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Research Article

The Newly Proposed an Ultrasound Scoring System for Early Prediction of Intrauterine Growth Restriction in High-Risk Pregnancy: A Prospective Cohort Study

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Abstract

Introduction: *IUGR describes a decrease in fetal growth rate that prevents an infant from obtaining his or her complete growth potential. A fetus with IUGR may be born small for gestational age or appropriate for gestational age according to population reference charts. Early prediction of fetuses at risk for development of IUGR may help in proper antenatal care, proper treatment of the cause and proper timing for intervention, to have the best perinatal outcome. The aim of this study is to assess the value of using ultrasonography scoring system as well as Doppler angiography in early screening of IUGR in high-risk pregnancy.*

Patients and methods: *This study was carried out on 200 pregnant women attending the antenatal care clinic of Zagazig University Hospital observed all through the pregnancy with or without admission to hospital and followed till delivery. The inclusion criteria were, age from 18 to 40 years old, singleton pregnancies and during 1st trimester 11-13+6 weeks as calculated by date of LMP and early ultrasonography scan. In this study, CCC, CRL, placental length, PT, uterine artery Doppler and placental shape were examined.*

Result: *By U/S there were statistically high significant differences between normal live born and IUGR regarding all U/S parameters. A scoring system for U/S parameters that include: CCC, CRL, PT, placental length, PT, placental length / PT ratio, uterine artery Doppler and placental morphology was proposed to help differentiating fetuses at high risk and those at low risk for developing IUGR. At cut off level ≥ 4, there is high sensitivity, specificity, positive predictive value and negative predictive value for detecting fetuses at risk for developing IUGR.*

Conclusion: *In clinically high-risk pregnancies, early prediction of adverse perinatal outcome is of ut most importance for proper antenatal care , start of early treatment and proper timing of delivery. -Use of combination of U/S parameters in 1st trimester: CCC, CRL, PT, placental length, PT, placental length / PT ratio, uterine artery Doppler and placental morphology shows fairly higher sensitivity and specificity than individual parameters and may help in early diagnosis. The newly proposed scoring system may facilitate the use of these parameters for diagnosis.*

Introduction

The best prenatal diagnostic test for IUGR is serial ultrasound, although a significant proportion up to 20% of affected pregnancies will not be identified correctly. The diagnosis of IUGR can be made based on 'crossing centiles' of fetal biometry, particularly the abdominal circumference. The abdominal circumference is the single most important measurement [1].

Appropriate management of maternal and fetal risk factors and complications that are detected in pregnancy and labour could prevent a large proportion of the world's 2-3 million estimated annual stillbirths, as well as minimize maternal and neonatal morbidity and mortality [2].

Early screening of IUGR can be done in 1st trimester by crown-Rump Length CRL is the length of the embryo in the natural C-shaped state with an unstretched body. The positive predictive value of the CRL for IUGR in the general population increases with the severity of the disease. However, it would be more useful in high-risk pregnancies. Sensitivity and specificity for reduced CRL were 29 and 100%, respectively [3].

Cerebro-Corporeal Coefficient CCC, a new parameter, is defined as the relation of the length of the head part to the body part of the embryo, as the most feasible ultrasound markers in the first trimester that can be used to predict IUGR in the general population [3].

Abnormal placental morphology was defined either by abnormal shape, abnormal texture, or by both. Maximal placental length and thickness were measured in centimeters. Because reference ranges for placental shape in the first trimester have not been reported, first trimester measurements for placental length, thickness, and length-to-thickness ratio below the 5th percentile or above the 95th percentile were abnormal [2].

Doppler interrogation of the uterine artery blood flow permits an assessment of the resistance to blood flow in the uteroplacental circulation. The advent of colour Doppler enabled clear vessel identification and it is now possible to be specific in the interrogation of uterine artery [4].

Combination of the above factors in the scoring sytem may increase its sensitivity for early detection of IUGR and proper management in proper time this was the aim of this study to evaluate this scoring system.

