Journal of Advances in Medicine and Medical Research

33(17): 20-27, 2021; Article no.JAMMR.71842
ISSN: 2456-8899
(Past name: British Journal of Medicine and Medical Research, Past ISSN: 2231-0614, NLM ID: 101570965)

Relationship between Sonographic Umbilical cord Diameter and Gestational Age in Third Trimester of Pregnancy

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JAMMR/2021/v33i1731024
Editor(s):
(1) Dr. Ashish Anand, GV Montgomery Veteran Affairs Medical Center and University of Mississippi Medical Center and William Carey School of Osteopathic Medicine, USA.
Reviewers:
(1) Jyoti Vikas Rokade, Government Medical College , India.
(2) Renuka.S, Chettinad hospital and research institute, India.
(3) Prabha Thangaraj, Dr. MGR Medical University, India.
Complete Peer review History: https://www.sdiarticle4.com/review-history/71842

Review Article

Received 20 May 2021
Accepted 26 July 2021
Published 27 July 2021

ABSTRACT

Background: Throughout the fourth week of embryonic development the umbilical cord (UC) is formed, which corresponds to the fifth to the twelfth weeks of gestation. Fetuses with intrauterine growth restriction (IUGR) have leaner UCs than fetuses of appropriate gestational age do, and the caliber of the umbilical vein decreases significantly, resulting in a worsening of the Doppler parameters of the umbilical artery in the mother. The goal of this study was to evaluate the significance of sonographic UC diameter in determining gestational age in third trimester in pregnant women.
Methods: We conducted a comparative cross-sectional research on 300 pregnant women aged range between (20-35) years, singleton gestation, gestational age (3rd) trimester estimated from antenatal mothers last menstrual period (LMP), viable fetus, presenting to obstetrics and gynecology department at Tanta university hospital.
Results: Highly statistically significant positive correlation between UC diameter and gestational age, BPD, FL, AC, AFI, and estimated fetal weight was found. The increase in UC diameter was

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positively and significantly correlated with the increase in gestational age and estimated fetal weight, indicating that those who have prolonged gestational age and estimated fetal weight are more likely to have wider UC diameter.
Conclusions: The UC diameter (UCD) has the potential to be a valuable indicator of fetal growth, well-being, and perinatal outcome.
Sonographic measurement of UC diameter could be an efficient method of measuring fetal growth and predicting gestational age (GA), particularly between 28-40 weeks GA. It is possible that abnormal UC diameter can be a strong indicator to identify antenatal mothers at risk for IUFD and poor fetal outcomes.

Keywords: Sonographic; umbilical cord diameter; gestational age; third trimester of pregnancy.

1. INTRODUCTION

During the fourth week of embryonic development the umbilical cord (UC) is developed, which corresponds to the fifth to the twelfth weeks of gestation [1].

In comparison to the artery, the media layer of the umbilical vein has a more developed elastic composition but a slimmer wall. Wharton's jelly is constituted of myofibroblasts that are submerged in an extracellular matrix that is composed of a sponge-like layer of collagen fibers and small fiber strings that coat the umbilical vessels, to protect those vessels from tearing and pressure throughout gestation and labor [2].

Recently, it has been discovered that a lean umbilical cord is correlated with low birth weight and a poor neonatal outcome [3]. The diameter of the umbilical cord of the recipient fetus was found to be larger than that of the donor fetus, in the twin-to-twin transfusion syndrome (TTTS).

The goal of the study was to measure the significance of sonographic umbilical cord diameter in determining gestational age in third trimester in pregnant women.

2. METHODS

Our cross-sectional study was held on 300 pregnant mothers at or above 28 weeks gestation presenting to obstetrics and gynecology department at Tanta university hospital after approved of Tanta University Institutional Review Board and written informed consent was obtained from each participant in the study.

Inclusion criteria were antenatal mothers aged ranges between (20-35) years, singleton gestation, gestational age (3rd) trimester estimated from antenatal mothers LMP, viable fetus, intact membranes and normal amniotic fluid index.

Exclusion criteria where antenatal mothers had diabetes mellitus, unreliable date of LMP, multiple pregnancy, hypertension of any etiology, any medical disease, IUGR, any Congenital anomalies & macrosomia.

All antenatal mothers were subjected to the following: Personal history, General examinations, Abdominal examinations, The laboratory investigations, trans-abdominal sonographic examinations Biparietal diameter (BPD), abdominal circumference (AC), femur length (FL) and head circumference (HC). Fetal weight • UCD.

