

Correlation Of Umbilical Cord Area And Diameter With Standard Fetal Biometric Parameters For Estimation Of Gestational Age And Fetal Weight: A Prospective Study

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ABSTRACT

Background Umbilical cord is a vital structure of fetal life. The growth of the umbilical cord increases during pregnancy, peaking at 32 weeks, plateauing till 34th week and then marginally declines, and hence constitutes an appropriate parameter for verifying the prediction of fetal growth pattern.

Objectives To correlate umbilical cord area and diameter with established fetal parameters (biparietal diameter, head circumference, femur length and abdominal circumference) in estimating gestational age and fetal weight.

Methods The study was a prospective hospital-based study. This study included 200 patients who will undergo USG imaging in our Department of Radiodiagnosis, Vinayaka Missions Kirupananda Variyar Medical College & Hospital, Salem for a time period of two years for obstetrics ultrasound scan from 14 weeks to 40 weeks of gestation. If the inclusion criteria was fulfilled, informed consent was taken, the patient was briefed about the procedure and relevant instructions were given to the patient.

Results The mean umbilical cord diameter as well as cross sectional increases steadily with gestational age from 14 weeks to 34 weeks and then it declines till 39 week of gestational age.

Conclusion There is a very strong correlation between HC, AC, EFW and UCD. Strong correlation was also observed between FL, BPD and UCD. There is also a very strong correlation between HC, AC, EFW and UCA. Strong correlation is observed between FL, BPD and UCA.

Keywords Ultrasonography, Umbilical cord diameter, Umbilical cord area, Gestational age, Estimation of fetal weight.

INTRODUCTION

Accurate knowledge of the gestational age is an vital determinant of both antenatal care and successful delivery of fetus. Gestational age is also an important factor in the interpretation of biochemical screening tests. Correct knowledge of these and other maternal serum markers is essential in the assessment of fetal anomalies and also in assessing fetal growth by differentiating the normal from pathological fetal development. Furthermore, important clinical decisions as elective caesarean section and induction of labor for vaginal delivery depend on exact knowledge of the gestational age.[1,2] Calculation of the GA based on LMP is often wrong as many women, particularly those with a history of irregular menstrual periods preceding conception, are often uncertain of the date of onset of their LMP. Ultrasound imaging is now a frequently used modality to estimate the GA by calculating fetal parameters such as biparietal diameter (BPD), head circumference (HC), femur length (FL) and abdominal circumference (AC).[3,4,5]

Studies have shown that as pregnancy advances, the accuracy of fetal parameters as estimators of GA might wax or wane. [6,7] Umbilical cord diameter and cross-sectional area are easily obtainable sonographic measurements with highly reliable intra and inter-observer reproducibility. Unlike measuring other conventional biometric parameters, that can be technically difficult in late gestation due to low position of fetal head, abdominal circumference distortion, posterior placement of femur, a successful assessment of umbilical cord area is not influenced by gestational age or amniotic fluid volume. [8]

In the past, sonographic investigations of the umbilical cord were limited to identification of the number of vessels and Doppler evaluation of the blood flow. Improved ultrasound techniques in measuring the diameter and cross sectional area of the umbilical cord can help in better estimation of foetal weight and gestational age.[9] Evaluating umbilical cord parameters and comparing it with the normal values benefit us in the early identification of fetal abnormalities. The purpose of this study is to correlate umbilical cord diameter and area with established fetal parameters (biparietal diameter, head circumference, femur length and abdominal circumference) in estimating gestational age and fetal weight.

MATERIALS AND METHODS

It was a prospective hospital-based study. The source of data for this study will be patients referred to the Department of Radiodiagnosis, Vinayaka Missions Kirupananda Variyar Medical College & Hospital, Salem for obstetrics ultrasound scan from 14 weeks to 40 weeks of gestation. The study will include 200 patients who will undergo ultrasound study for a time period of two years. Women with singleton pregnancy coming to Department of Radio-Diagnosis, Vinayaka Missions Kirupananda Variyar Medical College & Hospital, Salem for obstetric ultrasound scan during study period will be included in the study. If the inclusion criteria was fulfilled, informed consent was taken, the patient was briefed about the procedure and relevant instructions were given to the patient.

