ESTIMATION OF FETAL WEIGHT SONOGRAPHICALLY USING MORPHOMETRY OF UMBILICAL CORD AND AREA OF WHARTON'S JELLY

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ABSTRACT

The aim of the present study is to establish a sonographic relationship between area of wharton jelly and umbilical cord morphometry with the birth weight of the fetus. Traditionally fetal weight is determined sonographicaly using biparietal diameter, head circumference femur length & abdominal circumference. Umblical cord morphometry along with Area of Wharton jelly can be utilized as other parameters to increase the accuracy of fetal weight. A total of 800 singletone pregnant females were subjected for routine sonographic evaluation. The umbilical cord length, diameter & area of wharton's jelly was determined. The gestatinal age & fetal weight were determined using usual fetal parameters. By using stastistical analysis a positive correlation was established between estimated fetal weight & fetal age with umbilical cord morphometry & area of wharton's jelly.

KEYWORDS: Gestational age,fetal weight,Wharton's jelly.

INTRODUCTION

The well being of the foetus is influenced by a number of factors all of which are clearly seen in terms of the birth weight. A low birth weight baby is definitely a challenge to the obstetrician & neonatologist. So accurate estimation of fetal weight in antenatal period is helpful in proper management of the pregnant mother & also decreases the associated morbidity.[1]

The umbilical cord is the l connection between the foetus 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.[2]

Studies on the morphological and morphometric characteristic of umbilical cord over the years have found positive correlation with perinatal outcome and foetal weight.[3] While morphological characteristics such as tensile strength, diameter, umbilical cord circumference, Wharton"s jelly content, umbilical cord length and weight were determined genetically, the umbilical cord development, differentiation, growth and elongation would depend on the sex, nutrient supply and health status of the foetus.[4] The Wharton's jelly is one of the major components of the umbilical cord in the 2nd and 3rd trimesters of pregnancy.

In our study we want to evaluate the accuracy of morphometry of umbilical cord and area of wharton's jelly with relation to birth weight.

MATERIALS AND METHODS

A total of 800 singleton pregnant female coming to department of OBGY during study period of one year subjected for routine ultrasonography between 14 weeks to 40 weeks of gestation were included in the study The study was conducted in Anatomy Department of IMS in collaboration with Obstetrics & Gynecology along with Radiology Department of both IMS & SUM Hospital and KIMS Hospital Bhubaneswar; Odisha.

The study was conducted after obtaining clearance from the Ethical Committee of the institute and permission from the appropriate authority.

Normal, healthy, singleton pregnant woman having accurate knowledge of her last menstrual period and bearing healthy single live foetus was considered as a subject for the above mentioned study.

A. Inclusion Criteria:
1. Healthy antenatal cases with singleton pregnancy.

2. Ready to participate and follow up.

B. Exclusion Criteria:
1. Twin pregnancy.
2. Foetus with congenital malformation.
3. Foetus with growth retardation.
4. Intra-uterine death.
5. Maternal medical, surgical or obstetric complication associated with pregnancy.

Ultrasonography was performed by a single sonologist using single ultrasound machine to avoid intra observer bias.. Area of the umbilical cord was measured along with diameters of all umbilical vessels. Area of wharton's jelly was computed by the . formula used below .

AWJ= UCA –(UCV+UCA1+UCA2)
AWJ- area of wharton's jelly
UCA- area of umbilical cord
UCV- area of umbilical vein
UCA1, UCA2- area of both the umbilical arteries

STATISTICAL ANALYSIS
Statistical analysis were done using Microsoft Excel (2007 version) and the Statistical Package for the Social Sciences (SPSS) version 12. The various statistical test like Student t test was done using Microsoft Excel and Pearson's correlations were done using SPSS. All charts were drawn with Microsoft Excel. Statistical significance was defined as $P < 0.05$.

