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Association of Ultrasound Estimated Fetal Weight with Actual Birth Weight of Baby

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Abstract: ***Introduction: Fetal weight estimation is a precious tool for doctors to take informed decisions about timing & mode of delivery, and is also an independent risk factor for perinatal mortality. But there is conflicting evidence regarding accuracy of USG estimated fetal weight in literature. Our study was designed to find predictive ability of 3rd trimester USG estimated fetal weight for the actual birth weight & its ability to predict LGA/SGA babies. Methods: A retrospective analytical study was conducted on 1280 patients after matching inclusion & exclusion criteria, from January 2016 to December 2020. Estimated fetal weight (EFW) was calculated on growth scan performed at 36th/37th week of gestation & it was compared with the actual birth weight of babies. The proportion of SGA, AGA & LGA babies was determined by plotting on INTERGROWTH - 21 charts. Results: Study population was divided into 4 groups based on scan to delivery interval - Group A (≤ 1 week) (42.66%), B (1 - 2 weeks) (30%), C (2 - 3 weeks) (15.08%) & D (3 - 4 weeks) (12.26%). There was no significant difference between EFW & actual birth weight in Group A (p=0.12); groups B, C, D had significant difference between EFW and newborn weight (p<0.001). This infers that EFW on USG can predict birth weight accurately if delivery occurred within 1 week of scan. The estimated percentages of SGA, AGA & LGA in the last growth scan & actual percentage of Low Birth Weight (LBW), Normal Weight & Big Babies at birth were significantly different overall (p<0.01). But, in group A (≤ 1 week scan to delivery interval), these were not significantly different (p=0.308), implying that growth scan, if the scan - delivery interval was within 1 week, was very effective in predicting the proportion of SGA & AGA babies. Conclusion: Ultrasound Estimated Fetal weight was accurate in predicting actual birth weight only when the scan - delivery interval is within 1 week. Also, last ultrasound done within 1 week of delivery, is able to predict SGA babies with significant accuracy, but not for LGA babies.***

Keywords: Ultrasound, Estimated fetal weight, Actual birth weight, INTERGROWTH - 21, SGA, LGA.

1. Introduction

In utero estimation of fetal weight is a precious tool for management of pregnancy, as it helps to take informed decisions regarding timing & mode of delivery. Fetal weight estimation is also important to monitor & detect intrauterine growth restriction & macrosomia, and can also guide to assess lung maturity.1 Fetal weight is also an independent risk factor for perinatal mortality & morbidity.

Several methods of fetal weight estimation have been described in literature – clinical & USG (Ultrasonographic) estimation. Obstetric USG have remained cornerstone for measuring estimated fetal weight (EFW).1 It is imperative for EFW to accurately depict the actual weight of the fetus in utero at that point in time.2 But there are conflicting reports on accuracy of USG estimated fetal weight at term.3

Moreover USG - estimated fetal weight can classify SGA & LGA, and can optimise monitoring and planning timely delivery

Given the importance of EFW in management & prognosis, it is necessary to compare this estimated fetal weight with the actual birth weight of the babies to know how much & till how long interval we can rely on the 3rd trimester growth scan. Our study was designed to find whether and to what extent growth scan at 36th/37th can predict birth weight of baby.

Objective:

- **Primary objective** - To estimate the association of Estimated Fetal Weight determined on 3rd trimester ultrasound at 36th/37th week of gestation & the actual birth weight of the baby.
- **Secondary objective** - To estimate the accuracy of 3rd trimester ultrasound in predicting the probability of SGA/LGA babies.

2. Material & Methods

A retrospective analytical study was conducted at the Institute of Reproductive Medicine and Women's Health (IRM), Madras medical mission hospital, Chennai over a period of 5 years, from January 2016 to December 2020.

Patients who delivered in our hospital between January 2016 - December 2020 and had a 3rd trimester USG at 36/37 weeks of gestation and delivered within 4 weeks were included in our study. The exclusion criteria were - patients who did not have a 3rd trimester USG at 36/37 weeks of gestation, patients who had a scan but did not deliver in our hospital, multiple pregnancy & known congenital anomaly. Total 1280 patients were included in our study after matching these criteria.

