Evaluation of Using Multiple Ultrasonographic Parameters in the Prediction of Macrosomia in Pregnancies Affected By Gestational Diabetes

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Abstract: Gestational diabetes mellitus is one of the most common medical complications of pregnancy, with an overall prevalence of 4–14 %. In pregnancies complicated by diabetes mellitus, fetal macrosomia is common, which is defined as a birth weight of at least 4000 grams or greater than the ninetieth percentile for gestational age. Macrosomia increases the risk of shoulder dystocia, brachial plexus injury, clavicular fractures, and increases the rate of admissions to the neonatal intensive care unit. For the mother the risks associated with macrosomia are caesarean delivery, postpartum hemorrhage and perineal lacerations. Antenatal prediction of macrosomia helps in identifying the population at highest risk for complications. The aim of this study is to evaluate the usefulness of using multiple ultrasonographic parameters for prediction and follow up of macrosomia in gestational diabetic pregnancies between 28 and 32 weeks of gestation. This study included 100 pregnant women diagnosed with gestational diabetes diagnosed by the presence of one or more oral glucose tolerance test values exceeding the normal thresholds, which are 92 mg/dl, 180 mg/dl and 153 mg/dl respectively. All patients had serial third-trimester u/s scans, Trans-abdominal scanner (3.5 MHz transducer) using **Voluson E6** machine was used with recording of: basic fetal biometry, fetal anterior abdominal thickness, abdominal circumference percentile, placental thickness, interventricular septal thickness and estimated fetal weight by u/s then fetal birth weight is recorded. Results were collected and statistical analyses of the recorded measurements of the third trimester scan are done to evaluate the usefulness of each in prediction of fetal macrosomia. In present study the cut off of AAWT ≥5.5 mm as predictor of macrosomia had sensitivity of 63.9% and specificity of 75% and the cut off of Interventricular septal thickness ≥ 4 mm as a predictor of macrosomia had sensitivity of 50%, specificity of 93.75%, and negative predictive value of 76.9% and AC measurement ≥90th percentile was also useful as a screening tool. The obvious disadvantage of the AC ≥90th percentile cut- off is its false positive rate (12/36 positive results were false- positives). Final conclusion is that AAWT and IVS and AC PERCENTILE are useful parameters for early prediction of macrosomia in pregnant women with gestational diabetes.

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1. Introduction

Gestational diabetes mellitus (GDM) is the commonest metabolic disorder of pregnancy and is defined as varying degrees of glucose intolerance first recognized in pregnancy. The obstetric complications of gestational diabetes are linked to the vaginal delivery of a large for gestational age fetus and to the increased risk of late stillbirth ***(Kamana, 2015).***

The prevalence of gestational diabetes, as reported in different studies, varies between 1% and 14% in all pregnancies depending on the genetic characteristics and environment of the population under study ***(Guariguata et al., 2014).***

The traditional and most often reported risk factors for GDM are high maternal age, pre-pregnancy obesity, high parity, family history of diabetes (FHD) (especially in first-degree relatives), previous delivery of a macrosomic infant and previous obstetric outcome history (e.g. previous history of GDM, congenital malformation, caesarean section) and excess weight gain in pregnancy ***(Erem et al., 2015).***

In gestational diabetes, patient's maternal glycaemia and obesity appear to be independent contributors to the occurrence of fetal macrosomia and operative delivery ***(Ian Donald's, 2014).*** Subsequently, gestational diabetes appears to be associated with the development of diabetes in the mother and diabetes and obesity in the offspring. Therefore, evaluation of fetal intrauterine growth by ultrasound measurements is advisable ***(Ian Donald's, 2014).***

Many of the investigations and management strategies in pregnancies complicated by gestational diabetes are aimed at reducing the rate of macrosomia

(Freeman et al., 2017). Macrosomic fetuses are at risk for a range of complications at birth (shoulder dystocia, obstructed labor, low Apgar scores) and in the postnatal period (poor glucose and body temperature control). Long-term complications have also been reported such as increased insulin resistance, hypertension and type 2 diabetes (***Freeman et al., 2017).***

The antenatal detection of macrosomia is met with difficulties. The traditional technique is biometric estimation of fetal weight (EFW) using a number of parameters ***(Kaur et al., 2018).***

