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Comparative study of effective fetal weight by clinical formula with USG Hadlock formula

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Abstract
It has become increasingly important to estimate fetal weight especially for prevention of prematurity, evaluation of fetopelvic disproportion, induction of labour before term and detection of IUGR. The study was a prospective study conducted at J. J. group of hospitals on 1500 pregnant women selected by simple random sampling who attended the antenatal clinic or were admitted in the antenatal ward during August 2015 to December 2017. Birth weight was estimated and comparative analysis were done using sonographic fetal growth parameters at or near term or in early labour by Hadlock's formula and clinically by Johnson's formula and Dare formula correlated after birth with actual birth weight. My study suggested that Ultrasonography is the most accurate in terms of Overall Percentage Error. Johnsons Formula has least accuracy as only 18.1 cases are within 20% error and Hadlock has maximum accuracy as 97.7% cases are within 20% error.

Keywords: Fetal weight, birth weight, Johnson's formula, Dare formula, Ultrasonographny, Hadlock's formula.

Introduction
Present day obstetrics has in fact rightly been able to focus on the concept of fetal medicine as distinct and significant entity in view of rapid decline in maternal mortality and morbidity. Growth is a basic fundamental of life. Assessment of fetal weight in utero leads to an improved prospective management of high risk pregnancies and considerable reduction in perinatal mortality and morbidity. It has become increasingly important especially for prevention of prematurity, evaluation of fetopelvic disproportion, induction of labour before term and detection of IUGR. Thus a quick, easy and accurate method for estimating the fetal weight in utero with optimum precision would be of obvious benefit to the clinical practicing modern obstetricians. Estimation of birth weight by Johnson's formula, Dare Formula based on symphysio fundal height has advantages of speed, economy and general applicability. Obstetric ultrasound has in fact revolutionized the knowledge of fetal medicine in the present day and can predict fetal weight with a great degree of precision. In our study birth weight will be estimated using sono-graphic fetal growth parameters at or near term or in early labour by Hadlock's formula and clinically by Johnson's formula and Dare formula correlated after birth with actual birth weight.

Aims and Objectives
1. Comparative analysis of fetal weight to be made.
2. Accuracy of both the methods were evaluated using the actual birth weight of baby after delivery.
3. Average error in both methods
4. Standard deviation of prediction error in each birth weight category.

Materials and methods
Study design: Prospective study conducted at J. J. group of hospitals, Grant medical college, Mumbai between August 2015 till December 2017. The study was a prospective study conducted on 3000 pregnant women during the period selected by simple random sampling who attended the antenatal clinic or were admitted in the antenatal ward at our hospital after 28 weeks of gestation, delivered within one week of ultrasonography as well as measuring the fundal height without any maternal complications and with cephalic presentation.

Pregnant women with multiple gestation, malpresentation, poly/oligohydraminos, IUFD & with fibroids/ adnexal masses were excluded.

After an accurate clinical evaluation, the symphysiofundal height & abdominal girth were measured. The fetal weight was estimated by using:

1. Johnson and R.W formula: (Symphysio fundal height in cm – n) x 155 gms.

- n = 13 (if vertex is at or above the level of ischial spines)
- n=12 (if vertex is at ischial spines)
- n = 11 (if vertex is below the level of ischial spines)

2. Dare Formula: Symphysiofundal height in cm x Abdominal Girth.

3. Hadlock's formula: 10^ (1.335-(0.0034*AC * FL) + (0.0316*BPD) + (0.0457* AC) + (0. 1623*FL).

The formula yields estimated fetal weight in gm when the BPD, AC and FL are in centimeters.

The patients were followed until delivery. The date of delivery was noted. Baby was weighed within 2hrs of the delivery and weight noted by electronic weighing machine. All 1500 women are delivered within one week of ultrasound examination and clinical estimation of fetal weight. Finally, comparative analysis of fetal weight was made. Accuracy of both the methods was evaluated using the actual birth weight of baby after delivery.

Observations: 1. **Mean Birth weight** by different methods

Table 1: Mean birth weight

Method	EFW (Johnsons)	EFW (Dare's)	EFW (USG)	BABY WT
Mean	3656.94	3256.01	2833.98	2835.35
SD	374.81	317.17	454.70	455.63

Overall the Mean birth weight (SD) estimated by Johnsons, Dares, USG and Actual Fetal weight were 3656.94 (374.81) GM, 3256.01 (313.92) GM, 2833.98 (454.70) GM and 2835.35 (455.63) GM respectively.