Aim of the work

The aim of this study is to assess the value of using ultrasonography scoring system in early screening of Intra-uterine growth restriction in high-risk pregnancy.

Patients and methods

A prospective cohort study was carried out at Obstetrics and Gynecology Department, Zagazig Universit Hospitals. In the period from March 2016 to August 2017.

Patients

Two hundred patients were included in the study. The patients were recruited from Antenatal Outpatient Clinic.

Inclusion criteria

- Age from 18 to 40 years old.
- Singleton pregnancies.
- During 1st trimester (11-13+6 weeks) as calcualted by date of LMP and early ultrasonography scan.

The patient is considered high risk if she has

- Chronic hypertension.
- Diabetes mellitus.
- Body mass index > 30.
- Chronic lung diseases e.g. bronchial asthma.
- Chronic autoimmune disease e.g. lupus erythematosus.
- Antiphospholipid Syndrome (APLS).
- Previous bad obstetric history e.g. previous stillbirth, preterm delivery < 37weeks due to combinations of abruption, IUGR or hypertension.

Exclusion criteria

- Major fetal structural anomaly.
- Nuchal translucency > 95th percentile for gestational age.

Methods

Patients were subjected to

- History taking for current pregnancy.
- Past medical disorder and her current treatment.
- Past obstetric history.
- A written informed consent taken to share in the study after explanation of the procedures.

Antenatal follow up

Clinically:

- The patient was followed antenatally being high risk case every two weeks.
- She was followed for her medical condition in the appropriate clinic according to her schedule.
- In every visit, she was asked about her medical condition, any medication used, and any obstetric complication.
- Women whose pregnancies are considered at risk of delivery at < 37 weeks were offered a single course of prenatal steroids (dexamethasone 6 mg IM twice daily for 48 hours).
- Prophylactic low molecular weight heparin is given according to maternal indications (thromboembolism and APLS).

Laboratory:

- Investigations were done for her medical condition according to the schedule of health care provider.
- Routine ante-natal clinic investigations (Kidney function test - Liver function test - Complete blood count – Blood grouping- Urine analysis) were done.

Ultrasonography (U/S) and Doppler:

(1) CCC

It's defined as the relation of the length of the head part to the body part of the embryo. It's normal value 0.4 – 0.6 (3). It's measured by putting the scanview in the sagittal scan and the spine directed anterior or posterior. Measurement of CCC are taken from top of head crown to the junction of head with trank and measure the body from the junction of head and trunk to the end of the trunk rumb.

(2) CRL

It's the length of the embryo in the natural Cshaped state with an un-stretched body. Confirmatory of CRL to GA was determined using the percentile values [5].

It's measured by put the scan view in the sagittal scan. The long axis of fetus is obtained (fetal spine) measurment are taken from top of head crown to the end of trunk rumb.

(3) Uterine artery Doppler

It's considered abnormal if the PI > 1.96 [2]. The mainbranch of the uterine artery isolated at cervico-corporal junction. The Doppler velocimetry measurment

was performed near this location. We take the mean of 3 successive waves in the measurement.

(4) Placental thickness

PT was measured at the level of umblical cord insertion it's considered normal if the thickness > 2.92 cm. with the patient in supine position with full urinary bladder [2].

(5) Placental length

It's considered normal if < 5.1cm. Longitudinal view of placenta in which upper and lower edge clearly visible in one plane tracing from the upper and lower edge [2].

Placental morphology:

It considered normal if texture is homogenous. and abnormal if texture appeared heterogeneous, one or more echogenic cystic lesion, or assumed jelly like apperance with turbulent uteroplacental flow [2].

In the second and third trimester, the patient was followed by U/S examination for early detection of any fetal compromise by: routine hospital protocol, (fetal biometry, biophysical profile, umbilical artery Doppler and middle cerebral artery Doppler when needed, CTG when indicated). Pregnancy was terminated according to medical and obstetric indications.