Many studies have demonstrated that EFW is not a reliable indicator of macrosomia or peripartum complications and consequently several other ultrasound parameters have been proposed such as anterior abdominal wall thickness (AAWT), Cardiac interventricular septum thickness (IVS) and abdominal circumference percentile ***(Kaur et al., 2018).***

Assessing the abdominal fetal fat layer (FFL) has been shown to be highly reproducible with good inter- and intra-observer variability ***(Bauer et al., 2015).***

(FFL) measurement has also been demonstrated to be of value in detecting macrosomic fetuses at term. In one study scans were performed in pregnancies more than 36 weeks' gestation, a cut-off for macrosomia of 5 mm yielded a sensitivity of 85% and specificity of 65% ***(Janani, et al., 2018).***

Cardiac interventricular septum (IVS) thickness has also been postulated as a useful marker for macrosomia. The fetal cardiac interventricular septum thickness has been noted to be thicker in diabetic than in normal pregnancies ***(Janani et al., 2018).***

Assessing the abdominal fetal fat layer (FFL) has been shown to be highly reproducible with good inter- and intra-observer variability. This measurement has also been demonstrated to be of value in detecting macrosomic fetuses at term ***(Janani et al., 2018).***

FFL has also been successfully used at 38 weeks' gestation to predict growth restriction and an increased incidence of neonatal morbidity (using a cut-off of <5 mm). Although these approaches have shown value they have not entered common practices ultrasound is not generally performed at term and other than choosing the mode of delivery there is limited benefit in having this knowledge at such late gestation ***(Janani et al., 2018).***

Aim of the work

The aim of this study is to evaluate the usefulness of using multiple ultrasonographic parameters for prediction and follow up of macrosomia in gestational diabetic pregnancies between 28 and 32 weeks of gestation.

2. Patients And Methods

This prospective study includes 100 pregnant women complicated by gestational diabetes between 28 and 32 weeks of gestation done in the period from August 2017 to September 2018.

All participants who met the eligibility criteria were informed of the U/S procedure and follow up and provided informed written consent for participation in the study.

This study is designed according to ethics committee rules of obstetrics & gynecology department at Al Azhar university hospital.

Inclusion Criteria

1. Pregnant patient of the out-patient clinic.
2. Gestational age between 28+0 and 31+6 weeks.
3. Reliable dates confirmed by last menstrual period date or established by an ultrasound scan performed no later than 22 weeks.
4. Gestational diabetes diagnosed by Oral glucose tolerance (OGTT) at 24 weeks of gestation.
5. Singleton living pregnancy.
6. No other medical disorder.

Exclusion Criteria

1) Multiple pregnancies.
2) History of previous gestational hypertension or preeclampsia.
3) Congenital fetal anomalies.
4) Obstetrics complications (fetal intrauterine growth restriction, preeclampsia or intrauterine fetal deaths).
5) Patients with systemic diseases or pre-existing diabetes mellitus.

All patients included in the study are diagnosed with gestational diabetes.

Gestational diabetes is defined by the presence of one or more (75 mg oral glucose tolerance test) values exceeding the normal thresholds, which are 92 mg/dl, 180 mg/dl and 153 mg/dl respectively ***(American Diabetic Association, 2015).***

All patients had serial third-trimester u/s scans with trans-abdominal scanner (3.5 MHz transducer) using **Voluson E6 machine (GE Healthcare.2015)** with recording of:

1. Fetal biometry (BPD, HC, AC, FL)
2. AC percentile
3. Fetal anterior abdominal wall thickness (AAWT)
4. Interventricular septum thickness (IVS)
5. Amniotic fluid Index
6. Placenta thickness
7. Estimated fetal weight

1. Fetal biometry: (using Hadlock formula)

Biparital diameter

A transverse section of the head that had both lateral ventricles symmetrically in view with a horizontal midline was used, and the measurement

was made perpendicular to the midline (Falx cerebei) from outer edge to inner edge at the widest point.

Head circumference

Measuring whole head circumference from outer to outer edge of the skull at the same transverse section used in measuring Biparital diameter.

