## Original Article

# The predictive value of ultrasound assessment of amniotic fluid index, biophysical profile score, nonstress test and foetal movement chart for meconium-stained amniotic fluid in prolonged pregnancies

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## Abstract

**Objective:** To evaluate the value of non-stress test (NST), biophysical profile score (BPS), amniotic fluid index (AFI) and foetal movement charted (FMC) by mother in the prediction of meconium passage in post-date pregnancies.

**Methods:** In a cross-sectional study performed from 2003 to 2005, in the Ali-Ebne-Abitaleb Hospital, all post-date singleton pregnant women were included and evaluated a few hours before delivery for AFI, NST, BPS and FMC. Based on the results of the mentioned tests the occurrence of foetal distress was foreseen and the judgments were compared with the results of evaluation of the amniotic fluid after amniotomy during labour. Our judgment of occurrence of foetal distress was based on meconium staining of amniotic fluid (MSAF) as the gold standard.

**Results:** In this study 250 women were included. The sensitivity and specificity of these tests respectively were: 62% and 42% for NST, 66% and 56% for BPS, 38% and 83% for AFI and 44% and 64% for FMC. The highest positive predictive value was recorded respectively for AFI (52%) and negative predictive value was recorded for NST (94%). There was a significant association between MSAF and BPS. In univariate analyses, there was a significant association between MSAF and BPS (P = 0.010 for linear by linear association, exact method). Also there was a significant association between MSAF and AFI< 5 cm. (OR= 2.99, 95% CI, 1.57-5.74).

**Conclusion:** Although BPS and AFI had the highest level of prediction, they are of limited usefulness in prediction of foetal distress. The reactive NST is more conclusive (JPMA 59:471; 2009).

## Introduction

Post term pregnancies are associated with numerous adverse outcomes. In addition to mortality, there is an increased risk of meconium aspiration syndrome, neonatal seizure and long term handicap.[1]

The management of pregnancy beyond 40 week's gestation relies on an accurate assessment of the gestational age. Many authors agree with expectant management and foetal monitoring of a low risk prolonged pregnancy. This often includes twice-weekly non-stress test (NST) detection of amniotic fluid index (AFI) by ultrasonography, and biophysical profile score (BPS).[2,3] However, the majority of still births now occur in low risk women.

Elective labour induction at 41 weeks gestation compared with expectant management until 44 weeks gestation has been proposed to reduce rates of cesarean section[4] and lower perinatal mortality rate.[5]

Evidence of benefit from antenatal surveillance is lacking[6] and no single antenatal test is superior to another.[3] "The aim of this study was to assess the sensitivity and specificity of the BPS, NST, AFI, FMC (foetal movement charted by mother) as an early intrapartum non-invasive predictor of foetal hypoxia. The meconium-stained amniotic fluid (MSAF) was used as a representative (proxy variable) for hypoxia."

## Subjects and Methods

Between June 2003 and June 2005, all postdate singleton pregnant women who were admitted to the labour unit of Ali-Ebne-Abitaleb Hospital of Zahedan University, Iran and who expected to be delivered within 24 hours and had the inclusion criteria joined the study. Pregnant women who were admitted to labour and delivery, but who remained undelivered and were subsequently admitted to the antenatal hospital wards, were excluded.

The present prospectively designed study was approved by the ethics and clinical studies committee of Zahedan University of Medical Sciences and informed and signed consent was obtained from all the patients who were enrolled in the study. Singleton pregnancy beyond 40 weeks gestations, with intact membranes and cephalic presentation were included. The expected date of delivery was calculated from menstrual dates or ultrasound in early pregnancy.

Exclusion criteria were multiple gestations, premature rupture of membrane, known foetal anomalies, maternal medical complications such as diabetes and hypertension.

The non stress test (NST) was performed one hour after free infusion of 500 ml dextrose 5% solution for each participant. Each session of NST lasted about 20 minutes. A NST was considered reactive or normal when two or more foetal heart accelerations were at least 15 beats/min and 15 sec in duration were noted within a 20-min period. As the most common cause for a nonreactive test is a period of foetal inactivity or quiet sleep and not hypoxia. Hence, if the test result was interpreted as non reactive, the test would continue for another 20 minutes.[7,8] The gold standard in evaluation of the accuracy values of the tests in predicting foetal distress was the status of the foetus after birth with regard to meconium staining.