OBSERVATIONS AND RESULTS:
Table 1: Distribution according to maternal age

Age group	No. of patients	Percentage
18-20	308	38.50
21-25	404	50.50
26-30	64	08.00
>30	24	03.00
Total	**800**	**100**

The above table shows distribution of cases according to maternal age. In our study majority of selected cases were in the age group of 21-25 years (50.50%) followed by age group 18-20 years (38.50%) and least were in age group of >30 years (03%). The mean age of cases was 22.47 ±3.86 years (Range: 18-40 years)
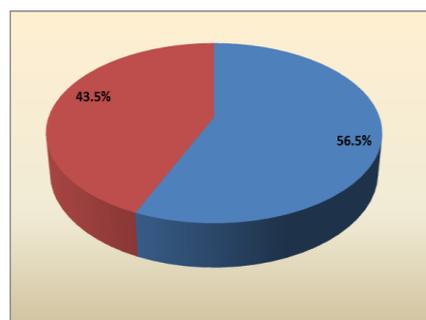
1: Distribution Figure according to maternal age group:
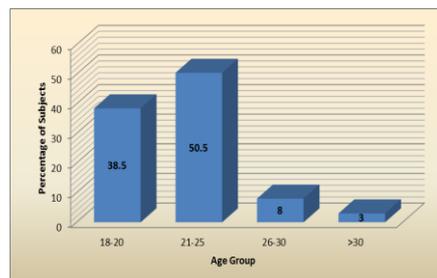
Table 2: Distribution of patients according to trimester of pregnancy:

Trimester	No. of patients	Percentage
II trimester (>12 Wks-28 Wks)	452	56.50
III trimester (>28 Wks)	348	43.50
Total	800	100

The above table described the distribution of patients according to trimester of pregnancy. It was observed that majority of patients were from second trimester (56.50%) followed by third trimester (43.50%). The mean gestational age among patients during pregnancy was 26.16 ±6.72 weeks. (Range: 14-38 weeks)

Figure 1: Distribution of patients according to trimester of pregnancy

Table 3: Distribution of Patients according to umbilical cord diameter during Pregnancy

Gestational age	No. of patients	Umbilical cord diameter	SD
14	08	3.73	0.66
15	12	4.25	0.41
16	28	5.30	0.22
17	28	5.98	0.21
18	56	6.86	0.24
19	24	7.43	0.19
20	28	8.14	0.18
21	28	8.83	0.20
22	52	9.65	0.31
23	36	10.33	0.28
24	44	11.05	0.21
25	24	11.69	0.42

26	24	12.61	0.34
27	24	13.27	0.26
28	36	14.21	0.31
29	28	14.77	0.34
30	40	15.88	0.28
31	36	16.16	0.41
32	32	16.87	0.61
33	44	17.70	0.54
34	36	18.36	0.62
35	60	19.02	0.42
36	36	19.70	0.51
37	24	20.53	0.43
38	08	20.87	0.37
39	04	21.27	0.21

The above table showed distribution of patients according to umbilical cord thickness. The mean umbilical cord thickness at 14 weeks was 3.73 ±0.66 mm while 21.27 ±0.21 mm at 39 weeks.

Figure 3: Relationship between Gestational age and Umbilical cord length:

The relation of gestational age and umbilical cord length during pregnancy showed an R² of 0.999 and an adjusted R² of 0.990. ANOVA analysis showed F-value of 3651.701 and a p-value of < 0.0001. This shows a very strong correlation between umbilical cord length and gestational age which was also statistically significant. The regression equation for umbilical cord length was $Y = 0.721x - 6.242$

Table 4: Distribution of Patients according to Area of Wharton's Jelly during Pregnancy

Gestational age	No. of patients	Area of Wharton's Jelly	SD
14	08	22.50	0.20
15	12	21.67	2.08
16	28	28.57	4.35
17	28	35.85	3.89
18	56	41.92	1.89
19	24	44.83	1.47
20	28	67.14	1.34
21	28	69.83	1.67
22	52	79.38	2.75
23	36	86.22	5.54
24	44	95.36	2.37
25	24	113.50	2.34
26	24	115.83	2.22
27	24	120.16	1.47
28	36	128.77	5.51
29	28	134.42	1.98
30	40	137.80	2.09
31	36	141.55	2.12

32	32	142.12	1.55
33	44	141.81	1.47
34	36	141.11	1.45
35	60	140.86	1.95
36	36	142.44	1.23
37	24	138.33	2.18
38	08	139.67	1.37
39	04	141.32	1.28

