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Original Research Article

# Hospital Based Observational Study to Predict Neonatal Respiratory Distress by Evaluating the Colour Doppler of the Foetal Pulmonary Artery

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**Conflict of interest: Nil**

## Abstract

**Aim:** The objective of the present study was to predict neonatal respiratory distress by evaluating the colour doppler of the foetal pulmonary artery.

**Methods:** This was a hospital based observational study conducted among Department of Radiology, Narayan Medical College and Hospital, Jamuhar, Sasaram, Bihar, India for one year. 100 pregnant women who presented for institutional delivery in Obstetrics ward.

**Results:** 40 (40%) participants were < 2.25 & remaining 60 (60%) participants were > 2.25 Pulsatility index of pulmonary artery. 40 (40%) participants were < 0.9 & remaining 60 (60%) participants were > 0.9 Resistive index of pulmonary artery. 42 (42 %) participants were < 0.305 & remaining 58 (58 %) participants were > 0.305 AT/ET ratio of pulmonary artery. 60 (60 %) participants required neonate oxygen support > 24 hours. AT/ET ratio had sensitivity of 95.31 % (95 % CI 86.91 % to 99.02 %) in predicting respiratory distress. Specificity was 93.48 % (95 % CI 82.10 % to 98.63 %), false positive rate was 6.52 % (95 % CI 1.37 % to 17.9 %), false negative rate was 4.69 % (95 % CI 0.98 % to 13.09 %), positive predictive value (PPV)was 95.31 % (95 % CI 86.91 % to 99.02 %), negative predictive value (NPV) was 93.48 % (95 % CI 82.1 % to 98.63 %), & total diagnostic accuracy was 94.55 % (95 % CI 88.51 % to 97.97 %). Foetuses with MPA PI < 2.25, 2 (5%) developed no respiratory distress & foetuses with MPA PI > 2.25, majority of 57 (95 %) developed respiratory distress. Difference in proportion of PI between neonate respiratory distress was statistically significant (P value < 0.001). Foetuses with MPA RI < 0.9, 2 (5 %) developed no NRD & foetuses with RI > 0.9, majority of 57 (95 %) developed NRD. Difference in proportion of RI between neonate respiratory distress was statistically significant (P value < 0.001).

**Conclusion:** The Study found that all parameters, pulmonary artery RI, PI, & AT/ET ratio showed good performance as predictors of RD development in neonates. It is recommended that a foetus with AT/ET <0.305 be delivered in a well-equipped hospital with respiratory support facilities, as it is at risk of developing neonatal RD.

**Keywords:** Colour doppler, foetal main pulmonary artery, acceleration time/ejection time (AT/ET), Pulsatility index (PI), Resistive index (RI) & Neonatal Respiratory Distress (NRD).

## Introduction

Respiratory distress syndrome (RDS) is a frequent and morbid condition of the neonate which develops due to deficiency of surfactant in the lung alveoli. This in turn leads to inefficient gaseous exchange leading to hampered respiratory function. [1] Various studies worldwide cite about 50% incidence of RDS in infants born before 30 weeks of gestation [2] and such incidence reduces with increase in gestational age, from about 60–80% in foetuses born at 26–28 weeks, to about 15–30% of those born at 32–36 weeks. [3]

Incidence of RDS is higher in India which approximates to about 200,000 infants per year. [4] The mortality rate of infants from RDS remains as high as 40–60%. [5,6] RDS is a major cause of neonatal mortality and morbidity. Prenatal determination of foetal lung maturity (FLM) is of paramount importance in diagnosing RDS. Evaluation of FLM is one of the most challenging processes because we are yet to develop an optimal strategy that can determine it. Several prenatal markers like Lecithin/Sphingomyelin ratio, detection of Phosphatidyl Glycerol, Fluorescence Polarization test and Amniotic Fluid Lamellar body count test are used to analyse FLM. All of these though lucrative, depend on Amniocentesis which in addition to being invasive has a complication rate of approximately 0.7%; some of the worrying complications include preterm rupture of membranes, preterm labour, placental abruption and foeto-maternal

haemorrhage. [7] Also, various studies about these methods were not able to confirm the superiority of one test over another. [8] In contrast, USG is a non-invasive, safe, widely available and universally accepted method to evaluate FLM.

Respiratory distress (RD) is a frequent & morbid condition of neonate which develops due to deficiency of surfactant in lung alveoli. Ineffective gaseous exchange results from this, which in turn impairs respiratory function. [9] RD is reported in roughly 50 % of new-born before 30 weeks of gestation across world. [10] Neonatal respiratory distress incidence of 15 – 30 % in new- born at 32-36 weeks. [11] 200,000 infants affected with NRD each year in India. [12] RD continues to have a 40-60 % new-born mortality rate. Neonatal death & morbidity are largely attributed to RD. [13] Lecithin/ Sphingomyelin ratio & Colour Doppler of neonatal pulmonary artery acceleration time/ejection time (AT/ET) ratio are two techniques used for determination of neonatal respiratory distress. [14] Neonatal pulmonary artery AT/ET ratio can be used to predict occurrence of neonate respiratory distress (NRD). [15,16] Colour Doppler evaluation of main pulmonary artery is useful in predicting neonatal respiratory distress has no risks involved in amniocentesis.