B- The outcomes:

The neonate was examined by neonatologist for detection of IUGR. IUGR is defined as birth weight < 10th percentile for sex and gestational age.

Results

This study was A prospective cohort study included 200 patients from January 2017- December 2019. Gestational age was 11-13+6 weeks. Patients have chronic illness making them high risk pregnancy.

Table (1) shows the demographic data of the studied population. The mean ± SD of age was 28 ± 5.5 years ranging from 20-39 years. The mean ± SD of the gestational

age was 12±0.83 weeks ranging from 11-13+6 weeks. Twenty percent were primiparous and 80% were multiparous. Seventy percent were housewives and 30% were employee. The mean body mass index was 31±5 kg/m2 ranging from 23- 37 kg/m2. Thirty five percent of patients were poor class, 60% of moderate class and 5% were of high class. Most of the patients were hypertensive 28 patients. Five patients have hypertension and diabetes mellitus.

The mean and range of the ultrasound findings in the first trimester scan. CCC mean+ SD was 0.54±0.15, ranging from 0.3–0.8, crownrumb length mean ± SD was 82.2 ± 10mm ranging from 62-98mm. the placental length mean±SD was 4.9±1.3 cm, ranging from 3-7cm. In the present sutdy the PT mean±SD was 2.9±0.5 cm, ranging from 2-4cm and the mean placental length/ placental thickness ratio was 1.75 ± 0.5, ranging from 0.85- 3.2.

In the present study the PI mean ±SD was 1.9±0.16, ranging from 1.5-2.1. ,61% placenta was homogeneous and 39% were heterogeneous (table 2).

The fetal outcome of this study the liveborn infants were 18 IUGR and 138 normal babies. Fetal loss was 30 abortions and 14 IUFD.

Table (3) shows the different ultrasonographic findings tested in this study. The CCC is highly significant in the prediction of IUGR (P<0.001). , CRL is highly significant in prediction of IUGR (p < 0.001).the uterine artery Doppler was highly significant for prediction of IUGR (P < 0.001). , the PT is highly significant (P< 0.001) for prediction of IUGR. In the present study the placental shape is also highly significant for prediction of IUGR, being homogenous in normal babies and heterogenous in those with IUGR.

Table (4) shows a proposal of scoring system of U/S findings used in this study with score 0 for normal findings and score 1 for abnormal findings. The score system performance at cut off level 4. At score ≥ 4, there is high sensitivity 92%, specificity 93.3%, positive predictive value 82.1% and negative predictive value 97.2% for predicting abnormal fetal outcome Table (5).

Characteristic	Range	Mean ± SD
Age (years)	20-39	28 ± 5.5
Gestational age	11-13	12 ± 0.83
Parity	1-4	2.5 ± 0.5
Primiparous	40 (20%)	
Multiparous	160 (80%)	
Occupation		
Housewife	140 (70%)	
Employee	60(30%)	
BMI	23.5-37	31 ± 5
Social class		
Poor	70 (35%)	
Moderate	120 (60%)	
High	10 (5%)	

Table 1: Demographic data of the studied population.

	%	No
Obesity (BMI ≥ 30)	23	46
Hypertension	28	56
Diabetes mellitus	15	30
Preterm delivery	20	40
Others		
Bronchial asthma	10	20
Lupus erythematosus	9	18

Table 2: Clinical data of the patients

P	Modified X^2	Normal (n =138 1)	IUGR (n = 18)	Total	Tests
					CCC
< 0.001 (HS)	20.81	20	16	36	Abnormal
		118	2	120	Normal
					CRL
< 0.001 (HS)	22.04	26	18	22	Abnormal
		112	0	112	Normal
					Uterine artery Doppler
< 0.001 (HS)	40.25	6	16	22	Abnormal
		132	2	134	Normal
					Placental length
< 0.001 (HS)	13.47	42	18	60	Abnormal
		96	0	96	Normal
					PT
< 0.001 (HS)	13.47	42	18	60	Abnormal
		96	0	96	Normal
					Placnetal shape
< 0.001 (HS)	8.07	46	16	62	Heterogeneous
		92	2	94	Homogeneous

Table 3: Ultrasonographic findings.

