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An Observational Study of Accuracy of Ultrasound Determination of Estimated Fetal Weight in Small for Gestational Age Pregnancies in Women Attending Antenatal Clinic

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Abstract: ***Objectives: To determine the ultrasound accuracy of estimated fetal weight in small for gestational age and appropriate for gestational age pregnancies and compare ultrasound accuracy in the two groups. Method: In a Prospective randomized observational study 50 pregnant women at term with AGA pregnancy and 50 other women at term with SGA pregnancy were included and ultrasonic estimation of fetal weight was performed within a week of delivery. Result: In present study, EFW overestimated birth weight in a total of 69% cases and underestimated in 31% cases. Underestimation was more in SGA cases (40%) as compared to AGA (22%). Overestimation was more in AGA (78%) cases as compared to SGA (60%) cases. The mean absolute error of EFW for estimation of birth weight was more in AGA neonates (154.4 ± 266.2 gm) as compared to the SGA neonates (45.96 ± 191.3 gm) (p=0.021). The mean relative error of EFW for estimation of birth weight was more in AGA neonates (5.70 ± 9.08%) as compared to the SGA neonates (2.15 ± 8.75 %) (p=0.049). Conclusion: Ultrasound estimation of fetal weight in small for gestational age pregnancies is comparable to accuracy of estimation of fetal weight in appropriate for gestational age pregnancies.***

Keywords: estimated fetal weight, small for gestational age, appropriate for gestational age

1. Introduction

In modern Obstetrics, to deliver a healthy baby in a healthy mother is the primary goal. Birth weight is the single most important factor which determines the neonatal outcome and survival[1]. So, accurate estimation of foetal weight is one of the important aspects in management of labor, thereby markedly improving perinatal outcome [2]. Babies having a lower birth weight - 2000 g or higher birth weight - 4000g are at an increased risk of disease, morbidity and mortality[3]. Gestational age of - 32 weeks also influence the health and survival of the foetus. Therefore, it becomes pertinent to decipher the foetal weight accurately.

In the last few decades, the estimation of fetal birth weight has advanced from estimation by physical examination to fetal ultrasound using multiple parameters. This has increased the accuracy of the foetal weight estimation significantly[4]. Various factors influence the accuracy of foetal weight such as gestational age, race, ethnicity of females, amniotic fluid index, location of placenta, BMI of the mother, time between estimation and delivery and the type of formula used for estimation [5].

AGA (appropriate for gestational age) refers to the one with birth weight above 10th percentile and below or equals to 90th percentile. SGA (small for gestational age) refers to a foetus that has failed to achieve a specific biometric or estimated foetal weight (EFW) threshold by a specific gestational age i.e., EFW of 10th centile. SGA foetuses are at greater risk of stillbirth, birth hypoxia, neonatal complications [6], impaired neurodevelopment [7], and possibly type 2 (non – insulin dependent) diabetes and hypertension in adult life [8].

Late onset foetal growth restriction is often missed and is responsible for most intrauterine deaths. The main prerequisite to determine IUGR is precise dating. The physician must determine if dating is incorrect and the fetal size is actually normal or if the mother truly needs further evaluation for IUGR Many studies have supported the use of ultrasound for fetal weight estimation as this method is more precise and accurate[9, 10, 11]. Multiple formulae have been developed for the estimation for birth weight using ultrasound measurement. One of the widely accepted and extensively used formula is Hadlock's formula Ultrasonography is normally the study done to assess IUGR. This test loses accuracy as the pregnancy progresses, but sensitivity and positive predictive value can be improved if several variables are combined.[12] Ultrasound estimation of foetal weight are accurate to a large extent but the error associated with it ranges between ±6 to 11%. This largely

depends on the parameters that are being evaluated and the equation that is being used for estimation.[13]

2. Aim and Objectives

- To determine the ultrasound accuracy of estimated fetal weight in small for gestational age pregnancies.
- To determine the ultrasound accuracy of estimated fetal weight in appropriate for gestational age pregnancies.
- To compare ultrasound accuracy of estimated fetal weight in small for gestational age pregnancy and in appropriate for gestational age pregnant.

3. Review of Literature

Estimation of foetal weight plays a very important role in determining the health of the foetus and is a pivotal part of antenatal care. It helps in management of labor and delivery especially during pregnancies which are riskier[15]. The survival of the new born highly depends on the birth weight and therefore, this acts as an independent factor.[15, 16]

Both low and extreme foetal weights at the time of delivery are related to an expanded danger to the infant specifically during labor and puerperium. The high perinatal morbidity and mortality are related with low birth weight. Hence, the babies born with lower weight are given much more care post - birth in NICU for their survival. The current rate for antenatal detection is 25 - 36%.[17]

Neonates with low birth weight <1500gm are often at an increased risk of death. Infants with extremely lower birth weight <1000gm are at a higher risk even more. Figure 1 shows the neonatal mortality with birth weight among singleton live births. Gestational age also determines the foetal survival. Gestational age of <32 weeks or lower increasing the danger to the foetus. Lower gestational age <28 weeks further increases the risk to foetus.[19] Neonates with birth weight >4000gm are known as macrosomic babies and they are difficult to carry and deliver through vaginal delivery (Figure 2).