2.1 Technique of Umbilical Cord Estimation

The images of the UC that were utilized for the measurements were taken only when the umbilical cord's outer edges were outlined in a longitudinal plane. From this plane, the probe was then rotated in order to obtain a transverse scan image. The diameters of the umbilical cord were measured on the transverse section.

Diameter's measurements of the umbilical cord were gathered from a cross-sectional plane of the umbilical cord at a 2.0 cm away point from its implantation into the fetal’s abdomen. Based on reliable recollection of the start date of the last menstrual period (LMP), we estimated the GA. The GA calculated from LMP was confirmed by an ultrasound scan performed during the first trimester [4].

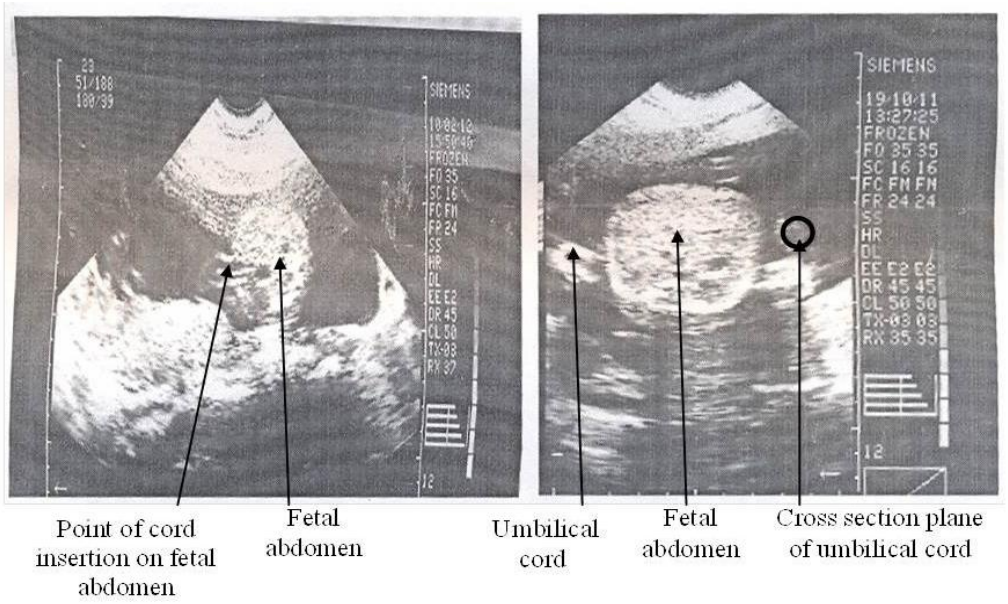

Fig. 1. Plane for obtaining the cross – sectional diameter of umbilical cord. [4]

2.2 Statistical Analysis

IBM's SPSS statistics (Statistical Package for the Social Sciences) for windows (version 25, 2017) was utilized for collected data's statistical analysis. The normality of the data distribution was checked by using Shapiro-Wilk test. Quantitative variables were stated in the form of mean and standard deviation, inter-quartile range, median, maximum and minimum. Depending on the nature of data, Bivariate Correlations were evaluated using Spearman's or Pearson's correlation coefficient. A linear regression model was conducted to determine the efficacy of Umbilical cord diameter in prediction of Gestational age, Estimated fetal weight (R2). All of the tests were conducted with 95% confidence interval. P (probability) value < 0.05 was taken into consideration as statistically significant.

3. RESULTS

The ages of women that ranged from 18 to 43 years with mean age ±SD being 29.25 ± 5.543 years and median was 29 years. The BMI of cases was ranged from 21.97 to 40.57(kg/m2) with mean ±SD= 29.22 ± 2.665(kg/m2).The mean gravidity and parity in cases were 2.57 ± 1.348 and 1.30 ± 1.013 respectively. Mean gestational age at labor was 33.67 weeks. the systolic blood pressure ranged from 90 to 145mm/Hg with mean ±SD being 115.13 ± 11.427 mm/Hg and median was 115mm/Hg .The diastolic blood pressure ranged from 55 to 95mm/Hg with mean ±SD being 70.97 ± 7.806 mm/Hg and median was 70mm/Hg (Data is *expressed as mean and standard deviation, median, range and interquartile range*).