Femur length

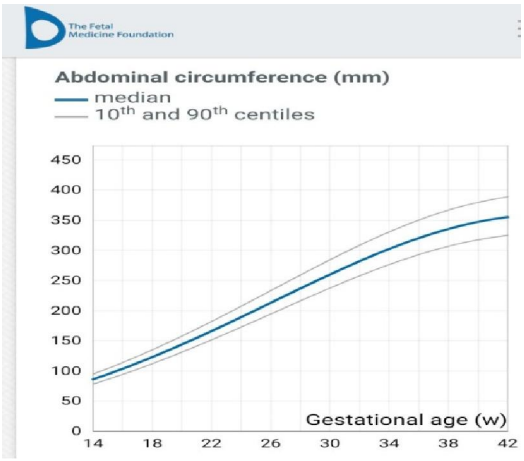
The FL measurement included only the femoral diaphysis length, from greater trochanter to lateral epicondyl excluding the hypoechogenic cartilaginous structures at the ends of the femur.

Abdominal circumference

The AC measurement was taken from a transverse section of the abdomen at the level of the fetal liver including umbilical vein complex, stomach bubble and abdominal Aorta.

2. Abdominal circumference percentile:

The AC percentile is estimated using the provided charts ***(fetalmedicine, 2018)***



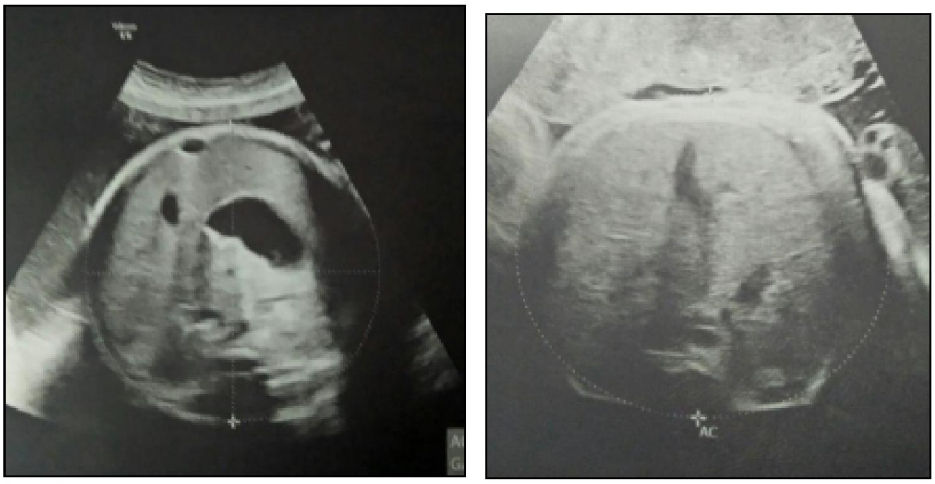


Figure (1): Measurement of abdominal circumference and AC percentile chart.

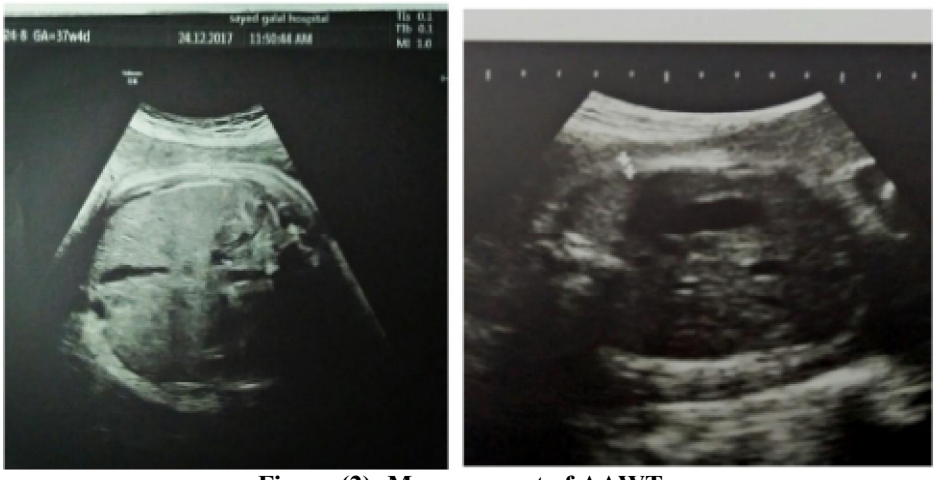


Figure (2): Measurement of AAWT.