The objective of the present study was to predict neonatal respiratory distress by evaluating the colour doppler of the foetal pulmonary artery.

## Materials and Methods

This was a hospital based observational study conducted among Department of Radiology, Narayan Medical College and Hospital, Jamuhar, Sasaram, Bihar, India for one year. 100 pregnant women who presented for institutional delivery in Obstetrics ward.

### Inclusion criteria

Pregnant women with gestational age 34 to 38 completed weeks are admitted for safe confinement & expected to deliver within one week were included in study.

### Exclusion criteria

1. Foetal chromosomal abnormality
2. Multiple pregnancies.

Before enrolling subject for study, a written consent was taken.

**Statistical Methods**

PI pulmonary artery, RI pulmonary artery, AT/ET ratio of pulmonary artery, neonate requiring oxygen support more than 24 hours, APGAR (appearance, pulse, grimace, activity, respiration) score < 7 were considered as primary outcome variables & respiratory distress was considered as primary explanatory variable.

Descriptive analysis was carried out by mean & standard deviation for quantitative variables, frequency & proportion for categorical variables.

Categorical outcomes were compared between study groups using Chi square test.

Sensitivity & specificity of screening test along with their 95 % CI were presented. Reliability of screening test was assessed by kappa statistic along with its 95 % CI & p value.

P value < 0.05 was considered statistically significant.

**Results**

**Table 1: Descriptive analysis of pulsatility & resistive index of pulmonary artery in study population**

| **Pulsatility index of pulmonary artery** | **Frequency** | **Percentage** |
|---|---|---|
| Descriptive Analysis of Pulsatility Index of Pulmonary Artery in Study Population (N = 100) | | |
| < 2.25 | 40 | 40 % |
| > 2.25 | 60 | 60 % |
| Descriptive Analysis of Resistive index of Pulmonary Artery in Study Population (N = 100) | | |
| **Resistive index of pulmonary artery** | **Frequency** | **Percentage** |
| < 0.9 | 40 | 40 % |
| > 0.9 | 60 | 60 % |

40 (40%) participants were < 2.25 & remaining 60 (60%) participants were > 2.25 Pulsatility index of pulmonary artery. 40 (40%) participants were < 0.9 & remaining 60 (60%) participants were > 0.9 Resistive index of pulmonary artery.

**Table 2: Descriptive Analysis of AT/ET Ratio of pulmonary artery & neonate requiring oxygen support more than 24 hours in the study population**

| **AT/ET Ratio of Pulmonary Artery** | **Frequency** | **Percentage** |
|---|---|---|
| **Descriptive Analysis of AT/ET Ratio of Pulmonary Artery in Study Population (N = 100)** | | |
| <0.305 | 58 | 58 % |
| >0.305 | 42 | 42 % |
| **Descriptive Analysis of Neonate Requiring Oxygen Support More Than 24 Hours in the Study Population (N = 100)** | | |
| **Neonate Requiring Oxygen Support More Than 24 Hours** | **Frequency** | **Percentage** |
| Yes | 60 | 60 % |
| No | 40 | 40 % |

42 (42 %) participants were < 0.305 & remaining 58 (58 %) participants were > 0.305 AT/ET ratio of pulmonary artery. 60 (60 %) participants required neonate oxygen support > 24 hours.

**Table 3: Descriptive Analysis of Neonate Respiratory &Predictive Validity of AT/ET in Predicting Respiratory Distress**

| **Neonate Respiratory Distress** | | **Frequency** | **Percentage** |
|---|---|---|---|
| **Descriptive Analysis of Neonate Respiratory Distress in the Study Population (N = 100)** | | | |
| Yes | | 58 | 58 % |
| No | | 42 | 42 % |
| **Predictive Validity of AT/ET in Predicting Respiratory Distress** | | | |
| **Parameter** | **Value** | **95 % CI** | |
| | | **Lower** | **Upper** |
| Sensitivity | 95.31 % | 86.91 % | 99.02 % |
| Specificity | 93.48 % | 82.10 % | 98.63 % |
| False positive rate | 6.52 % | 1.37 % | 17.90 % |
| False negative rate | 4.69 % | 0.98 % | 13.09 % |
| Positive predictive value | 95.31 % | 86.91 % | 99.02 % |
| Negative predictive value | 93.48 % | 82.10 % | 98.63 % |
| Diagnostic accuracy | 94.55 % | 88.51 % | 97.97 % |

AT/ET ratio had sensitivity of 95.31 % (95 % CI 86.91 % to 99.02 %) in predicting respiratory distress. Specificity was 93.48 % (95 % CI 82.10 % to 98.63 %), false positive rate was 6.52 % (95 % CI 1.37 % to 17.9 %), false negative rate was 4.69 % (95 % CI 0.98 % to 13.09 %), positive predictive value (PPV)was 95.31 % (95 % CI 86.91 % to 99.02 %), negative predictive value (NPV) was 93.48 % (95 % CI 82.1 % to 98.63 %), & total diagnostic accuracy was 94.55 % (95 % CI 88.51 % to 97.97 %).