Inclusion Criteria

1. Singleton pregnancy with live fetus.
2. Gestational age from 13 weeks to 40 weeks of gestation.
3. Presence of three vessel cord.
4. Normal amount of amniotic fluid.
5. Known last menstruation period.

Exclusion Criteria

1. Multiple pregnancy.
2. Presence of fetal anomalies.
3. Intra uterine fetal demise.
4. Single umbilical artery.
5. Systemic diseases.

With due informed consent, umbilical cord cross sectional area will be measured using GE LOGIQ F8 curvilinear transducer (Figure). Examinations will be carried out with subjects in supine position. All measurements will be made on still images captured with the freeze facility of the ultrasound scanner with the on-screen electronic caliper of the ultrasound unit.[9] Established fetal parameters for GA estimation such as the BPD, FL, HC and AC will be measured following the departmental protocols for such measurements. Furthermore, images of the umbilical cord used for measurements will be captured only when outer edges of the umbilical cord are outlined in a longitudinal plane. From this plane, the probe will be turned to obtain a transverse scan image.

Statistical methods

Microsoft word & Excel will be used to generate graphs, tables etc. For descriptive statistics & correlation study, statistical package for social sciences (SPSS) version 17.0 will be used.

RESULTS

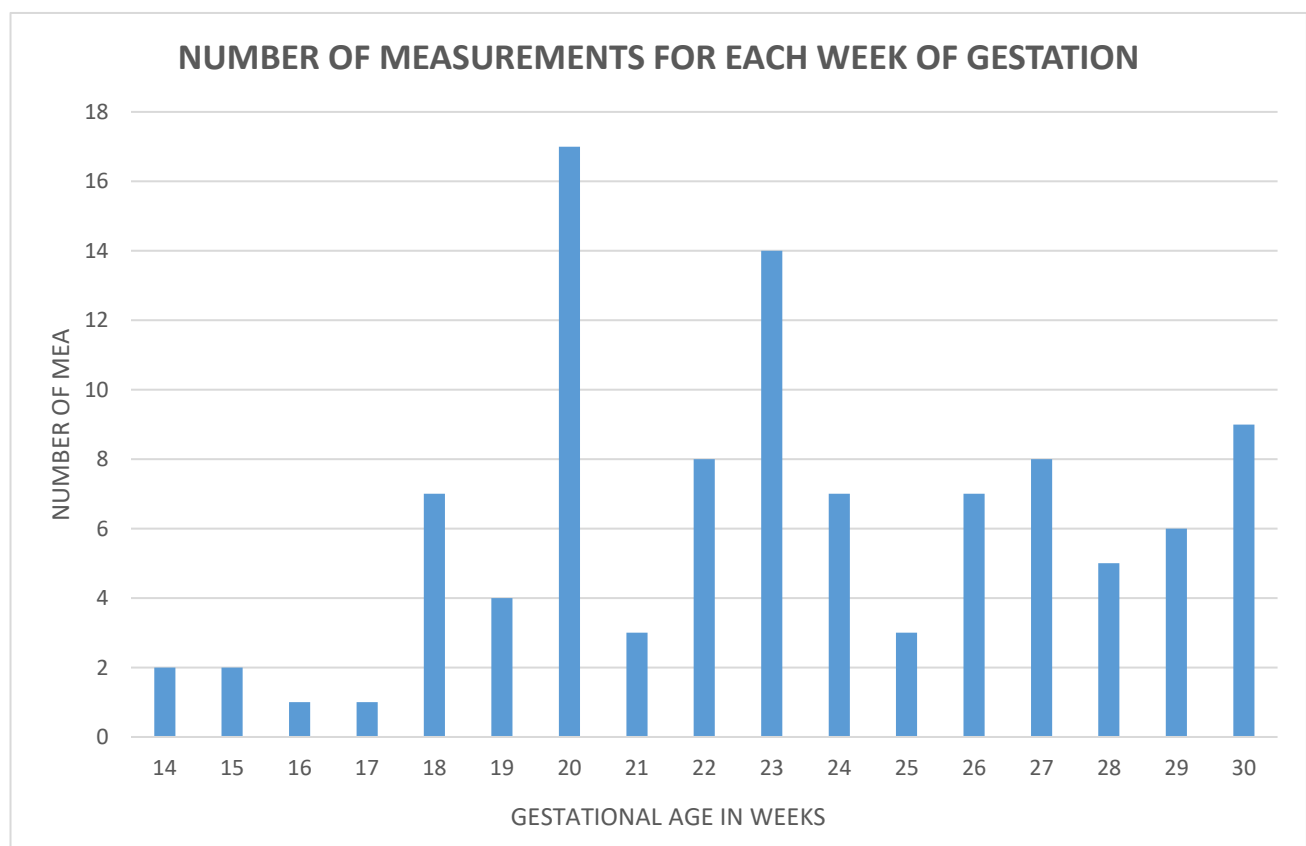
Table 1- Age wise distribution of antenatal women studied