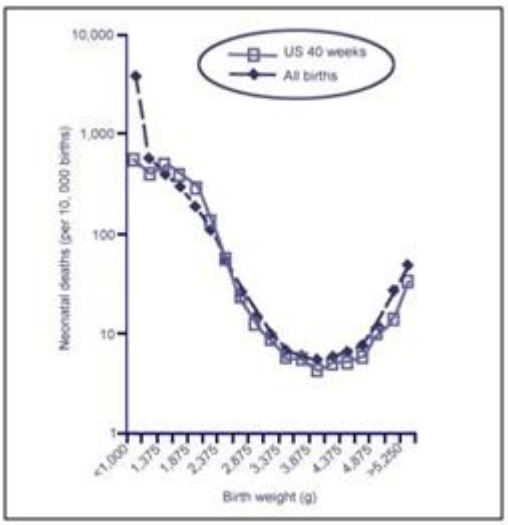


Figure 1: Neonatal mortality by birth weight [*Adapted from - Basso O et al (20)]*

Therefore, proper management and clinical examination of both mother and the baby becomes pertinent in order to plan the proper maternal and foetal care and the course of treatment and delivery. The birth weight of neonates varies from place to place and gender to gender and gestational age. Boys are heavier than girls. Normal birth weight ranges between 3250 to 4250gm.[22 - 24]

Figure 2: Macrosomic baby [Adapted from Nahum et al. (25)]

Factors Affecting Foetal Weight Estimations

Various factors determine the accuracy of foetal weight estimations. Some of these factors act independently in determining the accuracy of estimating foetal weight. In a study by Huber et al, gestational age, BMI, amniotic fluid index, ruptured membrane, presentation of foetus, location of placenta and multiple foetuses have no impact on the accuracy of estimating foetal weight. However, controversial results were obtained with respect to foetal gender and the experience of the examiner. Foetal weight, time between

estimation and delivery, type of formula used showed a positive effect on the accuracy of foetal weight estimation.[5]

Methods of Foetal Weight Estimations

Several techniques and methods are used to estimate the foetal birth weight. The accuracy of each of the method being used depends on the gestational age and the range of birth weight that is being studied. However, none of the method is 100% accurate and there are chances of error in using each of the methods available specially in determining the low birth weight (<2500gm) which is the product of preterm deliveries and extremely high birth weight (>4000gm) or macrosomia.

Tactile Assessment of foetal weight

This is one of the oldest methods for estimating the weight of the baby. It is also known as clinician palpation or Leopold maneuvers. In this technique, obstetric practitioner measures the size of the foetus manually. By placing both hands on the belly of woman, the examiner can describe the position of the foetus as well as the level of the uterine fundus and thus detect a disproportion between foetus and the female pelvis. Experienced examiners are able to give a clinical estimation of foetal weight after performing Leopold's manoeuvres including symphysis - fundal height and abdominal palpation.[28]This method is extensively used worldwide. It is more convenient and is economical with no cost involved. The major disadvantage of this technique is that it is more prone to errors as this method is based on a subjective approach.[25]

Clinical risk factor assessment

Quantitative assessment of clinical risk factors can be valuable in predicting deviations in fetal weight. These factors include -

1) Maternal diabetes mellitus
2) Prolonged gestation >41 weeks
3) Maternal obesity
4) Maternal weight gain during pregnancy >35 lb
5) Maternal height > 5'3 feet
6) Male foetus
7) Multiparity
8) Maternal age >35 years
9) Caucasian maternal race

Maternal self - estimations

The third method for determining the weight of the foetus is maternal self - estimations. Literature supports the use of self - estimations to be more accurate to the findings of clinical palpation for determining the weight of the foetus.

Ultrasound/ Obstetric Ultrasonography

This is one the most widely used method today for estimation of foetal weight. It is undertaken as a part of routine management of pregnancies or when there is complication associated with the pregnancy.[29] Ultrasound estimation of foetal weight are accurate to a large extent but the error associated with it ranges between ±6 to 11%. This largely depends on the parameters that are being evaluated and the equation that is being used for estimation.[30] Accuracy of birth weight estimation using ultrasound is more during early gestations, because at term ultrasound resolution significantly decreases due to decrease in the fluid to foetus ratio, increased calcification of bony structures and the vertex descends in the pelvis, making measurements of head circumference and biparietal diameter more difficult[31] (Figure 4, 5).

