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Research Article

A Retrospective Cross-Sectional Study about Ultrasound Accuracy in Estimating Fetal Weight Compared to Actual Birth Weight, and the Impact on Delivery Planning

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Introduction

Determining the Fetal growth is a crucial element in following the progress of pregnancy .Growth of the fetus can be defined as small for gestational age (SGA) when the baby is born with a birth weight of <10% estimated as <2500 grams (1), and large for gestational age (LGA) when born with a birth weight of >97% estimated as >4500grams. (2,3)

Calculating the Fetal weight aids in deciding the mode and the timing of delivery. Iatrogenic premature delivery through induction of labour has various adverse effects on mother as well as the foetus. In mother it leads to increase in the rate of caesarean section and operative vaginal deliveries (4,5) whereas, in the neonate it can cause increased perinatal complication rate including hypoglycaemia, hyperbilirubinemia, and respiratory complications. (6)

During antenatal period, fetal weight can be predicted by measuring the symphysiofundal height. However, it may cause some inaccuracies in the presence of factors like maternal obesity, uterine anomaly, or abnormality in the amount of amniotic fluid. In recent times ultrasonography has proven to accurately estimate the weight of the fetus in-utero with less than 10% scan error rate. This is achieved with the help of various formulas. (7,8) Hadlock A. formula is one of the recommended formulas by Royal College of Obstetrics and Gynaecology (RCOG) and widely used in United Kingdom for clinical practice. (8) Hadlock A. formula is a regression method that calculates Estimated Fetal Weight (EFW) by combining four Fetal parameters including head circumference (HC) which is the length around Fetal head, abdominal circumference which is the length around Fetal waist, femoral length (FL) which is the length of fetus femur bone and biparietal diameter (BPD) which is the diameter of Fetal head between the both parietal bones. (9) Based on some hypothesis, Certain factors like maternal Body Mass Index (BMI), (10) amount of Amniotic Fluid, (11) and Fetal presentation (12,13) have been suggested to influence the accuracy of measurement of EFW.

Hypothesis

1. Various Maternal and Fetal risk factors might have an impact on the accuracy of EFW measurement.

2. Early induction of labour due to inaccurate EFW may contribute to increased caesarean section rate.

Objective:

Our aim is to define the accuracy of the ultrasound in measuring the EFW and distinguishing the difference of it in comparison to the actual weight of the new-born. It is also to assess the impact of various maternal and fetal risks on the accuracy of ultrasound measurement. It is however well known that EFW has an impact on

the mode and timing of delivery as well as perinatal outcome. (8)

Material and Methodology

This is a retrospective cross-sectional study including 126 pregnant women out of 1532 women who had regular follow up at Women's Health Institute (WHI) and delivered in Tawam hospital, located in Alain, United Arab Emirates. Data was extracted retrospectively from the Citrix system to include all the patients that had ultrasound report with the calculation of EFW and actual birth weight of the new-born (AW), within the interval of 7 days from scan date to delivery date. (14) The scan was performed in the WHI by ultrasonographic technician or Fetal medicine specialist. The inclusion period is one year between August 2019 till August 2020. The selected patients were between the age of 18 years old and 40 years old, with the estimated gestational age of 36 weeks to 40 weeks at the time of scan and delivery. The study was not restricted to local and non-local population, nor to maternal body mass index and neither to other medical condition like diabetes, gestational diabetes, hypertension, or previous history of bariatric surgery.

Our exclusion criteria included fetal congenital anomalies, intrauterine fetal death at the time of scan, or presence of multi-fetal pregnancies and fetuses with abnormal Doppler or preterm premature rupture of membrane. We also excluded cases with extremes of maternal age and gestational age. Most of the cases that were excluded were due to in-adherent follow up or failure to deliver their babies within the same Institute.
Each included patient was scheduled and followed regularly in our WHI and delivered in the same institute. They were assessed thoroughly prior to ultrasound (US) using various parameters namely, vitals, history taking, and examination. Post delivery the new-borns were cared for by the midwives who charted all the new-born's measurements' as per the World Health Organization (WHO) growth chart recommendation.
The sonographers and fetal medicine specialists used a Voluson machine which is a real-time grayscale scanner with a 3.5 MHz transducer and a linear probe. Hadlock formula was used by the US machine for the estimation of fetal weight which was then reflected to a system where EFW was calculated using Williams fetal weight calculator.