Score	
	Ccc
0	• **Normal**
1	• **Abnormal**
	CRL
0	• **Normal**
1	• **Abnormal**
	PI
0	• **Normal**
1	• **Abnormal**
	Placental length
0	• **Normal**
1	• **Abnormal**
	PT
0	• **Normal**
1	• **Abnormal**

	Placental shape	
0 1	• **Homogenous** • **Heterogenous**	
6	**Total**	

Table 4: Proposal of scoring system of u/s criteria.

Negative predictive value	Posilive predictive value	Specificity	Sensitivity	
97.2	82.1	93.3	92.0	**Score** • Abnormal ≥ 4 • Normal < 4

Table 5: Score system performance at cut off level (4).

Discussion

This study was done on 200 patients from March 2016 to August 2017. Gestational age was 11-13+6 weeks. Patients have chronic illness making them high risk pregnancy.

The demographic data of the studied population. The mean ± SD of age was 28 ± 5.5 years ranging from 20-39 years. The mean ± SD of the gestational age was 12±0.83 weeks ranging from 11-13+6 weeks. Twenty percent were primiparous and 80% were multiparous. Seventy percent were housewives and 30% were employee. The mean body mass index was 31±5 kg/m² ranging from 23- 37 kg/m². Thirty five percent of patients were poor class, 60% of moderate class and 5% were of high class.

Most of the patients were hypertensive 56 patients. ten patients have hypertension and diabetes mellitus. The mean and range of the ultrasound findings in the first trimester scan. CCC mean+ SD was 0.54±0.15, ranging from 0.3–0.8.

Walid and Pomortsev (2009), studied the CCC for prediction of IUGR. They studied 139 diseased patients, CCC > 0.6 or < 0.4 was considered abnormal (3).

In the present study crownrumb length mean ± SD was 82.2 ± 10mm ranging from 62-98mm. This study was concordant with Walid and Pomortsev (2009) who studied CRL in 139 diseased patients for prediction of IUGR mean ± SD, was 85.1± 11 mm, ranging from 65-100 mm In the present study the placental length mean±SD was 4.9±1.3 cm, ranging from 3-7cm. Costa et al., (2009), studied the placental length in the first trimester and 2nd trimester .They included 61 normal singletone pregnancies. Placental length in the first trimester, mean±SD was 7.3 ±1.8cm in the first trimester ranging from 4.59-10.98cm. It was more than that of the present study, which may be due to, normal pregnancies included in costa study, while those in the current study were high risk patients (2).

In the present sutdy the PT mean±SD was 2.9±0.5 cm, ranging from 2-4cm. Habib FA (2002), studied PT in 498 normal pregnancies. The mean value of the placental thickness was 1.24± 0.023 cm [6].

Mital P, Hooja (2002), studied the PT for prediction of IUGR. He studied 211 healthy pregnancies. The mean ±SD was 1.78 ± 0.79 cm (7).

Costa et al., (2009), studied the PT of 61 normal singletone pregnancies for prediction of IUGR. The mean±SD of the placental thickness of the studied patients were 1.84±0.6cm, ranging from 0.86-3.30cm (2).

All the previous studies showed PT less than that of the current study. This may be due to healthy pregnancies included in these studies, while the present study included high risk pregnancies.

In the present study, the mean placental length/ placental thickness ratio was 1.75 ± 0.5, ranging from 0.85- 3.2. In the study of Costa et al. (2009), the mean ±SD placental length/placental thickness ratio was 4.68 and ranging from 2.39-9.50. The ratio in the present study was less than that of Costa because placental length was smaller and placental thickness was bigger as the patients included in this study were high risk patients (2).

