Section: Radiology

Original Research Article

ASSESSMENT OF FETAL LUNG MATURITY BY ULTRASONOGRAPHY: A TEACHING HOSPITAL BASED STUDY

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Abstract

Background: There have been attempts to assess lung maturity using prenatal diagnostic ultrasound. A widely accessible, non-invasive technique like ultrasound would be more acceptable. Assessing the precision of ultrasonography indicators to gauge fetal lung maturity was the goal of this investigation. **Materials and Methods:** 76 pregnant patients, either term or preterm, were chosen at random for this prospective longitudinal study. These patients' APGAR scores at one and five minutes, indications of a respiratory issue, admission to the neonatal intensive care unit, amniotic fluid index, placental grading, biparital diameter, fetal tibia, femur epiphysis, and thalamic echogenicity were all assessed by ultrasound. **Result:** According to these comparisons, it had been noticed that the fetaltibial epiphysis was highly sensitive (98.6%), highly specific (89.6%) and had the highest accuracy (98.5%) with PPV (98.7%) and good NPV (89.0%). Fetal femoral epiphysis was also highly sensitive (93.5%) but low specific (64.2%) and good accuracy (92.4%). **Conclusion:** An effective non-invasive method with high accuracy and predictive values is ultrasound evaluation of fetal lung maturity. greatest accuracy in forecasting the fetal lung maturity, along with thalamic echogenicity and distal femur epiphysis.

INTRODUCTION

The most important element in a neonate survival after an preterm delivery is fetal lung maturity.[1] Only amniotic fluid laboratory tests can quantify the fetal lung maturity (FLM), which is mostly dictated by the pulmonary surfactant.[2,3] The therapeutic application of this knowledge has decreased as a result of the necessity for amniocentesis. Clinical approaches have limitations. Patients frequently don't know the precise LMP or quickening date. Abdominal exams may potentially provide inaccurate results in situations like multiple gestation, polyhydrominosis, or IUGR. The procedure of amniocentesis is invasive. Fetal lung maturity is assessed by measuring biochemical markers such as phosphatidylcholine, sphingomyelin, and lecithin in amniotic fluid. Gray-level measures, lung tissue movement, and relative features of lung-to-placenta or liver pictures, among other methods, were used for 25 years to try to predict FLM noninvasively using fetal lung ultrasound images.[4,5] Although there was a strong association between these investigations and respiratory morbidity, the diagnostic precision was insufficient for practical application. Since the 1980s, ultrasonography has been used by numerous studies to monitor the development of the fetal lungs. The B-mode ultrasound, a noninvasive, affordable, and practical treatment, is one promising option. There are currently no standard sonographic measures, despite the fact that the fetal lung's echo amplitude, respiratory movements, breathing-related continuity of nasal fluid flow, and lung capacity are all associated with fetal lung maturity. In particular, computational techniques known as "texture analysis approaches" are able to examine medical photographs and spot minute variations in texture or aspect that are not evident to the naked eye.[6] These textural patterns can subsequently be used to train algorithms to predict clinical information. Assessing the accuracy of ultrasonography markers for assessing fetal lung maturity was the aim of this study.

MATERIALS AND METHODS

The present study was a carried out in the Department of Radiology, World College of Medical Sciences Research and Hospital, Jhajjar, collaboration with Obstetrics and Gynaecology department. 76 pregnant patients, either term or

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preterm, were chosen at random over a twenty month period. These patients' ultrasounds were performed in the radiodiagnosis department. All participating women gave their informed consent. In inclusion, every woman with a viable fetus and regular fetal monitoring is experiencing a typical singleton pregnancy. During the first trimester of pregnancy, women who are certain of the date of their last menstrual cycle should have had this date confirmed by ultrasound. Cases including many gestations, fetal abnormalities, problematic pregnancy (diabetes, hypertension, etc.), intrauterine growth restriction or macrosomic babies, antepartum hemorrhage, the presence of meconium-stained fluid, or suboptimal fetal position where epiphyses were not visible excluded from the study. Ultrasonography was used to check all mothers for fetal development during pregnancy, postpartum, and neonatal development. On the same day of delivery, an ultrasound test was performed in the radiology department using a convex transducer frequency of 3.5 MHZ. The ultrasonic examination was conducted by the same ultrasonographer in order to reduce intraobserver variance. The outcomes of the ultrasound:

Placenta: Grannum's placental grading system was applied.

Biparietal diameter (BPD): Using calipers, the fetal skull is measured from the outer table to the inner table in the axial portion where the septum pellucidum and a distinct midline echo of the thalamus are visible.

Amniotic fluid free-floating particles: The amniotic fluid's linear densities are observed.

Epiphyseal centers: Using calipers, the fetus's lower limbs are screened, and the proximal and distal femoral epiphyses are measured.

Thalamic density on either side of the third ventricle at the BPD level is classified as either echogenic if its echogenicity is similar to that of the rest of the brain tissue or echolucent if it is less echogenic.