3. Fetal anterior abdominal wall thickness:

The AC plane is selected; adequate magnification is defined as the AC at least filling the screen area. The measurement is taken as close to vertical as possible (using axial resolution). Measurements are not taken on the fetal back (not in the quadrant which includes the spine). Electronic calipers are used to measure the inner to the outer aspect of the echogenic subcutaneous fat that surrounds the abdomen ***(Rigano et al., 2000).***

4. Interventricular septum:

A four-chamber view is obtained; the septum is positioned horizontally (in order to use the axial plane for measurement). The midpoint of IVS (halfway between the apex and the mitral valve) is selected and cineloop is used to obtain the image of maximum ventricular filling (The smallest measurement). The image is optimized by using adequate magnification (heart approximately half of screen) and low dynamic range (compression) ***(Patchakapat et al., 2006).***

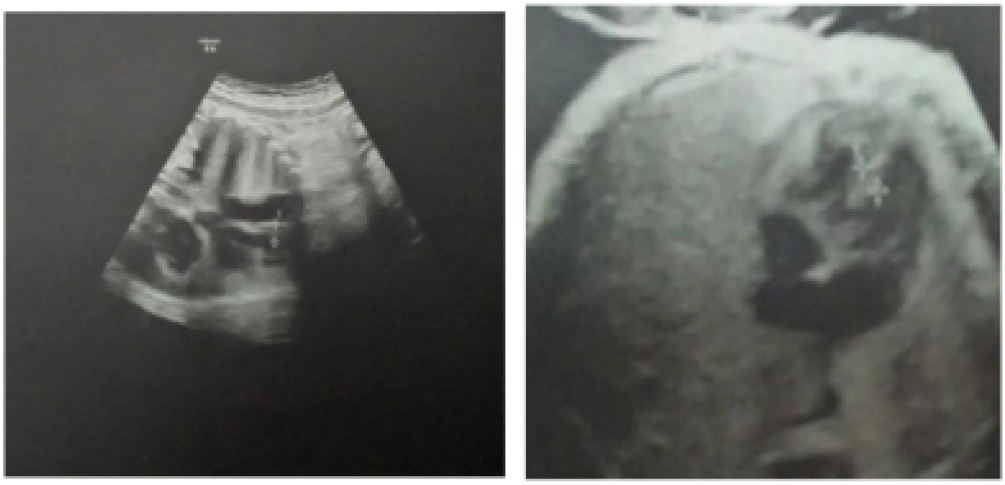


Figure (3): Measurement of the interventricular septum thickness.

5. Placental thickness:

The placental thickness was measured at the level of the umbilical cord insertion; the maximum thickness was noted in the cross section. Each placenta was measured at its greatest thickness, which was perpendicular to the uterine wall. The uterine myometrium and the retro-placental veins were excluded.

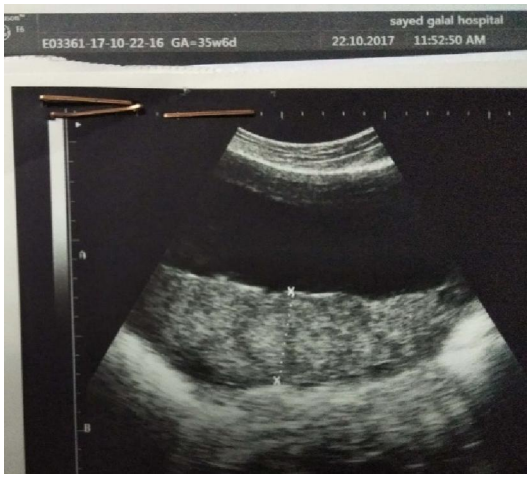


Figure (4): Measurement of placenta thickness

6. Amniotic fluid Index:

Amniotic fluid is measured using maximum vertical pool in 4 quadrants and classified into:

Average amniotic fluid: AFI less than **20**

Above average: AFI **20-25**

Polyhydraminous: AFI more than **25**

After delivery, fetal weight is recorded and birth weight percentile is calculated.

Results: statistical analyses of the recorded measurements of the third trimester scan are done to evaluate the usefulness of each in prediction of fetal macrosomia.

Fetal macrosomia is defined as a birth weight of at least 4000 grams or greater than the ninetieth percentile for gestational age ***(Edward et al., 2017).***

3. Results

Table (1) shows that 36% of children were macrosomic.