Age (in years)	Frequency	Percentage (%)
18-20	20	10
20-25	105	52.5
25-30	64	32
>30	11	5.5

* Mean age :24.84 years

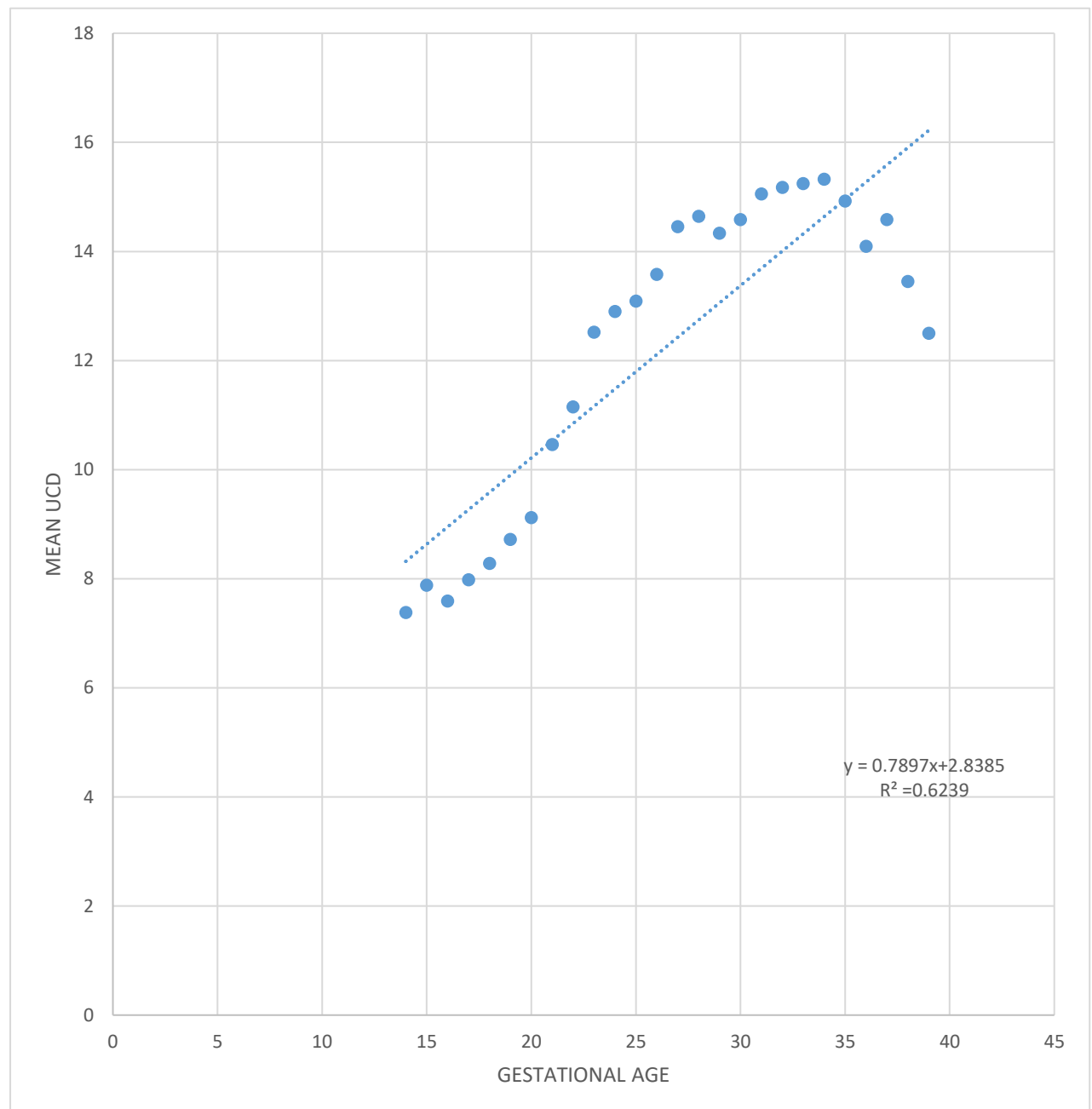
In the total study group of 200 normal antenatal women, the age of antenatal women ranged from 18 - 38years. The mean age was 25 years. The distribution of cases with respect to maternal age groups is as given in the table. Majority of the antenatal women were in the age group between 20-25 years, followed by 25-30 years age group as depicted in the above table and the chart.