Obstetric ultrasounds were performed in our department by the senior radiologists & senior obstetricians using ob Philips

HD15 & Voluson P8 USG machine. Estimated fetal weight was calculated using Hadlock formula which uses 4 fetal parameters - head circumference (HC), biparietal diameter (BPD), abdominal circumference (AC) and femur length (FL).4

Actual birth weight of neonates were measured within 1 hour of birth using same well calibrated weighing scale.

Our study population was divided into 4 groups based on scan to delivery interval - Group A (≤ 1 week), B (1 - 2 weeks), C (2 - 3 weeks) & D (3 - 4 weeks). For each baby, the estimated fetal weight & actual birth weight were compared. Fetal weight estimation was considered to be accurate if actual birth weight was within ±15% of estimated fetal weight, which is an accepted standard. Accuracy rate was calculated for each group.

We used the INTERGROWTH - 21 (IG - 21) percentile charts for plotting the estimated fetal weights on ultrasound & newborn birth weights for this study. The INTERGROWTH – 21st project was a multi - centre, multi - ethnic population - based project conducted between 2009 & 2014, in 8 demarcated urban areas (including Nagpur, India), studying the growth & development pattern from <14 weeks Gestational Age to 2 years of age.5 Advantages of using these charts were that it represented percentile of fetal weights as well as newborn weights, and it was validated in Indian population.

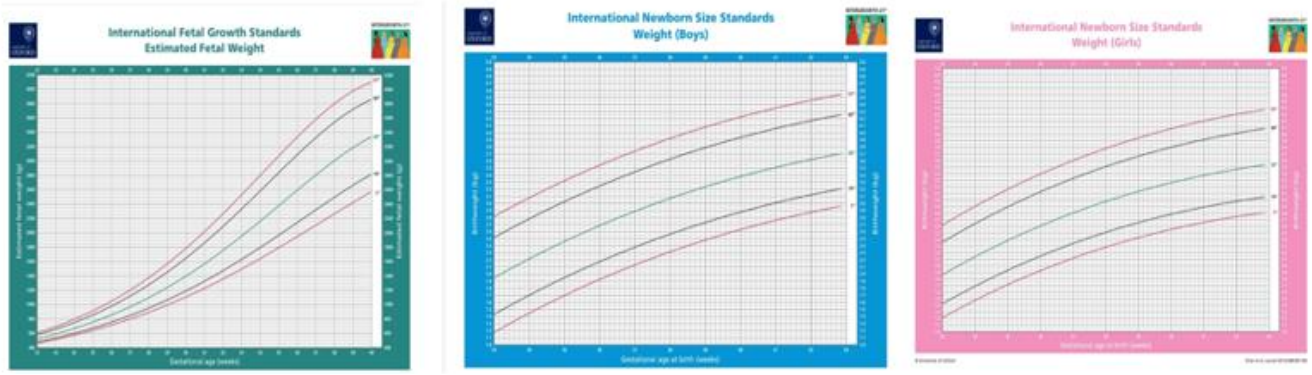

Figure 1: Charts of INTERGROWTH – 21

EFW < 10th percentile as per gestational age is considered SGA (Small for gestational weight), and > 90th percentile was considered LGA (Large for gestational weight).

Birth weight <10th percentile at respective gestational age was considered Low Birth Weight (LBW) & >90th percentile was considered Big baby.

Data was compiled in Excel, was analyzed with SPSS version 26. T - test & Chi - squared test were used for statistical analysis.

3. Results

Total 1280 patients were included in our study & they were classified into 4 groups based on scan to delivery interval - Group A (≤ 1 week), B (1 - 2 weeks), C (2 - 3 weeks) & D (3 - 4 weeks).
Patient distribution in each group is as follows –

Table 1: Patient distribution among groups

Groups	Time Between Last Scan & Date of Birth	Number of Patients	Percentage
A	≤ 1 WEEK	546	42.66%
B	1 – 2 WEEK	384	30%
C	2 – 3 WEEK	193	15.08%
D	3 – 4 WEEK	157	12.26%

