Research Paper **Medical Science**

Relationship of Umbilical Cord Size With Gestational Age: A Sonographic Study

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ABSTRACT

BACKGROUND: There are several sonographic parameters to estimate gestational age antenataly. Diameter of umbilical cord may be a reliable sonographic parameter to predict gestational age as well as the fetal out come.

OBJECTIVE :To assess the relationship of diameter of umbilical cord and gestational age of the fetus in 2ND and 3RD trimester of pregnancy.

MATERIALS AND METHODS : 170 Patient in 2ND to3RD trimester of pregnancy(i.e between 13th to 40TH week of gestation)are subjected to sonographic evaluation .Clinically   gestational age was estimated by Naegele's formula (EDD determined by adding 7days & 9 month to LMP) & Clinical examination(i.e symphasio fundal height) . Sonographic fetal assessment was done for BPD,AC,FL,HC along with umbilical cord diameter. Gestational age thus determined by Naegele's formula & sonographic findings were tabulated.

RESULT: The fetal parameters & umbilical cord diameter increases in fetus with increase in gestational age. It appears there is a linear relationship & statistical significant correlation ($p<0.001$) between umbilical cord diameter and other fetal parameters for gestational age estimation. The umbilical cord diameter appeared to increase at the rate of 1mm/week between 13TH to 35TH week of gestational period.

CONCLUSION : Umbilical cord diameter has a strong   linear relationship with commonly used fetal gestational age estimation parameters & can be used as a reliable method of assessing fetal growth and prediction of gestational age .

INTRODUCTION:-

The umbilical cord is the only link between the developing fetus and placenta. The umbilical cord is important because the vessels in the cord are an essential part of fetal circulation. Umbilical cord is definitely visible in 2nd &3rd trimester of pregnancy. Umbilical cord is routinely evaluated in all obstetric sonography . Diameter of umbilical cord can be determined easily & also it changes throughout the antenatal period. So the above parameter can be used independently or can supplement commonly used parameters for determination of gestational age . The fetal wellbeing depends on normal anatomy & physiology of   umbilical cord. At term the normal umbilical cord is about 55-65 cm in length and with a diameter of 2.0-2.5 cm which normally insert centrally or eccentrically on the fetal side of the placenta. The umbilical cord is the lifeline connection between the fetus and the mother through which materials such as nutrients, oxygen, and fluids necessary for intrauterine life are supplied. In view of this, abnormalities associated with umbilical cord would have adverse effects on the perinatal outcome. Although obstetricians appreciate the major role played by umbilical cord towards the wellbeing of the fetus. Morphological characteristics such as tensile strength, diameter, umbilical cord circumference, Wharton's jelly content, umbilical cord length and weight could be determined genetically. The umbilical cord development, differentiation, growth and elongation would depend on the sex, nutrient supply and health status of the fetus. Therefore, morphometric study of umbilical cord by ultrasonography was done to establish the fetal weight. It was compared with the fetal weight obtained conventionally from gestational week, biparietal diameter, head circumference, abdominal circumference & femur length. A combination of the use of these fetal parameters is known as multiple fetal growth parameters. Accurate estimation of fetal age is important for appropriate antenatal management (R.L. Peter et.al. 1993).

OBJECTIVES:-

To assess the relationship between umbilical cord diameter & gestational age of the fetus.To compare the findings with all other parameters like-BPD,HC,AC,FL.

MATERIALS & METHODS:-

170 Pregnant women are subjected for routine 2nd & 3rd trimester obstetric scan. All pregnancies are singleton. Complicated pregnancies like IUGR, multiple pregnancy, diabetic & hypertensive are excluded from the study. BPD,AC,HC,FL along with umbilical cord diameter measured in mm and tabulated. Gestational age determined by Nagele's formula (i.e. EDD determined by adding 7 days and 9 months to LMP). All subjects were performed only transabdominal sonographic examinations in supine position. Commonly measured fetal parameters for gestational age estimation such as the BPD,-FL,AC,HC were all measured following departmental protocols for these measurement. Ultrasound estimation of GA was obtained using the scanner based on the formula proposed by Hadlock et.al 1985. The images of the umbilical cord used for measurements were captured only when outer edges of cord were outlined in a longitudinal plane. Umbilical   cord diameters were measured only on the transverse section as described by Ghezzi et.al.2001.The GA estimation was based on reliable collection of date of onset the last menstrual peri-

od(LMP) and the GA calculated from LMP was validated by ultrasound scan done within 1st trimester of pregnancy.