Figure1- The number of measurements for each week of gestational age



The number measurements ranged from 1 to 20 for each week of gestational age. A total of 200 measurements were obtained in this study.

Figure 2: Gestational age vs Mean umbilical cord diameter



Umbilical cord diameter in antenatal women from 14 – 39 weeks of gestation is plotted with gestational age and is observed that the mean umbilical cord diameter increases with gestational age from 7.38mm at 14 weeks to 15.32mm at 34 weeks and then it declines to 12.5mm at 39 week of gestational age.

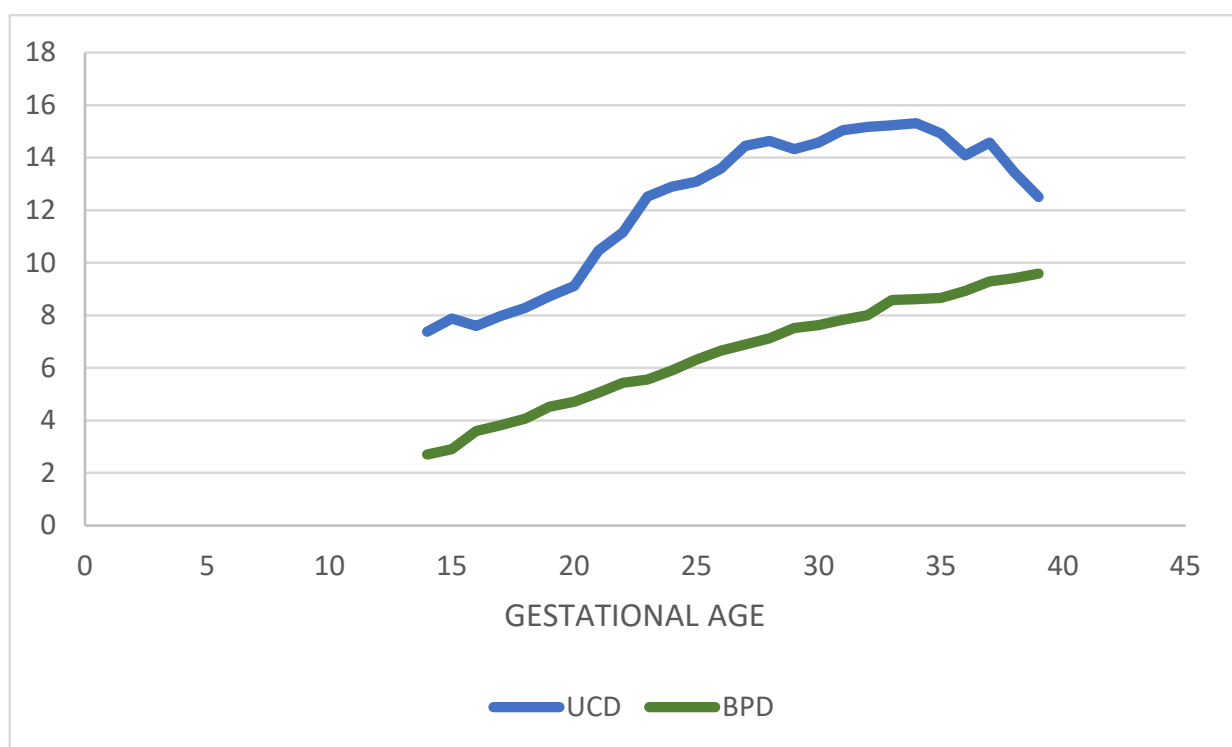


Figure 4: Mean umbilical cord diameter and Biparietal diameter with gestational age

