

The Value of Ultrasonic Epiphyseal Ossification Centers and Placental Grading in Prediction of Fetal Lung Maturity in Normal, Pre Eclamptic and Diabetic Pregnancies

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Abstract

In the present study a non-invasive method for assessment of fetal lung maturity via sonographic characterization of placental maturity and fetal epiphyseal ossification centers around the knee and shoulder was evaluated. These sonographic parameters were correlated with the amniocentesis phospholipid profile as an indicator of accuracy. They were studied in 40 normal pregnancies, 40 pre-eclamptic and 40 diabetic pregnancies with gestational ages ranging between 32-41 weeks. It was found that in normal pregnancies, the presence of grade III placenta, or DFE ≥ 5 mm or PTE ≥ 3 mm or the presence of PHE predicts a mature phospholipid profile in 100% of patients. However, in pre-eclamptic patients, the presence of grade III placenta is not a reliable predictor of lung maturity, but the presence of DFE ≥ 5 mm or PTE ≥ 3 mm or the presence of PHE has 100% positive predictive value of mature phospholipid profile. On the other hand, in diabetic pregnancies neither grade III placenta nor DFE ≥ 5 mm are reliable indicators of fetal lung maturity. Finally the identification of PTE ≥ 5 mm or the presence of PHE can reliably identify a mature phospholipid profile in all studied groups with 100% accuracy. Such a perfect correlation between these epiphyseal ossification dimensions and fetal lung maturity favours the use of these selective non-invasive sonographic parameters as an alternative to invasive amniocentesis phospholipid profile in prediction of fetal lung maturity. This could save time, money, emotional investment, fetal and maternal morbidity.

Introduction

THE ability to assess fetal lung maturity in utero is required for optimal obstetric management of high risk pregnancy especially in patients who present late in pregnancy

with unknown dates [1]. Iatrogenic prematurity and the respiratory distress syndrome are the leading factors responsible for fetal morbidity and mortality associated with elective delivery [2].

For pregnancies in which precise gestational dating is not available, but delivery is desired the currently acceptable test of fetal lung maturity is the determination of the phospholipid profile in amniotic fluid samples obtained by amniocentesis [3]. However, amniocentesis is an invasive procedure which is associated with maternal and fetal morbidity [4]. Therefore, replacement of amniocentesis with a non invasive rapid test of reliable safety and equal accuracy would save time and expense and would further lessen possible complications.

Ultrasonography has been a widely used procedure for the determination of fetal gestational age and consequently gestational maturity by using standard fetal biometry [5]. However, the accuracy of this standard fetal biometry is poor after 23 weeks because of the greatest heterogeneity of fetal skeletal growth in the general population during the third trimester [6]. Therefore, other sonographic parameters of fetal development which are less dependent on somatic growth but reflecting gestational maturity were used. Of these sonographic parameters, both placental maturity and epiphyseal ossification centers of the fetal knee and shoulder have been evaluated by many authors [7,8]. They confirmed that antenatal identification of distal femoral epiphysis (DFE), proximal tibial epiphysis (PTE) and proximal humeral epiphysis (PHE) and their size correlate well with amniotic fluid L/S ratio.

This promoted us to evaluate the value of non invasive sonographic assessment of placental maturity, distal femoral, proximal tibial and proximal humeral ossification centers as alternative to invasive amniocentesis method in prediction of fetal pulmonary maturity in uneventful, diabetic and pre-eclamptic pregnancies.

Material and Methods

The present study was conducted on 60 pregnant women who were selected from patients attending Kasr El Aini Maternity Hospital. These cases were divided into three groups:

- A) Control group: 40 uneventful pregnancies
- B) Diabetic group: 40
- C) Pre-eclamptic group: 40 having severe pre-eclampsia

Gestational age of studied patients ranged between 32 and 41 weeks. It was based upon data of the last menstrual period and regularity of cycles. It was further confirmed by obtaining a composite sonographic age estimate [9].

All cases in the present study were subjected to the following: (1) Clinical study: This included thorough history taking, as well as general and obstetric examination and special laboratory investigations. (2) Ultrasonography: This included standard biometric measurements including biparietal diameter, femur length, head circumference, abdominal circumference and estimated fetal weight. This was followed by sonographic assessment of placental maturity by grading of the placenta according to criteria developed by Grannum et al. [10]. Finally, sonographic location and measurement of the largest diameter of the ecogenic distal femoral, proximal tibial and proximal humeral ossification centers as described by Mahony et al. [8]. (3) Amniocentesis was performed under sonographic guidance. Amniotic fluid samples were used to determine the fetal pulmonary phospholipid profile according to the Helena fetal Tek 200 method which uses a one dimensional thin layer chromatographic technique for separating phospholipids in

amniotic fluid (Helena lab., Beaumont, Texas). A mature pulmonary phospholipid profile was indicated by lecithin/sphingomyelin ratio = 2 together with phosphatidyl glycerol = 2% [11].