Table 1. Demographic characteristics, Gravidity, parity, gestational age, Systolic and diastolic blood pressure of the studied participants

(All = 300)	**Mean & SD**	**Median**	**Range**	**IQR**
Age (years)	29.25 ± 5.543	29	18, 43	25, 33
BMI (kg/m^2)	29.22 ± 2.665	28.72	21.97, 40.57	28.26, 30.01
Gravidity	2.57 ± 1.348	2	1, 8	2, 3
Parity	1.30 ± 1.013	1	0, 4	1, 2
Gestational age (weeks)	33.67 ± 5.131	35	25, 41	30, 38
SBP	115.13 ± 11.427	115.00	90.00, 145.00	110.00, 125.00
DBP	70.97 ± 7.806	70.00	55.00, 95.00	65.00, 75.00

Data is expressed as mean and standard deviation, median, range and interquartile range

This table shows that there was highly statistically significant positive correlation between UCD and gestational age (p<0.001), BPD (p<0.001), FL (p<0.001), AC (p<0.001), AFI (p<0.001), and estimated fetal weight (p<0.001), respectively (Table 2).

This table expresses the mean values of BPD, FL, AC, AFI, estimated fetal weight and umbilical cord diameter that recorded according to gestational age estimated by US and LMP in the studied antenatal mothers. It was noticed that these fetal biometry parameters increase with gestational age. As total, the mean gestational age detected by US was 34.92 weeks and the mean values of BPD, FL, AC, AFI, estimated fetal weigh umbilical cord diameter were 8.73, 6.88, 31.79, 12.24, 2651.90 and 21.43 respectively Table 3.

The proportion of all the scores in the distribution was equal to or lower than the percentile that denotes the percentage of scores that fall within that particular percentile. For instance, the 50th percentile (the median) was the below score which 50% or at / below which 50% of the scores in the distribution can be found. It was found that the minimum, 90th percentile and maximum of umbilical cord diameter as total was 10, 25.59 and 20.6, respectively (
Fig. **2**).

Correlation and regression analyses were conducted to examine the correlation between Umbilical cord diameter and various potential predictors. An apparent relationship was discovered between gestational age and estimated fetal weight on one hand and the UCD on the other. suggesting that those with gestational ages and higher estimated fetal weights tend to have greater umbilical cord diameter. (**Error! Reference source not found.**).

Table 2. Correlation between Umbilical cord diameter and other studied parameters of the studied participants

(All participants = 300)	Correlation coefficient	P
Gestational age (weeks)	0.721	< 0.001
BPD	0.598	< 0.001
FL	0.585	< 0.001
AC	0.613	< 0.001
AFI	0.434	< 0.001
Estimated fetal weight	0.703	< 0.001

Table 3. Fetal biometry according to gestational age in the studied participants

Number	Gestational age by US (weeks)	Gestational age by LMP (weeks)	BPD	FL	AC	AFI	Estimated fetal weight	Umbilical cord Diameter (mm)
Total	34.92	34.96	8.73	6.88	31.79	12.24	2651.90	21.43
22	28.00	28.08	7.56	5.87	27.28	10.61	1081.82	15.93
13	29.00	28.99	7.58	6.06	27.57	11.24	1156.15	16.85
21	30.00	30.01	7.45	5.84	26.81	10.56	1532.86	17.70
5	31.00	31.02	7.36	5.75	26.56	9.66	1730.00	18.94
14	32.00	32.07	8.05	6.29	29.69	10.95	1661.43	19.09
16	33.00	33.12	8.28	6.59	30.18	10.99	2210.00	21.76
31	34.00	33.98	8.58	6.77	30.67	12.03	2296.45	22.04
30	35.00	35.04	8.75	6.94	31.97	12.51	2744.67	23.47
8	36.00	36.09	8.70	6.94	31.63	13.11	2962.50	23.34
62	37.00	37.03	9.24	7.26	33.78	12.90	3187.74	23.17
30	38.00	38.09	9.47	7.47	34.33	13.43	3474.33	23.38
31	39.00	39.01	9.53	7.51	35.55	13.56	3622.90	24.14
17	40.00	40.11	9.79	7.61	34.98	12.73	3874.71	23.71