The ultrasound based method is based on the principle that involves the interaction of the sound waves with the living tissues and hence produces the image. In the Doppler - based modes, the interaction is based on the velocity of moving tissue primarily blood.[32]

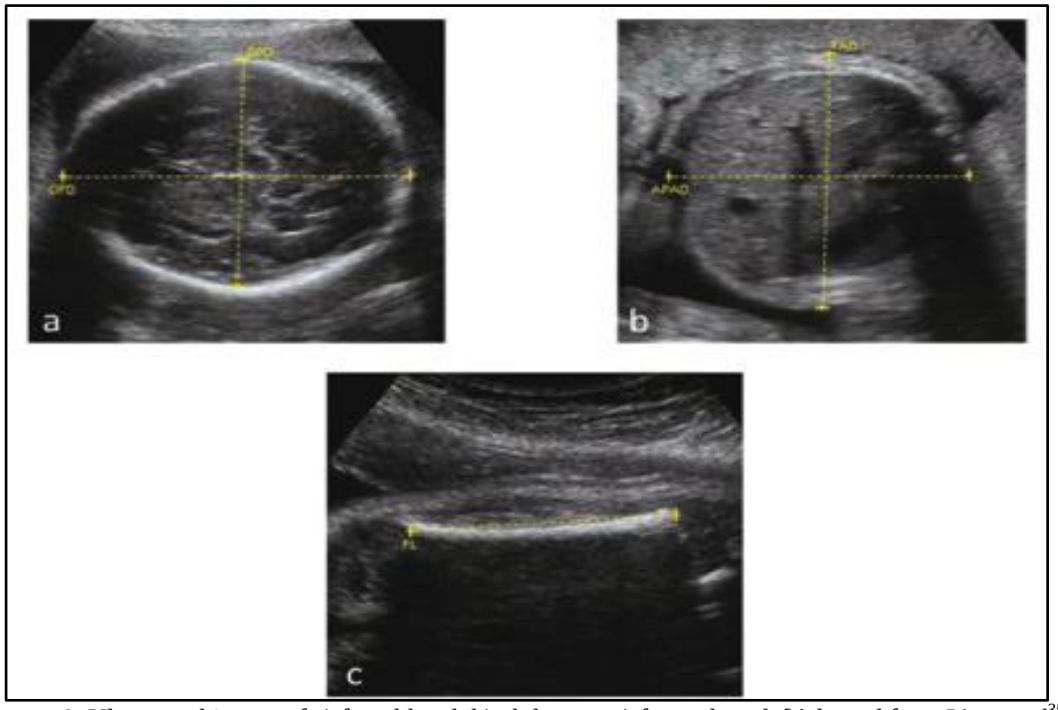


Figure 4: Ultrasound image of a) foetal head, b) abdomen, c) femur length [*Adapted from Liao et al*[35]*]*

