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Shahinaz Hamdy Elshourbagy
Department of Obstetrics and Gynecology, Faculty of Medicine, Tanta University, Egypt

Manal Abd El-raoof Farahat
Department of Obstetrics and Gynecology, Faculty of Medicine, Tanta University, Egypt

Mohamed Mohsen Elnamory
Department of Obstetrics and Gynecology, Faculty of Medicine, Tanta University, Egypt

Abd Ellatif Abd-Elrahim Mohamed Elnagar
Department of Obstetrics and Gynecology, Faculty of Medicine, Tanta University, Egypt

Corresponding Author:
Abd Ellatif Abd-Elrahim Mohamed Elnagar
Department of Obstetrics and Gynecology, Faculty of Medicine, Tanta University, Egypt

Evaluation of fetal lung maturity by ultrasound

Shahinaz Hamdy Elshourbagy, Manal Abd El-raoof Farahat, Mohamed Mohsen Elnamory and Abd Ellatif Abd-Elrahim Mohamed Elnagar

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Abstract
Background: Monitoring lung development is important for both birth preparation and counselling parents. Clinical procedures such as menstrual history, LMP, pelvic abdomen inspection, and date of quickening can be used to estimate when a foetus' lungs are fully developed. Extra diagnostic procedures include amniocentesis, x-rays, and ultrasounds.
Objective: to assess the non-invasive parameters to determine the fetal lung maturity by ultrasound.
Patients and Methods: it was is a cross-sectional study was conducted on Department of Obstetrics and Gynecology, Faculty of Medicine, Tanta University Hospitals on 75 pregnant cases. Study duration was from August 2020 till 30th May 2022.
Results: Correlation foetal biometry and Shake scores significantly differed among groups. Test, Relation between Placental grading and postnatal lung maturity, Relation between Shake test and postnatal lung maturity and the Diagnostic profile.
Conclusion: Based on the previous findings, ultrasound might be a useful method of evaluation of fetal lung maturity. Either of placental grading, free floating particles and shake test are good predictive tools for detecting lung maturity, with the superior hand for the floating particles.

Keywords: Fetal lung, ultrasound

Introduction

The perinatal prognosis depends on the lungs' ability to adjust to the various physiologic changes that occur during pregnancy and immediately after birth, therefore foetal lung development is crucial. Monitoring lung development is important for both birth preparation and counselling parents. Lecithin and surfactant levels in the amniotic fluid are commonly used as indicators of foetal lung maturity [1].

Whether or not a pregnancy should be continued depends in part on an evaluation of the fetus's lung maturity [2].

Clinical procedures, including menstrual history, LMP, per abdominal inspection, and date of quickening, are used to ascertain foetal lung maturity. Extra diagnostic procedures such amniocentesis, x-rays, and ultrasounds [3].

Three disadvantages of clinical procedures exist. In many circumstances, patients have no idea of their LMP or their date of quickening. Polyhydramnios, multiple pregnancies, and intrauterine growth restriction are all conditions in which a per abdominal examination may provide false positive results [4].

Certain biochemical indicators, such as lecithin, sphingomyelin, and phosphatidyl choline, are tested in amniotic fluid to evaluate lung development in the foetus. Lecithin to sphingomyelin ratio (L/S), phosphatidyl glycerol levels in amniotic fluid, DPPC (Dipalmitoyl phosphatidyl choline) levels in amniotic fluid, and fluorescence polarisation of amniotic fluid are just a few of the amniotic fluid assays used to measure foetal lung maturity [5].

The ratio of lecithin to sphingomyelin is the most reliable of the aforementioned tests; nevertheless, amniocentesis is intrusive, can cause serious consequences, is difficult to perform, and is very expensive. In terms of precision, the shake test is on par with the L/S ratio. This simple test may be done right at the patient's bedside, and it doesn't break the bank [6].

Because it has been established that X-rays pose risks to the developing foetus, ultrasound has replaced X-rays as the gold standard for prenatal screening of foetuses in order to determine whether or not they have fully developed lungs. Predictive markers for prenatal lung maturity based on ultrasonography are Judging the quality of a placenta As the placenta reaches a maturity level of 3, the foetal lungs will be fully developed [7].