The identification and measurements of DFE, PTE, PHE and placental grading were studied in comparison with the presence or absence of a mature phospholipid profile. The clinical efficiency test was used for statistical analysis of this work.

Results

The results are shown in tables 1-3 and Figs. 1-3.

Discussion

This study evaluated sonographic markers of fetal lung maturity in terms of their ability to predict a mature pulmonary phospholipid profile. It was revealed that grade III placenta predicted a mature phospholipid profile in each studied group. In normal

pregnancies the presence of grade III placenta was correlated with phospholipid profile in all cases (positive predictive value 100%). In pre-eclamptic pregnancies, 14 out of twenty cases with grade III placenta had a mature phospholipid profile (positive predictive value 70%). In diabetic pregnancies, ten out of twelve patients with grade III placenta had a mature phospholipid profile (positive predictive value 83%), tables (1 & 2).

The previous findings suggest that the ability of a grade III placenta to predict fetal pulmonary maturity is affected not only by gestational age but also by pregnancy complications. Several authors agree with these findings [2,12]. The imperfect association of grade III placenta and fetal lung maturity in pre-eclamptic pregnancies could be explained on the basis that both placental and fetal lung maturation are accelerated beyond normal, however, placental maturity likely precedes lung maturity [13]. In diabetic pregnancies, hyper insuli-

Table (1): Correlation of Placental Grade with L/S Ratio, PG Level and Phospholipid Profile in Control (A), Pre-eclamptic (B) and Diabetic Groups (C).

Group	Placental grade	No. of patients	L/S ratio $\geq 2:1$		PG level = 2%		Mature phospholipid profile	
			No.	%	No.	%	No.	%
A	0	2	0	0	0	0	0	0
	I	8	2	25	2	25	2	25
	II	20	18	90	18	90	18	90
	III	10	10	100	10	100	10	100
B	0	0	0	0	0	0	0	0
	I	4	2	50	0	0	0	0
	II	16	12	75	12	75	12	75
	III	20	14	70	16	80	14	70
C	0	6	2	33	0	0	0	0
	I	12	10	83	6	50	6	50
	II	10	8	75	4	40	4	40
	III	12	12	100	10	83	10	83

Table (2): Correlation of Diameters of DFE, PTE and PHE with L/S Ratio, PG Levels and Phospholipid Profile in Control (A), Pre-eclamptic (B) and Diabetic Groups (C).

Group	Epiph- ysis	Diameter (mm)	No. of patients	L/S ratio $\geq 2:1$		PG level = 2%		Mature phos- pholipid profile	
				No.	%	No.	%	No.	%
A	DFE	0-2	6	2	33	2	33	2	33
		3-4	14	8	57	8	57	8	57
		≥ 5	20	20	100	20	100	20	100
	PTE	0-2	16	6	37	6	37	6	37
		3-4	8	8	100	8	100	8	100
		≥ 5	16	16	100	16	100	16	100
	PHE	Absent	24	14	58	14	58	14	58
		Present	16	16	100	16	100	16	100
	B	DFE	0-2	10	2	20	2	20	0
3-4			26	22	85	22	85	22	85
≥ 5			4	4	100	4	100	4	100
PTE		0-2	28	16	57	16	57	14	50
		3-4	12	6	100	12	100	12	100
		≥ 5	0	0	0	0	0	0	0
PHE		Absent	36	24	67	24	67	22	61
		Present	4	2	100	4	100	4	100
C		DFE	0-2	6	0	0	0	0	0
	3-4		16	14	87	6	38	6	38
	≥ 5		18	18	100	12	67	12	67
	PTE	0-2	18	10	56	2	11	2	11
		3-4	12	12	100	6	50	6	50
		≥ 5	10	10	100	10	100	10	100
	PHE	Absent	30	22	73	8	27	8	27
		Present	10	10	100	10	100	10	100

Table (3): Value of Antenatal Sonographic Visualization of Grade III Placenta and Epiphyseal Ossification Center in Predicting Mature Phospholipid Profile.

