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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SUMMARY

Aim: Early prediction of fetuses at risk for fetal growth restriction (FGR) may help physicians perform proper antenatal treatment and in decide proper timing for intervention, leading to better perinatal outcome. We attempted to assess the value of using ultrasonography scoring system as well as Doppler angiography for early screening of FGR in high-risk pregnancies.

Methods: Study target were 200 pregnant women attending the University Hospital, who were observed throughout pregnancy till delivery. CCC, CRL, placental length, PT, uterine artery Doppler and placental shape were examined.

Results: Significant differences were observed in earlier stage ultrasound parameter between FGR (-) *vs.* (+) fetuses. An ultrasound scoring system included parameters as follows: CCC, CRL, PT, placental length, PT, placental length/PT ratio, uterine artery Doppler, and placental morphology. This scoring system was proposed to help differentiating fetuses at high- *vs.* low-risk for developing FGR. At cut off value? 4, there is high sensitivity, specificity, positive predictive value and negative predictive value for detecting fetuses for FGR.

Conclusion: The present scoring system may be of some use in predicting later occurrence of FGR. Further validating study is needed.

Keywords: High-risk pregnancy; Ultrasound; Fetal growth restriction

Abbreviations: CCC: Cerebro-corporal Coefficient; CRL: The Crown–rump Length; PT: Placental Thickness; FGR: Fetal Growth Restriction

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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 on the basis of '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 color 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 system 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, University Hospitals.

Patients

Two hundred patients were included in the study. The patients were recruited from Antenatal Outpatient Clinic the study was done in during the period from January 2020 - December 2021.

Inclusion criteria:

- Age from 18 to 40 years old
- Singleton pregnancies
- During 1st trimester (11-13+6 weeks) as calculated 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:

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 scan view in the sagittal scan and the spine directed anterior or posterior. Measurement of CCC is 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.

CRL: It's the length of the embryo in the natural C-shaped 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) measurement are taken from top of head crown to the end of trunk rumb.

Uterine artery Doppler: It's considered abnormal if the PI >1.96 [2]. The main branch of the uterine artery isolated at cervico-corporal junction. The Doppler velocimetry measurement was performed near this location. We take the mean of 3 successive waves in the measurement

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

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 appearance 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.

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 2020-December 2021. Gestational age was 11-13+6 weeks. Patients have chronic illness making them high risk pregnancy.

Tab. 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/m^2 ranging from 23- 37 kg/m^2. 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 ± 10 mm ranging from 62-98 mm. The placental length mean ± SD was 4.9 ± 1.3 cm, ranging from 3-7 cm. In the present study the PT mean ± SD was 2.9 ± 0.5 cm, ranging from 2-4 cm 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 were homogeneous and 39% were heterogeneous (**Tab. 2.**).

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

Tab. 3. Shows the different ultrasonography 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.

Tab. 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 **Tab. 5.**

DISCUSSION

This study was done on 200 patients from January

Tab. 1. Demographic data of the studied population.	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%)	-

Tab. 2. Clinical data of the patients.	Demographic Data	%	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

Tab. 3. Ultrasonography findings.

Tests	P	Modified X²	Normal (n=1381)	IUGR (n=18)	Total
CCC					
Abnormal	< 0.001(HS)	20.81	20	16	36
Normal			118	2	120
CRL					
Abnormal	< 0.001 (HS)	22.04	26	18	22
Normal			112	0	112
Uterine artery Doppler					
Abnormal	< 0.001 (HS)	40.25	6	16	22
Normal			132	2	134
Placental length					
Abnormal	< 0.001 (HS)	13.47	42	18	60
Normal			96	0	96
PT					
Abnormal	< 0.001 (HS)	13.47	42	18	60
Normal			96	0	96
Placental shape					
Heterogeneous	< 0.001 (HS)	8.07	46	16	62
Homogeneous			92	2	94

Tab. 4. Proposal of scoring system of u/s criteria.

Tests	Score
CCC	
Normal	0
Abnormal	1
CRL	
Normal	0
Abnormal	1
PI	
Normal	0
Abnormal	1
Placental length	
Normal	0
Abnormal	1
PT	
Normal	0
Abnormal	1
Placental shape	
Homogenous	0
Heterogenous	1
Total	6

Tab. 5. Score system performance at cut off level [4].

Score	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value
Abnormal ≥ 4	92	93.3	82.1	97.2
Normal <4				

2020- December 2021. Gestational age was 11-13+6 weeks. Patients have chronic illness making them high risk pregnancy.

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 and Crown rumb length mean SD was 82.2 ± 10 mm ranging from 62-98 mm.

Walid and Pomortsev studied the CCC and CRL for prediction of FGR. They studied 139 diseased patients, CCC > 0.6 or < 0.4 was considered abnormal [3].

In the present study the placental length mean±SD was 4.9 ± 1.3 cm, ranging from 3-7 cm. The PT mean ± SD was 2.9 ± 0.5 cm, ranging from 2-4 cm, the mean placental length/placental thickness ratio was 1.75 ± 0.5, ranging from 0.85- 3.2 and the PI mean ± SD was 1.9 ± 0.16, ranging from 1.5-2.1.

Habib FA and Hooja MP, studied the PT for prediction of IUGR. He studied 211 healthy pregnancies. The mean ± SD was 1.78 ± 0.79 cm [6,7]. 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.

Manning et al. Examined 3045 singleton normal pregnancies at 11-14 weeks. The mean PI was 2.35 [8].

The live born infants were 18 FGR and 138 normal babies. Fetal loss was 30 abortions and 14 IUFD.

In the study of Costa et al., for prediction of FGR in first trimester weeks, fetal loss <20 weeks was 3 cases, still birth >20 weeks was 2 cases, FGR 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., which may be due to the chronic illness in the patients of the current study.

The CCC and CRL in the present study is highly significant in the prediction of FGR (P<0.001). This agrees with Smith and Colleagues. They studied 4229 normal pregnancies in the first trimester at 11-13 weeks, they found that, the crown rumb length and CCC is significant in prediction of FGR [9,10].

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., these authors evaluated uterine artery Doppler in 878 unselected pregnancies. They found strong association between reduced uteroplacental blood flow and adverse outcome [11]. However, this disagrees with Gomer et al., and Dugoff et al. 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 [12,13].

In the present study, placental length has high significance in prediction of FGR (P <0.001). The present study agrees with Toal Mchanc, 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 [14-17].

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.

In the study of Walid and Promertser, CCC and CRL were studied for predicting FGR at 11-13 weeks. Sensitivity of CCC was 78%, Sensitivity of CRL was 66% [3].

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.

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