Accuracy of the scan was calculated by comparing the percentage difference between the EFW compared to the AW using the following formula: Relative difference % = [(EFW – AW) / AW] × 100. A relative difference within ±10% was counted as accurate, and any outrange value either smaller than -10% counted as underestimation or value greater than +10% were counted as overestimation.

Ethical approval was obtained for the study from the Institutional Review Board of Tawam hospital, academic affair.

Statistical analysis:

The Data was extracted using a customised Microsoft Excel template, and subsequently imported into Stata statistical package. The total data was analysed using Microsoft Excel® and SPSS program.

Independent sample t-test and chi square tests were performed to find any significance and impact of numerous factors and the scan accuracy. P-value < 0.05 was considered as statistically significant. Further classifications were made in patients who were induced for labour according to their mode of delivery.

Results

The study included 126 women, and among them 83% were of local ethnicity and 17% of non- local population. As the UAE nationals prefer to have multiple pregnancies, our sample set had various grand multipara reaching the parity of 8 and above. In our study was 30 years old and the mean gestational age at the time of scan equalled to 37 weeks.

Maternal Body mass index ranged between 19.7 to 49.8, the mean and standard deviation (SD) was 31 ± 5.5. Table 1

1. Fetal scan measurements, and it's accuracy.

The results showed minimum EFW was 1913gm while maximum was 4417gm with mean and SD of 3063g ±493.9gm, and 31.7% of the scanned fetuses had intrauterine growth restriction. While the AW ranged between minimum 2205gm to 4515gm maximum, mean and SD of 3075gm ±455gm. The estimated head circumference (E-HC) was from 29 – 32.8 cm, with mean 32.4cm ±3.6, and actual head circumference (A-HC) was from 30 – 38 cm with mean 34cm ±1.9. Table 2

Table 1: Mean values of the study population and standard deviation (SD).

	Min	Max	Mean	SD
Age	18	40	30.4	5.6
Gravida	1	14	3.9	2.6
Parity	0	8	2.2	1.9
Weight	49.9 kg	115 kg	77.6 kg	14.6
Height	136 cm	173 cm	158.3 cm	5.8
BMI	19.7	49.8	31.0	5.5

Table 2: Fetal scan measurement compared to the new-born measurement with APGAR score.

Variables	**Categories**	**N**	**%**	
IUGR	Yes	40	31.7	
	No	86	68.3	
	Min	Max	Mean	SD
EFW g	1913	4417	3063.8	493.9
AW g	2205	4515	3075.8	455.4
E-HC cm	29	35.7	32.4	3.6
A-HC cm	30	38	34	1.9
APGAR 1min	3	10	8.5	1.1
APGAR 5min	7	10	9.5	0.6
APGAR 10min	8	10	9.9	0.4

Overall, the absolute relative difference was 6.4% and 76.2% (n=96) of the EFW was accurate when compared with AW showing mean absolute relative difference of 4%. In both the calculations the mean interval between the scan and delivery was 3 days and the mean gestational age was 37 weeks. While 23.8% (n=30) of the scans showed incorrect estimation that can be divided to overestimation by 50% (n=15), and underestimation by 50% (n=15). When EFW was compared with AW the average weight difference was overestimated by +403g and underestimated by -454g, and the days interval of 5 days was noticed when EFW was underestimated.

Table 3: scan accuracy

ARD = Absolute relative difference in percent, SD = standard deviation, max = maximum, min= minimum.

