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The Role of Fetal Biacromial Diameter measurement in the Prediction of Fetal Macrosomia in the last trimester of Pregnancy

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ABSTRACT

Background: The sonographic measurement of fetal biacromial diameter can be used easily as a predictive method for prevention of perinatal complications of macrosomia by early detection and management. **Aim of work:** The objective of our study was the prediction of fetal macrosomia to improve fetal and maternal outcome, as well as to assess the measured value of biacromial diameter by ultrasound and to comparing the accuracy of various formulas for macrosomia prediction at different thresholds. **Patients and Methods**: This study included 151 pregnant women at last trimester of pregnancy (30-40 weeks) with intact membranes, who were attended to the department for complete ultrasound examination. **Results :** The current study showed that there was a statistical significant difference in biacromial diameter between non macrosomic and macrosomic babies and there was significant positive correlation between biacromial diameter and both estimated fetal and neonatal birth weight. **Conclusion:** The ultrasound measurement of fetal biacromial diameter could be an accurate and simple method for prediction of fetal macrosomia at birth.

Keywords: Fetal Biacromial Diameter, Fetal Macrosomia, ultrasound.

INTRODUCTION

The large of gestational age fetus was predisposed to a different adverse obstetric and neonatal outcomes, especially the increase of risks related with labour and delivery, including shoulder dystocia and injuries of brachial plexus [(1)].

large infant delivery also increases the risk of birth complications[(2)].

In the neonatal period, macrosomic infants are predisposed to metabolic and electrolyte disturbances, such as hypoglycemia, hypomagnesaemia and hyperbilirubinemia [(3)].

In the long term, infants whom at the highest distribution end of the weight or body mass index (BMI) could be obese in childhood, adolescence, and early adulthood, and could be predisposed to cardiovascular risk and metabolic complications later on[(4)].

Fetal macrosomia a different definitions such as absolute birth weight greater than 4000 g, 4500 g or 5000 g, or a customized birth weight have a great percent > 90th, 95th or 97th percent for the infant's gestational age. None of these definitions discriminates the abnormality of fetus body composition from the normal. Customized percent based on individual fetal growth potential were

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recognized to increase the likelihood of differentiating between pathological and physiological growth [(5)].

Fetal macrosomia was associated with important maternal and neonatal morbidity. In the long term, infants with a large gestational age could be obese in childhood, adolescence and early adulthood than other infants and predisposed to cardiovascular risk and metabolic complications in adulthood. Over one billion adults in the world overweight and more than 600 million of them obese, preventing the vicious cycle effect of fetal macrosomia and childhood obesity is an important pertinent matter [(6)].

The rates of birth trauma for the macrosomic fetus was highly related to absolute birth weight more than birth weight percent, which showed a strong correlation between fetal macrosomia with a short maternal stature and the probability of birth injury [(7)].

AIM OF WORK

The objective of our study was the prediction of fetal macrosomia to improve fetal and maternal outcome, as well as to assess the measured value of biacromial diameter by ultrasound and to compare the accuracy of various formulas for macrosomia prediction at different thresholds..

PATIENTS AND METHODS

A cross sectional study was carried at ultrasound unit & obstetrics and gynecology department, faculty of medicine, Zagazig university from January to July 2019. The study had included 151 pregnant ladies at last trimester of pregnancy (37-41 weeks) with intact membranes and biacromial diameter measured by US at (37-41) weeks then measured actually after delivery, who were attended to the department for complete ultrasound examination.

Fetal macrosomia" defined as a newborn who's significantly larger than average. A baby diagnosed with fetal macrosomia has a birth weight of ≥ 4,000 grams), regardless of his or her gestational age.

Written Informed consent was taken from the subjects participated in this study. the study was approved by the research ethical committee of Faculty of Medicine, Zagazig University. The work has been carried according to The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Exclusion criteria

We exclude pregnant ladies before the last trimester of pregnancy & exclude women with Antepartum hemorrhage, Pre term birth, IUFD, Multiple gestation, Maternal HTN, Congenital malformed fetuses, Any medical disorder except GDM and Those with other risk factors. Additionally patient had known to have macrosomic infant & sent for follow up.

All participants was subjected to the following:

History: Personal history, Present history, Menstrual history: (Date of Last menstrual period for calculation of gestational age), Past history: (History of previous macrosomic infant and history of unexplained IUFD and any medical illness was reported), Family history.

General examination (vital signs, height and weight of patient to calculate BMI.)