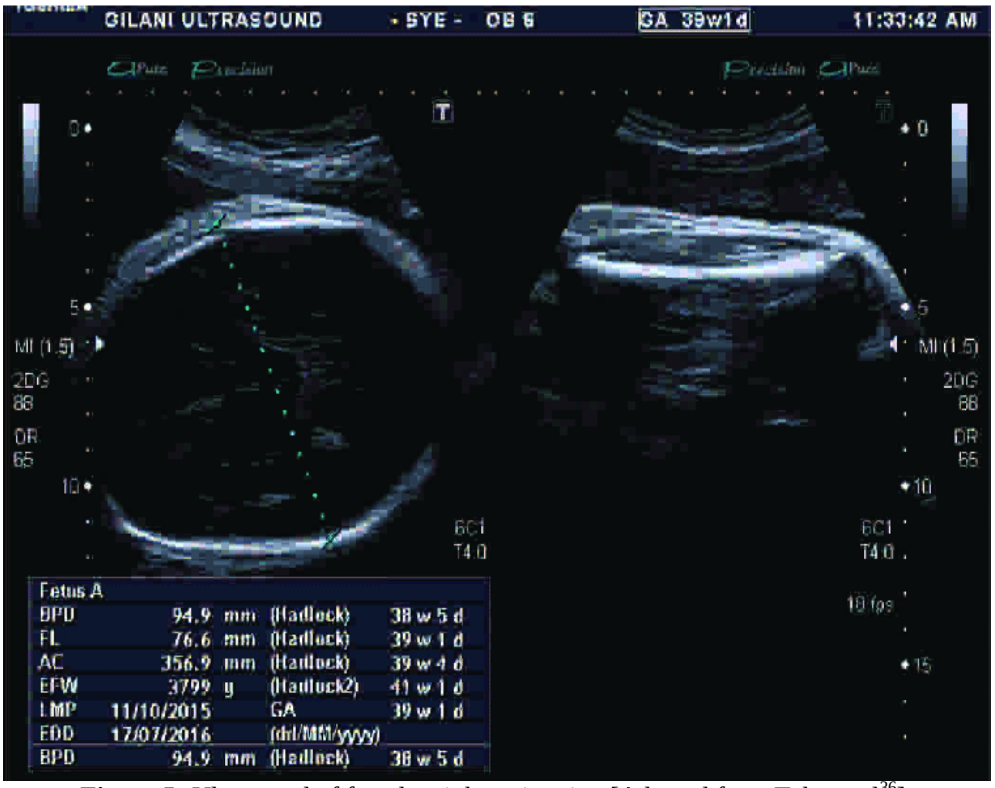


Figure 5: Ultrasound of foetal weight estimation [Adapted from Taha et al[36]]

The estimations of foetal weight are based on determining femoral length, head circumference, biparietal diameter and abdominal circumference.

- **Biparietal diameter -** BPD is measured from transaxial sonogram of the fetal head at the level of paired thalami and cavum septum pellucidum.
- **Head circumference -** Head circumference measures child's head around its largest area. A soft inch tape is used for measurement which is passed through supraorbital ridges to occipital protuberance.3[7] (Figure 6).

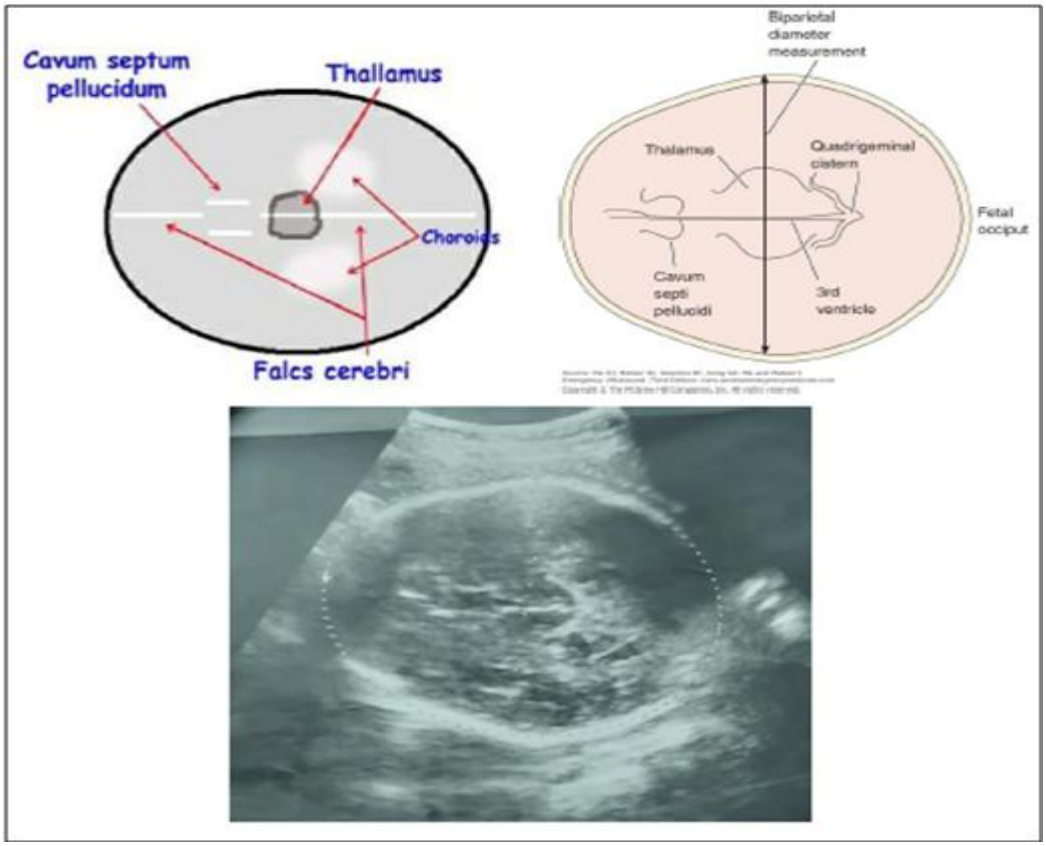


Figure 6: Estimation of biparietal diameter and head circumference

- **Abdominal circumference -** It is measured from transverse axial image of the foetal abdomen at the level of the stomach and intrahepatic portion of umbilical vein.[38] (Figure 7)