Total Study % (126 patients)	**Mean ARD%**	**Mean Gestational age by weeks**	**Mean weight difference**	**Mean days interval (scan to delivery)**
	6.41% SD 5.2	37.6	195g	3.4
Scan accuracy	Frequency	Mean ARD%		
Correct (within ±10%)	96 ~ 76.2%	4% GA=37.7	122g	3.3
Not correct (beyond ±10%)	30 ~ 23.8%	14.1%		
Overestimation (> +10%)	15 ~ 50%	13.5%	403g	2
Underestimation (< -10%)	15 ~ 50%	-14.7%	454g	5

2. Correlation of the Maternal and Fetal factors to the Scan accuracy.

Table 4.a: Demonstration of the maternal and fetal factors in the selected population.			
Variables	**Category**	**N**	**%**
Residence	Yes	104	83
	No	22	17
invitro fertilization	Yes	13	10
	No	113	90
Previous caesarean section	Yes	30	24
	No	96	76

Hypertension	Yes	8	6
	No	118	94
Diabetes mellitus	Yes	3	2
	No	123	98
Gestational diabetes mellitus	Yes	41	33
	No	85	67
Bariatrics surgery	Yes	7	6
	No	119	94
SCAN performed	Sonographer	115	91.3
	Fetal medicine	11	8.7
Fetal Presentation	Cephalic	119	94.4
	Breech	7	5.6
Liquor	Normal	107	84.9
	Decreased	4	3.2
	Increased	15	11.9
Placenta	Anterior	53	42.1
	Posterior	66	52.4
	Fundal	3	2.4
	Lateral	4	3.2

Table 4.a shows various patients' demography and gestational characteristics, major statistics representation can be concluded in the following: 24 % of the patients had previous CS, 33% with Gestational diabetes and 94% with cephalic presentation while 84.9% with normal AF amount. There are other factors that were considered for testing like different maternal conditions (Diabetes, hypertension, BMI, and bariatric surgery) beside the mentioned fetal factors earlier, other factors like days interval and placental localization were evaluated as well.

However, all these factors are without any statistical significance. The results showed there was no significant association between scan accuracy and Maternal history of Previous CS, bariatric surgery, hypertension, diabetes mellites, gestational DM, or fetal presentation, AF amount, and placenta. Also, there is no significant difference in the scan accuracy due to body mass index and days interval. Table 4.b

Table 4b: Testing the Scan accuracy based on the factors.

		Scan accuracy		Test	p-value
		Correct	Not correct		
Previous CS	Yes	24	6	0.315**	0.575
	No	72	24		
Bariatric	Yes	6	1	0.371**	0.543
	No	90	29		
Presentation	Cephalic	92	27	1.482**	0.223
	Breech	4	3		
Hypertension	Yes	4	4	3.230**	0.072
	No	92	26		
Diabetes mellites	Yes	2	1	0.154**	0.695
	No	94	29		
Gestational DM	Yes	27	14	3.850**	0.058
	No	69	16		
Liquor	Normal	84	23	3.478**	0.062
	Decreased	4	0		
	Increased	8	7		
Placenta	Anterior	38	15	4.417**	0.177
	Posterior	51	15		
	Fundal	3	0		
	Lateral	4	0		
Body mass index		30.68	31.8	-0.872*	0.333
Day interval		3.31	3.87	-1.109*	0.270

*Independent sample t test ** chi square

3. The outcomes after Induction of labour

Among the 126 women, around 46% (n=58) were induced due to different clinical reasons, twenty-two women were induced due to suspected IUGR fetus in the scan. Out of the 58 women around 32.8% (n=19) pregnant ladies ended up with emergency caesarean section, and 6.9% (n=4) pregnant ladies had instrumental deliveries.

Table 5: The association between Induction of labour and Emergency Caesarean section, normal vaginal delivery, and instrumental delivery.