The above table showed distribution of patients according to Area of Wharton's Jelly. The mean Area of Wharton's Jelly thickness at 14 weeks was 22.50 ±0.20 mm while 141.32 ±1.28 mm at 39 weeks.
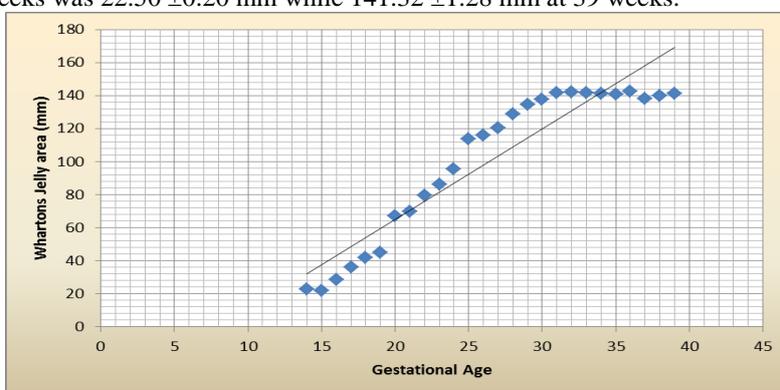

Figure 4: Relationship between Gestational age and Whartons jelly area

The relation of gestational age and **Area of Wharton's Jelly** during pregnancy showed an R^2 of 0.886 and an adjusted R^2 of 0.881. ANOVA analysis showed F-value of 2413.28 and a p-value of < 0.0001. This shows a very strong correlation between the **Area of Wharton's Jelly** and gestational age which was also statistically significant. The regression equation for whartons jelly area was $Y = 5.495x - 4.11$.

Table 5: Distribution of Patients according to Umbilical cord characteristics after Pregnancy

Umbilical cord Characteristic		Mean	2SD
Length (cm)		54.94	± 6.89
Diameter (cm)		01.20	± 00.20
Wharton Jelly Area (mm)		90.06	± 7.92
Cord Insertion (n=800)	Central	508	63.50%
	Peripheral	280	35.00%
	Paracentral	12	01.50%

The above table described umbilical cord characteristics after pregnancy. The mean umbilical cord diameter was 1.20 ±0.20 cm; length 54.94 ±6.89 cm and mean Wharton Jelly area was 90.06 ±7.92 mm.

The umbilical cord insertion among majority of subjects was central (63.50%) followed by peripheral insertion (35%) and paracentral (1.50%)

Table 6: Distribution of neonates according to birth weight:

Birth weight (grams)	No. of Neonates	Percentage
<2000	56	07.00
2000-2500	404	50.50
>2500	340	42.50
Total	800	100

The distribution of neonates according to birth weight showed that among 800 neonates, 404 (50.50%) neonates were having weight between 2000-2500 grams. 56 (7%) neonates had weight <2000 grams while 340 (42.50%) neonates were having weight >2500 grams.
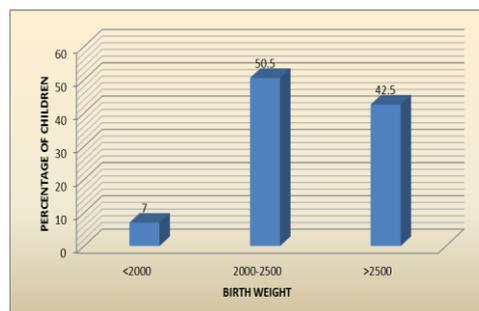

Figure 5: Distribution of neonates according to birth weight

Table 7: Correlation of Birth weight and umbilical cord characteristics after birth:

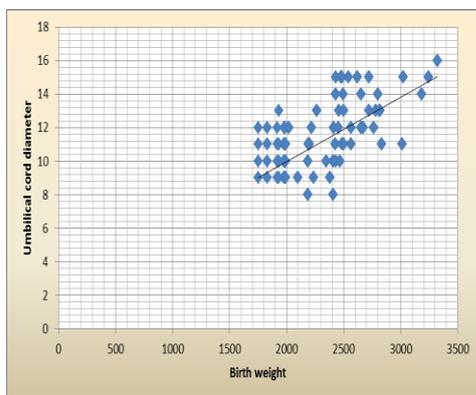| Correlation of Birth weight	R value	P value
Umbilical cord length	0.112	<0.001*
Umbilical cord diameter	0.167	<0.001*
Area of Wharton's Jelly	0.214	<0.001*