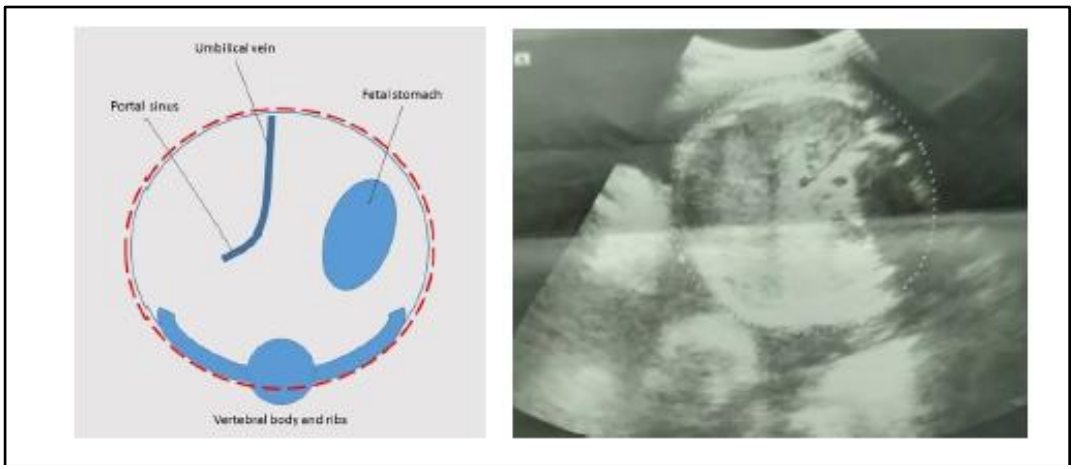


Figure 7: Abdominal circumference estimation

- **Femur length -** Femur shaft is the long bone of foetus which can be easily visualised and measured. Femur length is measured from the greater tronchanter to lateral condyle[39] (Figure 8).

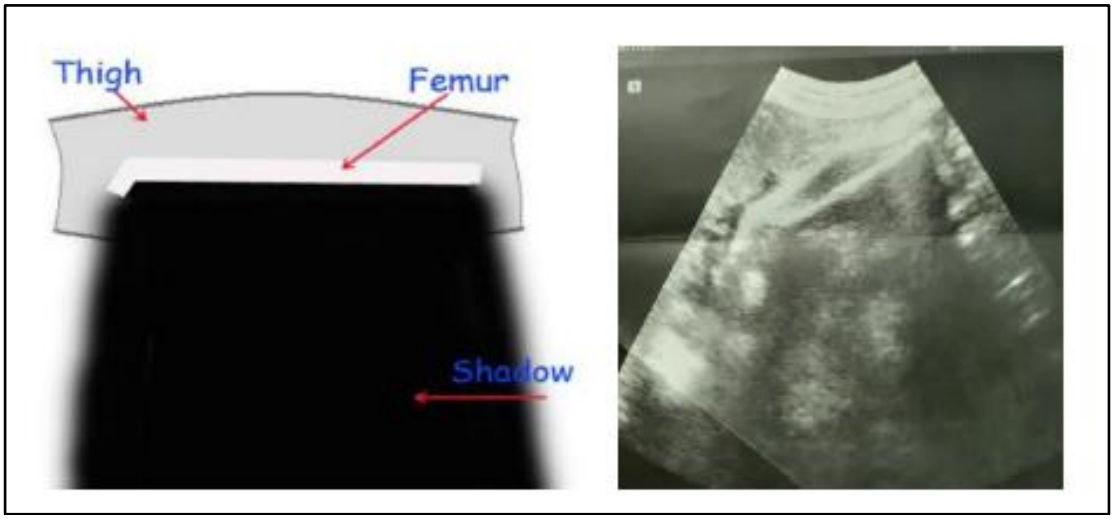


Figure 8: Femur length estimation

Algorithms for determination of foetal weight

- Shepard algorithm
- Warsof algorithm
- Hadlock algorithm
- Sabbagha

Previous Studies

Savchev S. et al (2012) conducted a study to estimate weight centile as a predictor of perinatal outcome in small for gestational age pregnancies with normal foetal and maternal Doppler indices at University of Barcelona, Spain. They evaluated the risk of adverse perinatal outcome according to estimated foetal weight (EFW) in a cohort of term small for gestational age (SGA) pregnancies with normal umbilical, foetal middle cerebral and maternal uterine artery Doppler indices. A cohort of 132 term SGA fetuses with normal umbilical artery pulsatility index (PI), mean uterine artery PI cerebroplacental ratio was compared to a control group of 132 appropriate - for - gestational - age babies, matched by gestational age at delivery. The capacity of the EFW percentile to predict Cesarean delivery, Cesarean delivery for non - reassuring foetal status (NRFS), neonatal acidosis and days of neonatal hospitalization was analyzed. As a whole, SGA fetuses with normal Doppler findings did not show a statistically significant difference for intrapartum cesarean delivery (22.0 vs.15.9%; P=0.21) and neonatal acidosis (3.3 vs.1.5%; P=0.30), but had significantly higher risk for cesarean delivery for NRFS (15.9 vs.5.3%; P <0.01) and longer neonatal hospitalization (1.39 vs.0.87 days; P<0.05) than did controls. SGA fetuses with EFW<3rd centile had a significantly higher incidence of intrapartum Cesarean delivery (30.0 vs.15.3%; P=0.04), Cesarean delivery for NRFS (25.0 vs.8.3%; P<0.01) and longer neonatal hospitalization (2.0 vs.0.9 days; P<0.01) than those with EFW ≥ 3rd centile. SGA cases with EFW ≥ 3rd centile had perinatal outcomes similar to those controls with normal EFW. They concluded that among SGA fetuses with normal placental and cerebral Doppler ultrasound findings, EFW <3rd centile discriminates between those with a higher risk for adverse outcome.

