.2%)	3(8.8%)	

Table III results of neonatal Apgar at minute 1, 3 and 5 at the bale ABG results

| Apgar | ABG | | P-value |
	Normal	Abnormal	
Minute 1	7.9 ± 1.0	4.2 ± 0.8	<0.001
Minute 3	8.5 ± 1.0	5.7 ± 1.0	<0.001
Minute 5	9.3 ± 0.8	6.9 ± 1.3	<0.001

Table IV: NST results at the base of BPP

| NST | BPP | | | P-value |
	8-10	6-8	≤ 6	
Reactive	16(12.7%)	59(46.8%)	51(40.5%)	<0.001
Non Reactive	13(43.3%)	12(40%)	5(16.7%)	

Table V: Results of neonatal Apgar at minute 1, 3 and 5 at the base of NST results

| | NST | | |
Apgar	Reactive	Non Reactive	P-value
Minute 1	7.4 ± 1.7	4.2 ± 0.8	<0.001
Minute 3	8.2 ± 1.5	7.0 ± 1.7	0.001
Minute 5	9.0 ± 1.1	8.0 ± 1.8	0.003

4. Discussions

In this study, the predictive value of biophysical profile (BPP) and non-stress test (NST) was examined in determining the immediate after birth consequences in pregnancies with preterm premature rupture of membranes (PPROM).

Frequency percentage of cases with abnormal umbilical cord ABG in the group with BPP≤6 and abnormal NST group was significantly higher than that in the group with BPP>6 and normal NST group.

Also, a moderate significant correlation was observed between overall BPP score and Apgar score at minutes 1, 3 and 5. Mean Apgar scores at minutes 1, 3 and 5 in the group with normal NST were also significantly higher than those in the group with abnormal NST.

Finally, sensitivity, specificity, positive predictive value, negative predictive value and accuracy predicting the immediate after birth consequences in PPROM pregnancies based on ABG results of umbilical cord were calculated 52.9, 91.1, 62.1, 87.4 and 81.1 percent respectively for BPP; and 50, 89.3, 56.7, 86.5 and 80.8 percent respectively for NST.

Although numerous studies have been done in this area, most studies have only examined the results in PROM pregnancies. On the other hand, the congenital or neonatal consequences have been limited to infection only. In this regard, based on the results, the related studies can be divided into two general categories:

A) Studies introducing BPP and NST to be useful in this situation and recommending them:

Vintzileo et al (1987) in a study on 13 PPROM cases showed that frequency percentage of cases with worse neonatal or maternal prognosis is higher in the group with abnormal BPP and NST (Vintzileos, 1987).

Hovick et al (1989) in another study showed that BPP can improve Apgar score and prevent infection predicting the fetal condition (Hovick, 1989).

Fleming et al (1991) in another study have recommended using BPP to follow up the cases with PPROM (Fleming, 1991).

Roussis et al (1991) in a study have studied 99 PPROM cases. Sensitivity and specificity of NST predicting neonatal infection or chorioamnionitis were reported 75% and 95% respectively(Roussis, 1991).

Accordingly, using BPP and NST to predict the risk of infection in these patients has been recommended (Leeman, 1996).

In the study by Arauz et al (2005), 75 patients with gestational age of 27-33 weeks with PROM were studied(Romero Arauz, 2005).

All cases were under conservative treatment. In this study, it was shown that the prevalence of infection in cases with BPP≤6 was significantly higher than that in other groups.

Sensitivity, specificity, positive predictive value and negative predictive value of BPP predicting pre-

birth infection, were reported 80, 85, 64 and 85 percent respectively (Hannah, 2000).

B) Studies not recommending BPP and NST in this situation:

Gauthier et al (1992) in a study on 111 PPROM cases showed that, although cases with chorioamnionitis are significantly more in the group with abnormal BPP and non-reactive NST, none of them possess the sensitivity and specificity sufficient to predict the situation and therefore, should not be considered for this purpose (Gauthier, 1992).

