ORIGINAL ARTICLE

PROGNOSTIC INDICES FOR PREGNANCY OUTCOME ON ULTRASOUND: A PROSPECTIVE STUDY

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ABSTRACT

PURPOSE: To Determine the prognostic significance of sonographic measurements of umbilical cord thickness and area in pregnancy and their relation to pregnancy outcome. **MATERIAL AND METHODS:** 230 pregnant patients were referred for the study. Ultrasound was performed and the 190 patients who satisfied the criteria were included in study. Umbilical cord diameter and cross sectional area were measured in 20-24 weeks gestation. The patients were followed and after delivery birth weight, 5-minute APGAR score of baby were recorded .The sonographic parameters (umbilical cord diameter, cross sectional area) were compared with baby birth weight, 5-minute APGAR score. Pearson correlation test and receiver operating characteristic curve (ROC) was performed to determine the prognostic significance of these parameters **RESULTS:** The mean umbilical cord diameter was 1.42 mm, mean cross sectional area was 140.mm^2. Mean birth weight was 3112.15 gms and mean APGAR score was 7. Statistically significant correlation was found ($P<0.05$) between umbilical cord diameter, cross sectional area and baby birth weight, APGAR score. **CONCLUSION:** The sonographic parameters of umbilical cord diameter, and cross sectional area measured between 20-24 weeks of gestation are good prognostic tool, especially in rural areas, for pregnancy outcome. Sonographic finding of a lean umbilical cord should prompt the physician for strict monitoring of the pregnancy.

Key words: Ultrasound(USG), umbilical cord diameter, umbilical cord cross sectional area, low birth weight (LBW)

Introduction

The umbilical cord can be easily demonstrated and assessed by conventional real-time ultrasound. Gray scale ultrasound is easily available and measurements of umbilical cord diameter and cross sectional area easily allow prognostic evaluation of pregnancy, especially in rural areas, to help pregnant patients.

The umbilical cord thickness depends on luminal diameter of vessels and amount of Wharton's jelly. Antenatal nomograms of the umbilical cord thickness from 10 to 42 weeks[1-4] and Wharton's jelly area between 15 to 42 weeks of gestational age have been described.[5,6] A generated nomograms demonstrated an increase in umbilical cord thickness as a function of gestational age up to 34-36 weeks of gestation, followed by a reduction of umbilical cord size.[2,5] These morphologic cord characteristics have been associated with antenatal and perinatal outcomes.

In the past many studies have correlated pregnancy outcome with umbilical cord thickness and cross sectional area. Previously it was restricted to the post-partum period. Pathologists performed evaluation of umbilical cord morphology and demonstrated that a thin umbilical cord was associated with adverse pregnancy outcome.[7,8] Raio and colleagues also studied and concluded the association of a lean umbilical cord with small-for-gestational-age (SGA) neonates.[6] In the first and early second trimesters of gestation, significant differences in mean gestational age, mode of delivery, birth weight, and adverse

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perinatal outcome was found by Goynumer et al.[9] Ghezzi et al, studied umbilical vein cross sectional area and found a significant relationship between umbilical vein cross-sectional area below the 10th percentile and adverse neonatal outcome.[10]
The present study was done using ultrasound in pregnant patients by measuring umbilical cord diameter, cross sectional area between 20-24 weeks pregnancy. We calculated optimal threshold of these parameters to evaluate their prognostic significance.

Material and Methods

The institute subcommittee on human studies approved the study. Written informed consent was obtained from the patients or their attendants before the patient was enrolled in the study.

Design: This prospective study was designed to assess the prognostic value of umbilical cord diameter and cross sectional area in pregnancy.
Patients presenting to maternity services of our institute, in second trimester were evaluated by ultrasound. Gestational age was based on a reliable history (last menstrual period), or any USG examination before 20 weeks. Routine USG parameters for pregnancy and umbilical cord diameter and cross sectional area were recorded, Patients were followed till delivery and at delivery; gestational age at time of delivery, baby birth weight and 5 minute APGAR score were recorded

Patient Selection: 230 pregnant patients were referred for the study.Ultrasound was performed and the 190 patients who satisfied the criteria were included in study. Patients with twin or more pregnancy, abnormal amniotic fluid index, abnormal umbilical cord, fetus with congenital fetal malformation, patients with history of maternal disorder like diabetes mellitus, gestational diabetes, hypertension, and thyroid disease were excluded from this study. Patients who could not be followed till delivery or at delivery if they had meconium stained amniotic fluid were also excluded from study.