(* P<0.05 statistically significant)

The above table described the correlation between birth weight and umbilical cord characteristics. It was observed that umbilical cord length, diameter and Area of Wharton Jelly showed statistically significant positive correlation with birth weight. (P<0.001)
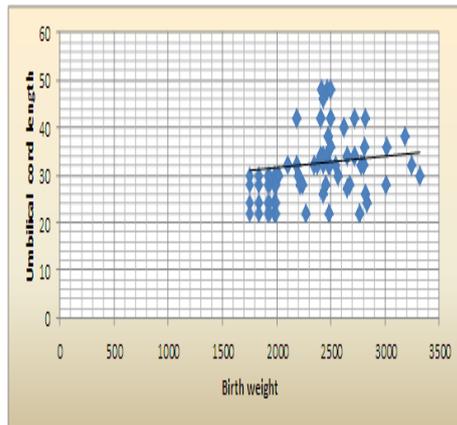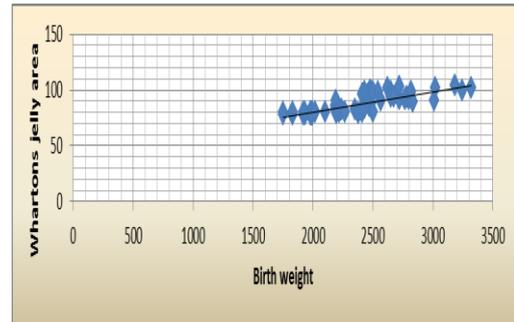

Figure: 5 Correlation of Birth weight and umbilical cord length

The above figure shows correlation between birth weight and umbilical cord length. It was observed that umbilical cord length at birth showed statistically significant positive correlation with birth weight. (R=0.112; P<0.001)


Figure: 6) Correlation of Birth weight and umbilical cord diameter

The above figure shows correlation between birth weight and umbilical cord diameter. It was observed that umbilical cord diameter at birth showed statistically significant positive correlation with birth weight. (R=0.167; P<0.001)

Figure: 7) Correlation of Birth weight and Whartons Jelly area

The above figure shows correlation between birth weight and Whartons Jelly area. It was observed that Whartons Jelly area at birth showed statistically significant positive correlation with birth weight. (R=0.214; P<0.001)
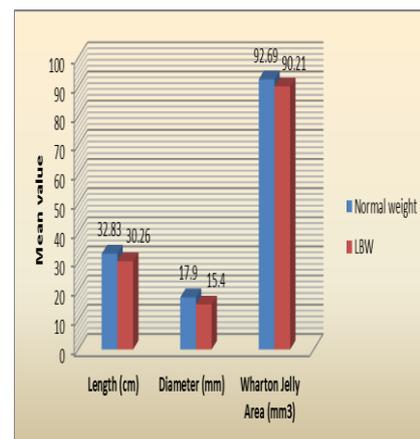
Figure 8): Comparison of umbilical cord morphology in normal and LBW neonates

DISCUSSION
In the present study majority of selected cases were in the age group of 21-25 years (50.50%) followed by age group 18-20 years (38.50%) and least were in age group of >30 years (03%). The mean age of cases was 22.47 ±3.86 years (Range: 18-40 years) Among 800 patients majority of patients were from gestational age 35 weeks (7.5%) followed by 18 weeks.(7%)

The mean umbilical cord thickness at 14 weeks was 3.73 ±0.66 mm while 21.27 ±0.21 mm at 39 weeks. The relation of gestational age and umbilical cord length during pregnancy showed an R^2 of 0.999 and an adjusted R^2 of 0.990. ANOVA analysis showed F-value of 3651.701 and a p-value of < 0.0001. This shows a very strong correlation between umbilical cord length and gestational age which was also statistically significant. The regression equation for umbilical cord length was Y = 0.721x- 6.242.