Abdominal (obstetric) examination

Vaginal examination

Routine investigations

Sonographic examination: The ultrasound examination was done in ultrasound unit & obstetrics and gynecology department , Zagazig university hospital by machine (SIEMENS,ACUSON X300) with trans abdominal convex probe (3.5 – 5.5 MHZ) frequency to evaluate the fetal diameters. The acquired measure were; Biacromial diameter (TTD , Mid-arm D), BPD, HC, AC, FL, EFW based on Hadlock B formula (Log 10 EFW =1.3596-0.00386(AC) (FL)+0.0064(HC) +0.00001 (BPD) (AC) + 0.0424 (AC)+0.174(FL) [(8)].additionally AFI was measured & the following points were considered through examination: Confirmation of fetal presentation, assessment of fetal biophysical profile & placental site.

Measurement of biacromial diameter as following:

We used Youssef 's formula = TTD +2 ×mid-arm diameter for measuring the fetal biacromial diameter.

TTD was the measurement of transverse section of fetal chest at the level of the heart

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(4-chamber view) in a circular manner at right angles to the fetal spine.

Diameter of mid-arm was measured from skin to skin of upper arm at level of heart at mid humeral point. The formula accuracy was compared with the actual biacromial diameter of the newborn after delivery[9].

Biparietal diameter:

Take a view of across - section for the head at the level of the thalami close to horizontal. The thalami should be located symmetrically on both sides of the midline, the calipers intersection should be placed on outer border of the parietal bones (outer to outer) at the wide part of the skull [10].

Abdominal circumference:

Take a view of across - section for the fetal abdomen in a circular manner as possible, with the umbilical vein in the anterior third of the abdomen (at the level of the portal sinus), with the stomach bubble visible, the spine should be positioned either 3 or 9 o'clock to avoid internal shadowing. The kidney and bladder should not be visible. the ultra sonographer should avoid applying much pressure with the transducer which can distort the circular shape of fetal abdomen. The line of ellipse should be placed on the outer border of the abdomen [10].

Femur length:

Take a longitudinal view of the fetal thigh close to the probe with femur with the full length of the bone visualized, the outer borders of the edges of the femoral diaphysis (outer to outer) ensuring that the trochanter was not included in the measurement [10].

Amniotic fluid index :

The patient was lied down in supine position, the uterus was divided into four quadrants, the maximum depth of amniotic fluid was calculated in centimeters (cm) after excluding the cord loops & small fetal parts, the four quadrants values were added to get the final AFI. [11].

F-follow up the patients & record the mood of delivery .

The mood of delivery was caesarean section and vaginal delivery.

After delivery:

The actual neonatal biacromial diameter was measured after birth Biacromial diameter measured as the distance between the two acromial processes of the scapulae while the neonate lied on his or her back in the prone position and the arms lied to the sides of body and the diameter was measured by an orthopedic anthropometry; as inner edges of the anthropometry's arms were adjusted under the outside edges of the acromial processes then the distance was measured in cm, the mean of the three measurements was recorded .

Neonatal weight and actual biacromil diameter was measured, then all d*ata were tabulated and analyzed statistically to evaluate prediction of fetal macrosomia by measuring biacromial diameter.*

Statistical analysis

Data were collected, tabulated and analyzed by SPSS 20, software for Windows. The significance level was < 0.05.

RESULTS

Table (1), showed that the mean age of the studied patients = 27.3 years ranged from 18 to 38 years. Mean BMI= 23.7, ranged from 20 to 31.9 kg/m^2. Gestational age ranged from 37 to 41 weeks with mean 38.9 weeks. About 38% was gravid for more than three times and 24% was multipara for more than 3 times. Only 9.3% had history of macrosomia. No patient had history of IUFD. About 83% and 68% of them had no history of gestational diabetes or relevant family history respectively. **Table (2),** showed that the neonatal birth weight ranged from 2.5 to 4.5 kg with a mean of 3.4 kg. Actual biacromial diameter ranged from 8.3 to 16.4 with mean 12.26 cm. About 13% of the studied patients had delivered a baby ≥ 4 kg. **Table (3),** showed that there was no statistical significant difference between biacromial diameter which measured by US and the actual biacromial diameter. **Table (4),** showed that there was no statistical significant difference between the measured and actual birth weight among the studied patients. **Table (5),** showed that there was a highly statistical significant difference between biacromial diameter and presence of macrosomia (higher in babies with macrosomia). **Table (6),** showed that the best cutoff of biacromial diameter in prediction of

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fetal macrosomia is ≥15.5 with area under curve 0.98, sensitivity 95%, specificity 97.7%, positive predictive value 86.4%, negative predictive value 99.2% and accuracy 97.3%. **Table (7),** showed that there was significant positive correlation between biacromial diameter and both estimated fetal weight and neonatal birth weight. **Table (8),** showed that there was a statistical significant difference between presence of macrosomia and mode of delivery. All babies with macrosomia were delivered by CS mode.