RESULT:-
The mean cord diameter is around 2.0mm at beginning of 2nd trimester (14th wk) while it is around 24.2mm at last trimester (40th wk).The findings showed that the cord diameter increases gradually as pregnancy advances (at the rate of approx 1mm/wk).There were linear relationship and statistically significant correlation between umbilical cord diameter and fetal parameters

(BPD, AC,HC,FL). Data on Umbilical cord diameter, gestational age (USG), gestational age (LMP), and fetal biometric parameters like Biparietal Diameter (mm), Femur Length (mm), Head Circumference (mm), Abdominal Circumference (mm) were collected 170 cases and entered into SPSS 16.0 software for analysis. Descriptive analysis, mean, SD, correlation and regression analysis were under taken.

Table 1 depicted mean ± SD of gestational parameters according to gestational age. All the gestational parameters like Biparietal Diameter, Femur Length, Head Circumference, Abdominal Circumference have shown steady increase with gestational age.

Table 1
Descriptive statistics of gestational parameters with gestational age (LMP)

Gestational Age based upon LMP in week	N	Biparietal Diameter (mm) Mean ± SD	Femur Length (mm) Mean ± SD	Head Circumference (mm) Mean ± SD	Abdominal Circumference (mm) Mean ± SD
13-16	16	30±1.69	20.13±1.77	96.67±11.87	91.87±10.32
17-20	22	38.27±3.22	28.18±3.14	145.91±15.58	135.36±16.05
21-24	28	47.63±3.09	37.7±3.02	195.48±17.31	181.26±17.74
Second Trimester	66	40.28±7.6	30.31±7.58	155.28±42.16	144.53±38.82
25-28	24	61.08±5.56	51.17±5.47	265.5±25.84	249.13±25.56
29-32	26	75.15±2.27	65.08±2.28	323.77±13.01	337.08±18.09
33-36	25	85.84±3.26	75.84±3.91	345.12±3.37	364.4±5.13
37-40	29	95.14±2.1	82.35±1.78	347.17±2.85	368.28±3.57
Third Trimester	104	80.05±13.19	69.27±12.32	321.98±35.33	332.05±49.67
Total	170	64.9±22.46	54.43±21.8	258.48±89.63	260.61±102.14

The correlation matrix (Table 2) of gestational parameters in different trimester indicated very high level of correlation (p <0.01) with in themselves in second trimester, third trimester and overall.

Table 2
matrix Correlations of gestational parameters in different trimesters

Second Trimester (N = 66)	Umblical diameter (mm)	Gestational Age based upon LMP in week	Biparietal Diameter (mm)	Femur Length (mm)	Head Circumference (mm)	Abdominal Circumference (mm)	Gestational Age through USG (Week)
Umblical diameter (mm)	1	.990**	.990**	.989**	.990**	.984**	.993**
Gestational Age based upon LMP in week		1	.992**	.991**	.996**	.991**	.997**
Biparietal Diameter (mm)			1	.998**	.997**	.996**	.997**
Femur Length (mm)				1	.997**	.996**	.996**
Head Circumference (mm)					1	.998**	.998**
Abdominal Circumference (mm)						1	.994**
Gestational Age through USG (Week)							1
Third Trimester (N = 104)							
Umblical diameter (mm)	1	.976**	.984**	.981**	.924**	.931**	.941**
Gestational Age based upon LMP in week		1	.988**	.972**	.870**	.880**	.963**
Biparietal Diameter (mm)			1	.991**	.919**	.92 1**	.948**
Femur Length (mm)				1	.935**	.933**	.933**
Head Circumference (mm)					1	.988**	.826**

Abdominal Circumference (mm)						1	.831**
Gestational Age through USG (Week)							1
Over all (N = 170)							
Umblical diameter (mm)	1	.993**	.993**	.994**	.984**	.987**	.983**
Gestational Age based upon LMP in week		1	.995**	.992**	.966**	.973**	.991**
Biparietal Diameter (mm)			1	.998**	.972**	.982**	.986**
Femur Length (mm)				1	.978**	.986**	.982**
Head Circumference (mm)					1	.994**	.952**
Abdominal Circumference (mm)						1	.959**
Gestational Age through USG (Week)							1
**. Correlation is significant at the 0.01 level (2-tailed).							