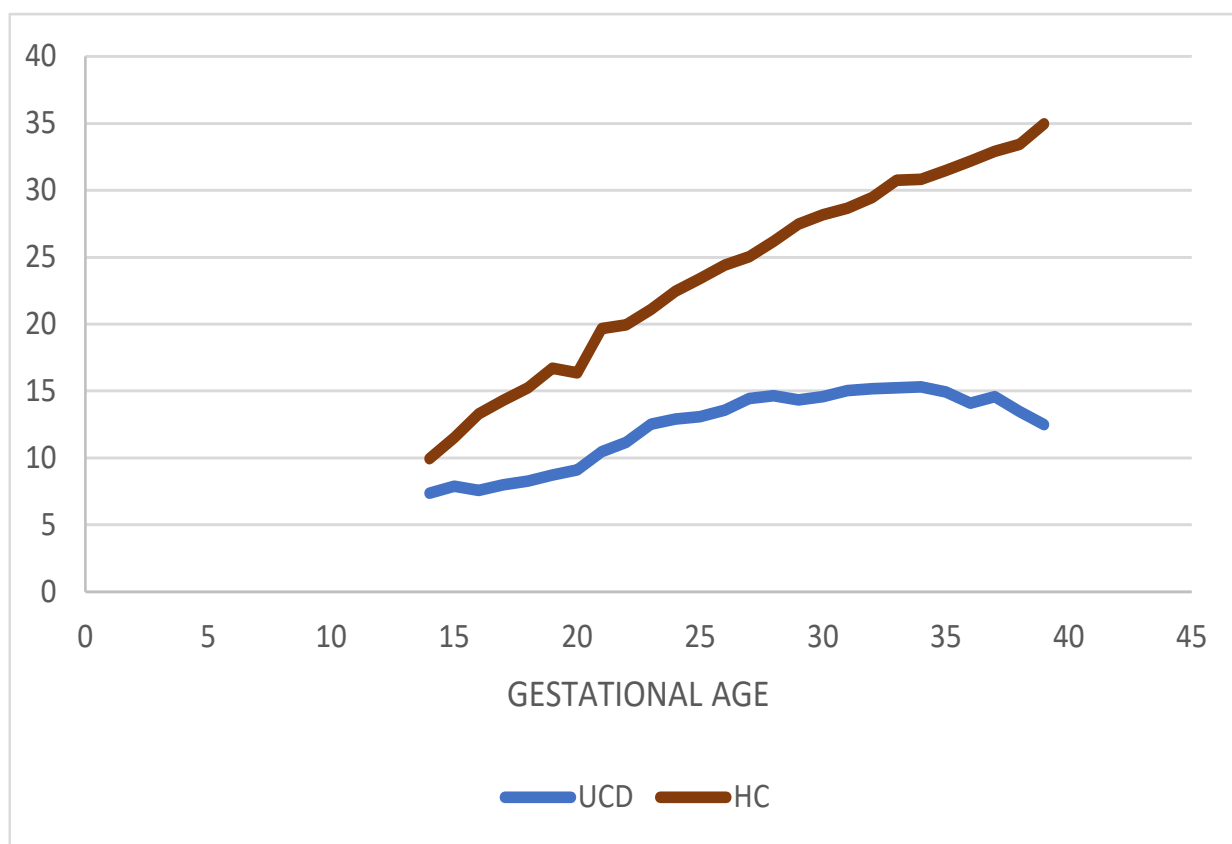


Figure 5: Mean umbilical cord diameter and head circumference with gestational age