Then biophysical profile score (BPS) and measurement of amniotic fluid index (AFI) were performed by Radiologist who was blinded to the participants clinical information using a real time ultrasonographic device (ALOKA model SSD 680; ToKyo, Japan) with a curvilinear 3.5- MHZ transducer.

Biophysical profile components included: nonstress test, foetal breathing, foetal movement, foetal tone and amniotic fluid volume. Normal variables were assigned a score of two each and abnormal variables a score of zero.[8] Thus, the highest score possible for a normal foetus was 10.

The AFI was calculated by adding the vertical depths of the largest pocket in each of four equal uterine quadrants and AFI of equal to or more than 5cm was considered normal.[8]

Foetal movement was charted by the mother (FMC) and recorded during 2h after ultrasonography. A perception of 10 foetal movements in up to 2 hours was considered normal.

After amniotomy, colour of amniotic fluid was recorded (clear or meconium stained). Based on the completed questionnaires, a computerized data bank was produced. These data were analyzed using SPSS version 12 (SPSS Inc., Chicago, IL, USA), and Stata version 8 (version 8.0 STATA Corp., College Station, TX, USA). For univariate analysis the odds ratio statistic (OR), linear by linear association, exact method were used.[9] The sensitivity and specificity and positive and negative predictive values of BPS, NST, AFI, FMC in predicting meconium-stained amniotic fluid were calculated using Microsoft Excel (version 2000). The 95% confidence intervals (CI) were calculated by assuming normal approximation of binomial distribution. All P-values $< 0.05$ were considered statistically significant.

## Results

Two hundreds and fifty women were approached for inclusion in the study. The demographic characteristics of the women in the study are shown in Table-1. The frequency of MSAF was 21.2%. There was no perinatal death.

The sensitivity and specificity of the NST, BPS, AFI and FMC in predicting meconium-stained amniotic fluid are presented in Table-2.

**Table-1: Demographic data of study women .Values are numbers of women (%) and mean ± SD.**

| | |
|---|---|
| Age (years) | 27.2 ± 5.2 |
| Nulliparous | 178 (71.2) |
| gestational age | |
| 40 weeks | 102 (40.8) |
| 41 weeks | 93 (37.2) |
| ≥ 42 weeks | 55 (22) |
| Induction of labor | 87 (34.8) |
| Mode of delivery | |
| Normal vaginal delivery | 173 (69.2) |
| Caesarean section | 77 (30.8) |
| Apgar < 7 | |
| 1 min | 50 (20) |
| 5 min | 15 (6) |
| Admission to neonatal unit | 30 (12) |

The negative predictive value of NST (94%) and foetal movement chart by mother for MSAF (91%) was higher than other tests and the positive predictive values was 12% and 10%.

The positive predictive value of AFI for MSAF was 52% and the negative predictive value was 76%. The positive predictive value of BPP $\leq 6$ for MSAF was 41% and the negative predictive value was 79%.

**Table-2: Sensitivity and Specificity (95% CI) of foetal well being tests for the prediction of meconium-stained Amniotic fluid.**

| Test | Sensitivity(95% CI) | Specificity(95% CI) |
|---|---|---|
| Non stress test | 62% (41% - 83%) | 42% (34%- 49%) |
| Biophysical profile(? 6) | 66% (55% -77%) | 56% (48%- 64%) |
| Amniotic fluid index(<5 cm) | 38% (26% - 49%) | 83% (77%- 89%) |
| Foetal movement chart | 44% (25%- 64%) | 64% (58%- 71%) |

In univariate analyses, there was a significant association between MSAF and BPS ($P = 0.010$ for linear by linear association, exact method). In other words, as BPS increased, the probability of MSAF decreased. On the other hand BPS shows a protective effect against foetal hypoxia. Also there was a significant association between MSAF and AFI < 5 cm (OR= 2.99, 95% CI, 1.57-5.74). In other words, when AFI decreases below 5 cm, the risk of hypoxia increases.

This finding confirms the results of calculations of PPV of AFI (52%) and insists on the importance of this variable in prediction of hypoxia.