Del Valle et al (1992) in another study investigated the cases with prolonged PPROM. In this study, there was no significant correlation between chorioamnionitis or fetal infection and abnormal BPP (≤ 6) or non-reactive NST. Finally, it was concluded that none of the two tests have the needed efficiency in this group of patients (Del Valle, 1992).

Devoe et al (1994) in a study on 50 PPROM cases showed that the sensitivity of BPP is low predicting the neonatal outcome (Devoe, 1994).

In another study, Carroll et al (1995) studied 89 patients with PPROM. This study showed that intrauterine infection can lead to lower BPP score and non reactive NST; however, regarding low predictive value of these tests, none have been recommended (Carroll, 1995).

In a study by Lewis et al (1999), 135 patients with PPROM were studied. In this study, BPP≤ 6 was considered abnormal. Sensitivity, specificity, positive predictive value and negative predictive value in predicting neonatal complications were reported 39.1, 84.6, 52.9 and 75.9 percent respectively for BPP, and 25, 92.6, 66.7 and 68.4 percent respectively for NST (Lewis, 1999).

Ghidini et al (2000) in another study on 166 PPROM cases showed that there is no significant relationship between the BPP score and incidence of acute infection, and this test is not recommended (Ghidini, 2000).

According to the results by the studies mentioned, it seems that our findings are more consistent with the results of the second category, which means that although the abnormal results of BPP and NST infants have been associated with worse neonatal prognosis, use of these two modalities is not a reliable predictor of neonatal outcome.

Should be noted that the studies mentioned in the first category either were some old reviews, or they had low sample size. More modern methods of support for pregnant mothers and infants after birth may have made the results by new studies distinct from previous studies (Vintzileos, 1987; Hovick, 1989; Leeman, 1996; MacDonald, 2005).

In the study by Arauz et al (2005), only patients with PROM have been studied and this led to improved results, and generally, prognosis (Romero Arauz, 2005).

Bobby et al (2003) compared the two tests in this regard and concluded that despite NST is a simple method, it has high false positive cases. In this study, the sensitivity of BPP has been reported higher than that of NST (Bobby, 2003).

In our study as well, the sensitivity of NST and BPP has been the main weak point of the two tests predicting neonatal outcome. Accordingly, these two tests are not recommended to predict the neonatal prognosis in these cases, although they may be helpful for follow-up and control.

Conclusion

Sensitivity, specificity, positive predictive value, negative predictive value and accuracy of biophysical profile predicting immediate after birth consequences in pregnancies with preterm premature rupture of membranes based on ABG results of umbilical cord were 52.9, 91.1, 62.1, 87.4 and 81.1 percent respectively.

There was a direct and significant relationship between overall biophysical profile score and Apgar scores at minutes 1, 3 and 5 of this group of infants. Sensitivity, specificity, positive predictive value, negative predictive value and accuracy of NST predicting immediate after birth consequences in pregnancies with preterm premature rupture of membranes based on ABG of umbilical cord were 50, 89.3, 56.7, 86.5 and 80.8 percent respectively.

The mean Apgar scores at minutes 1, 3 and 5 were significantly higher in the group with a reactive NST.

Suggestions

According to the results of the present study, sensitivity of biophysical profile and non-stress test predicting immediate after birth consequences in pregnancies with preterm premature rupture of membranes based on ABG results of umbilical cord is low.

Therefore, the use of these two tests is not recommended in these groups of patients and for this purpose.

However, due to the relationship between the neonatal prognosis and the results of BPP and NST, the use of these two tests is helpful and still recommended for monitoring the patients and following up the condition of fetus.

Corresponding Author:
Dr. Shamsi Abbasalizadeh

Women's Reproductive Health Research Center, Department of Obstetrics & Gynecology, Faculty of Medicine, Tabriz University of Medical Sciences, Tabriz, Iran.
E-mail: sabbasalizadeh@yahoo.com

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9/26/2012