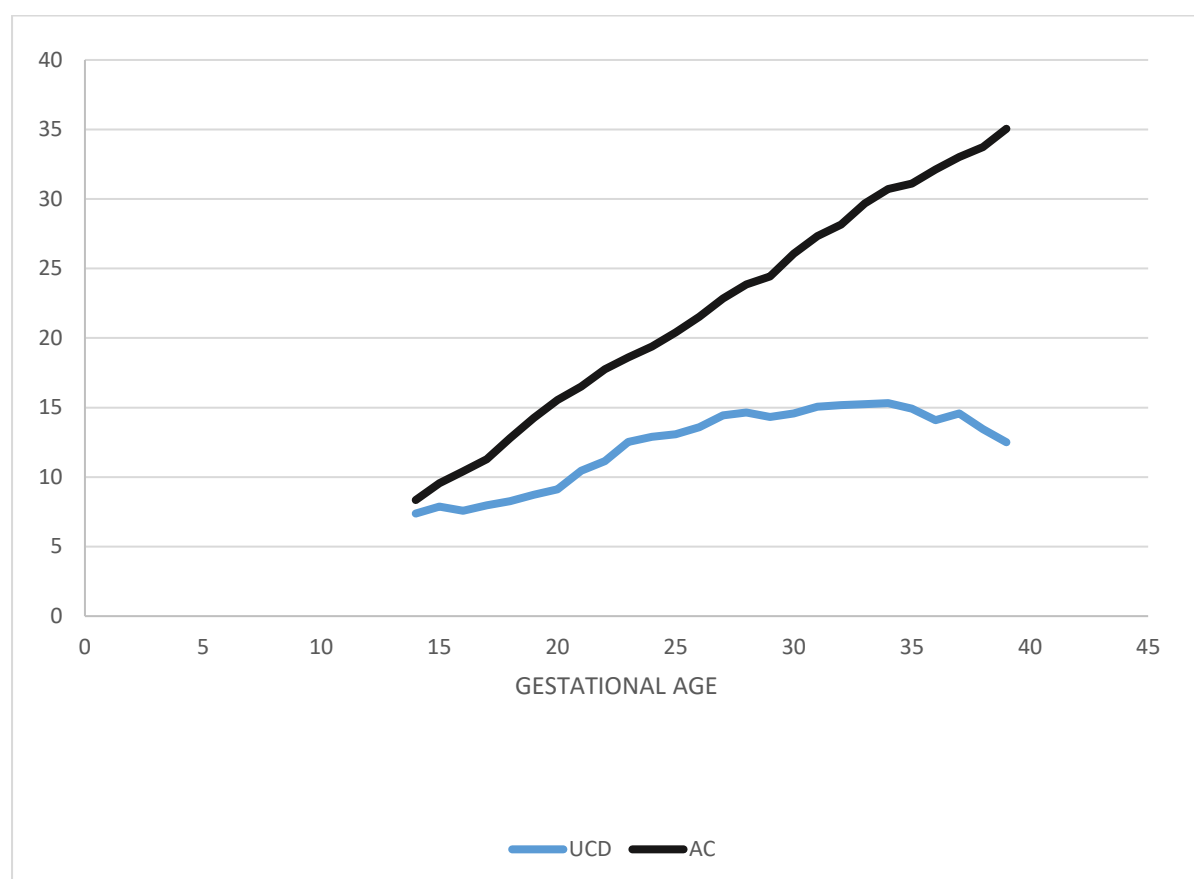


Figure 6: Mean umbilical cord diameter and abdominal circumference with gestational age