Table (1): Studied groups

	No	**%**
***Average weight fetus**	64	64.0%
***Macrosomic fetus**	36	36.0%

***Macrosomic fetus:** fetal birth weight 4000 grams or more.

***Average weight fetus:** fetal birth weight less than 4000 grams.

Table (2) shows that there was increase statistically significant in parity, glycemic state and age as regards average weight fetus and macrosomic fetus.

Patients included have mean age 30.5 years, 28 patients are on insulin therapy and 72 patients are on diet control (56 patients are controlled on diet and 16 patients are uncontrolled on diet and refused insulin therapy).

Table (2): Comparison between birth weights as regards demographic data of mothers

		Average weight fetus (No.=64)		Macrosomic fetus (No.=36)		Chi Square Test	P value
		No	%	No	%	X^2/t*	P value
Parity	P1	24	37.3%	16	44.4%	35.197	0.001
	P2	16	25%	8	22.2%		
	P3	10	15.6%	3	8.3%		
	P4	8	12.6%	5	13.9%		
	PG	6	9.5%	4	11.2%		
Mode of delivery	CS	46	65.6%	26	72.2%	4.982	0.083
	NVD	18	21.9%	10	27.8%		
Glycemic state At time of delivery	Controlled	46	71.9%	4	11.1%	37.446	0.001
	Mild elevated BGL on diet control	7	10.9%	5	13.9%		
	Uncontrolled	11	17.2%	27	75.0%		
Age	Mean ±SD	29.34 ± 5.26		32.03 ± 4.83		-2.520*	0.013

* Independent t test

Table (3) shows that there was statistically significant difference between average weight fetus in comparison to macrosomic fetus regarding AC percentile, AAWT, IVS, AF and EFW% at early third trimester scan.

Table (3): Comparison between average weight fetuses and macrosomic fetuses regarding u/s parameters measured at early third trimester*

		Average weight fetus (No.=64)		Macrosomic fetus (No.=36)		Chi Square Test	P value
		No/ Mean	%/SD	No/ Mean	%/SD	X^2/t*	P value
GA (wk)	Mean ±SD	30.16	1.31	30.81	1.28	-2.394	0.019
Biometry	Mean ±SD	31.11	1.46	31.94	0.95	-3.079	0.003
AC percentile	Mean ±SD	83.73	14.56	92.97	4.41	-3.704	0.001
AAWT (mm)	Mean ±SD	4.74	0.94	5.22	0.78	-2.601	0.011
IVS (mm)	Mean ±SD	3.45	0.63	4.15	0.94	-4.405	0.001
AFI	Average	36	56.2%	11	30.6%	-21.497	0.001
	Above average	16	25.0%	4	11.1%		
	Polyhydraminous	12	18.8%	21	58.3%		
Placental thickness	Mean ±SD	33.18	4.37	34.58	3.25	-1.689	0.094
EFW (grams)	Mean ±SD	1760.25	316.09	1920.17	336.55	-2.372	0.020
EFW (%)	Mean ±SD	87.95	7.16	95.00	6.92	-4.778	0.001

* Independent t test * Early third trimester u/s were done at 28-32 weeks of gestation

Anterior abdominal wall thickness

Among 44 patients with AAWT above 5 mm 28 patients delivered macrosomic fetus (PPV 63.6%), among 56 patients with AAWT below 5 mm only 8 delivered macrosomic fetus (NPV 85.7%), among 36 patients who delivered macrosomic fetus 28 patients had AAWT above 5mm (sensitivity 64%). In present study the cut off of fetal fat layer ≥ 5.5 mm as predictor of macrosomia had sensitivity of 63.9% and specificity of 75%.

Inter ventricular septum thickness

Among 28 patients with IVS above 3.9 mm 16 patients delivered macrosomic fetus (PPV 57.1%), among 72 patients with IVS below 3.9 mm 52 patients delivered non-macrosomic fetus (NPV 72.2%), among 36 patients who delivered macrosomic fetus 16 patients have IVS above 3.9 mm. In present study a cut off of Interventricular septal thickness ≥ 4 mm as a

predictor of macrosomia had sensitivity of 50%, specificity of 93.75%, and negative predictive value of 76.9%. Thus, interventricular septal thickness ≥ 4 mm is a reliable predictor of macrosomia.