IOL	Emergency CS		NVD		Instrumental delivery	
	Yes	**No**	**Yes**	**No**	**Yes**	**No**
Yes	19	39	38	20	4	54
	32.8%	67.2%	65.5%	34.5%	6.9%	93.1%
No	17	51	82	44	3	65
	25%	75%	64.7%	35.3%	4.4%	95.6%
Chi-square	0.923		0.009		0.368	
p-value	0.337		0.924		0.544	

Discussion

This study evaluated the accuracy of measuring the EFW in comparison to the actual new-born weight in Tawam hospital using US. The relative difference was 6.4% which is an acceptable error of falling as it is less than 10%. (7) Out of all the cases 76.2 % of the cases estimated the EFW correctly in comparison to AW whereas 23.8% were inaccurate. (15) Out of the 23.8 % of inaccurately estimated cases 15 were found to be underestimated by an average of 454g and their mean interval of days between scan and the delivery time was found to be 5 days which was higher than the 3.3 days found in accurately estimated cases.

The increased scan interval could have been an attributing factor for the under-estimation of EFW, putting into consideration the fetal growth velocity that allowed more weight gain from the scan day until delivery day. However, even if we consider the fetal weight gain, the underestimation of (-454g) in 5 days interval with mean error ARD of -14% or overestimation of (+403g) in 2 days interval with mean error ARD of +13.5% might not be justified knowing that the average weight difference was 122 g at average of 3.3 days interval in the accurate group which can be close to the published growth velocity that shows an average fetal weight gain of 215g per week (7days). (16)

The importance of accurate fetal weight estimation during the scan arises from the concerns of avoiding high neonatal mortality rate that was due to low birth weight. As previously reported statistics in United Arab

Emirates, particularly Alain showed mortality rate of 6.7 per 1000 live births, with higher mortality related to lower birth weight especially with moderately low birth weight infants ranging between 1500gm to 2499 gm that accounted around 3.1% of the mortality rate. (17)

Hence, determining the fetal weight accurately is crucial for determining proper delivery timing while maintaining the balance of clinical judgment between allowing optimum intrauterine fetal growth and early intervention by early termination of pregnancy either through induction of labour or caesarean.

Induction of labour case rate was around 46% (n= 58) in our study, and about 32.8% (n=19) of them had emergency caesarean section, 65.5% (n=38) had normal vaginal delivery while 6.9% (n=4) had instrumental delivery. When these rates were compared with patient who did not undergo induction of labour the vaginal delivery rate was found similar 64.7%, with a slight improvement in the instrumental delivery rate 4.4% and emergency CS rate 25% but this was not found significant as well. However, the slight increased rate of emergency caesarean in cases with induction of labour was highlighted in other studies as well, which was found to be doubled in number. Fortunately, with no perinatal risks. (18) But this does not neglect the maternal burden and risks. The complication increases with every uterine scar leading to abnormal placentation (19) and affecting their childbearing journey especially in a society that intends to have multiple children and prefers bigger family.

Many hypothesises were made to find a corelation between different maternal or fetal factors and the accuracy of scanning like fetal presentation, (20) placental localization, amniotic fluid amount (21,22) or other medical conditions like diabetes, (23) hypertension or maternal BMI. (24) In our study we evaluated our hypothesis with maternal factors like previous CS, DM, GDM, hypertension, Bariatric surgery, and BMI. And Fetal factors like: Fetal presentation, AF amount, placental localization and the interval between scan and delivery day. None of them were found significant to effect on Scan accuracy.

Limitation: small population size made it difficult to compare some factors properly.

Conclusion

We can conclude that Scan accuracy in our facility was high and matched with the widely published percentages. However, this does not limit the improvement in this matter, as we know using ultrasound technology has shown great accuracy in estimating fetal weight, therefore using it when feasible is important to make the proper clinical judgment.

Our hypothesis regarding increased CS rate due to improper timing of IOL is reassuring to the patients. Also, various maternal and fetal factors were not found to any effect on the scan accuracy as was initially hypothesised. This could however, be attributed to the small population number. It is therefore, recommended to be assessed in larger population with different formulas to overcome the known relative difference.

Disclosure

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The authors declare that there is no conflict of interests regarding the publication of this paper.