4. Material and Methods

Study Setting:
The study was conducted in the Department of Obstetrics and Gynaecology, SMS Medical College, Jaipur.

Study design:
Prospective randomized observational study.

Study period:
From March 2020 to February 2021.

Study population
Fifty pregnant women at term with appropriate for gestational age pregnancy and fifty other women at term with small for gestational age pregnancy having ultrasonic estimation of fetal weight performed within a week of delivery.

In our project we had defined **Small for Gestational Age** neonate as one with birth weight equal to or below 10th percentile for gestational age according to normograms proposed by Alexander et al. This comprise the test group.

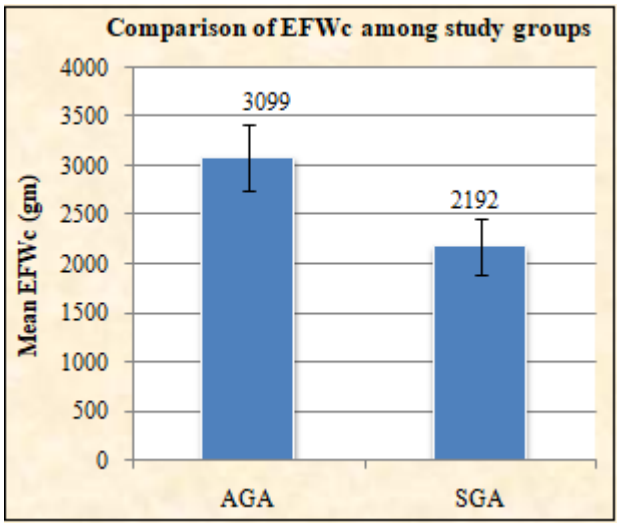
Appropriate for Gestational Age Neonatehad been defined as one with birth weight above 10th percentile and below or equal to 90thpercentile

Inclusion Criteria
- Women given written informed consent.
- Singleton live pregnancy with term gestation
- Women reliably knowing last menstrual period, and having regular menstrual cycles.

Exclusion Criteria
- Obese female (weight more than 90 kg)
- Polyhydramnios
- Oligohydramnios
- Ruptured membranes
- Abnormal lie or presentation
- Antepartum hemorrhage
- Large for gestational age pregnancy
- Babies with congenital anomalies

Sample Size
- 50 pregnant women with full term gestation (i. e. >37 weeks), single live pregnancy, cephalic presentation and appropriate for gestational age fetus as determined by full term ultrasonography report were taken as control group.
- 50 pregnant women with full term gestation (i. e. >37 weeks), single live pregnancy, cephalic presentation with small for gestational age fetus as determined by full term ultrasonography report were taken as case group.
- Before enrolling the patient into the study, patient was explained the type and nature of the study and informed written consent was taken. On admission the age, the parity, maternal age, body weight, antenatal risk factor if any of the patient was taken into consideration.

Statistical Analysis
- The data will be analysed as per appropriate statistical analysis.



5. Discussion

Estimation of fetal birth weight has advanced from estimation by physical examination to fetal ultrasound using multiple parameters. This has increased the accuracy of the fetal weight estimation significantly.

This observational study was aimed at determine the ultrasound accuracy of estimated fetal weight included 50 small for gestational age pregnancies and 50 adequate for gestational age pregnancies.

In present study most of study subjects (60%) were aged 21 – 25 years, followed by 28% were aged 26 – 30 years. Only 8% females were aged 20 years or below, while 4% females were aged 31 - 35 years. Mean age was 24.47 ± 2.89 years. Similarly **Sharma et al (2020)** found that the mean maternal age was 25.1±4.3 years.[57]**Hameed and colleagues (2021)** found the mean age to be 27.8±4.2 years.[10]**Njoku et al (2014)** also observed the mean age of mothers to be 28.86 ± 6.355 years.[53]**Preyer et al (2019)** found that mean maternal age was 29.2 ± 5.0 years.[11]**Caballero and team (2021)** found that the mean age of mothers was found to be 30.82 ±6.68 years.[58]

Further socio demographically most of the study subjects belonged to lower socio economic status (53%), were Hindu (67%), and were from urban area (53%). Those differences were not statistically significant.

