ORIGINAL RESEARCH ARTICLE

A Clinical Study of Fetal Lung Maturity Correlated by Various USG Parameters

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A B S T R A C T

Introduction: Efforts have been made to use prenatal diagnostic ultrasonography as a means of evaluating lung maturity. Ultrasonography, a non invasive and widely available method, would be more acceptable.The aim of this study was to assess the accuracy of ultrasound indices to evaluate fetal lung maturity.

Material and methods: It is prospective longitudinal study done in 89 pregnant preterm or term patients were selected randomly. Ultrasound of these patients was done to asses Amniotic fluid vernix, placental grading, biparital diameter, Fetal tibia, femur epiphysis and Thalamic echogenicity also APGAR score at one and five minutes, signs of a respiratory problem, admission to the neonatal intensive care unit (NICU).

Results: Apgar score at 1 min. was < 7 in 41 neonates and ≥ 7 in the remaining 48. At 5 min, 30 neonates still with Apgar score of <7 while 79 neonates showed Apgar score ≥7. The clinical evaluation of the newborn revealed RDS in 9 of them (10%), while the remaining 80 (90%) newborn with no RDS. The RDS degree was used as an index for the fetal lung maturity, those with RDS considered to have immature fetal lung and those with no RDS to have mature fetal lung. fetal tibial epiphysis was highly sensitive (98.7%), highly specific (88.8%) and had the highest accuracy (97.7%) with PPV (98.7%) and good NPV (88.8%). Fetal femoral epiphysis was also highly sensitive (92.8%) but low specific (60%) and good accuracy (91.0%).

Conclusions: Ultra sound assessment for fetal lung maturity is a useful non-invasive procedure with good predictive values and accuracy. Best success in predicting the foetal lung maturity, accompanied by distal femur epiphysis and thalamic echogenicity.

Keywords: Fetal Lung Maturity, USG Parameters

INTRODUCTION

The fetal lung maturity (FLM) is primarily determined by the pulmonary surfactant and can only be measured with amniotic fluid laboratory tests.[1,2] The need for amniocentesis has resulted in a decline in the use of this information clinically. Clinical methods have drawbacks. In many cases patients do not know the exact LMP or date of quickening. Per abdominal examinations can also give erroneous results in cases such as polyhydrominos or multiple gestation or IUGR. Amniocentesis is an invasive technique. Biochemical indicators like lecithin, sphingomyelin, phosphatidyl choline are measured in amniotic fluid to determine the fetal lung maturity. For a quarter of a century, the non-invasive prediction of FLM by foetal lung ultrasound images was attempted by gray-level measurements, lung tissue movement, and relative features of lung-to-placenta or -liver images, among others.[3,4] These studies revealed a good correlation with respiratory morbidity, but the diagnostic accuracy was inadequate for clinical use.

A lot of researchers have been using ultrasound since the 1980s to track foetal lung maturity. One optimistic possibility is the B-mode ultrasound, which is a non-invasive, cheap, and convenient procedure. Although the echo amplitude of the foetal lung, foetal respiratory motions, breathing-related continuum of nasal fluid flow and lung volume are correlated with foetal lung maturity, there are still no standard sonographic parameters.[2] Specifically, texture analysis approaches are computerized methods that can analyze medical images and identify subtle changes in the aspect, or texture, that are invisible to the human eye.[5] To train algorithms to predict clinical details, these textural patterns can then be used. The purpose of this analysis was to test the accuracy of ultrasound indices for foetal lung maturity assessment.

MATERIAL AND METHODS

This was a prospective longitudinal study conducted between April 2017 and August 2019. 89 pregnant preterm or term

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patients were selected randomly. Ultrasound of these patients was done in the Department of Radio-diagnosis.
Informed consent for all participated women was obtained.

Inclusion criteria: All women having normal singleton pregnancy with a viable fetus and regular fetal surveillance. Women sure of their last menstrual period date and to have had this date reinforced by ultrasonography during the first trimester of gestation.

Exclusion criteria: cases with multiple gestations, fetal malformations, complicated pregnancy (hypertension, diabetes. etc…), intrauterine growth restriction or macrosomic fetuses, suboptimal fetal position in which epiphyses could not be observed, antepartum hemorrhage or presence of meconium-stained fluid.
All mothers were checked prenatally by ultrasound for signs of foetal development after birth and the neonates.
Ultrasound test was conducted at the radiology department with convex transducer frequency of 3.5 MHZ for an obstetric ultrasound scan on the same day of delivery. To minimise the intraobserver variance, the same ultrasonographer performed the ultrasonic examination. Ultrasound Findings:

i. Placenta: Grannum' s classification of placental grading was used.
ii. Biparietal diameter (BPD): Fetal skull is measured in the axial section where clear midline echo of the thalamus is evident along with septum pellucidum with the help of calipers from outer table to the inner table of the skull.
iii. Free-floating particles in amniotic fluid: Linear densities in the amniotic fluid are noted.
iv. Epiphyseal centers: Lower limbs of the fetus are screened and measurements of distal femoral epiphysis and proximal tibial epiphysis are measured with calipers.
v. Thalamic density at the level of the BPD, on each side of the third ventricle, the density is divided to either echogenic if similar to the rest of the brain tissue in echogenicity, or echolucent if it was less echogenic to the rest of the brain tissue.