References

1. Small-for-Gestational-Age Fetus, Investigation and Management (Green-top Guideline No. 31) | RCOG [Internet]. [cited 2023 May 14]. Available from: https://www.rcog.org.uk/guidance/browse-all-guidance/green-top-guidelines/small-for-gestational-age-fetus-investigation-and-management-green-top-guideline-no-31/

2. Shoulder Dystocia (Green-top Guideline No. 42) | RCOG [Internet]. [cited 2023 May 14]. Available from: https://www.rcog.org.uk/guidance/browse-all-guidance/green-top-guidelines/shoulder-dystocia-green-top-guideline-no-42/

3. Ye J, Zhang L, Chen Y, Fang F, Luo ZC, Zhang J. Searching for the Definition of Macrosomia through an Outcome-Based Approach. PLoS One [Internet]. 2014 Jun 18 [cited 2023 May 14];9(6):e100192. Available from: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0100192

4. Heffner LJ, Elkin E, Fretts RC. Impact of labor induction, gestational age, and maternal age on cesarean delivery rates. Obstetrics and Gynecology [Internet]. 2003 Aug 1 [cited 2023 May 14];102(2):287–93. Available from: https://pubmed.ncbi.nlm.nih.gov/12907101/

5. Knight HE, Cromwell DA, Gurol-Urganci I, Harron K, van der Meulen JH, Smith GCS. Perinatal mortality associated with induction of labour versus expectant management in nulliparous women aged 35 years or over: An English national cohort study. PLoS Med [Internet]. 2017 Nov 1 [cited 2023 May 14];14(11). Available from: https://pubmed.ncbi.nlm.nih.gov/29136007/

6. Ofir K, Lerner-Geva L, Boyko V, Zilberberg E, Schiff E, Simchen MJ. Induction of labor for term small-for-gestational-age fetuses: what are the consequences? Eur J Obstet Gynecol Reprod Biol [Internet]. 2013 [cited 2023 May 14];171(2):257–61. Available from: https://pubmed.ncbi.nlm.nih.gov/24139542/

7. Hammami A, Mazer Zumaeta A, Syngelaki A, Akolekar R, Nicolaides KH. Ultrasonographic estimation of fetal weight: development of new model and assessment of performance of previous models. Ultrasound Obstet Gynecol [Internet]. 2018 Jul 1 [cited 2023 May 14];52(1):35–43. Available from: https://pubmed.ncbi.nlm.nih.gov/29611251/

8. Hadlock FP, Harrist RB, Sharman RS, Deter RL, Park SK. Estimation of fetal weight with the use of head, body, and femur measurements—A prospective study. Am J Obstet Gynecol. 1985 Feb 1;151(3):333–7.

9. Konwar R, Basumatary B, Dutta M, Mahanta P. Accuracy of Fetal Weight Estimation by Ultrasonographic Evaluation in a Northeastern Region of India. Int J Biomater. 2021;2021.

10. Fuchs F, Houllier M, Voulgaropoulos A, Levaillant JM, Colmant C, Bouyer J, et al. Factors affecting feasibility and quality of second-trimester ultrasound scans in obese pregnant women. Ultrasound Obstet Gynecol [Internet]. 2013 Jan [cited 2023 May 14];41(1):40–6. Available from: https://pubmed.ncbi.nlm.nih.gov/23023941/

11. Blitz MJ, Rochelson B, Stork LB, Augustine S, Greenberg M, Sison CP, et al. Effect of Maternal Body Mass Index and Amniotic Fluid Index on the Accuracy of Sonographic Estimation of Fetal Weight in Late Gestation. Am J Perinatol [Internet]. 2018 Jan 10 [cited 2023 May 14];35(13):1235–40. Available from: https://pubmed.ncbi.nlm.nih.gov/29320802/

12. Chauhan SP, Magann EF, Naef RW, Martin JN, Aforrison JC. Sonographic assessment of birth weight among breech presentations. Ultrasound Obstet Gynecol [Internet]. 1995 [cited 2023 May 14];6(1):54–7. Available from: https://pubmed.ncbi.nlm.nih.gov/8528803/

13. Melamed N, Ben-Haroush A, Meizner I, Mashiach R, Yogev Y, Pardo J. Accuracy of sonographic fetal weight estimation: a matter of presentation. Ultrasound Obstet Gynecol [Internet]. 2011 Oct [cited 2023 May 14];38(4):418–24. Available from: https://pubmed.ncbi.nlm.nih.gov/21229551/