2. Average Error and Percentage Error in each Method

Table 2: Average & percentage error

	Johnsons Formula	% ERROR	Dares Formula	% ERROR	USG	% ERROR
Average Error	826.6	30.9	462.6	17.8	217.9	7.9
SD of Error	280.8		241.4		119.3	

Overall the Average Error incurred on calculations by Johnsons, Dares, USG with respect to Actual Fetal weight were 826.6 gm, 426.6 gm and 217.9 gm respectively while the Percentage Error was 30.9%, 17.8% and 7.9% respectively. Therefore, the Average Error was least with USG followed by Dares Formula and maximum error was with Johnsons formula.

3. Average Error in Various Fetal Weight Groups by Various Methods

Table 3: Average error

	BABY WT	< 2.5 KG	2.5-3 KG	3-3.5 KG	> 3.5 KG
	N	694	1284	818	204
Johnsons	Mean Error	981.7	897.5	702.3	351.2
	SD	281.2	207.4	205.6	224.2
Dares	Mean Error	664.8	486.7	304.1	258.7
	SD	246.2	185.6	166.5	196.2
USG	Mean Error	219.2	209.0	226.8	234.0
	SD	122.9	112.1	122.3	135.5

1. Average Error of Fetal weight estimate by Johnsons Formula in the above-mentioned weight categories was 981.7 gm, 897.5 gm, 702.3 gm, 351.2 gm respectively so the least Error was in the category >3.5 kg.
2. Average Error of Fetal weight estimate by Dares Formula in the above-mentioned weight categories was 664.8 gm, 486.7 gm, 304.01 gm, and 258.7 gm respectively so the least Error was in the category >3.5 kg and maximum error was in the <2.5 kg category.
3. Average Error by USG within 1 week of delivery in the weight categories was 219.2 gm, 209 gm, 226.8 gm and 234 gm respectively while with other studies USG error was 265.2 gm, 299.1 gm, 307.8 gm respectively. Suggesting USG had the minimum Error in Fetal weight estimate followed by Dares while Johnsons Formula had maximum average error.
4. Average Error of the Clinical Formula, Johnsons and Dares in comparison to Actual Fetal weight in various fetal weight categories suggested that maximum error by Johnsons formula was 981.7 gm in the < 2.5 kg category and minimum of 351.2 gm in the >3.5 kg category, while by Dares Formula maximum error of 664.8 gm in < 2.5 kg category and minimum of 258.7 gm in >3.5 kg category.

4. Percentage Error

Table 4: Percentage error

	Johnsons	%	Dares	%	USG	%
upto 5%	82.0	2.7	288.0	9.6	650.0	21.7
upto 10%	188.0	6.3	760.0	25.3	2360.0	78.7
upto 15%	326.0	10.9	1350.0	45.0	2844.0	94.8
upto 20%	542.0	18.1	2052.0	68.4	2932.0	97.7

According to our Study in terms of Overall Percentage Error, Johnsons Formula has least accuracy and Hadlock has maximum accuracy as only 18.1 cases are within 20% error while 97.7% cases are within 20% error by Johnsons and Hadlock respectively.

Amongst Clinical Formula Dares has more accuracy as 68.4% cases are within 20% error.

Results

1. Overall the Mean birth weight (SD) estimated by Johnsons, Dares, USG and Actual Fetal weight were 3656.94 (374.81) GM, 3256.01 (313.92) GM, 2833.98 (454.70) GM and 2835.35 (455.63) GM respectively.
2. Average Error of Fetal weight estimate by Johnsons Formula in the above-mentioned weight categories was

981.7 gm, 897.5 gm, 702.3 gm, 351.2 gm respectively so the least Error was in the category >3.5 kg.

3. Average Error of Fetal weight estimate by Dares Formula in the above-mentioned weight categories was 664.8 gm, 486.7 gm, 304.01 gm, and 258.7 gm respectively so the least Error was in the category >3.5 kg and maximum error was in the <2.5 kg category.
4. Average Error by USG within 1 week of delivery in the weight categories was 219.2 gm, 209 gm, 226.8 gm and 234 gm respectively while with other studies USG error was 265.2 gm, 299.1 gm, 307.8 gm respectively. Suggesting USG had the minimum Error in Fetal weight estimate followed by Dares while Johnsons Formula had maximum average error.
5. Average Error of the Clinical Formula, Johnsons and Dares in comparison to Actual Fetal weight in various fetal weight categories suggested that maximum error by Johnsons formula was 981.7 gm in the < 2.5 kg category and minimum of 351.2 gm in the >3.5 kg category, while by Dares Formula maximum error of 664.8 gm in < 2.5 kg category and minimum of 258.7 gm in >3.5 kg category.