The paediatrician analysed the following foetal outcomes for every neonate: foetal sex, weight, APGAR score at one and five minutes, symptoms of respiratory difficulties, admission to the Neonatal Intensive Care Unit (NICU) and accompanied by a paediatrician for the period of hospitalisation, and any adverse neonatal morbidity or mortality before discharge.
The statistical analysis was performed utilizing SPSS software and the significance level of value <0.05 was accepted as statistically significant.

Characteristic	Value
Maternal age (years) Mean ± SD	31.2± 5.1
Gestational age (weeks) Mean ± SD	36 ± 2
Gestational age at scan Mean ± SD	37± 2.2
Occupation Number of cases(%)	
Housewife	65(73)
Working women	24(27)
Gravidity Number of cases(%)	
1-2	45(50.5)
3-4	33(37.1)
>5	11(12.4)
Parity	
Nulliparous	15(16.8)
One	22(24.7)
Two	31(34.8)
Three	12(13.5)
>4	9(10.1)
H/o of previous abortions	11(12.4)

Table-1: Demographic characteristics in present study

RESULTS

The mean maternal age was 31.2± 5.1years, mean gestational age 36 ± 2.0 weeks and by ultrasound (U/S) 37± 2.2 weeks. Regarding the occupation; the majority of the participant women were housewives; (73%). Nulliparous was 16.8%, and the remaining 83.2% women had one or more parity. History of abortion was reported in 11 women (table-1).
Apgar score at 1 min. was < 7 in 41 neonates and ≥ 7 in the remaining 48. At 5 min, 30 neonates still with Apgar score of <7 while 79 neonates showed Apgar score ≥7. On the other hand, 42.7% needed to be admitted to the neonatal intensive care unit (NICU). 68.4% admitted for < 24 hours, 21% for 24–48 hours and 10.5% admitted to the NICU for > 48 hours (table-2).
In 9 of them (10 percent), the clinical examination of the neonates indicated RDS, while the remaining 80 (90 percent) were neonates with no RDS. The RDS status was used as a measure of foetal lung maturity, those with RDS termed immature foetal lungs and those without RDS deemed to

Variable		Number of cases	Percentages
APGAR score at 1 min	< 7	41	46.1
	>7	48	53.9
APGAR score at 5 min	< 7	30	33.7
	>7	59	66.3
Admission to the NICU		38	42.7
Duration of stay in the NICU	<24 hr	26	68.4
	24-48 hrs	8	21.1
	>48 hrs	4	10.5

Table-2: Characteristics of neonates

Ultrasound parameter	Ultrasound findings	No RDS	RDS	P-value
Amniotic fluid vernix	Positive	55	3	<0.05
	Negative	29	6	
placentl grading	Positive	52	2	<0.05
	Negative	31	7	
Bipariteal diameter	Positive	46	1	<0.05
	Negative	34	8	
Fetal tibia epiphysis	Positive	79	1	<0.05
	Negative	1	8	
fetal femur epiphysis	Positive	80	4	<0.05
	Negative	0	4	
Thalamic echogenicity	Positive	65	2	<0.05
	Negative	15	7	

Table-3: Results of ultrasound parameters in the prediction of fetal lung maturity.

Ultrasound parameter	Sensitivity	Specificity	PPV	NVP	Accuracy
Amniotic fluid vernix	65	66.6	94.8	17.1	65.59
placental grading	62.6	77.7	96.3	18.4	64.1
Bipariteal diameter	97.8	19	57.5	88.9	60.6
Fetal tibia epiphysis	98.7	88.8	98.75	88.8	97.7
fetal femur epiphysis	92.8	60	97.5	33.3	91
Thalamic echogenicity	81.2	77.7	97.	31.8	80.9

Table-4: Validity tests for prediction of lung maturity of the 89 neonate

have mature foetal lungs (table-3).

According to these comparisons, it had been noticed that the fetal tibial epiphysis was highly sensitive (98.7%), highly specific (88.8%) and had the highest accuracy (97.7%) with PPV (98.7%) and good NPV (88.8%). Fetal femoral epiphysis was also highly sensitive (92.8%) but low specific (60%) and good accuracy (91.0%) (table-4).

DISCUSSION

A total of 89 ultrasound images, obtained from different pregnancies, were analyzed in this study. Present study one to evaluate the predictive values and validity of measuring some fetal parameters by ultrasound as markers of fetal lung maturity. These parameters include amniotic fluid vernix, BPD, placenta grading, epiphyseal ossification centers of femur and tibia, fetal thalamic echogenicity. Previous studies exploring quantitative assessment of fetal lung ultrasound to predict fetal lung maturity used a variety of techniques. Prakash *et al.*[6] compared ratios of fetal lung to liver image feature values, with reported accuracies ranging from 73% to 96%. La Torre *et al.*[7] correlated accurately several patterns of fetal breathing movements with fetal lung maturity tests. The mean grey value of foetal lungs was evaluated by Tekesin et al.[8], showing a changing pattern of foetal lung development. No substantial differences were, however, observed beyond the gestation of 32 weeks. Later, Serizawa and Maeda[9] attempted to predict immaturity of the foetal lung by contrasting the foetal lung and liver ultrasonic grey level histogram width (GLHW) in 22 foetuses with respiratory distress syndrome and in 25 controls.