Throughout most of pregnancy, the reflectivity of the human foetal lung is about the same as, or even less than, that of the liver. Nevertheless, this trend reverses itself at the end of the pregnancy [8].

Recent sonographic descriptions of the proximal humeral centre have shown a strong association with full-term gestation and foetal maturity, Epiphyseal foci in the lower extremities Epiphyseal ossification centres form and expand during the third trimester of pregnancy3, and the emergence of the distal femoral epiphysis (DFE) and the proximal tibial epiphysis (PTE) at 5m is a sign of foetal lung maturity. The majority of the optical density in amniotic fluid comes from tiny particles. The ability to read newspaper headlines through amniotic fluid in a test tube is just one of many indicators of foetal lung maturity that has been studied in the past. Trimester to trimester, the particles' origin could change [9].

The development of the foetus' lungs can be evaluated in real time using ultrasound by using free floating particles (FFPs) that look like snowstorms or blizzards in the amniotic fluid. Researchers measured the optical density of amniotic fluid at 650 nm and the size of the largest echogenic amniotic fluid particle at several stages of pregnancy [10].

Patients and Methods

The following factors were considered when developing the sample size

The sample size, N>61, was calculated using the aforementioned criteria, and it will be increased to 75 to compensate for missing information and improve the quality of data from the study, which is a cross-sectional study with a 95% confidence limit and an expected prevalence of immature lung among newborns of 80% with a margin of error of 10%.

Inclusion criteria: Pregnant woman aged 18 to 35 years old**,** Singleton pregnancy, Gestational age 30 to 36 weeks and In labor.

Exclusion criteria: Maternal medical disorder as (Systemic lupus erythematosus (SLE), Hypertensive patients, Diabetes Mellitus, Chronic Renal Failure and Ischemic cardiac disease) and Fetal congenital anomalies.

All patients in this study will be subjected to the following: History taking, Clinical examination, Assessment of fetal well-being and Investigation (Laboratory and Ultrasound study).

Statistical analysis

Information was analysed with SPSS 20. (SPSS Inc., Chicago, IL, USA). Mean and standard deviation were used to characterise the quantitative variables. Quantitative and percentage descriptions were used for qualitative variables. Student t test was carried out to evaluate the difference in parametric quantitative variables between the two groups. If there were less than five observations per category, the chi-square (X2) test was used; otherwise, Fisher's exact test was used to compare qualitative variables. Correlation between two normally distributed variables was calculated using Pearson's correlation coefficient. Non-normally distributed variables are considered significant when the P value is less than 0.05.

Results

Table 1: Patients' demographic data:

All patients (n= 75)	Mean & SD	Median	Range	IQR
Age (years)	28.81±5.680	29.00	20.00, 41.00	24.00, 33.00
Height (cm)	162.09±4.375	162.00	154.00, 171.00	159.00, 166.00
Weight (kg)	76.01±4.016	75.80	68.00, 85.00	73.00, 78.80
In addition to the mean and standard deviation, the median, range, and interquartile range are used to express the data.				

The mean age of the included pregnant ladies was 28.81 years (range, 20 – 35). They had a mean weight of 76.01 kg (range, 68 – 85) while their mean height was 162.09 cm (154 – 171).

Table 2: Placental grading, Free-floating particles, Shake Test in the studied patients:

		All patients (n= 75)	
Gestational age (weeks)		33.04±2.873	
Placental grading	I	5	6.7%
	II	39	52.0%
	III	31	41.3%
Free-floating particles		37	49.3%
Shake Test		57	76.0%
Data is expressed as percentage and frequency.			

On assessment of placental grading, it was detected as follows; grade I (6.7%), grade II (52%) and grade III (41.3%). Free floating particles were detected in 37 ladies (49.3%), whereas shake test was positive in 57 women (76%).

Table 3: Correlation fetal biometry and Shake Test in the current study:

Shake Test	Correlation coefficient	P
Gestational age (weeks)	0.456	< 0.001
BPD	0.572	< 0.001
Distal femoral epiphysis	0.624	< 0.001
Proximal tibial epiphysis	0.628	< 0.001
Estimated fetal weight	0.456	< 0.001

P is significant when < 0.05.