Therefore, both Clinical Formulae were more accurate in >3.5 kg category.

6. According to our Study in terms of Overall Percentage Error, Johnsons Formula has least accuracy and Hadlock has maximum accuracy as only 18.1 cases are within 20% error while 97.7% cases are within 20% error by Johnsons and Hadlock respectively.

Amongst Clinical Formula Dares has more accuracy as 68.4% cases are within 20% error.

Discussion

It is generally accepted that a simple, accurate and universally applicable method of assessing in utero foetal weight leads to improved prospective management of high-risk pregnancies and a possible reduction in perinatal mortality and morbidity.

In the present study, the mean of estimated foetal weight by Hadlock's method is almost closer to mean of actual birth weight. This shows that foetal weight estimation by Hadlock's method (2833.98 ± 454.70 gm) is almost closer to actual birth weight (2835.68 ± 455.63 gm). This is followed by Dares method (3256.01 ± 317.17 gm), while Johnsons method has the maximum Error (3656.94 ± 374.81 gm). Dare FO *et al*. (1990) [1] studied that product of SFH*AG in cm fairly correlates with the actual birth weight. This signifies that there is not much statistically significant difference in SFH * AG and Hadlock's formula for estimation of foetal weight, Hadlock's Formula being more accurate followed by Dare's formula.

In present study, the average error in gm was least by Hadlock's formula, which was 217.9 gm and by Dare's (AG x SFH) method was 462.6 gm then followed by Johnson's formula, which was 826.6 gm.

The Comparison of Average Error calculated by Johnsons Formula amongst various fetal weight groups with studies conducted at

Study 1: KIMSDU, Maharashtra,
Study 2: SBKS Medical Institute, Vadodara,
Study 3: Kolkata Medical College, Kolkata

Table 5: Comparison of average error by Johnsons formula

Baby weight	average error (our study)	Average error Study 1	Average error study 2	Average error Study 3
<2.5 kg	981.7	1184	415.4	454.33
2.5-3 kg	897.5	832	339.6	454.33
3-3.5 kg	702.3	519.3	299.4	672.61
>3.5 kg	351.2	202.5	300	672.61

The Comparison of Average Error calculated by Dares Formula amongst various fetal weight groups with studies conducted at

Table 6: Comparision of average error by Dares formula

Baby Weight	Average Error	Study 1 (Average Error)	Study 2 (Average Error)	Study 3 (Average Error)
<2.5 kg	664.8	396.16	301.2	342.18
2.5-3 kg	486.7	288.54	218.2	342.18
3-3.5 kg	304.1	212.1	213.4	236.6
>3.5 kg	258.7	137.48	207	236.6

Accuracy: EFW (Johnsons) against Baby WT:

Percentage accuracy calculations: Percentage accuracy of Different weight to be read from the columns of Actual weight in each category. That is, in the first table for category 1 (for weight < 2.5) Johnsons test can diagnosis only 2.5% cases only and overall accuracy is only 26.1%. But test is efficient in diagnosis of weight > 3.5 kg.

Table 7: Accuracy of Johnsons formula

			Actual				Accuracy
			<2.5 kg	2.5 to 3 kg	3 to 3.5 kg	> 3.5 kg	
Johnsons	<2.5 kg	Count	16	0	0	0	
		%	2.3%	.0%	.0%	.0%	2.3
	2.5 to 3 kg	Count	168	14	4	0	
		%	24.2%	1.1%	.5%	.0%	1.1
	3 to 3.5 kg	Count	358	278	32	6	
		%	51.6%	21.7%	3.9%	2.9%	3.9
	> 3.5 kg	Count	152	992	782	198	
		%	21.9%	77.3%	95.6%	97.1%	97.1
Overall Average accuracy							26.1

EFW (Dare) against Baby WT

Percentage accuracy calculations

Percentage accuracy of Different weights to be read from the columns of Actual weight in each category. That is, in the first table for category 1 (for weight < 2.5) Dare test can diagnosis only 4.9% cases only and overall accuracy is only 60.8%. But test is moderately efficient in diagnosis of weight 3 to 3.5 kg and > 3.5 kg.