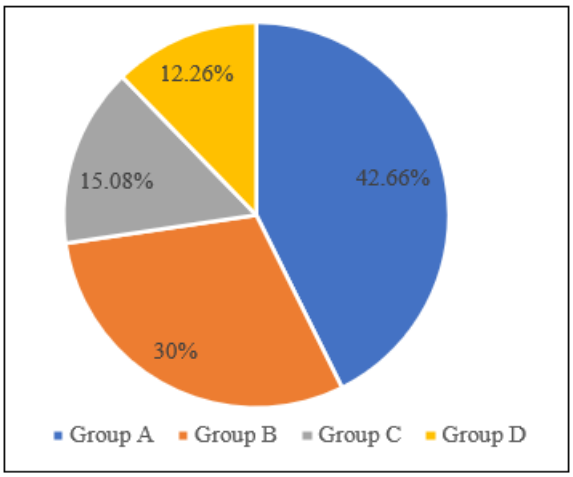

Figure 2: Patient distribution among groups

Accuracy of USG estimated fetal weight, when compared to actual birth weight are described below in all groups – (when estimated fetal weight is within ±15% of actual birth weight, it is considered "accurate" by common practice).

Table 2: Accuracy of estimated birth weight across different groups

Group	Accuracy Rate
Group A	79.85%
Group B	72.40%
Group C	53.09%
Group D	26.75%

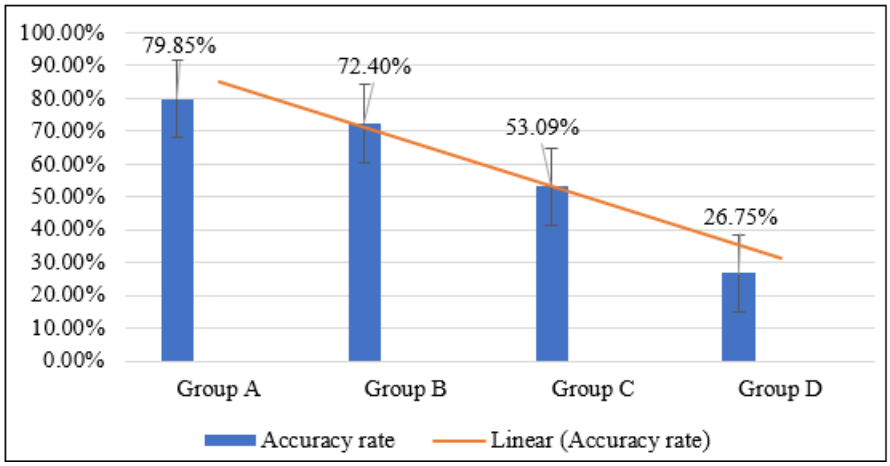

Figure 3: Accuracy of estimated birth weight across different groups

As evident, accuracy of EFW to predict actual birth weight is highest in group A (79.85%), and it gradually decreases with increasing scan to delivery interval, being lowest in group D (26.75%).

Mean & Standard Deviations of the Estimated Fetal Weight as per the last growth scan & the Actual Birth Weight of the baby in different groups were as follows –

Table 3: Actual birth weight & EFW among different groups

Groups	Actual Birth Weight (Mean ±2SD) (grams)	Estimated Fetal Weight (Mean ±2SD) (grams)	p Value of Difference
Group A	2815.12 ± 1476.44	2751.52 ± 2049.82	0.12
Group B	2919.50 ± 1743.46	2670.76 ± 1107.16	<0.001
Group C	2997.71 ± 1077.16	2606.71 ± 853.50	<0.001
Group D	3035.29 ± 1024.74	2448.31 ± 1043.76	<0.001