Data is expressed as mean

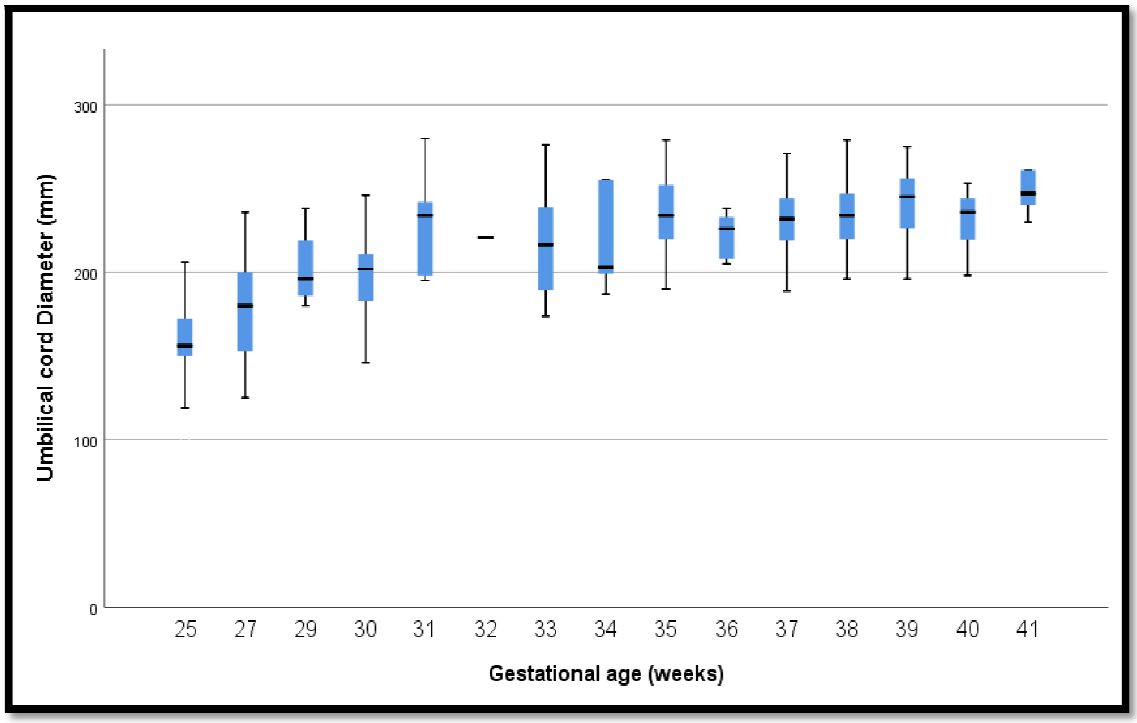

Fig. 2. Boxplots showing percentiles of umbilical cord diameter according to gestational age in the studied participants

Table 4. Regression analysis for value of Umbilical cord diameter for prediction of gestational age and fetal weight in the current study

Umbilical cord Diameter (mm)	R2	B	95% CI of B	P
Gestational age	51.9%	0.745	0.663, 0.827	< 0.001
Estimated fetal weight	49.4%	184.8	163.5, 206.2	< 0.001

4. DISCUSSION

It is essential to estimate the random blood sugar because fetuses of gestational diabetes antenatal mothers tend to have umbilical routine cords that are bigger than nondiabetic antenatal mothers which is mostly because of a greater concentration of Wharton's jelly. Change in the dispersion of Wharton's jelly fibers with wide empty spaces interspersed among them, was thought to lead to an increase in the surface area of the jelly, due to an accumulation of liquid and plasma proteins inside Wharton's jelly [5].

In this study, there were highly statistically significant positive correlation between gestational age an Umbilical cord diameter ($p<0.001$), BPD ($p<0.001$), FL ($p<0.001$), AC ($p<0.001$), AFI ($p<0.001$) and estimated fetal weight ($p<0.001$) respectively.

Udoh et al. [6] supported Our results in which UCD increased with widely used sonographic measurements used to provide and estimation of GA and FW (such as BPD, HC, FL, and AC). Afroze et al. [7] Reported a tight relationship between widely used fetal metrics for GA and UCD. As such, UCD continues to provide helpful parameters for fetal growth monitoring.

The findings of another study indicated commonly used fetal parameters in sonographic approximation of GA like BPD, FL, HC and AC all of them amplified as GA advanced, and that they are all associated positively with GA. Also, they detected that UCD increased more and more, with GA, in the study they conducted on umbilical cord cross-sectional diameter, for various GAs [8].

Eze et al. [4] Earlier, they had reported an important association between cord cross-sectional area and other fetal anthropometric parameters. According to the findings of this research, previous suggestions that the umbilical cord component sonographic measurements are essential for the fetal growth evaluation is correct.

The current study results showed the distribution of Umbilical Cord Diameter in each gestational age. In 28 weeks, the umbilical cord diameter was 15.93mm, it was 16.85 mm at 29 weeks, 17.7 mm at 30 weeks, 18.94 mm at 31weeks, 19.09 mm at 32 weeks, 21.76 mm at 33 weeks, 22.04 mm at 34 weeks, 23.47 mm at 35 weeks, 23.34 mm at 36 weeks, 23.17 mm at 37 weeks, 23.38 mm at 38 weeks, 24.14 mm at 39 weeks and 23.71 mm at 40 weeks.