AC Percentile

An AC measurement ≥90th percentile was also useful as a screening tool. The obvious disadvantage of the AC ≥90th percentile cut-off is its false positive rate (12/36 positive results were false-positives).

Table (4) shows that there was statistically significant difference between average weight fetus in comparison to macrosomic fetus regarding AAWT, IVS, placental thickness and EFW% in at late third trimester scan.

Table (4): Comparison between average weight fetuses and macrosomic fetuses regarding u/s parameters measured at late third trimester*

		Average weight fetus (No.=64)		Macrosomic fetus (No.=36)		Chi Square Test	P value
		No/ Mean	%/SD	No/ Mean	%/SD	X^2/t*	P value
GA (wk)	Mean ±SD	35.97	1.22	35.61	1.54	1.279	0.204
Biometry	Mean ±SD	36.20	1.31	36.72	1.39	-1.862	0.066
AC percentile	Mean ±SD	87.48	8.00	91.06	10.49	-1.916	0.058
AAWT (mm)	Mean ±SD	5.33	0.88	7.77	1.79	-9.119	0.001
IVS (mm)	Mean ±SD	4.40	0.55	5.31	1.27	-5.035	0.001
AFI	Average Above average Polyhyrdaminous	30 15 19	46.9% 23.4% 29.6%	4 1 31	11.1% 2.8% 86.1%	-36.181	0.001
Placental thickness	Mean ±SD	42.75	4.52	47.83	5.02	-5.184	0.001
EFW (grams)	Mean ±SD	3164.92	340.14	3400.06	336.80	-3.330	0.001
EFW (%)	Mean ±SD	88.78	5.47	93.81	5.87	-4.295	0.001

* Independent t test * Late third trimester u/s were done at 36 weeks of gestation or more

Placental thickness

Among 36 patients who delivered macrosomic fetus 24 patients had placental thickness above 50mm in late third trimester (PPV 66.7 %). Thus, Placental thickness ≥ 50 mm could be a useful parameter in detecting fetal macrosomia, but later in pregnancy (≥ 34 weeks of gestation).

Table (5) shows that there was statistically significant decrease in average weight fetus in comparison to macrosomic fetus with birth weight.

Table (5): Comparison between birth weight categories as regards birth weight

	Average weight fetus (No.=64)		Macrosomic fetus (No.=36)		Independent t-test	
	Mean	SD	Mean	SD	t	p value
Birth weight (gr)	3660.938	172.39	4166.67	126.49	-15.408	0.001

Table (6) shows that in AAWT:

- The cut of point of AAWT >5.5
- Its sensitivity is 63.89%
- Its specificity is 75%
- The positive predictive value is 59%
- The negative predictive value is 78.7%

Table (6): Cut of point, sensitivity and specificity of AAWT in first visit between birth weight

Cut off point	AUC	Sensitivity	Specificity	-PV	+PV
>5.5	0.682	63.89	75.00	78.7	59.0

Table (7) shows that in IVS:

- The cut of point of IVS>4
- Its sensitivity is 50%
- Its specificity is 93.75%
- The positive predictive value is 81.8%
- The negative predictive value is 76.9%

Table (7): Cut of point, sensitivity and specificity of IVS in first visit between birth weight

Cut off point	AUC	Sensitivity	Specificity	-PV	+PV
>4	0.705	50.00	93.75	76.9	81.8

4. Discussion

Gestational diabetes mellitus is one of the most common medical complications of pregnancy, with an overall prevalence of 4–14 % ***(ACOG, 2015).***

In pregnancies complicated by diabetes mellitus, fetal macrosomia is common, which is defined as a birth weight of at least 4000 grams or greater than the ninetieth percentile for gestational age ***(Edward et al., 2017).***

Macrosomia increases the risk of shoulder dystocia, brachial plexus injury, clavicular fractures and increases the rate of admissions to the neonatal intensive care unit. For the mother, the risks associated with macrosomia are caesarean delivery, postpartum hemorrhage and perineal lacerations. Antenatal prediction of macrosomia helps in identifying the population at highest risk for complications ***(Janani, et al., 2018).***