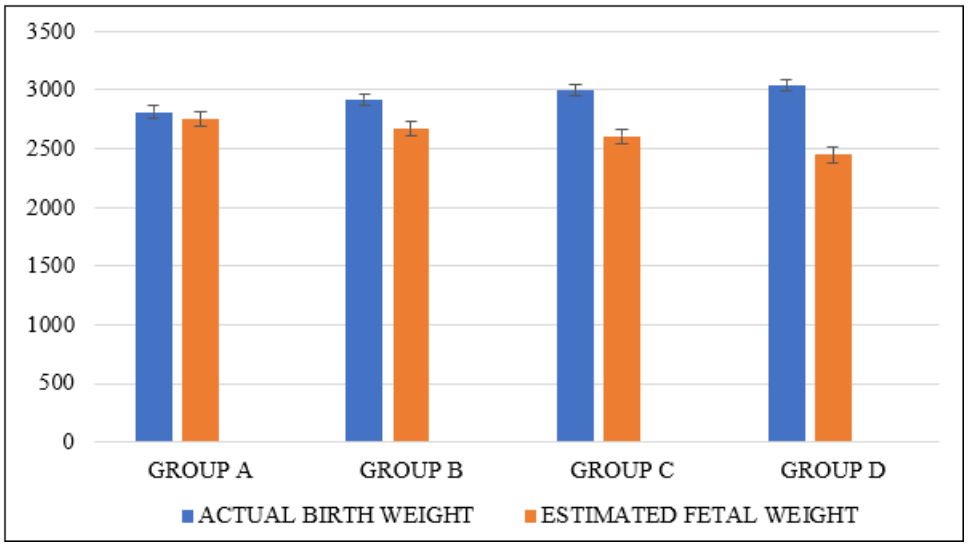

Figure 4: Actual birth weight & EFW among different groups

There was no significant difference between birth weights & estimated fetal weights in Group A (p=0.12); while all other groups had statistically significant difference between these two (p<0.001).

Overall, across all groups, proportion of SGA, AGA & LGA in the last growth scan & actual Percentage of Low Birth Weight (LBW), Normal Birth Weight & Big Babies at birth were compared –

Table 4: Distribution of EFW groups in total population

Estimated Fetal Weight Groups	Number	%
SGA	443	34.61%
AGA	807	64.05%
LGA	30	2.34%

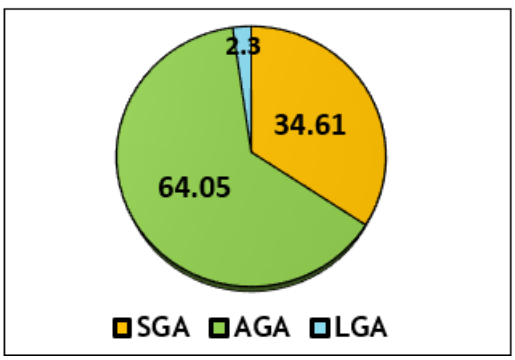

Figure 5: Distribution of EFW groups in total population

Table 5: Distribution of birth weight groups in total population

Birth Weight Groups	Number	%
LBW	278	21.72%
Normal birth weight	916	71.56%
Big baby	86	6.71%

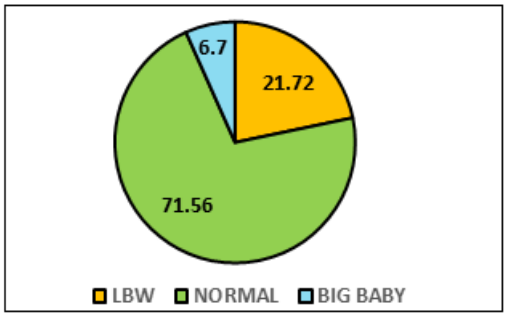

Figure 6: Distribution of Birth weight groups in total population

The proportion of SGA, AGA & LGA in the last growth scan & proportion of Low Birth Weight (LBW), Normal Weight & Big Babies at birth were significantly different ($p<0.01$). This implies that overall 3rd trimester growth scan at 36/37th week was not very effective in predicting the proportion of SGA, AGA & LGA babies.

Then, this same comparison was done only in group A. (≤ 1 week scan - delivery interval). The results were as follows –

Table 6: Distribution of EFW groups in Group A

Estimated Fetal Weight Groups	Number	%
SGA	168	30.77%
AGA	351	64.01%
LGA	27	4.95%

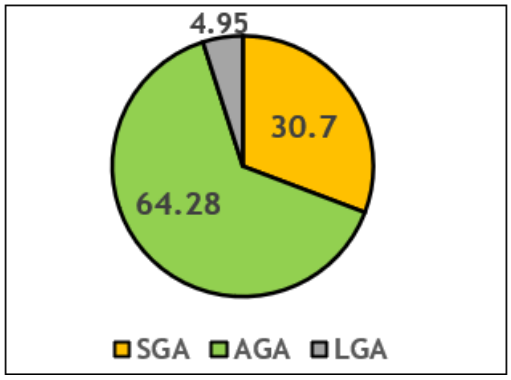

Figure 7: Distribution of EFW groups in Group A

Table 7: Distribution of Birth weight groups in group A

Birth Weight Groups	Number	%
LBW	148	27.11%
Normal birth weight	355	65.01%
Big baby	43	7.88%