Every neonate's sex, weight, APGAR score at one and five minutes, respiratory symptoms, admission to the Neonatal Intensive Care Unit and the presence of a pediatrician during the hospital stay, and any unfavorable neonatal morbidity or mortality prior to discharge were all examined by the pediatrician. SPSS-20 software was used to conduct the statistical analysis, and a value of less than 0.05 was considered statistically significant.

RESULTS

The mean gestational age was 36.6 ± 4.02 weeks, the mean mother age was 32.6±9.26 years, and the mean ultrasound (U/S) age was 37.0±2.42 weeks. In terms of occupation, 73.7% of the participating women were housewives. Of the women, 82.9% had one or more parities, whereas 17.1% were nulliparous. Ten women (13.15%) reported having an abortion history [Table1].

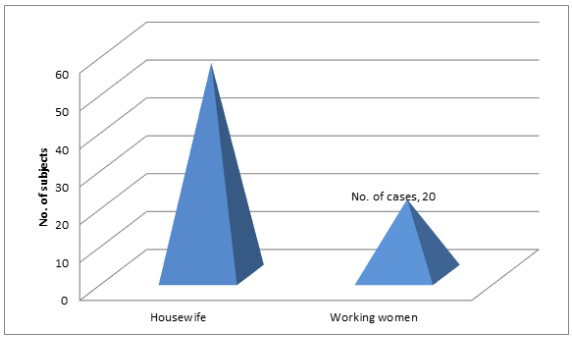

Figure 1: Shows the distribution of subjects a/c to occupation.

At one minute, 35 neonates (46.05%) had an APGAR score of less than 7, and the remaining 41 (53.94%) had a score of greater than 7. 32 neonates (91.4%) with APGAR score of < 7 had been admitted to NICU, with 22(68.7%) neonates had been admitted for < 24 hours, 8 (25%) neonates for 24-48 hrs & 2(6.25%)neonates for > 48hrs[Table 2]. The newborns' clinical evaluation revealed RDS in 7 of them (9.2 percent), while the remaining 69 (90.8 percent) had no RDS. Foetal lung maturity was measured by the RDS status; individuals with RDS were considered to have immature lungs, while those without RDS were considered to have mature lungs. These comparisons revealed that the fetal tibial epiphysis had the best accuracy (98.5%) with PPV (98.7%) and good NPV (89.0%), as well as being extremely sensitive (98.6%) and specific (89.6%). High sensitivity (93.5%), low specificity (64.2%), and good accuracy (92.4%) were also observed in fetal femoral epiphysis [Table3].

Table 1: Shows the demographic characteristics

Variables	Characteristic	No. of cases (%)
Maternal age (years)(Mean ± SD)		32.6± 9.26
Gestational age (weeks)(Mean ± SD)		36.6 ± 4.02
Gestational age at scan(Mean ± SD)		37.0± 2.42
Occupation Number of cases(%)	Housewife	56(73.7%)
	Working women	20(26.3%)
Gravidity Number of cases(%)	1-2	38(50.0%)
	3-4	29(38.15%)
	>5	09(11.84%)
Parity	Nulliparous	13(17.1%)
	One	19(25.0%)
	Two	26(34.2%)
	Three	10(13.15%)
	>4	08(10.52%)

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H/o of previous abortions	10(13.15%)

Table 2: Shows the characteristics of neonates in present study

Variables	Timing in hrs	No. of cases (%)
APGAR score at 1 minute	< 7	35 (46.05%)
	>7	41 (53.95%)
APGAR score at 5 minute	< 7	25 (32.9%)
	>7	51 (67.1%)
Admission to the NICU		32 (42.1%)
Duration of stay in the NICU	<24 hrs	22 (68.75%)
	24-48 hrs	08 (25.0%)
	>48 hrs	2 (6.25%)

Table 3: Validity tests for prediction of lung maturity of the 76 neonate

Ultrasound parameter	Sensitivity	Specificity	PPV	NPV	Accuracy
Amniotic fluid vernix	67.2	68.4	94.6	18.2	66.42
placental grading	64.8	79.2	36.4	20.6	65.8
Bipariteal diameter	98.6	20.4	58.2	90.1	62.4
Fetal tibia epiphysis	98.9	89.6	98.5	89.0	98.1
fetal femur epiphysis	93.5	64.2	97.6	34.6	92.4
Thalamic echogenicity	82.4	79.0	96.2	30.5	82.3