Table 8: Accuracy of Dares formula

			Actual				Accuracy
			<2.5 kg	**2.5 to 3 kg**	**3 to 3.5 kg**	**> 3.5 kg**	
Dare	<2.5 kg	Count	34	0	0	0	
		%	4.9%	.0%	.0%	.0%	4.9
	2.5 to 3 kg	Count	416	100	22	6	
		%	59.9%	7.8%	2.7%	2.9%	7.8
	3 to 3.5 kg	Count	216	1060	432	74	
		%	31.1%	82.6%	52.8%	36.3%	52.8
	> 3.5 kg	Count	28	124	364	124	
		%	4.0%	9.7%	44.5%	60.8%	60.8
Overall Average accuracy							31.575

EFW (USG) against Baby WT

Percentage accuracy calculations:

Percentage accuracy of Different weight to be read from the columns of Actual weight in each category. That is, in the first table for category 1 (for weight < 2.5) USG test has overall accuracy is of 62.85% and properly distributed over the all weight range.

Table 9: Accuracy of USG

			Actual				Accuracy
			<2.5 kg	**2.5 to 3 kg**	**3 to 3.5 kg**	**> 3.5 kg**	
USG	<2.5 kg	Count	452	224	4	0	
		%	65.1%	17.4%	.5%	.0%	65.1
	2.5 to 3 kg	Count	242	862	202	6	
		%	34.9%	67.1%	24.7%	2.9%	67.1
	3 to 3.5 kg	Count	0	194	510	82	
		%	.0%	15.1%	62.3%	40.2%	62.3
	> 3.5 kg	Count	0	4	102	116	
		%	.0%	.3%	12.5%	56.9%	56.9
Overall Average accuracy							62.85

Sherman *et al*. [2]. (1998) reported that rates of estimates within 10% of birth weight was not statistically significant in clinical and USG method (72% and 69%, respectively). Bhandary Amritha *et al*. [3] reported that rates of estimates within 10% of birth weights was not statistically significant in AG x SFH method and USG method (67% and 62%, respectively).

Percentage Error

	Johnsons	**%**	**Dares**	**%**	**USG**	**%**
upto 5%	82.0	2.7	288.0	9.6	650.0	21.7
upto 10%	188.0	6.3	760.0	25.3	2360.0	78.7
upto 15%	326.0	10.9	1350.0	45.0	2844.0	94.8
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Amongst Clinical Formula Dares has more accuracy as 68.4% cases are within 20% error.

Present study showed that the maximum error in various foetal weight groups was least by Hadlock's method, which is similar to the results obtained by the study conducted by Dr. Syeda Ayesha Siddiqua in October 2014[4]. It was noted that average error in estimating foetal weight by Johnson's and Dare's formula was least in >3500 g group, which is very similar to the results obtained by the study conducted by Bhandary Amritha *et al*. (2004) [3], Kathiriya *et al*. in 2014 [5] and Jili Basumatary *et al*. in October 2015 [6] suggesting that Johnson's and Dare's method is more accurate in the higher weight category.

On performing the Paired-t test for both the clinical formula and USG with an alpha value of 0.05 for Null hypothesis to determine if the Formulae and USG are able to calculate Fetal weight within a 5% range of actual baby weight.

Table 10: p value by different methods

		Johnson	**Dare**	**USG**
Actual	**Pearson Correlation**	.764**	.737**	.851**
	p-value	.000	.000	.000
	N	3000	3000	3000

**. Correlation is significant at the 0.01 level (2-tailed).

The highest correlation is observed between USG and Actual weight. All correlations are significant as p-value is less than 0.05.

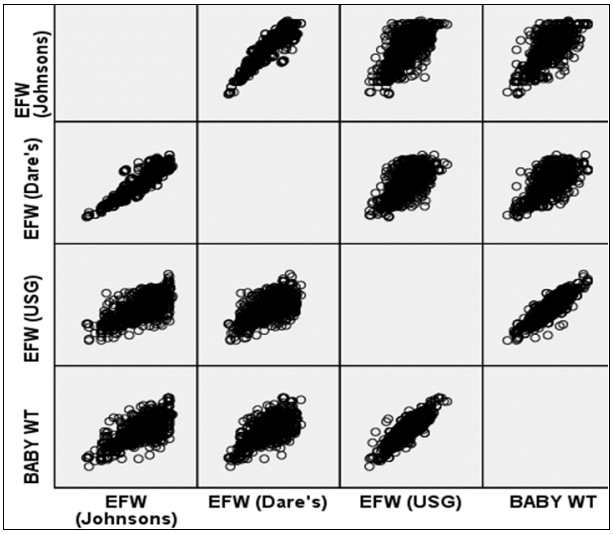

Fig 1: Correlation of EFW by different methods

Conclusion: Finally, my study suggests that Ultrasonography in the most accurate in estimating Effective Fetal Weight as it considers multiple Fetal measurements in its calculations while clinical formulae of Dares and Johnsons used in the study were found to be inaccurate although Dares Formula gives an overall better estimate of Fetal weight amongst the two clinical Formulae.

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