Among the 100 subjects in present study, 53% delivered by vaginal route, while 47% delivered by LSCS. LSCS rate was slightly more common among subjects with SGA babies (50%), as compared to those with AGA babies (44%), was however not statistically significant. **Njoku et al (2014)** observed that majority (82%) delivered normally through vagina.[53] In yet another similar study, **Preyer et al (2019)** found that 63% women underwent spontaneous vaginal delivery, 8.3% operative vaginal delivery and 28.7% caesarean section.[11]**Sharma et al (2020)** reported that normal vaginal delivery was observed in 78.2% and caesarean section was performed in 20.9% women while 0.9% women had undergone instrumental delivery.[57]**Hameed and colleagues (2021)** reported that

Caesarean section being performed in 84% of the subjects and normal vaginal delivery was carried out in 16% of the subjects.[10] These findings suggest that vaginal route is still the preferred delivery mode at most sites. Though, rate of caesarean section can vary at different places depending on the medical care practices.

The mean EFWc was higher in AGA neonates (3099gm) than the mean actual birth weight (2944gm). And in SGA neonate the mean EFWc was higher (2192 gm) than the mean actual birth weight (2146 gm), this was not statistically significant (p>0.05). Considering all patients together, the mean EFWc was higher (2646 gm) than the mean actual birth weight (2545 gm), the difference was however not found to be statistically significant (p>0.05).

In another similar study**, Njoku et al (2014)** observed that the mean birth weight of babies by clinical and ultrasound methods was observed as 3, 541 ± 633g and 3, 141 ± 441gm, respectively.[53] No significant difference was found in the actual birth weight and ultrasonic weight before birth (p=0.122).[54]**Mehendale et al (2018)** also found that no significant difference was observed in the actual birth weight and ultrasound estimated fetal weight in both the groups.[56]In yet another similar study**, Hameed and colleagues (2021)** observed that the mean fetal birth weight was found to be 2.9516±0.59 kg and mean actual birth weight was found to be 2.9948±0.60 kg. The authors did not observe any significant difference in the mean estimated and actual birth weight of the fetus in the study.[10]In another similar study, **Sharma et al (2020)** found that mean estimated birth weight of infants using ultrasound was 3120.8±349.4 g and actual mean birth weight was 3088.2±404.5gm.[57]

In present study, EFWc overestimated birth weight in a total of 69% cases and underestimated in 31% cases. Underestimation was more in SGA cases (40%) as compared to AGA (22%). Overestimation was more in AGA (78%) cases as compared to SGA (60%) cases. Overestimated fetal weight was more in small for gestation age pregnancies compared to appropriate for gestation age (65% vs 54%; p>0.05). Supporting our findings, **Milner and Arezina (2018)** in their systemic review observed an overestimation of fetal birth weight in majority of the studies included.[55] In another similar study, ***Mehendale et al (2018)*** reported that overestimated fetal weight was more in small for gestation age pregnancies compared to appropriate for gestation age (65% vs 54%; p>0.05).[56]

The absolute error in birth weight estimation by USG (EFWc) ranged from - 600 gm to 802 gm. The mean absolute error was 100.2 ± 236.9 gm, i. e. on an average EFWc overestimated birth weight by 100.2 gm. **Sabrina Q. Rashid et al (2015)** in a similar study observed that the mean absolute difference between EFW and Birth Weight was - 64.5 (±218.5) g (95% CI of the difference, - 116.2 gm to - 12.7 gm).9 In another similar study, **Sharma et al (2020)** reported a mean absolute error in estimation of birth weight was 258.5 gm.[57] **Sabrina Q. Rashid et al (2015),** found that mean estimated fetal weight was 65 gm less when compared to actual birth weight. Above findings suggest that EFWc overestimates the birth weight, the magnitude varying slightly from study to study.[9]