14. Barel O, Vaknin Z, Tovbin J, Herman A, Maymon R. Assessment of the accuracy of multiple sonographic fetal weight estimation formulas: a 10-year experience from a single center. J Ultrasound Med [Internet]. 2013 May 1 [cited 2023 May 14];32(5):815–23. Available from: https://pubmed.ncbi.nlm.nih.gov/23620324/

15. Benson-Cooper S, Tarr GP, Kelly J, Bergin CJ. Accuracy of ultrasound in estimating fetal weight in New Zealand. Australas J Ultrasound Med [Internet]. 2021 Feb 1 [cited 2023 May 14];24(1):13. Available from: /pmc/articles/PMC8412010/

16. Grantz KL, Kim S, Grobman WA, Newman R, Owen J, Skupski D, et al. Fetal growth velocity: the NICHD fetal growth studies. Am J Obstet Gynecol [Internet]. 2018 Sep 1 [cited 2023 May 14];219(3):285.e1. Available from: /pmc/articles/PMC7035912/

17. Dawodu A, Varady E, Verghese M, Al-Gazali LI. Neonatal audit in the United Arab Emirates: a country with a rapidly developing economy. East Mediterr Health J. 2000 Jan;6(1):55–64.

18. Davey MA, King J. Caesarean section following induction of labour in uncomplicated first births- a population-based cross-sectional analysis of 42,950 births. BMC Pregnancy Childbirth [Internet]. 2016 Apr 27 [cited 2023 May 14];16(1). Available from: https://pubmed.ncbi.nlm.nih.gov/27121614/

19. Tahlak MA, Abdulrahman M, Hubaishi NM, Omar M, Cherifi F, Magray S, et al. Emergency peripartum hysterectomy in the Dubai health system: A fifteen year experience. Turk J Obstet Gynecol [Internet]. 2018 Mar 1 [cited 2023 May 14];15(1):1–7. Available from: https://pubmed.ncbi.nlm.nih.gov/29662708/

20. Shmueli A, Aviram A, Bardin R, Wiznitzer A, Chen R, Gabbay-Benziv R. Effect of fetal presentation on sonographic estimation of fetal weight according to different formulas. Int J Gynaecol Obstet [Internet]. 2017 Jun 1 [cited 2023 May 14];137(3):234–40. Available from: https://pubmed.ncbi.nlm.nih.gov/28295324/

21. Janas P, Radoń-Pokracka M, Nowak M, Staroń A, Wilczyńska G, Brzozowska M, et al. Effect of oligohydramnios on the accuracy of sonographic foetal weight estimation in at term pregnancies. Taiwan J Obstet Gynecol [Internet]. 2019 Mar 1 [cited 2023 May 14];58(2):278–81. Available from: https://pubmed.ncbi.nlm.nih.gov/30910153/

22. Karahanoglu E, Altinboga O, Akpinar F, Gultekin IB, Ozdemirci S, Akyol A, et al. The Effect of the Amniotic Fluid Index on the Accuracy of Ultrasonographic-Estimated Fetal Weight. Ultrasound Q [Internet]. 2017 [cited 2023 May 14];33(2):148–52. Available from: https://pubmed.ncbi.nlm.nih.gov/28221239/

23. Pretscher J, Kehl S, Stumpfe FM, Mayr A, Schmid M, Schild RL, et al. Ultrasound Fetal Weight Estimation in Diabetic Pregnancies. J Ultrasound Med [Internet]. 2020 Feb 1 [cited 2023 May 14];39(2):341–50. Available from: https://pubmed.ncbi.nlm.nih.gov/31436342/

24. Kritzer S, Magner K, Warshak CR. Increasing maternal body mass index and the accuracy of sonographic estimation of fetal weight near delivery. J Ultrasound Med [Internet]. 2014 Dec 1 [cited 2023 May 14];33(12):2173–9. Available from: https://pubmed.ncbi.nlm.nih.gov/25425375/