DISCUSSION

In this study, 76 ultrasound pictures from various pregnancies were examined. The purpose of the current study is to assess the validity and predictive values of using ultrasound to measure a few prenatal measures as indicators of fetal lung maturity. These criteria include the index of amniotic fluid, BPD, placenta grading, fetal thalamic echogenicity, and the epiphyseal ossification centers of the femur and tibia. Numerous methods were employed in earlier research investigating the quantitative evaluation of prenatal lung ultrasonography to forecast fetal lung maturity. The ratios of fetal lung to liver imaging feature values were evaluated by Prakash et al,[7] who reported accuracies ranging from 73% to 96%. A number of fetal respiratory movement patterns were accurately associated with fetal lung maturity tests by La Torre et al.[8]Tekesin et al.'s evaluation of the mean gray value of fetal lungs,[9] revealed a shifting pattern of fetal lung development. However, after 32 weeks of gestation, no discernible changes were seen. Later, by comparing the ultrasonic grey level histogram width (GLHW) of the fetal lung and liver in 22 fetuses with respiratory distress syndrome and 25 controls, Serizawa and Maeda,[10] tried to predict the immaturity of the foetal lung. Of the neonates delivered, 46.05 percent had an Apgar score of less than 7 at 1 minute, compared to 32.95 percent after 5 minutes, according to our study. RDS was utilized as a metric from a different perspective in our investigation of fetal lung immaturity, and it revealed a mere 9.2 percent RDS, which declined as gestational age increased. This result is consistent with the investigation by Hibbard et al,[11] who reported similar results and discovered that the incidence was 10.5% for infants born between 34 and 36 weeks gestation compared to 0.3% at 38 weeks. According to a research by Thikra N. Abdulla et al,[12] only 33% of the newborns delivered had an Apgar score of less than 7 at 5 minutes, compared to 55% at 1 minute. From a different angle, our study's use of RDS as a marker for fetal lung immaturity revealed that it was only 9.2 percent, and that this percentage declined with increasing gestational age. Other studies revealed a lower frequency of RDS, like Ghafoor et al,[14] which found an incidence rate of 3.7% among neonates at 36 weeks of gestation, and Edwards et al,[13] which claimed that RDS occurs in up to 7% of newbornnewborns. Our investigation found that the fetaltibial epiphysis had the best accuracy (98.1%) with PPV (98.5%) and good NPV (89.0%), as well as being extremely sensitive (98.9%) and specific (89.6%). High sensitivity (93.5%), low specificity (64.2%), and good accuracy (92.4%) were also seen in the fetal femoral epiphysis. According to Thikra N. Abdulla et al,[12] our study supports their findings that fetal tibia epiphysis was the best predictor when compared to the other five parameters (having sensitivity, specificity, and accuracy of 95.5%, 91.7%, and 95%, respectively). Fetal femur epiphysis came in second (having sensitivity of 97.7%, specificity of 50%, and accuracy of 92%). Mahony et al,[15] assessed sonographic epiphyseal ossification centers in conjunction with the amniocentesis lung profile to assess fetal lung maturity. They observed that the proximal tibia epiphysis had a 100% precision and 100% prediction accuracy for a mature amniocentesis lung profile. The distal femoral and proximal tibial epiphyseal centers can be sonographically evaluated as adequate indicators for the computation of gestational age during the third trimester, according to a study by Ahmad T et al.[16] Ossification centers around the fetal knee (DFE and PTE), as determined by ultrasonography, have a good correlation with the lecithin:sphingomyelin ratio of amniotic fluid, according to another study by Tabsh KM.[17] In their study, Saba et al,[18] found that the size and appearance of the femur, tibia, and humerus's epiphyseal ossicationcenters on ultrasound can be helpful in predicting gestational age (GA) during the third trimester of pregnancy, when standard fetal

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biometric estimates of gestational age are least accurate. Based on whether the distal femur epiphysis is present or absent, this method seems to indicate GA33 weeks. The emergence of proximal humerus epiphyseal ossication almost guarantees the fetus'smaturity, while ultrasound observation of proximal tibia epiphyseal ossication is a strong signal of GA(36) weeks. Biparietal diameter, placental grading, lower limb epiphyseal centers, and free floating particles in the amniotic fluid were the ultrasonography characteristics employed in the study by LokhandePallaviet al.[19] These characteristics are contrasted with the results of the amniotic fluid Shake test. concluded that the ultrasonography criteria used to measure fetal lung maturity were helpful. Of them, BPD is the most beneficial, followed by the placenta, lower limb epiphyseal centers, and free-floating particles in the amniotic fluid. According to other research, there is a linear relationship between gestational age and fetal lung maturity. Due to racial disparities in fetal development, the mean fetal lung maturity in this investigation was somewhat lower than that found by Pohls and Rempen,[20] Chang et al,[21] and others. The results of this study raise the prospect of prenatally predicting fetal lung maturity using non-invasive techniques. Respiratory morbidity seems to be a major contributor to neonatal morbidity and death in babies born late preterm and even early in pregnancy, despite improvements in therapeutic practice such as the administration of prenatal corticoids and postnatal surfactant.

CONCLUSION

Our study concludes that the ultrasound assessment of fetal lung maturity is a useful non-invasive method with high accuracy and predictive values. With differing degrees of accuracy, each of the six ultrasonic measures that were assessed might be regarded as a predictor of fetal lung maturity. Foetal lung maturity was best predicted by ultrasonic detection of the proximal tibia ossification centers, followed by distal femur epiphysis and thalamic echogenicity. Fetal biometry, ultrasound visualization, and the measurement of the size of the epiphyseal ossification centers of the long bones (femur, tibia, and humerus) can all be used to confirm the fetal maturity.

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