Table (1) Distribution of the studied patients according to demographic characteristics:

	Mean ± SD	**Range**
Age (years)	27.3 ± 5.6	18 – 38
Gestational age (weeks)	38.9 ± 1.4	37-41
BMI (kg/m^2)	23.7 ± 4.1	20 – 31.9
	N= 151	%
Gravidity: 1-3 >3	 94 57	 62.3 37.7
Parity: 1-3 >3	 115 36	 76.2 23.8
History of macrosomia: No Yes	 137 14	 90.7 9.3
History of IUFD: No Yes	 151 0	 100 0
Gestational diabetes: No Yes	 126 25	 83.4 16.6
Family history: No Yes	 102 49	 67.5 32.5

Table (2) Distribution of the studied patients according to delivery data:

	Mean1 ± SD	**Range**
Neonatal birth weight (kg)	3.4 ± 0.7	2.5 – 4.5
Actual biacromial diameter (cm)	12.26 ± 1.85	8.3 – 16.4
	N = 151	%
Fetal macrosomia ≥ 4 kg Yes No	 20 131	 13.2 86.8

NBW: Neonatal birth weight, ABAD actual biacromial diameter

Table (3) Comparison between measured BAD by US and actual BAD:

	Mean ± SD (range)	**P**
Measured BAD	12 ± 1.7 (8.3 – 16.4)	0.11 (NS)
Actual BAD	12.26 ± 1.85 (8.3 – 16.4)	

BAD: biacromial diameter NS Non-significant,

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Table (4) Comparison between EBW and ABW between studied patients:

	Mean ± SD (range)	p
EBW	3.37 ± 0.7 (2.48 – 4.45)	0.14 (NS)
ABW	3.4 ± 0.7 (2.5 – 4.5)	

EBW: estimated birth weight, ABW: actual birth weight, NS : Non-significant

Table (5) Measured BAD in relation to presence of macrosomia:

Macrosomia	US measured BAD (Mean ± SD (range)	t	P
No (131)	11.6 ± 1.26 (8.3 – 13.6)	11.2	<0.001** (HS)
Yes (20)	14.9 ± 1 (12.5 – 16.5)		

HS highly-significant

Table (6): Predictive value of biacromial diameter in prediction of macrosomia at birth:

Cutoff	AUC	Sensitivity	Specificity	PPV	NPV	Accuracy	P
≥15.5	0.98	95	97.7	86.4	99.2	97.3	<0.001**

** **highly-significant**

Table (7) Correlation between US measured BAD and EFW and neonatal birth weight:

	Measured BAD		
	R	P	Sig.
EFW (kg)	0.77	<0.001	HS
NBW (kg)	0.75	<0.001	HS

BAD: **biacromial diameter,** EFW: **estimated birth weight,** NBW: Neonatal birth weight, HS highly significant

Table (8): The Relation between Macrosomia & Mode of delivery :

	No macrosomia N	%	Macrosomia N	%	P
vaginal	71	54.2	0	0	< 0.001
CS	60	45.8	20	100.0	

DISCUSSION

In present study Mean age of the studied patients = 27.3 years ranged from 18 to 38years. Mean BMI= 23.7, ranged from 20 to 31.9 kg/m2. Gestational age of studied patients ranged from 37 to 41 weeks with mean 38.9 weeks. About 38% was gravid for more than three times and about 24% was multipara for more than 3 times. Only 9.3% had history of macrosomia. No patient had history of IUFD. About 83% and 68% of them had no history of gestational diabetes or relevant family history respectively. These demographic data was logic , good representative to the study group and homogenous with other studies like study of **O'REILLY-GREEN and Divon [12],** where the demographic characteristics of their study population were as follow the mean of maternal age was 25.63±3.68 years while the median was 25 years (range from 18 to 35 years). The mean parity was 0.89±0.82 while the median was 1 (range 0-3). The mean of maternal BMI was 21.57±2.49kg/m^2 while the median was 21.51kg/m^2 (range from 15.4kg/m^2 to 31.39 kg/m^2). The mean of gestational age at the delivery time was 38.73±0.83 weeks and the median was 38.6 weeks (range from 37 to 40 weeks).

In the current study neonatal birth weight ranged between 2.5 to 4.5 kg with a mean of 3.4kg. Actual biacromial diameter ranged

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from 8.3 to 16.4 with mean12.26 cm. About 13% of the studied patients had delivered a baby ≥ 4kg which was in agreement with the study of **Eze et al.** [13] whose study resulted in 12.1% of the ultrasonography estimated were macrosomic, while 15.2% of ere macrosomic at the birth, also with the study of **Aviram et al.** [4] who reported that (9.4%) delivered a neonate weighing ≥ 4000 grams, while 266 (3.3%) delivered a neonate weighing ≥ 4250 g and 75 (0.9%) delivered a neonate weighing ≥ 4500 g.