The data in the table demonstrated a strong link between BPD, placental grading, free floating particles, distal femoral epiphysis, proximal tibial epiphysis, estimated fetal weight and shake test ($p<0.001$).

Table 4: Relation between Placental grading and postnatal lung maturity:

Postnatal lung maturity	Immature	Mature	P
I	3	1	0.006
II	18	21	
III	5	27	

P is significant when < 0.05.

There was a significant correlation amongst lung maturity and placental grading. The highest prevalence of mature lungs was present in women with stage III placenta.

Table 5: Relation between Shake test and postnatal lung maturity:

Postnatal lung maturity		Immature	Mature	P
Shake Test	Negative	13	5	< 0.001
	Positive	13	44	

P is significant when < 0.05.

Shake test was positive in half of babies with immature lungs, while it was positive only in 89.79% of subjects in the mature group. Free floating particles showed the same results.

Table 6: Diagnostic profile of Placental grading, Free-floating particles, Shake Test, Distal femoral epiphysis, proximal tibial epiphysis, and estimated fetal weight in detection of postnatal lung maturity:

	Placental grading	Free- floating particles	Shake Test	Distal femoral epiphysis	Proximal tibial epiphysis	Estimated fetal weight
P	**0.005**	**< 0.001**	**0.005**	**< 0.001**	**< 0.001**	**< 0.001**
Cutoff	-	-	-	2.5	2.5	2180.0
Sensitivity	89.8%	85.7%	89.8%	75.5%	73.5%	79.6%
Specificity	50.0%	65.4%	50.0%	23.1%	19.2%	100.0%
PPV	77.2%	82.4%	77.2%	86.0%	87.8%	100.0%
NPV	72.2%	70.8%	72.2%	62.5%	61.8%	72.2%
Accuracy	76%	78.7%	76%	76.0%	76.0%	86.7%

P is significant when < 0.05.

Placental grading and Shake test had sensitivity and specificity of 89.8 and 50% respectively for determining lung maturity.