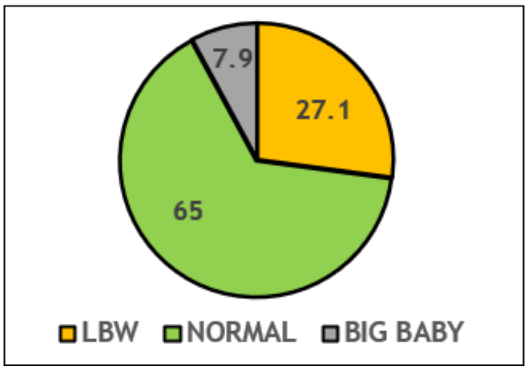

Figure 8: Distribution of Birth weight groups in Group A

The proportions of SGA & AGA in the growth scan at 36/37th week of gestation and actual proportion Low Birth Weight (LBW) & Normal Birth Weight at birth were not significantly different in Group A (≤ 1 week scan - delivery interval) ($p=0.308$). Although proportion of LGA fetuses & proportion of big babies at birth were not significantly different ($p=0.075$), but only 27 fetuses were predicted to be LGA whereas 43 babies were big babies at birth. This implies that 3rd trimester growth scan at 36/37th week of gestation was very effective in predicting the proportion of SGA & AGA babies, but less reliable for LGA babies, if the scan - delivery interval was within 1 week.

4. Discussion

We found that there was no significant difference ($p=0.12$) between estimated fetal weight by USG & actual birth weight in group A patients, i. e. when scan to delivery interval was ≤1 week. But where scan to delivery were >1 week, i. e. in groups B, C & D, the difference between EFW & actual birth weight were statistically significant ($p<0.001$). This may be attributed to natural increase in body weight of fetus in third trimester.

Also, the USG estimated percentage of SGA, AGA & LGA were statistically different from actual percentage of LBW, normal weight & big baby at birth overall in study population ($p<0.01$). But this difference was not statistically significant when compared with group A only ($p=0.308$). This implies that USG done within 1 week of delivery can accurately predict probability of LBW baby.43 babies were born large, but it was accurately predicted in 27 fetuses only, thus making predictive ability of big baby less reliable.

Beyond 1 week interval from scan to delivery the weight of the fetus is bound to change unless there is static growth. The EFW centile can be used for predictability providing the fetus is maintaining normal growth trajectory ie this is a fetus demonstrating normal linear growth. Linear fetal growth is determined by placental, fetal and maternal factors and 2 serial scans at the least 2 - 3 weeks apart is the objective in - utero assessment tool.

Fetus that has an acceleration or slowing of growth can take different trejectories and hence cannot be reliably predicted when the scan to delivery interval is > 3 - 7days.

On review of literature there are several studies that have assessed the predictability of ultrasound. A margin of 10 -

15% weight difference between the calculated fetal weight and the actual birth weight is reported to be within acceptable predictability. This is due to interobserver and interobserver variability with ultrasound and fetal & maternal factors that influence biometry measurement. The fetal, maternal factors that contribute are image resolution, calliper placement, fetal position, maternal body habitus, liquor volume, fetal movements operator experience and time availability to undertake the scan.

Konwar et al[6] said that the ultrasonographic evaluation of fetal weight within 72 hours of delivery, helps predict fetal birth weight precisely and can influence obstetric management decisions concerning timing and route of delivery, thus reducing perinatal morbidity and mortality.

Sharma et al[7] inferred that for singleton term pregnancies, where USG was done within 7 days of delivery, there was strong positive correlation between actual birth weight and sonographically estimated fetal weight. EFW was found to be within ±10% of the actual birth weight in 67.3% cases.

Dittkrist et al[8] concluded that with USG performed within 7 days of delivery, EFW was within 10% of birth weight in 71.6% cases. In this study mean percent error of estimated fetal weight from birth weight was 2.39% ± 9.13%. But percentage of error was significantly higher in both extremes (SGA/LBW & LGA/Big baby) with clinically significant over & under estimations. In this study prediction for LBW, AGA was statistically significant.

Khalid et al[9] stated that the difference among estimated fetus weight in 3rd trimester by USG and actual fetus weight after birth is not statistically significant.

Hameed et al[10] found that EFW by USG done at term & actual birth weight had no statistically significant difference.

Elnazeer et al[11] found that Fetal weight estimated by Hadlock formula within one week prior to delivery, correlated with actual fetal weight (AFW).