Regarding comparison between the diameter of biacromial measured by US and actual biacromial diameter, there was no statistical significant difference between biacromial diameter measured at (37-41 weeks) by US and compared with actual one after delivery (12 ± 1.7) and (12.26 ± 1.85) respectively, which was in agreement with the study of **Youssef et al.,** [9] whose results showed that there was no statistical significance difference between the diameter of fetal biacromial measured by ultrasound and the actual diameter of biacromial measured after the birth.

Considering comparison between EBW and actual birth weight, There was no statistical significant difference between estimated or actual birth weights (3.37 ± 0.7) and (3.4 ± 0.7) respectively among the studied patients. This was completely in agreement with study of **Eze et al.** [13] who found that the mean of estimated and actual birth weights were (3378±40g) and (3393±60g) respectively with no statistical significant difference between them. Also, there was no significant difference between the number of ultrasonography measured macrosomia and the actual number of macrosomic babies.

The current study showed that there was statistically significant difference in biacromial diameter between non macrosomic and macrosomic (higher in babies with macrosomia) (11.6 ± 1.26) versus (14.9 ± 1) respectively, this was in agreement with the study of **Winn et al** [14] who reported that there were ultrasonography difference between non macrosomic and macrosomic fetus.

Concerning the predictive value of biacromial diameter in prediction of macrosomia at birth, the current study showed that the best cutoff of biacromial diameter in prediction of fetal macrosomia is ≥15.5 with area under curve 0.98, sensitivity 95%, specificity 97.7%, negative predictive value 86.4%, positive predictive value 99.2% and accuracy 97.3%. this was in agreement with the study of **Aviram et al.** [4] who found that the predictive ability of ultrasound parameters at 4000gm sensitivity was 98.53%, specificity 62.88%, negative predictive value 24.13% positive predictive value 99.72%, accuracy 56.31% and cut off 0.807, the predictive ability of ultrasound parameters at fetal weight 4250gm sensitivity was 96.20%, specificity 72.26%, negative predictive value 11.91%, positive predictive value 99.80%, accuracy 69.69% and cut off was 0.842 and the predictive ability of ultrasound parameters at 4500gm or more sensitivity was 93.24%, specificity 84.37%, negative predictive value 5.98%, positive predictive value 99.91%, accuracy 83.55% and cut off was 0.888. Also **Youssef et al.** [9] reported that the biacromial diameter cutoff of 15.4-cm had a high predictive value for macrosomia prediction (88.4%) and 96.4% sensitivity with overall accuracy of 97%.

The current study showed that there was a positive significant correlation between biacromial diameter and either estimated fetal weight or neonatal birth weight, this was in consistent with study **of Eze et al.**[13] who found a high positive correlation (r) between EFW and ABW of fetuses and most of women had ultrasonography estimated fetal weight of fetuses and actual birth weight within the same range.

The present study demonstrate that there was significant positive correlation between biacromial diameter and TTD, mid arm, BPD, HC, FL, AC and actual biacromial diameter this was consistent with study of **Kurmanavicius et al.** [15] whose results showed that the high interclass correlation coefficient and the stable results in BW groups were obtained with both Hadlock formulas. Both Had lock and Campbell formulas had the lowest percent errors (PE) in BW groups, where it was between <1500 g

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and 3500 g. Shepard and Merz formulas had lower PEs in BW groups, where it was between 3501 g and >4000 g. The PE of EFW ranged from -4.0 +/- 8.5% to 1.3 +/- 8.5% between examiners. Also **Youssef et al., [9]** found positive correlation between the different techniques and reported that ultrasound was a good estimator of ABW.

The current study showed that 53 % of babies were delivered by C\S & 47 % of them were vaginally delivered, this was in contrast with a study done by **Eze et al. [13]** who found that (13.9%) of babies were delivered vaginally (SVD) while (86.1%) were delivered in the caesarian section (CS).

The present study showed that there was statistically significant difference between presence of macrosomia and mode of delivery with (100.0%) of macrosomic fetuses were delivered by cesarean sections, this was in agreement with **Eze et al. [13]** whose study reported a statistical significant difference between the macrosomic fetuses delivered through SVD and the macrosomic fetuses delivered in the caesarian section (CS). (p=0.0001).

Conclusion : The ultrasound measurement of fetal biacromial diameter could be an accurate and simple method for prediction of fetal macrosomia at birth.

No conflict of interest

No financial disclosures

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