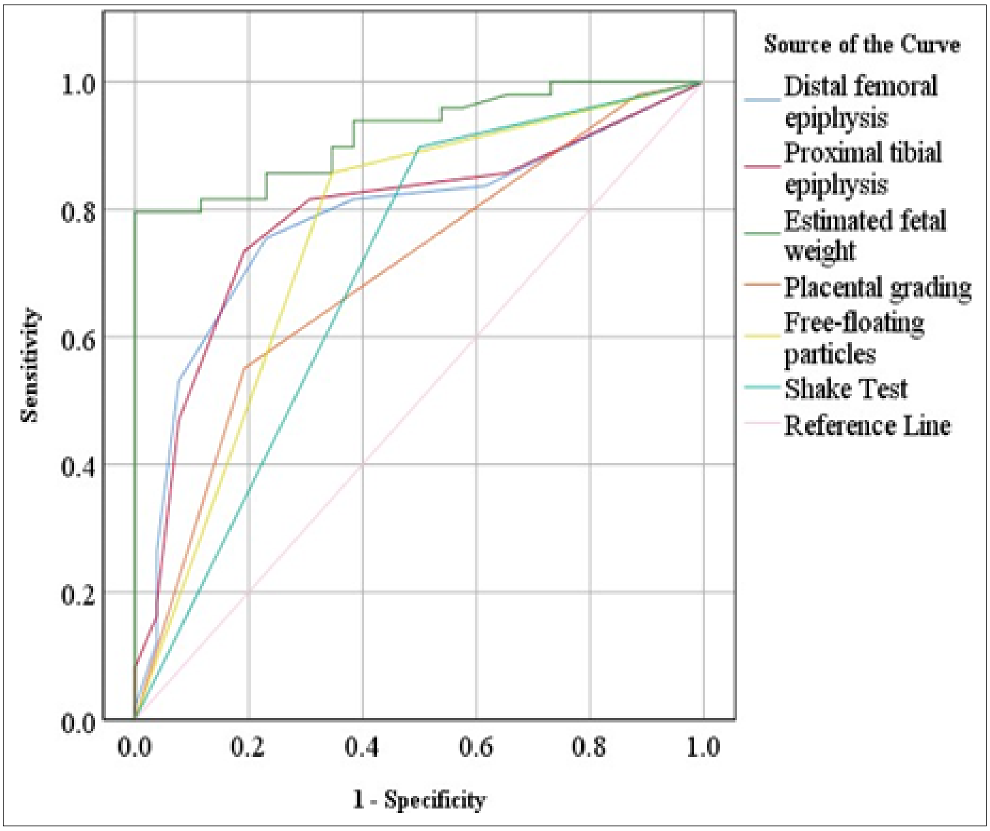

Fig 1: ROC curves for Placental grading, Free-floating particles, Shake Test, Distal femoral epiphysis, Proximal tibial epiphysis, and estimated fetal weight in detection of postnatal lung maturity.

Discussion

The pulmonary surfactant is the main factor affecting the foetal lung maturity (FLM), which can only be assessed through laboratory testing on amniotic fluid [11, 12]. Since the 1980s, a lot of studies have used ultrasound to monitor foetal lung maturity. Recent developments in technology and automated procedures have examined medical photographs to find minute changes in the aspect or texture that are undetectable to the human eye [13, 14]. In our study, there was a significant link amongst lung maturity and placental grading. The highest prevalence of mature lungs was present in women with stage III placenta.

Grannum and his associates also confirmed the good correlation between US defined placental maturity and fetal lung maturity. However, the previous authors used LS ratio for determination of lung maturity [15].

Patil *et al*. reported that placental grading was significantly different among fetuses with mature & immature lungs ($p<0.05$). The same parameter had sensitivity and specificity of 62.6 and 77.7% for prediction of lung maturity [14].

In the present research, free floating particles were detected in 51 ladies (68%). It was positive in half of babies with immature lungs, while it was positive only in 89.79% of subjects in the mature group ($p<0.001$).

Several studies by different authors have looked at the relationship between foetal maturity and the ultrasonic measurement of floating particles in amniotic fluid. Bree thought that these floating particles were vernix and could be a sign of foetal maturity in his report on two patients who were close to term [16].

Other researchers have also reported seeing vast numbers of echogenic flakes, thought to be vernix, swirling with foetal movement in the amniotic fluid of term pregnancies, resembling a snowfall [17].

In the current study, distal femoral epiphysis and proximal tibial epiphysis had mean values of 2.79 and 2.61 mm respectively. Both of these parameters had significant correlation with the sonographic indices of lung maturity.

Fetal tibia epiphysis, as determined by Thikra N. Abdulla *et al*., was the best predictor when compared to other parameters (with sensitivity, specificity, and accuracy values of 95.5%, 91.7%, and 95%, respectively). Fetal femur epiphysis came in second (with sensitivity, specificity, and accuracy values of 97.7%, 50%, and 92%, respectively) [18].

Along with the amniocentesis lung profile, Mahony *et al*. assessed the foetal lung maturity using sonographic epiphyseal ossification centres. It was determined that the proximal tibia epiphysis had a (100) mature amniocentesis lung profile and (100) precision in its positive prediction accuracy [19].

In the current study, placental grading and Shake test had sensitivity and specificity of 89.8 and 50% respectively for determining lung maturity.

Placental grading could be utilised to assess foetal lung maturity instead of estimating lecithin/sphingomyelin (L/S) ratio, as reported by Shweni and Moodley, which will reduce the number of amniocenteses [20].

Placental grade III was shown to have a poor sensitivity (64%) but a high specificity (98%). This was found by Loret de Mola *et al*. [21].

Grade III placental maturity has been shown to predict foetal lung maturity with an 81% sensitivity, 74% specificity, and 94% positive predictive value in a more recent investigation. 22 Using grade II and III placenta, Abdullah *et al*. found a sensitivity of 60%, specificity of 75%, and PPV of 94% for predicting foetal lung maturity [18].

According to the encouraging results of this investigation, non-invasive techniques may soon be available for prenatal prediction of foetal lung maturity. Our study has certain caveats, such as its single-center setting and its small sample size. Hence, in the near future, further studies should be undertaken, involving more pregnant women from various gynaecological clinics.

Conflict of Interest

Not available

Financial Support

Not available

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