Somographic parameter (group)	Sensitivity	Specificity	Positive predictive value	Negative predictive value
<i>Grade III placenta</i>				
Control group	50	100	100	50
Preeclamptic group	54	57	70	40
Diabetic group	50	90	83	64
Total population	46	83	81	49
<i>DFE $\geq 5mm$:</i>				
Control group	67	100	100	50
Preeclamptic group	15	100	100	39
Diabetic group	67	73	67	73
Total population	49	87	86	51
<i>PTE $\geq 5mm$:</i>				
Control group	80	100	100	36
Preeclamptic group	46	100	100	50
Diabetic group	89	73	73	89
Total population	38	87	81	49
<i>PHE (present):</i>				
Control group	53	100	100	42
pre eclamptic group	15	100	100	39
Diabetic group	55	100	100	39
Total population	41	100	100	51

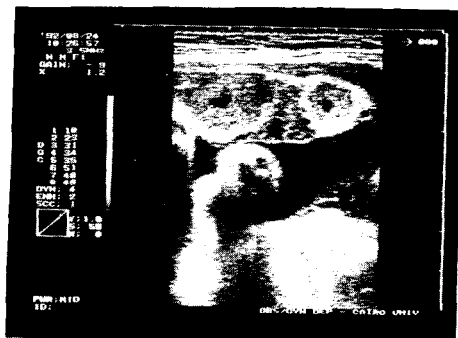


Fig. (1): Real-time sonogram of grade III Placenta.

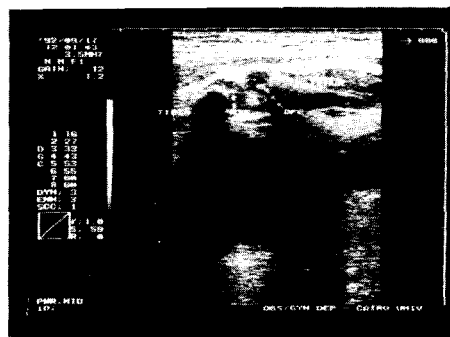


Fig. (2): Longitudinal real-time sonogram of the fetal knee demonstrating the acogenic DFE and PTE.

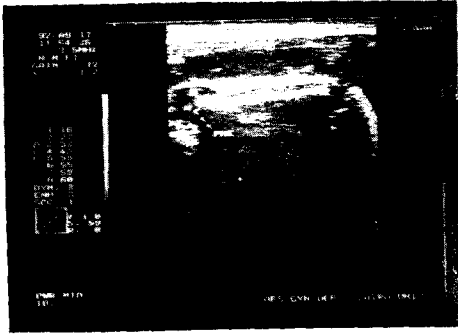


Fig. (3): Longitudinal real-time sonogram of the fetal humerus clearly demonstrates the ecogenic PHE.

nemia may lead to delay in pulmonary maturity, that may lag behind placental maturity [14].

Based on the findings that there is a highly significant correlation between the diameters of DFE, PTE and PHE and gestational age in the third trimester of pregnancy [7], the diameters of these ossification centers were used as sonographic markers to predict fetal lung maturity.

It was revealed that in normal and pre-eclamptic pregnancies, all fetuses with a DFE ≥ 5 mm or a visible PHE, had a mature amniocentesis phospholipid (positive predictive value 100%), tables 2,3. These results are comparable to those obtained by Maher et al. [15] who reported that visualization of PHE at any dimensions, predicted fetal pulmonary maturity in normal pregnancies (95 - 100% of cases).

The present study demonstrated also that in the diabetic population, a DFE ≥ 5 mm or PTE ≥ 3 mm appeared to be suboptimal predictors of pregnancies with mature phospholipid profile with unacceptable high false positive rates (33% for DFE ≥ 5 mm and 27% for PTE ≥ 3 mm), as in tables 2,3, Goldstein et al. [7] found a

poor agreement between DFE and PTE ≥ 2 mm and fetal lung maturity in their series of diabetic patients.

It was concluded that in normal pregnancies, the presence of grade III placenta or DFE ≥ 5 mm or PTE ≥ 3 mm or the presence of PHE predicts a mature pulmonary phospholipid profile in 100% of cases. In pre-eclamptic cases, the presence of grade III placenta is not a reliable predictor of lung maturity. In these situations, the presence of DFE ≥ 5 mm or PTE ≥ 3 mm or the presence of PHE can reliably identify a mature phospholipid profile (positive predictive value 100%). In diabetic pregnancies, neither grade III placenta, nor DFE are reliable indicators of fetal lung maturity. However, in all studied patients a PTE ≥ 5 mm or the presence of PHE can reliably identify a mature phospholipid profile (positive predictive value 100%).

Finally, this study revealed that the evaluation of placental grading, the characterization and measurement of DFE, PTE and PHE can provide valuable information regarding fetal lung maturity during the third trimester, a period in which standard fetal biometric estimates are not accurate. This offers a simple, safe and non invasive procedure which can be an alternative to amniocentesis in prediction of fetal lung maturity especially when elective Caesarean is planned in a patient near terms with uncertain date.

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