## Discussion

In this study the sensitivity of BPS (66%) and specificity of AFI (83%) were higher than the other tests for prediction of meconium-stained amniotic fluid as the indicator of foetal hypoxia. It is obvious that the most important explanatory variable in the model is the amount of AFI. This finding confirms the results of calculations of positive predictive value of AFI (52%) and insists on the importance of this variable in

prediction of meconium-stained amniotic fluid.

The negative predictive value of NST (94%) and FMC (91%) for meconium-stained amniotic fluid was higher than the other tests. This increases their value and usefulness in decision making during clinical practice.

Randomized controlled trials about the value of foetal movement counting by mother in low risk mothers have shown that the reporting of reduced foetal movements are associated with an increased likelihood of foetal death but have not improved the foetal outcome.[10]

In this study, positive predictive values of FMC for prediction of meconium-stained amniotic fluid was very low (10%) but negative predictive value was 91% and this test was found to be a good predictor of the healthy foetus.

Vassilis reported that the incidence of caesarean delivery for foetal distress was significantly lower in the Doppler sonography compared with NST[11] and in Salamaleki's study[12] a reactive NST was found to be a good predictor of the healthy foetus (negative predictive value = 91.2% and specificity = 85.4%) and the non reactive NST could identify a population at risk, but it was not helpful as a stand alone modality in decision making because of low sensitivity and positive predictive values (40.9% and 28.1%).

This study's results were similar to Salamaleki for the negative predictive value (94%), however, specificity in this study was low (42%). Hence, the negative side of using the NST is its high rate of false positive results.

Keegan[13] performed NST on 399 women with suspected post date pregnancies and a repeated test in the non reactive group later the same day, resulted in a reactive pattern in 78% of cases.

Scientific researches have already demonstrated the good correlation of BPS results with PH levels in foetal blood, and also, with the risk of hypoxia and perinatal morbidity and mortality.[14,15] Platt et al[16] reported that the BPS is more predictive in diagnosing foetal condition than the NST. Uncontrolled observational data have shown that foetal death is extremely unlikely in the presence of normal BPS in a high-risk pregnancy.[10]

Manning reported that, the normal result of BPS was associated to rates of foetal death within one week of only 0.4-0.6/1000.[14] This reveals that the rate of false-negative results is so low that it indicates the normal results of BPS has a high reliability in detecting normal foetuses. However, although the negative predictive value of a normal BPS is excellent, false positives can be high. Manning also reported that the results of BPS with a score of 6/10 had a false-positive rate of 75%, which demands retesting at different intervals, or complementing the test with some other methods.

Also a study done by Bresadola et al[17] showed a high specificity (82.4%) of BPS with a negative predictive value of 100% in post term pregnancies and reported that BPS has been proved to be a very accurate method of determination of foetal-well-being in post date pregnancy.

Conversely, in our study sensitivity of BPS (66%) is higher than specificity (56%). Furthermore, in our study BPS compared with other tests was the most sensitive test.

The sensitivity of AFI for predicting the adverse outcome was reported 28% with a specificity of 91.9% and perinatal death, meconium aspiration, birth asphyxia, cord arterial PH<7 were considered for major adverse outcome.[18] Casey[19] noted that as oligohydramnious is detected, perinatal morbidity and mortality increase.

In this study also ultrasound assessment of AFI had high specificity (83%) but low sensitivity (38%) in the prediction of meconium-stained amniotic fluid (MSAF) and there was a significant association between the MSAF and AFI<5 cm (OR=2.99, 95% CI: 1.57- 5.74), however, in our study meconium-stained amniotic fluid was an objective assessment of adverse outcome.

Magaun considered[20] AFI to be a poor diagnostic test which causes an increased rate of intervention without improved outcome.

The reason of low sensitivity of AFI <5 cm for the prediction of adverse outcome is probably that our report is based on a single assessment of amniotic fluid.

## Conclusion

This study suggests that the NST was found to be a good predictor of the healthy foetus; also the specificity of the AFI is high which indicates that if the test is abnormal, the probability of an adverse outcome such as meconium-stained amniotic fluid and hypoxia increases.

Large randomized controlled trials are necessary to asses post term pregnancies for developing an accurate test with especially high sensitivity and positive predictive values that can be clinically useful in the assessment of foetal well being and can increase the rate of improvement in perinatal outcome, without unnecessary intervention.

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