The estimated fetal weight is based on biometric data collected during the ultrasound examination. This exam is often obtained as close to delivery as possible to best estimate the fetal weight (EFW) at birth. Unfortunately, these late exams have relatively poor positive and negative predictive values for fetal macrosomia, which limits their clinical utility for the individual patient. Performing ultrasound exam so close to delivery can also present technical challenges such as decreased amniotic fluid and a fetal vertex well engaged in the pelvis, which may limit visualization and accuracy ***(Julia M and Jane A, 2018).***

Various investigators have sought to overcome these limitations by performing series of ultrasonographic examinations earlier in the third trimester and predicting estimated fetal weight. These were the reasons for this study design, which included evaluation of ultrasound parameters of glycemic control performed remotely from delivery to predict fetal macrosomia ***(Julia M and Jane A, 2018).***

Our study is done on 100 pregnant women diagnosed by GDM between 28-32 weeks of gestation.

Gestational diabetes is defined by the presence of one or more (75 mg oral glucose tolerance test) values exceeding the normal thresholds, which are 92 mg/dl, 180 mg/dl and 153 mg/dl respectively. In present study we evaluated the usefulness of sonographic measurement of basic fetal biometry, fetal anterior abdominal thickness, abdominal circumference percentile, placental thickness and interventricular septal thickness as early predictors of macrosomia in gestational diabetes mellitus.

In present study the cut off of AAWT ≥5.5 mm as predictor of macrosomia had sensitivity of 63.9% and specificity of 75% and the cut off of Interventricular septal thickness ≥ 3.9mm as a predictor of macrosomia had sensitivity of 50%, specificity of 93.75%, and negative predictive value of 76.9% and AC measurement ≥90th percentile was also useful as a screening tool but the obvious disadvantage of the AC ≥90th percentile cut-off is its false positive rate (12/36 positive results were false-positives).

Several studies of ultrasound measurement for predicting of fetal macrosomia were established before.

Greco, et al., 2003, had a prospective case–control study evaluating the abdominal fat layer thickness in diabetic pregnancies. They investigated the fetuses of 15 patients with diabetes and 16 with normal pregnancies and found that the adipose tissue disposition was increased in the fetuses of the diabetic patients. The mean abdominal wall thicknesses in the diabetic and healthy control groups at 31 weeks were (4.4±0.1 mm) and (3.7±0.1 mm) respectively. This study concluded the significance of abdominal wall thickness measurement in GDM which we used in our study for prediction for fetal macrosomia.

Bethune et al. (2003) had a study on 90 pregnant women with gestational diabetes using ultrasound third-trimester scan between 28 and 34 weeks' gestation. In their study IVS thickness ≥5mm had sensitivity of 53% and specificity of 87%.8, and fetal fat layer (FFL) measurement ≥5 mm in the early third trimester was nearly 10 times the probability of the baby being macrosomic if the FFL measurement was <5 mm. An AC measurement ≥90th percentile was also useful parameter in macrosomia prediction, the obvious disadvantage of the AC ≥90th percentile was its false positive rate (17/30 positive results were false-positives). this study used the same 3 parameters as our study and concluded nearly the same results as our study as cut off value of AAWT ≥5.5 mm and that of the IVS ≥4mm.

Mary et al. (2008) performed Prospective cohort study in a tertiary level maternity unit. 125 diabetic mothers (71 pre-gestational and 54 gestational diabetics on insulin) underwent routine serial third trimester ultrasound examination with the additional measurement of AAW thickness in diabetic pregnancy from 30 to 38 weeks gestation. Third trimester AAWT was significantly higher in macrosomic babies, the cut

off for AAWT in the prediction of macrosomia was 3.5 mm at 30 weeks and 5.5 mm at 36 weeks gestation. The prediction of birth weight greater than the 90th centile was better (88%) than with using AC percentile alone (70%). This study agreed with our study in the usefulness of AAWT and AC percentile in prediction of macrosomia but with difference in the cut off value of AAWT, at our study the mean cut off value at 30 weeks of gestation was 5.5 mm and the mean measurement of AAWT during follow up at late third trimester was 7.7 mm.