Okafor et al[1] inferred that ultrasound estimated fetal weight at term correlated with the actual birth weight and was helpful to aid the clinician in making decisions concerning modes of delivery.

Stephens et al[12] found that there was a significant correlation between the EFW and birthweight of fetuses undergoing ultrasound assessment within 2 weeks of delivery ($P < 0.001$). They also said that USG poorly detected SGA babies as in most cases EFW was falsely overestimated, but the mean difference between the birthweight and adjusted EFW 7 days before delivery was lowest.

Milner et al[13] found in their systematic review that Hadlock formula produced the most accurate results, with the lowest levels of random error. They stated though a lack of consistency remains evident, one source of inaccuracy was difficulty obtaining accurate fetal measurements in late gestation as fetus descends.

Tawe et al[14] concluded that ultrasound estimated fetal weight correlated strongly with actual birth weight especially for babies with normal birth weight.75% of the estimates were within 10% of the actual birth weight. Accuracy drops in case of extremes of weight (SGA & LGA).

Eze CU et al[15] demonstrated that sonographically estimated fetal weight using Hadlock 3 weight estimation model correlated positively with actual birth weight in a Nigerian population, when scan - delivery interval was 1 week.

Francis et al[16] inferred that EFW measured by USG at term were marginally better than scans done in the preterm period, with 73% of EFWs falling within a +/−10% margin of error.

Cohen et al[17] concluded that combining data from births > 1 day after the last ultrasound examination may lead to a false conclusion that there is systematic underestimation of weight. EFW tended to underestimate the weight of macrosomic fetuses and overestimate that of small fetuses.

Bertles et al[18] found that ultrasound EFW (within 7 days of delivery) & birth weight generally achieves comparable prediction of neonatal survival. This information may aid in counselling parents before delivery.

Dudley et al[19] found in a systematic review that there is significant interobserver error in estimating EFW, irrespective of timing of USG. They also found significant underestimation of weight of LGA fetuses.

Pressman et al[20] concluded that single sonogram between 34 - 37 weeks' gestation is recommended for prediction of birth weight. They said that that serial sonograms in the late third trimester do not improve the ability to predict birth weight, even in abnormally grown fetuses.

Table 5: Comparison with other literatures

Author	Year	Conclusion	Comparison With Our Study
Dittkrist et al[8]	2022	USG performed within 7 days of delivery, EFW was within 10% of birth weight in 71.6% cases	79.85% accuracy (±15% birth weight) (better predictability in this study)
Khalid et al[9]	2022	Difference among estimated fetus weight in 3rd trimester by USG and actual fetus weight after birth is not statistically significant	Similar finding
Hameed et al[10]	2021	EFW by USG done at term & actual birth weight had no statistically significant difference.	Similar finding
Sharma et al[10]	2020	In USG was done within 7 days of delivery, there was strong positive correlation between actual birth weight & EFW	Similar findings
Elnazeer et al[11]	2020	Fetal weight estimated within one week prior to delivery, correlated with actual fetal weight	Similar findings

Okafor et al[1]	2019	Ultrasound estimated fetal weight at term correlated with the actual birth weight	Similar findings
Eze CU et al[15]	2015	Sonographically estimated fetal weight correlated positively with actual birth weight in a Nigerian population, when scan - delivery interval was 1 week.	Similar finding
Cohen et al[17]	2010	EFW tended to underestimate the weight of macrosomic fetuses and overestimate that of small fetuses (scan delivery interval > 1 day).	On the contrary, we concluded that USG within 1 week of delivery could predict SGA fetuses with no significant statistical error; but less reliable for LGA fetuses

Limitation of our study was retrospective model & data about confounding factors like BMI, suboptimal fetal position & oligohydramnios that can contribute to reduced accuracy with scan biometry, were not available for analysis.

5. Conclusion

Ultrasound Estimated Fetal weight is accurate in predicting the actual birth weight of baby only when the scan - delivery interval is within 1 week. Also, last ultrasound done within 1 week of delivery, is able to predict SGA babies with significant accuracy, but is less reliable for LGA babies.

Conflict of Interest: None

Funding: None

List of Abbreviations:
USG – Ultrasonography
EFW – Estimated fetal weight
SGA – Small for gestational age
AGA – Average for gestational age
LGA – Large for gestational age
LBW – Low birth weight
HC - Head circumference
BPD - Biparietal diameter
AC - Abdominal circumference
FL - Femur length

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