The mean Area of Wharton's Jelly thickness at 14 weeks was 22.50 ±0.20 mm while 141.32 ±1.28 mm at 39 weeks.

The relation of gestational age and Area of Wharton's Jelly during pregnancy showed an R^2 of 0.886 and an adjusted R^2 of 0.881. ANOVA analysis showed F-value of 2413.28 and a p-value of < 0.0001. This shows a very strong correlation between the Area of Wharton's Jelly and gestational age which was also statistically significant. The regression equation for Whartons jelly area was $Y = 5.495x- 4.11$.

Similar findings were seen in study done by Cristiane Barbieri et al[11] where the area of WJ increased according to gestational age (R2 = 0.64), stabilizing from the 32nd week onwards. There was a significant linear correlation between area of WJ and EFW up to 26 weeks (R = 0.782) and after that it remained practically constant (R = 0.047). The area of WJ increases according to gestational age, with a trend to stabilize at around 32 weeks of gestation. It is also linearly correlated with EFW only up to 26 weeks of gestation.

In the present study; the mean umbilical cord diameter was 1.20 ±0.20 cm; length 54.94 ±6.89 cm and mean Wharton Jelly area was 90.06 ±7.92 mm.

The findings of the present study was in accordance with study done by Manirul Islam[10], the mean umbilical cord diameter was 1.22 ±0.24 cm; length 30.81 ±11.79 cm and mean Wharton Jelly area was 95.18 ±9.12 mm.
It was observed that umbilical cord length, diameter and Area of Wharton Jelly showed statistically significant positive correlation with birth weight. (P<0.001) It was observed that umbilical cord length at birth showed statistically significant positive correlation with birth weight. (R=0.112; P<0.001)

Similar findings seen in study done by Emine Petekkaya et al.[12] where there was a significant positive correlation between umbilical cord and birth weight
The effect of umbilical cord length on fetal development has been analyzed by many researchers. It was reported that there was a positive correlation between umbilical cord length and fetal weight.

The present longitudinal study carried out to evaluate the accuracy of fetal weight from measurement of umbilical cord morphometry and area of Wharton's jelly by ultrasound.
The study was conducted during the period of January 2013 to December 2015. A total sample size of 800 subjects was enrolled in the study.

- The majority of selected cases were in the age group of 21-25 years (50.50%). The mean age of cases was 22.47 ±3.86 years (Range:18-40

years) The mean gestational age among patients during pregnancy was 26.16 ±6.72 weeks. The mean umbilical cord thickness at 14 weeks was 3.73 ±0.66 mm while 21.27 ±0.21 mm at 39 weeks. A very strong correlation between umbilical cord length and gestational age which was also statistically significant. The regression equation for umbilical cord length was $Y = 0.721x- 6.242$. The mean Area of Wharton's Jelly thickness at 14 weeks was 22.50 ±0.20 mm while 141.32 ±1.28 mm at 39 weeks. A very strong correlation between the Area of Wharton's Jelly and gestational age which was also statistically significant was found. The regression equation for Whartons jelly area was $Y = 5.495x- 4.11$. It was observed that umbilical cord length, diameter and Area of Wharton Jelly showed statistically significant positive correlation with birth weight. (P<0.001). It was observed that umbilical cord length, diameter and Wharton Jelly Area were significantly lower in LBW as compared to normal weight neonates. (P<0.05). It was observed that umbilical cord length, diameter and Wharton Jelly Area showed statistically significant positive correlation with biometric parameters. (P<0.001).

CONCLUSION
The present longitudinal study was carried out to evaluate the accuracy of fetal weight from measurement of umbilical cord morphometry and area of wharton's jelly by ulrasonography. Correlation of cord parameters with perinatal outcomes suggests that antenatal detection of umbilical cord abnormalities may be useful in the detection of fetuses at risk of cord related complications.

There was a significant difference between the intrauterine ultrasonographic measurements and the gross anatomical measurements therefore intrauterine ultrasonography may be used as a preliminary guide for the determination of foetal well-being.

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