The regression of umbilical diameter on gestational age (USG) is presented in Table 3.

Table 3
Model summary of regression analysis of Umblical diameter on Gestational Age (USG)

Gestational Age based upon LMP in week	Model	Unstandardized Coefficients		t	p	ANOVA F	ANOVA p	R^2
		B	SE					
Second Trimester	(Constant)	-11	0.288	-38.22	0.000	4316.037	0.000	0.986
	Gestational Age (USG) in Week	0.954	0.015	65.697	0.000			
Third Trimester	(Constant)	-2.78	0.821	-3.379	0.001	792.735	0.000	0.886
	Gestational Age through USG (Week)	0.696	0.025	28.156	0.000			
Over all	(Constant)	-9.04	0.368	-24.56	0.000	4735.946	0.000	0.966
	Gestational Age through USG (Week)	0.878	0.013	68.818	0.000			

Regression of gestational age (LMP) on gestational parameters is presented in Table 4

Table 4
Model Summary gestational age (LMP) on gestational parameters

Model	Unstandardized Coefficients		t	p	ANOVA F	ANOVA p	R^2
	B	SE					
(Constant)	5.327	0.177	30.151	0.000	18124.87	0.000	0.991
Biparietal Diameter (mm)	0.346	0.003	134.629	0.000			
(Constant)	8.459	0.208	40.687	0.000	10045.57	0.000	0.984
Femur Length (mm)	0.356	0.004	100.228	0.000			
(Constant)	6.042	0.48	12.598	0.000	2307.041	0.000	0.933
Head Circumference (mm)	0.084	0.002	48.032	0.000			
(Constant)	8.414	0.386	21.82	0.000	2916.575	0.000	0.946
Abdominal Circumference (mm)	0.074	0.001	54.005	0.000			
Dependent Variable : Gestational age (LMP)							

The regression of gestational parameters on umbilical diameters in different trimesters is presented in Table 5.

Table 5
Model Summary of regression analysis of gestational parameters on umblical diameter

Gestational Age based upon LMP in week	Dependent Variable	Model	Unstandardized Coefficients		t	p	ANOVA F	ANOVA p	R^2
			B	SE					
Second Trimester	Biparietal Diameter (mm)	(Constant)	21.743	0.363	59.883	0.000	3029.304	0.000	0.98
		Umblical diameter (mm)	2.419	0.044	55.039	0.000			
Third Trimester		(Constant)	8.413	1.288	6.532	0.000	3193.527	0.000	0.969
		Umblical diameter (mm)	3.565	0.063	56.511	0.000			
Over all		(Constant)	15.715	0.5	31.448	0.000	11665.29	0.000	0.986
		Umblical diameter (mm)	3.202	0.03	108.006	0.000			
Second Trimester	**Femur Length (mm)**	(Constant)	11.841	0.374	31.643	0.000	2831.264	0.000	0.979
		Umblical diameter (mm)	2.41	0.045	53.21	0.000			
Third Trimester		(Constant)	2.585	1.325	1.951	0.054	2614.498	0.000	0.962
		Umblical diameter (mm)	3.319	0.065	51.132	0.000			
Over all		(Constant)	6.65	0.466	14.28	0.000	12674.21	0.000	0.987
		Umblical diameter (mm)	3.111	0.028	112.58	0.000			
Second Trimester	Head Circumference (mm)	(Constant)	52.447	2.009	26.112	0.000	3046.248	0.000	0.98
		Umblical diameter (mm)	13.418	0.243	55.193	0.000			
Third Trimester		(Constant)	141.883	7.498	18.923	0.000	595.726	0.000	0.854
		Umblical diameter (mm)	8.963	0.367	24.407	0.000			
Over all		(Constant)	64.013	3.032	21.11	0.000	4952.713	0.000	0.968
		Umblical diameter (mm)	12.662	0.18	70.376	0.000			
Second Trimester	Abdominal Circumference (mm)	(Constant)	50.41	50.41	50.41	50.410	1875.032	0.000	0.968
		Umblical diameter (mm)	12.281	12.281	12.281	12.281			
Third Trimester		(Constant)	76.913	76.913	76.913	76.913	663.363	0.000	0.867
		Umblical diameter (mm)	12.698	12.698	12.698	12.698			
Over all		(Constant)	38.341	3.133	12.237	0.000	6060.738	0.000	0.973
		Umblical diameter (mm)	14.472	0.186	77.851	0.000			