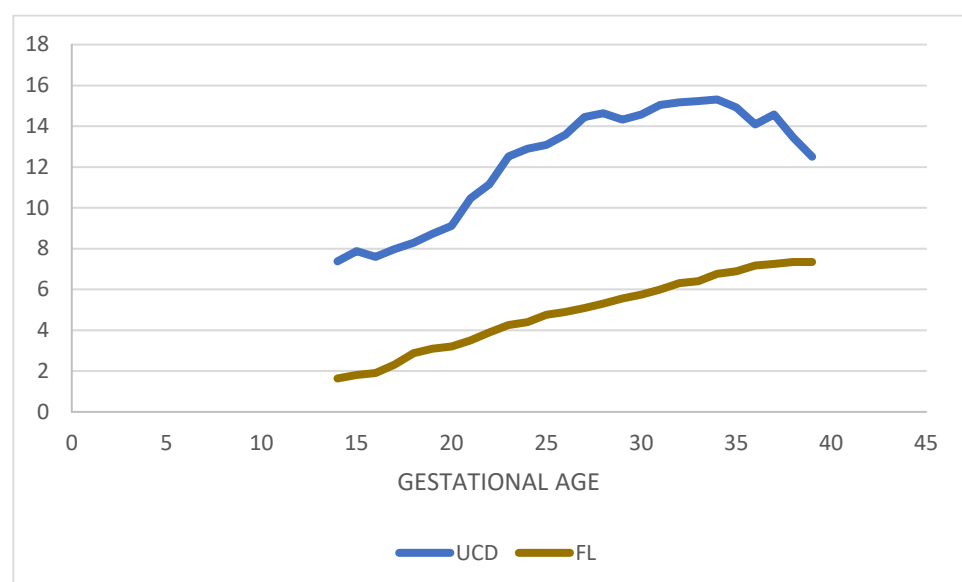


Table 2- Spearman's correlation between umbilical cord cross-section area and foetal anthropometric parameters.

FETAL ANTHROPOMETRIC PARAMETERS	SPEARMAN'S CORRELATION COEFFICIENT	P- VALUE
Biparietal diameter	0.412	0.03
Head circumference	0.612	0.006
Abdominal circumference	0.654	0.005
Femur length	0.52	0.02
Estimated fetal weight	0.728	0.009

It is observed that the mean umbilical cord diameter increases with estimated fetal weight as gestation advance from 14 weeks to 34 weeks and then it declines till 39 week of gestational age. The Spearman's correlation is 0.7281 which showed that there is a strong correlation between umbilical cord diameter and estimated fetal weight. The table represents the spearman's correlation (r and p) values between umbilical cord diameter and foetal anthropometric measurements ($p < 0.05$). It is observed that a very strong correlation between HC, AC, EFW and umbilical cord diameter. Strong correlation is observed between FL, BPD and umbilical cord diameter.

Table 3- Effect of advancing Gestational age on umbilical cord area

Gestational Age (weeks)	Number of subjects	% of subjects	Umbilical cord area(mm ²) Mean $\pm$ SD	95% confidence interval
14	2	1.0	42.83 $\pm$ 2.63	42.83 $\pm$ 3.645
15	2	1.0	48.72 $\pm$ 0.83	48.72 $\pm$ 1.15
16	1	0.5	45.2 $\pm$ 0	45.2 $\pm$ 0
17	1	0.5	50 $\pm$ 0	50 $\pm$ 0
18	7	3.5	53.91 $\pm$ 5.43	53.9143 $\pm$ 4.024
19	4	2.0	59.87 $\pm$ 5.77	59.875 $\pm$ 5.659
20	17	8.5	65.46 $\pm$ 6.02	65.4606 $\pm$ 2.864
21	3	1.5	85.97 $\pm$ 7.29	85.97 $\pm$ 8.258
22	8	4.0	97.81 $\pm$ 8.33	97.8175 $\pm$ 5.776
23	14	7.0	123.23 $\pm$ 7.85	123.2314 $\pm$ 4.114
24	7	3.5	130.57 $\pm$ 2.74	130.5786 $\pm$ 2.033
25	3	1.5	134.62 $\pm$ 3.35	134.6267 $\pm$ 3.795
26	7	3.5	144.87 $\pm$ 4.73	144.8743 $\pm$ 3.508
27	8	4.0	163.96 $\pm$ 4.30	163.9675 $\pm$ 2.986
28	5	2.5	168.24 $\pm$ 5.38	168.246 $\pm$ 4.716
29	6	3.0	161.36 $\pm$ 9.66	161.3617 $\pm$ 7.733
30	9	4.5	166.96 $\pm$ 7.22	166.9633 $\pm$ 4.723
31	8	4.0	177.94 $\pm$ 12.64	177.9413 $\pm$ 8.762
32	9	4.5	180.8 $\pm$ 11.53	180.8 $\pm$ 7.538
33	6	3.0	183.06 $\pm$ 24.92	183.0667 $\pm$ 19.436
34	16	8.0	186.84 $\pm$ 21.25	186.848 $\pm$ 10.758
35	20	10.0	175.31 $\pm$ 21.06	175.319 $\pm$ 9.231
36	13	6.5	156.53 $\pm$ 22.25	156.5354 $\pm$ 12.095

37	18	9.0	167.8±24.56	167.808 ±11.34
38	3	1.5	143.6130.22	143.6133 ±34.206
39	3	1.5	124.66±11.91	124.6667 ±13.484