In the present study the PI mean ±SD was 1.9±0.16, ranging from 1.5-2.1. In study of Costa et al. (2009), who studied 61normal singletone pregnancies at 11-13+6 weeks for prediction of IUGR by examining the uterine artrery Doppler, the mean of PI was ≥1.96 (2).

Manning et al. (2001) examined 3045 singleton normal pregnancies at 11-14 weeks. The mean PI was 2.35 (8). The previous studies showed PI more than that of the current one, as they included normal pregnancies while the present study included high risk patients.

In the present study, 61% placenta were homogeneous and 39% were heterogeneous. In the study of Costa et al., (2009), 89.5% placenta were homogenous and 11.5% were heterogenous (2).

The percentage of heterogenous placentae predicting IUGR was lower in Costa study as they included normal pregnancies, while the present study included high risk pregnancies giving higher percentag of heterogenous placentae. The liveborn infants were 18 IUGR and 138 normal babies. Fetal loss was 30 abortions and 14 IUFD.
In the study of Costa et al., (2009), for prediction of IUGR in first trimester weeks, fetal loss < 20 weeks was 3 cases, still birth > 20 weeks was 2 cases, IUGR was 4 cases, preterm delivery < 32 weeks was 10 patients one or more adverse outcome was 14 cases and 28 cases were normal (2).

Fetal loss in the present study was higher than that of Costa et al., (2009) which may be due to the chronic illness in the patients of the current study.

The CCC in the present study is highly significant in the prediction of IUGR (P<0.001). This agrees with Walid and Pomortsev (2009), who studied 139 diseased patients at 10–14 weeks and 25 patients as control group and reported that the CCC is highly significant in the prediction of IUGR (3).

In the present study, CRL is highly significant in prediction of IUGR (p < 0.001). This agrees with Walid and Promortsev (2009) who studied 139 diseased patients at 10–14 weeks and 25 patients as control group and reported that the CRL is highly significant in prediction of IUGR (3).

This also agrees with Smith and Colleagues (1998). They studied 4229 normal pregnancies in the first trimester at 11-13 weeks, they found that, CRL that was two to six days smaller than expected was associated with an increased risk of low birth weight so, they concluded that the crown rumb length is significant in prediction of IUGR (9).

This agrees with Leang, Tysahota et al. (2008). They screened 125 normal pregnant women between 10 – 14 weeks for IUGR prediction using the CRL. They found decrease in CRL below normal value corresponding to the gestational age associatted with IUGR (10).

In the present study the uterine artery Doppler was highly significant for prediction of IUGR (P < 0.001). This agrees with the study of Pilalis et al. (2007), These authors evaluated uterine artery Doppler in 878 unselected pregnancies. They found strong associattion between reduced uteroplacental blood flow and adverse outcome (11).

This agrees with Costa et al., (2009), who found that uterine artery Doppler was highly significant for prediction of IUGR. They studied 61 normal singletone pregncencies at 11-13+6 weeks by uterine artrey Doppler. P value of their study was 0.007 (highly significant) (3).

This disagrees with Manning et al., (2001), who examined 3045 normal singletone pregnancies at 11 – 14 weeks. The

PI 95th centile was 2.35 they reported that increased uterine artery Doppler (PI) was non-significant for detecting birth weight less than 10th percentile (8).

Also, this disagrees with Gomer et al. (2005). They studied 4993 normal patients at 11-14 weeks by uterine artery Doppler for prediction of IUGR. They identified 24% of SGA ≤ 5th centile fetus using 95th centile for the mean uterine artery PI. They found that uterine artery Doppler was non-significant for prediction of IUGR (12).

This disagrees with Dugoff et al., (2005). They studied 4993 normal patients at 11-14 weeks by uterine artery Doppler, and found 17% of SGA ≤ 10th centile, so, they concluded that uterine artery doppler wasn non-significant for prediction of IUGR (13).

In the present study, placental length has high significance in prediction of IUGR (P < 0.001). This agrees with Benirsckerk and Kaufman PB aergen (2006), who measured the placental length at 11–13+6 weeks for 125 normal pregnant patients. they reported a strong associattion between decreased placental length and adverse outcome (14).