Our study showed that more than half of the neonates delivered (46 percent) had an Apgar score of < 7 at 1 minute, while only 33 percent at 5 minutes. In our foetal lung immaturity analysis, RDS was used as a measure from another point of view and showed only 10 percent RDS, which decreased with advanced gestational age. This finding coincides with the Hibbard et al analysis.[10] who gave comparable outcomes and found an incidence of 10.5% for infants born at 34 – 36 weeks gestation versus 0.3% at 38 weeks. The study by Thikra N. Abdulla et al[11] stated that more than half of the neonates delivered (55 percent) had an Apgar score of < 7 at 1 minute, while only 33 percent at 5 minutes. From a different viewpoint, RDS was used as an indicator for foetal lung immaturity in our study and showed only 12 percent RDS which decreased with advanced gestational age. Other studies showed a lower incidence of RDS such as Edwards et al.[12] which documented that RDS occurs in up to 7% of newborn infants and Ghafoor et al.[13] which reported an incidence rate of RDS 3.7% among neonates at 36 weeks of gestation.

According to our study it had been noticed that the fetal tibial epiphysis was highly sensitive (98.7%), highly specific (88.8%) and had the highest accuracy (97.7%) with PPV (98.7%) and good NPV (88.8%). Fetal femoral epiphysis was also highly sensitive (92.8%) but low specific (60%) and good accuracy (91.0%). Our study is in agreement Thikra N. Abdulla et al[11] with fetal tibia epiphysis was the best predictor compared to other five parameters (with 95.5%, 91.7% and 95% for sensitivity, specificity, and accuracy respectively), followed by fetal femur epiphysis (with sensitivity of 97.7%, specificity 50% and accuracy of 92%). In the evaluation of foetal lung maturity in combination with the amniocentesis lung profile, Mahony et al.14 evaluated sonographic epiphyseal ossification centres. They found that

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proximal tibia epiphysis had a positive prediction accuracy of a (100 percent) mature amniocentesis lung profile and (100 percent) precision.

A study done by Ahmad T et al.[15] found that sonographic evaluation of distal femoral and proximal tibial epiphyseal centers can be practiced as sufficient markers for the calculation of gestational age during the third trimester. Another study by Tabsh KM[16] found that ossification centers about the fetal knee (DFE and PTE) as measured by ultrasound correlate well with amniotic fluid lecithin: sphingomyelin ratio.

Saba et al.,[17] in their study concluded that ultrasound appearance and size of epiphyseal ossi cation centers of femur, tibia and humerus can be useful in prediction of gestational age(GA) during the third trimester of pregnancy, a period in which standard fetal biometric estimates of gestational age are least accurate. This technique appears to identify GA<33wks or>33 wks based on the presence or absence of the distal femur epiphysis(DFE). Ultrasound visualization of proximal tibia epiphyseal (PTE) ossi cation is a strong indicator of GA(36)wks, where appearance of proximal humerus epiphseal (PHE) ossi cation virtually confirms the maturity of the fetus.

In Study done by Lokhande Pallavi et al[18] ultrasound parameters used were Biparietal diameter (BPD), Placental grading, epiphyseal centers of the lower limb and Free were floating particles in the amniotic fluid. These parameters with compared with Shake test performed on the amniotic fluid. Concluded that fetal lung maturity assessed by the ultrasound parameters was useful. BPD being most helpful among them followed by Epiphyseal centers of lower limb, Placenta and free floating particles in the amniotic fluid.

Other studies have reported that fetal lung maturity and Gestational age show a linear correlation. Mean fetal lung maturity in the present study was a little lower than that obtained by Pöhls and Rempen,[19] Chang *et al.*,[20] and others probably due to racial differences in fetal development.

The findings of this study open the possibility of using non-invasive methods for predicting foetal lung maturity prenatally. Despite advancements in clinical practise such as administration of prenatal corticoids and postnatal surfactant, respiratory morbidity appears to be a leading cause of neonatal morbidity and mortality in those born late preterm and even early gestations. It is apparent that, for some indications, delivery can occur irrespective of the effects of foetal lung maturity.

CONCLUSION

In conclusion, our research shows that the foetal lung maturity ultrasound evaluation is a valuable non-invasive technique with good predictive values and accuracy. All the six ultrasonic parameters evaluated could be considered as predictors of foetal lung maturity with varying degrees of efficiency. The ultrasonic detection of the proximal tibia ossification centres showed the best results in predicting foetal lung maturity, followed by distal femur epiphysis and thalamic echogenicity. Confirmation of fetal maturity obtained by fetal biometry and ultrasound visualization and measurement of size of the epiphyseal ossification centers of long bones (femur-tibia-humerus) can be used as a tool for estimation of fetal maturity.

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