DISCUSSION

Clinical dating of a pregnancy is estimated based on the patient's recollection of the first day of her LMP and on physical examination for the size of uterus. Unfortunately, both of these methods are inaccurate, leading to error in gestational age assignment. Ultrasound on the other hand offers an alternative and in most of the cases, superior approach to gestational age assessment than clinical dating. Many USG parameters have been proposed and used for estimating gestational age in the second and third trimesters. These include Biparietal diameter, Head circumference, Abdominal circumference, Femur length, as well as combinations of two or more fetal measurements. Studies have shown that as the pregnancy advances, the accuracy of fetal parameters as estimators of GA wax or wane. Hence, evaluating umbilical cord parameters and comparing it with the normal values benefit us in the early identification of fetal abnormalities as well as helpful in estimation of gestational age and fetal weight.[10,11,12] In this study, 200 women with singleton pregnancy fulfilling the inclusion criteria who came for obstetric ultrasound scan during the study period was included. Established fetal parameters for GA and EFW estimation such as the BPD, FL, HC and AC was measured followed by umbilical cord diameter and cross sectional area at 2 cm from point of insertion into the fetal abdomen as per the standard protocol. Thereafter, an attempt was made to correlate the UCD and UCA with fetal biometric parameters. In this study, the age of antenatal women ranged from 18 - 38 years with the mean age of 25 years and majority were in the age group between 20-25 years, followed by 25-30 years age group. Weissman A et al., observed that cord diameters increases progressively with the gestational age up to 32 weeks and then attains a plateau. In our study, the UCD were taken from 14- 39 weeks of gestation and it was observed that the mean umbilical cord diameter increases steadily with gestational age from 7.38 mm at 14 weeks to 15.32 mm at 34 weeks and then it declines to 12.5 mm at 39 week of gestational age. These observations were in agreement with the results of Togni FA et al., and Raio L et al.,. There is small disparity with our results which may be due to difference of the study populations.[13,14,15]. In our study, it is observed that there is a very strong correlation between HC, AC, EFW (Spearman's correlation is 0.7281) and UCD. Strong correlation was also observed between FL, BPD and UCD. Ohagwahu and Nyberg S et al., observed that umbilical cord cross sectional area was linearly increasing up to 32 and 30 weeks respectively, tending to stabilize from then onwards. In our study, it was observed that the mean umbilical cord area increases steadily with gestational age from 42.83 mm² at 14 weeks to 186.84 mm² at 34 weeks and then it declines to 156.53 mm² at 39 week of gestational age, a very strong correlation between HC, AC, EFW (Spearman's correlation is 0.7254) and UCA. Strong correlation is observed between FL, BPD and UCA.[16,17] Togni FA et al., observed a significant correlation between umbilical cord cross-sectional and other foetal anthropometric measurements like BPD, HC, AC, FL, and EFW. In our study, we also observed a similar correlation between all the foetal anthropometric measurements and umbilical cord cross-section area. All the parameters increase with gestational age with a positive correlation.[14] Various other studies have also shown a strong positive correlation between these parameters and umbilical cord cross-sectional diameter and area. [15,16,17] Furthermore, Gehzzi et al had equally reported that sonographic cross sectional diameter and area of umbilical cord increased as pregnancy advances.[18] The results of our study therefore support earlier opinions suggesting that sonographic measurement of umbilical cord components are important tools for the assessment of fetal growth. Hence, umbilical cord diameter and cross-sectional area can also be considered as sonographic parameters for foetal growth assessment. The major limitation of our study was the small sample size selected which may make results of the study less generally applicable in a country as populous as India. We suggest further studies with bigger sample sizes to validate the results of the present study.

CONCLUSION

The mean umbilical cord diameter and cross sectional increases steadily with gestational age from 14 weeks to 34 weeks and then it declines till 39 week of gestational age. There is a very strong correlation between HC, AC, EFW and UCD. Strong correlation was also observed between FL, BPD and UCD. There is a very strong correlation between HC, AC, EFW and UCA. Strong correlation is observed between FL, BPD and UCA. Umbilical cord diameter and cross-sectional area can also be considered as sonographic parameters for foetal growth assessment.

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