6. Summary and Conclusion

Summary

- Present study aimed to determine and compare the ultrasound accuracy of estimated fetal weight in SGA pregnancy and in AGA pregnancy.
- This prospective observational study included 50 AGA and 50 SGA subjects.
- Mean age of all subjects was 24.47 ± 2.89 years. Mean weight of females with AGA was 58.36 ± 6.35 Kg, while that of females with SGA babies was 56.5 ± 7.78 Kg (p>0.05).
- Most of the study subjects were from urban area (53%). Most of the study subjects belonged to lower socio economic status (53%) and (67%) Hindu.
- 46% females were gravida 2 and 18% females were gravida 3 or more. More than one third (36%) females were primigravida.
- 53% delivered by vaginal route, while 47% delivered by LSCS.
- Most of the AGA neonates were with normal birth weight (96%), while among SGA neonates most had low birth weight (96%) (p<0.001).
- The Relative error in birth weight estimation by USG (EFWc) ranged was 3.93 ± 9.05 %.
- The mean absolute error of EFWc for estimation of birth weight was more in AGA neonates (154.4 ± 266.2 gm) as compared to the SGA neonates (45.96 ± 191.3 gm) (p=0.021).
- The mean relativeerror of EFWc for estimation of birth weight was more in AGA neonates (5.70 ± 9.08%) as compared to the SGA neonates (2.15 ± 8.75 **%**) (p=0.049).

Conclusion

Ultrasound estimation of fetal weight in small for gestational age pregnancies is comparable to accuracy of estimation of fetal weight in appropriate for gestational age pregnancies. The present study suggested that the identification of factors influencing the accuracy of ultrasonographic EFW in extremely preterm infants provides knowledge to clinicians caring for women at risk of very early birth. Careful interpretation of EFW with consideration of risk factors can enhance guidance for timing and mode of delivery and for counseling parents about the expected neonatal outcome at gestational ages at the limit of viability.

References

[1] Barua A, Hazarika J, Dutta S. Correlates of Low Birth Weight: A Hospital - Based Study From Gangtok, India. *Glob Pediatr Health*.2014; 1: 2333794X14562229.
[2] Bajracharya J, Shrestha NS, Karki C. Accuracy of prediction of birth weight by fetal ultrasound. *Kathmandu Univ Med J (KUMJ)*.2012; 10 (38): 74 - 76.
[3] Medlock S, Ravelli AC, Tamminga P, Mol BW, Abu - Hanna A. Prediction of mortality in very premature

infants: a systematic review of prediction models. PLoS One 2011; 6: e23441.

[4] Harlev A, Walfisch A, Bar David J, Hershkovitz R, Friger M, Hallak M. Maternal estimation of fetal weight as a complementary method of fetal weight assessment: a prospective clinical trial. J Reprod Med.2006 Jul; 51 (7): 515 - 20.

[5] Huber C, Zdanowicz J, A, Mueller M, Surbek D. Factors Influencing the Accuracy of Fetal Weight Estimation with a Focus on Preterm Birth at the Limit of Viability: A Systematic Literature Review. Fetal DiagnTher.2014; 36: 1 - 8.

[6] Mclntire DD, Bloom SL, Casey BM, Leveno KJ. Birthweight in relation to morbidity and mortality among newborn infants. N Engl J Med 1999; 340; 1234 - 8.

[7] Roth S, Chang TC, Robson S, Spencer JA, Wyatt JS, Stewart AL. The neurodevelopmental outcome of term infants with different intrauterine growth characteristics. Early Hum Dev 1999; 55: 39 - 50.

[8] Barker DJ. The long - term outcome of retarded fetal growth. ClinObstet Gynecology 1997; 40: 853 - 63.

[9] Rashid SQ. Accuracy of Sonographic Fetal Weight Estimation in Bangladesh. J. Med. Ultrasound.2015; 23 (2): 82 - 85.

[10] Hameed S, Saleem Z, Rauf M, Aslam T, Hafeez A, Mehmod I. Comparison of ultrasonographic estimated fetal weight and actual birth weight. Prof. Med. J.2021; 28 (10).

[11] Preyer O, Husslein H, Concin N, Ridder A, Musielak M, Pfeifer C et al. Fetal weight estimation at term - ultrasound versus clinical examination with Leopold's manoeuvres: a prospective blinded observational study. BMC Pregnancy Childbirth.2019 Apr 11; 19 (1): 122.

[12] Cormick MC. The contribution of low birth weight to infant mortality and childhood morbidity. N Engl J Med.1985 Jan 10; 312 (2): 82 - 90.

[13] Dudley, N. J. A systematic review of the ultrasound estimation of fetal weight. Ultrasound Obstet Gynecol.2005; 25: 80 - 89.

[14] Poprzeczny AJ, Louise J, Deussen AR, Dodd JM. The mediating effects of gestational diabetes on fetal growth and adiposity in women who are overweight and obese: secondary analysis of the LIMIT randomised trial. *BJOG*.2018; 125 (12): 1558 - 1566.

[15] Ugwu EO, Udealor PC, Dim CC, Obi SN, Ozumba BC, Okeke DO et al. Accuracy of clinical and ultrasound estimation of fetal weight in predicting actual birth weight in Enugu, Southeastern Nigeria. Niger. J. Clin. Pract.2014; 17 (3): 270 - 275