LMP – Last menstrual period   USG – Ultra sonography
The linear model of umbilical diameter with gestational age in second, third trimester and overall depicted R^2 = 0.986, 0.886 and 0.966 respectively with significant model fit and significant coefficients (p=0.000). The linear regression model of gestational age with Biparietal Diameter, Femur Length, Head Circumference, Abdominal Circumference have R^2 = 0.991, 0.984, 0.933 and 0.946 respectively with significant model fit and significant coefficients (p=0.000). The linear regression of gestational parameters with different umbilical diameters have significant R^2 value ranging from 0.854 to 0.986 and significant model fit and coefficients with (p=0.000) in all the trimesters. The different models are placed below.

Y1 (UD) = -9.04 + 0.878 (GA-USG) + e

Y2 (GA-LMP) = 5.327 + 0.346 (Biparietal Diameter) + e

Y3 (GA-LMP) = 8.459 + 0.356 (Femur Length) + e

Y4 (GA-LMP) = 6.042 + 0.084 (Head Circumference) + e

Y5 (GA-LMP) = 8.414 + 0.074 (Abdominal Circumference) + e

Y6 (Biparietal Diameter) = 15.715 + 3.202 (UD) + e (Over all – All trimesters Combined)
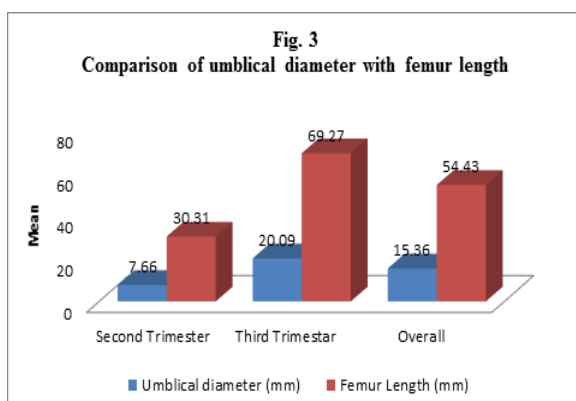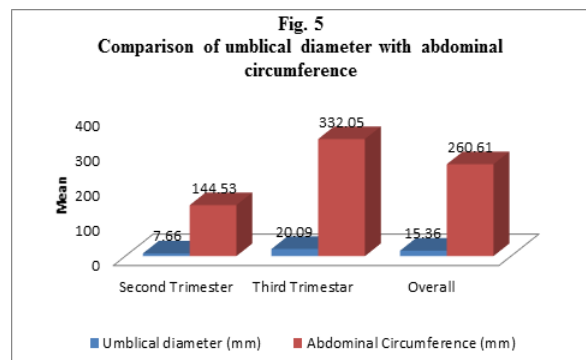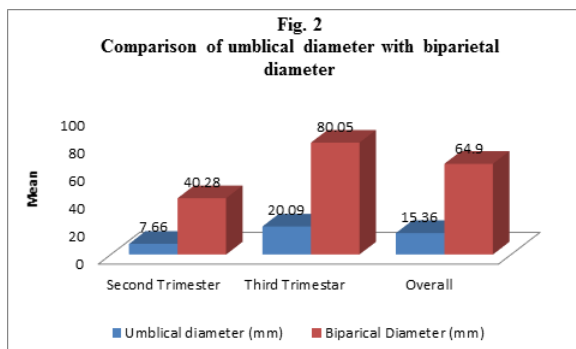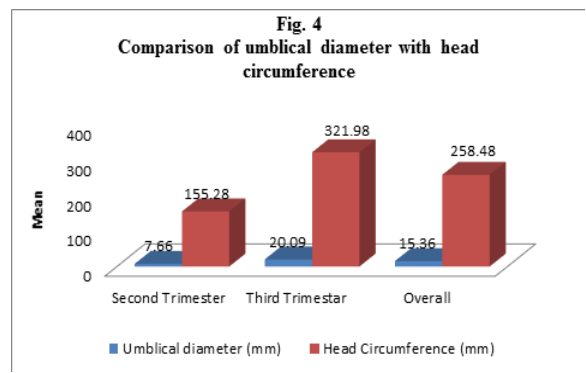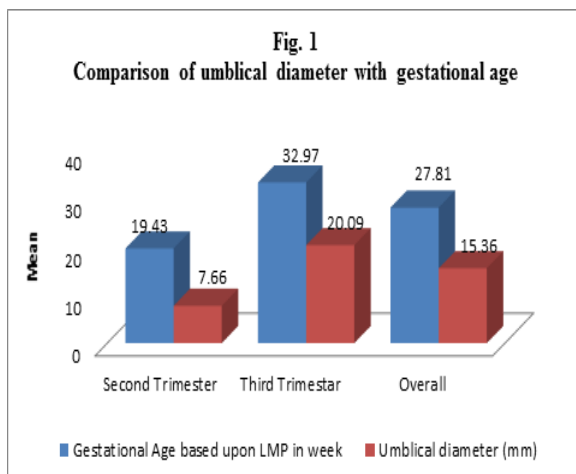
Y7 (Femur Length) = 6.65 + 3.111 (UD) + e (Over all – All trimesters Combined)