Also, this agrees with Costa et al., (2009), who studied 61 normal singletone pregnancies in first trimester using the placental length for prediction of IUGR. They found that decreased, placental length was associatted with adverse outcome (P < 0.05) (2).

In the presents study, the PT is highly significant (P< 0.001) for prediction of IUGR. The present study agrees with Habib FA (2002). Who studied PT in 498 normal patients. He reported that increase PT is associatted with low birth weight or adverse perinatle outcome (6).

Also, it agrees with Mitalp and Hooja (2002). They examiend 211 normal patients in first trimester using placental thickness. They reported strong relation between increased PT and increased adverse perinatal outcome (7).

Also, it agrees with Toal Mchanc (2007), He studied PT at 11- 13 weeks for 878 normal pregnant women for prediction of IUGR. He reported a strong association between increased PT and adverse pregnancy outcome (!5).

Also, the present study was concordont with Costa et al. (2009). Who found that increased PT was associatted with adverse perinatal outcome (2).

In the present study the placental shape is also highly significant for prediction of IUGR, being homogenous in normal babies and heterogenous in those with IUGR.

This agrees with study of Costa et al. (2009). They studied 61 normal singletone pregnant at 11-13+6 weeks and found that the abnormality in the placental shape has a strong relationship with adverse perinatal outcome (2).

Scoring system of U/S findings used in this study with score 0 for normal findings and score 1 for abnormal findings. As far as known, no scoring system has been proposed by any

author to be compared with this scoring system. The mean score of U/S parameters, according to the outcome. There is a highly significant difference between the mean score of abnormal and normal cases (P< 0.001). the score system performance at cut off level 4. At score ≥ 4, there is high sensitivity 92%, specificity 93.3%, positive predictive value 82.1% and negative predictive value 97.2% for predicting abnormal fetal outcome.

Gomez et al. (2005). Found that sensitivity of uterine artery Doppler was 24% for prediction of IUGR (16).
Dugoff et al. (2005). Found that sensitvity of uterine artery Doppler was 17% for prediction of IUGR (13).
PI Lalis et al. (2007). Evaluated uterine artery Doppler at 11-14 weeks, and the sensitivity was 23% for prediction of IUGR (11).

In the study of Costa et al., (2009), the sensitivity of uterine artery Doppler in the first trimester for prediction of IUGR was 25%, specificity was, 78%, positive predictive value was, 43% and negative predictive value was 62%. Sensitivity of placental morphology for prediction of IUGR was 43%, specificity was 80%, positive predictive value was 21% and negative predictive value was 92%. (2).

In the study of Walid and Promertser (2009), ccc and CRL were studied for predicting IUGR at 11–13 weeks. Sensitivity of ccc was 78%, Sensitivity of CRL was 66%. (3).

The sensitivity, specificity, positive predictive value and negative predictive value for the cummulative U/S parameters, using the proposed scorning system at cut off 4, were higher than those of the individual parameters in the previous studies.

Conclusion

-In clinically high-risk pregnancies, early prediction of adverse perinatal outcome is of most importance for proper antenatal care, start of early treatment and proper timing of delivery.

-Use of combination of U/S parameters in 1st trimester: CCC, CRL, PT, placental length, PT, placental length / PT ratio, uterine artery Doppler and placental morphology shows fairly higher sensitivity and specificity than individual parameters and may help in early diagnosis.

-The newly proposed scoring system may facilitate the use of these parameters for diagnosis.

Recommendations

Although combination of different U/S parameters gave higher sensitivity and specificity than individual parameters in high risk pregnancies, its use in low risk pregnancies is still questionable. The proposed scoring system needs further investigation in low risk population to evaluate its validity in detecting adverse perinatal outcome. The addition of biochemical markers as PAPP-A, HCG, AFP, may improve sensitivity and specificity of this scoring system for perdicting adverse perinatal outcome.

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