**Table 4: Comparison of PI, RI & AT/ET ratio with Respiratory Distress in Study Population**

| **Pulsatility Index** | **Neonate Respiratory Distress** | | **Chi Square Value** | **P Value** |
|---|---|---|---|---|
| | **Yes** | **No** | | |
| **Comparison of PI (Pulsatility Index) with Respiratory Distress in Study Population (N = 100)** | | | | |
| < 2.25 (N = 40) | 2 (5 %) | 38 (95 %) | 90.38 | < 0.001 |
| > 2.25 (N = 60) | 57 (95 %) | 3 (5 %) | | |
| **Comparison of RI (Resistive index) with Respiratory Distress in Study Population (N = 100)** | | | | |
| Resistive index | **Neonate Respiratory Distress** | | **Chi Square Value** | **P Value** |
| | **Yes** | **No** | | |
| < 0.9 (N = 40) | 2 (5 %) | 38 (95 %) | 90.38 | <0.001 |
| > 0.9 (N = 60) | 57 (95 %) | 3 (5 %) | | |
| **Comparison of Acceleration Time/ Ejection Time (AT/ET) with Respiratory Distress in Study Population (N = 100)** | | | | |
| AT/ET ratio | **Neonate Respiratory Distress** | | **Chi Square Value** | **P Value** |
| | **Yes** | **No** | | |
| < 0.305 (N = 58) | 55(94.83 %) | 3 (5.17 %) | 86.72 | < 0.001 |
| > 0.305 (N = 42) | 3 (7.14 %) | 43(92.86 %) | | |

Foetuses with MPA PI < 2.25, 2 (5%) developed no respiratory distress & foetuses with MPA PI > 2.25, majority of 57 (95 %) developed respiratory distress. Difference in proportion of PI between neonate respiratory distress was statistically significant (P value < 0.001). Foetuses with MPA RI < 0.9, 2 (5 %) developed no NRD & foetuses with RI > 0.9, majority of 57 (95 %) developed NRD. Difference in proportion of RI between neonate respiratory distress was statistically significant (P value < 0.001). Foetuses with MPA AT/ET ratio< 0.305, 55 (94.83 %) developed respiratory distress & foetuses with AT/ET ratio > 0.305, 3 (7.14 %) has no respiratory distress. Difference in proportion of AT/ET ratio between NRD was statistically significant (P value < 0.001).

## Discussion

Respiratory distress syndrome (RDS) is a common and life-threatening disease of the neonate, particularly preterm neonate, which primarily developes due to surfactant deficiency. Surfactant is a phospolipid mixture that reduces alveolar surface tension and maintains alveolar stability. As maturation of lung occurs with increasing gestational age, the pulmonary vasculature also develops with increase in number of pulmonary arteries, whereas there is a slight decrease in pulmonary arterial vascular resistance. [17,18] With the support of these facts the diagnostic accuracy of foetal MPA Doppler indices in predicting the occurrence of neonatal RDS in late preterm and early term foetuses was examined in our study. This gestational age (34 to 39 weeks) was appropriately chosen because the foetal lung is immature before 34 weeks thus rendering the testing of FLM useless before 34 weeks. Development of RDS was found to be lowest when the foetuses were delivered after 39 weeks of gestation, so many studies suggested that Caesarean section should be carefully planned around this gestational age. [19,20] Thus, between 34 and 39 weeks of gestation is an optimal timeline for the possibility of early detection of developing RDS and was selected in our study. Hence, it is also appropriate for an obstetric surgeon to test for foetal lung maturity before considering delivering a foetus in this particular gestational age range.

Pulmonary artery PI & RI were significantly higher in RD positive neonates compared to RD negative neonates (2.27 ± 0.23& 0.8 ± 0.11 versus 2.18 ± 0.23 & 0.76 ± 0.09); P: 0.003 & 0.002, respectively in Moety et al.'s study who have also chosen GA 34 to 38 weeks.16 Yadav et al. [21] observed that a cut-off value of 0.30 for AT/ET ratio in foetal main pulmonary artery in late pre-terms (delivered between 34 & 36+6 weeks) was statistically significant in predicting development of respiratory distress. Predictive capability of pulmonary artery AT/ET ratio was also appreciated by recent works of Büke et al [22] on 105 women. Cut-off value of 0.327 provided optimal sensitivity of 77.1 %, a sensitivity of 90.9 %, a NPV of 95.4 % & PPV of 52.7 %. [23]

Our results correlated with that of Yadav et al. [21] & Büke et al. [22] while found AT/ET is negatively correlated with development of RD, did not find any significant difference in PI & RI among neonates with & without RD. A foetus with an AT/ET <0.305 should be delivered in a well- equipped hospital with respiratory support facilities because it is at risk of developing neonatal RD. [24]

## Conclusion

The Study found that all parameters, pulmonary artery RI, PI, & AT/ET ratio showed good performance as predictors of RD development in neonates. It is recommended that a foetus with AT/ET <0.305 be delivered in a well-equipped hospital with respiratory support facilities, as it is at risk of developing neonatal RD.

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