Y8 (Head Circumference) = 64.013 + 12.662 (UD) + e (Over all – All trimesters Combined)

Y9 (Abdominal Circumference) = 38.341 + 14.472 (UD) + e (Over all – All trimesters Combined)

Table 6
Comparison of umblical diameter with gestational parameters

Fetal biometric Parameters	Second Trimester (N = 66)		Third Trimester (N = 104)		Overall (N = 170)	
	Mean	SD	Mean	SD	Mean	SD
Gestational Age based upon LMP in week	19.43	3.32	32.97	4.66	27.81	7.82
Umblical diameter (mm)	7.66	3.11	20.09	3.64	15.36	6.96
Biparietal Diameter (mm)	40.28	7.6	80.05	13.19	64.9	22.46
Femur Length (mm)	30.31	7.58	69.27	12.32	54.43	21.8
Head Circumference (mm)	155.28	42.16	321.98	35.33	258.48	89.63
Abdominal Circumference (mm)	144.53	38.82	332.05	49.67	260.61	102.14

Fig. 1
Comparison of umblical diameter with gestational age

Fig. 2
Comparison of umblical diameter with biparietal diameter

Fig. 3
Comparison of umblical diameter with femur length

Fig. 4
Comparison of umblical diameter with head circumference

Fig. 5
Comparison of umblical diameter with abdominal circumference

DISSCUSION:-

The antenatal care provided by the obstetrician and its outcome depends mostly on accurate assessment of gestational age. Ultrasonography is very important tool for the above said purpose .In the present study we found that umbilical cord diameter can be a reliable parameter along with other parameters for determining gestational age antenataly. Umbilical cord diameter have a strong correlation with fetal biometric parameters and with gestational age. The present study found that sonographic estimation of gestational age such with BPD,HC,AC, FL ,all the parameters increased as with advance pregnancy .They all correlated positively with each other. The sonographic measurement of umbilical cord diameter can be used to estimate gestational age need to compare for accuracy with commonly used fetal biometric parameters. Its could be a reliable method of assessing fetal growth and prediction of gestational age specially between 14th to 36th weeks GA .

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