LaTasha Nelson et al. (2011) performed a study to evaluate the ability of early third-trimester sonography to predict large for gestational age (LGA) birth weights in women with gestational diabetes mellitus using estimated fetal weight only. Eighty six women with gestational diabetes received a fetal sonogram for growth at gestational ages of 28 weeks to 32 weeks 6 days, Patients with an estimated fetal weight at or above the 75th percentile for gestational age were categorized as the exposed group (with evidence of fetal overgrowth), and patients with an estimated fetal weight below the 75th percentile were categorized as the unexposed group (without evidence of fetal overgrowth). Neonates whose early third trimester estimated fetal weight was at or above the 75th percentile were significantly more likely to be LGA at birth compared with neonates whose early third-trimester estimated fetal weight was below the 75th percentile: 65% exposed versus 15% unexposed. This study used only traditional fetal biometry parameters for detection of macrosomia which disagree with our study as we concluded that standard biometry could not predict macrosomia at early third trimester as there is no statistical difference in fetal biometry in average weight fetuses in comparison to macrosomic fetuses.

Gojnic et al. (2012) In a prospective clinical trial, 280 pregnant women underwent 100 g oral glucose tolerance test (OGTT) at 28th week of gestation for diagnosis of gestational diabetes and evaluation of ultrasound measurements of fetal anterior wall thickness (AAWT), abdominal circumference (AC), liver length (LL), and amniotic fluid index (AFI) in prediction of fetal macrosomia (FM) and gestational diabetes mellitus (GDM). Usual cut-off value of AC ultrasound measurement > 35 cm at term as an accurate method in identifying FM with high sensitivity (87.50%) and specificity (84.74%) but has lower diagnostic value comparing the proposed cut-off values for AC, AAWT, and LL during 32nd, 34th, 36th, and 38th week of gestation. The best results in this study were achieved by LL at 34 weeks (0.944), by LL at 32 weeks (0.942), and by AAWT at 36 weeks (0.923). This study also agreed in the usefulness of using AAWT for prediction of fetal macrosomia but disagreed in its usefulness in early third trimester.

Hüseyin Aksoy et al. (2016) performed a prospective study on 124 pregnant women at 26–28 weeks' gestation that had scheduled one-step 75-g OGTTs and found that there were no significant differences in the standard biometric measurements. The anterior abdominal wall was significantly thicker in the GDM group (4.07±0.46mm) than in the control group (3.28±0.37mm). This study agreed with our study in that standard biometric measurements have no significance in macrosomia prediction and the usefulness of AAWT measurement at early third trimester with cut of value >4 mm.

A recent study ***Janani et al. (2018)*** had a prospective study on sonographic measurement of umbilical cord thickness, fetal fat layer, interventricular septal thickness as predictors of macrosomia in fetus of women with gestational diabetes mellitus and concluded that the cut off of fetal fat layer ≥5 mm as predictor of macrosomia had sensitivity of 84.2% and specificity of 86.4% and cut off of Interventricular septal thickness ≥ 3.9mm as a predictor of macrosomia had sensitivity of 84.2%, specificity of 64.2%, and negative predictive value of 95.9%. This study agreed with our study and had the same results for AAWT and IVS measurements at early third trimester for macrosomia prediction.

Our study has many strengths, the major one is using 6 ultrasonic parameters for detecting the most useful parameters in early third trimesteric prediction of fetal macrosomia which wasn't used before in any other studies, also serial u/s examinations done to involved patients for follow up. Other important strengths include the wide and strict exclusion criteria. In addition, interobserver variability was avoided by having all ultrasound measurements performed on the same ultrasound machine by a single experienced obstetrician. An important strength point of this study is the presence of longitudinal data, including serial scans at different gestational weeks and actual birth weights.

Conclusion and Recommendations

Final conclusion is that AAWT and IVS and AC PERCENTILE are useful parameters for early prediction of macrosomia in pregnant women with gestational diabetes with cut off value for AAWT 5.5 mm and cut off value of IVS 4 mm and AC PERCENTILE more than 90th percentile for age at 28-32 weeks of gestation, while standard parameters used for fetal biometry (BPD, HC, FL) were not of good value in macrosomia prediction in early third trimester.

Recommendations obtained from our study are: performing OGTT for all pregnant women at 24

weeks of gestation for diagnosing of GDM especially for high risk groups, proper control of blood glucose level for pregnant women with GDM by diet control or pharmacological agents to minimize it's complication, using of new ultrasound parameters in addition to standard parameters for fetal biometry for prediction of fetal macrosomia for prevention of fetal and maternal complications.

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