This is in agreement with Eze et al. [4] who stated that the mean cord diameter was 16.0 mm at 28 weeks of gestation, while it reached 24.2 mm by the 40th week, a mean UCD of 14.5 mm and the cross-sectional area's mean was 201.6 mm^2. In contrast, this seems prominently bigger than 191mm2 reported among subjects from India [9]. Among the population studied, both cross-sectional area and UCD (452.4mm and 24.3mm respectively) detected at term in the study, may, be the higher limits of umbilical cord sizes. Causes behind these variations were not looked into.

Such changes in the mean of umbilical cord dimensions may indicate potential variations in the environmental or racial differences of umbilical cord development. Differences also may have been observed due to potential observation bias in the cord parameters measurements.

In another study, the UCD varied between 1.41-1.68 cm for GAs from 28 to 40 weeks [6].

From the study results, anthropometric measurements and the cross-sectional area of the umbilical cord increased as gestational age increased.

Similar results in another study by Rostamzadeh et al. [10], The circumference of the umbilical cord, umbilical vein, umbilical arteries and WJ area increased significantly throughout pregnancy in terms of gestational age [11].

The connection of UCD to anthropometric measurements may be explained via the function of the WJ in pregnancy. Pathologists showed that WJ cells may function like smooth muscle cells to help regulate umbilical blood flow. Moreover, infants born to mothers with greater weight during pregnancy have more WJ surrounding their umbilical cord vessels [7].

In this study, minimum and maximum umbilical cord diameter was reported at different gestational age. The results of this research correspond to the results of Togni et al. [1] who developed normality curves for the assessment of the gestational age utilizing the cross-sectional areas and amount of Wharton's jelly of the umbilical cord vessels, respectively. In the research, the cross-sectional area of the umbilical cord was reported to have expanded as pregnancy progressed.

The results of the study also confirms those of Weismann and Drugan [12] who had previously noted a positively strong association between the size of the umbilical cord (cross-sectional area and diameter) and GA. Furthermore, Gehzzi et al. [13] had similarly stated that sonographic area and cross-sectional diameter of umbilical cord enlarged as pregnancy progressed while Togni et al. [1] had previously noted a substantial connection between other fetal's cord cross-sectional area using anthropometric parameters.

The findings of this research corroborate previous opinions which indicate that sonographic measuring of umbilical cord components is a significant method for evaluating fetal development.

Weismann and Drugan [12]. Had significant connections between fetal parameters that are widely utilized in GA and umbilical cord size, documented in independent studies. Moreover, Gehzzi et al. [13] has discovered that the sonographic of the cross-section diameter and area of the umbilical cord enlarges as pregnancy progressed and that both are positively correlating with GA and fetal weight.

In the current research, we observed that the increase in umbilical cord diameter had a positive and significant correlation with gestational age and estimated fetal weight, indicating that those with increase gestational age and estimated fetal weight tend to have higher umbilical cord diameter.

The results of a prior study have shown that cross-sectional area and UCD have a significant

linear relation with common fetal GA estimating parameters particularly between 14 - 35 weeks GA. Prior to the 14th week as well as post 35th week, it seemed that there was no increase in the size of the umbilical cord along with the increase in GA. Apparently it indicates that umbilical cord size's sonographic measurement might be an essential addition when it is certain that other widely used fetal parameters, such as anencephaly, hydrocephalus, dwarfism and smaller for-date fetuses.

However, this needs furthermore research [4].

The umbilical cord's dimensions are a significant indicators of the integrity and functioning of the umbilical cord's ultrastructure. It might also represent its capacity to provide crucial assistance for a fetus that is rapidly growing [14].

This is in agreement with another study which reported that umbilical cord diameter has a strong linear relationship with generally used parameters for the estimation of fetus's gestational age and can be used as a dependable technique to evaluate fetal development and prediction of gestational age [15].

5. CONCLUSIONS

Umbilical cord's diameter showed significant positive association with fetal biometric measures in the group investigated. The UCD may act as a key indicator of the perinatal and fetal growth. Sonographic assessment of the diameter of the umbilical cord may be reliable evaluation method to assess fetal development and prediction of GA, particularly between 28-40 weeks of GA among the study group. Irregular umbilical cord diameter can be a significant indicator for the identification of fetuses at risk of IUFD and poor fetal outcomes.

CONSENT AND ETHICAL APPROVAL

Our cross-sectional study was held on 300 pregnant mothers at or above 28 weeks gestation presenting to obstetrics and gynecology department at Tanta university hospital after ethical approved of Tanta University Institutional Review Board and written informed consent was obtained from each participant in the study.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle4.com/review-history/71842