DATA Acquisition

Gestational age was based on reliable history of last menstrual period (LMP), or any ultrasound examination before 20 weeks of gestation. Routine Ultrasound was performed with a standard ultrasound scanner Logiq 500 pro (GE Medical Systems, USA) with 3.5-MHz-frequency convex transducer. Normal amniotic fluid index, normal fetal anatomy, gestational age was recorded. The umbilical cord diameter and cross sectional area were measured in floating loops of umbilical cord using software in USG unit at 20-24 weeks gestation.
Umbilical cord thickness was performed by making outer edges in transverse section of free floating loop of umbilical cord. Umbilical cord cross sectional area was measured by encircling the outer edges in transverse section of free floating loop of umbilical cord (Fig. 1,2). Patients were followed till delivery and after delivery; birth weight, 5-minute APGAR score of baby were recorded. Sonographic parameters of umbilical cord diameter, cross sectional area were compared with baby birth weight, 5-minute APGAR score.
The neonates having birth weight below 2500 grams were considered low birth weight (LBW). Birth weight above 4000 grams was considered as cut off for macrosomia. APGAR score below 7 was considered low.
Pearson correlation test and ROC (Receiver operating characteristic curve analysis) was performed to determine the prognostic significance of these parameters.

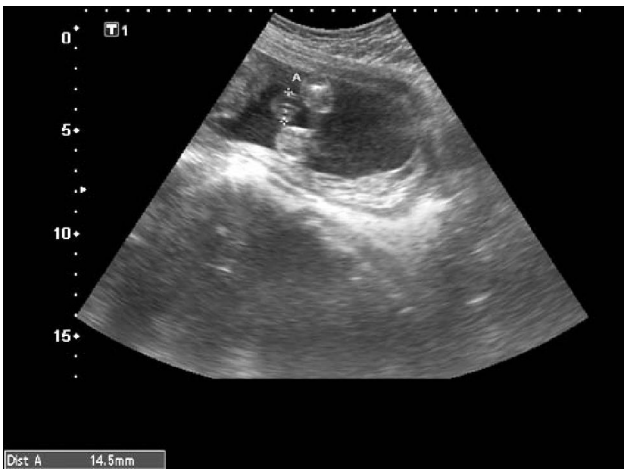


Figure 1: Transverse Ultrasound showing the method of measuerement of umbilical cord diameter in floating loop of umbilical cord

Figure 2: Transverse Ultrasound showing the method of measuerement of cross sectional area in free floating loop of umbilical cord (dotted circle)

Statistical Analysis

Statistical analysis was done by applying 't' test, Pearson's correlations. Prognostic indices based on sonographical parameters were retrospectively evaluated by using receiver operating characteristic (ROC) curve. The area under the ROC curve (AUC) and first derivate of the ROC curve corresponding to the best parameter were determined. All statistical analysis was performed by using commercially available software (SPSS 16.0).

Results

Out of the 230, only 190 patients were included in our study. The mean age was 29.6 ± 9.38 years, with an age range from 18-40 years. Most patients delivered at term and mean gestational age at delivery was 38.02 ± 2.2 weeks (Range 36-42.5 weeks).
As there was a significant degree of overlap between the parameters, patients were divided into two groups. Patients whose baby birth weight was more or equal to 2500 grams were put into group A (n=161) and patients who had baby birth weight less than 2500 grams on follow-up (n=29) were put in group B.

In group A: The mean umbilical cord diameter was 12.82 mm ± 2.19mm. Mean cross sectional area was 103.58 mm^2 ± 32.78mm^2. The mean birth weight was 2826.34 ± 184.42 Grams. Mean APGAR score was 8.291 ± 0.49

In group B : The mean umbilical cord diameter was 6.20 ± 1.18mm. Mean cross sectional area was 39.28 ± 16.82mm^2. The mean birth weight was 2100.69 ± 201.96 Grams. Mean APGAR score was 6.28 ± 1.69. Results are depicted in the (Tab. 1)

	Umbilical Cord thickness	Cross Sectional Area	Birth Weight	Apgar Score
Group A	12.82 ± 2.19mm	103.58 ± 2.78mm^2	2826.34 ± 184.42 Grams	8.29 ± 1.49
Group B	6.20 ± 1.18mm	39.28 ± 16.82mm^2	2100.69 ± 201.96 Grams	6.28 ± 1.69
	p< 0.001	p< 0.001	p< 0.001	p< 0.001

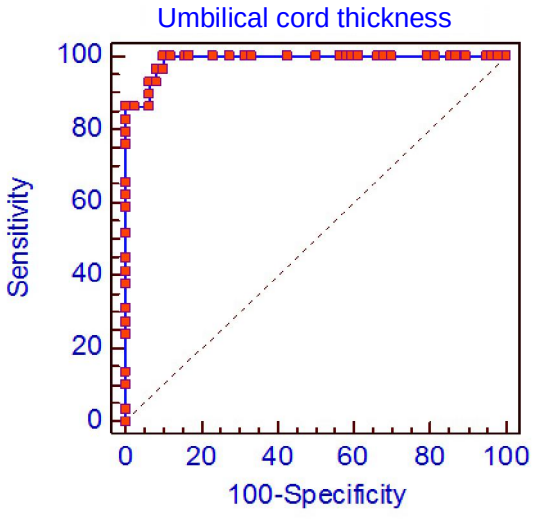
Table 1: Mean parameters GROUP A and GROUP B.

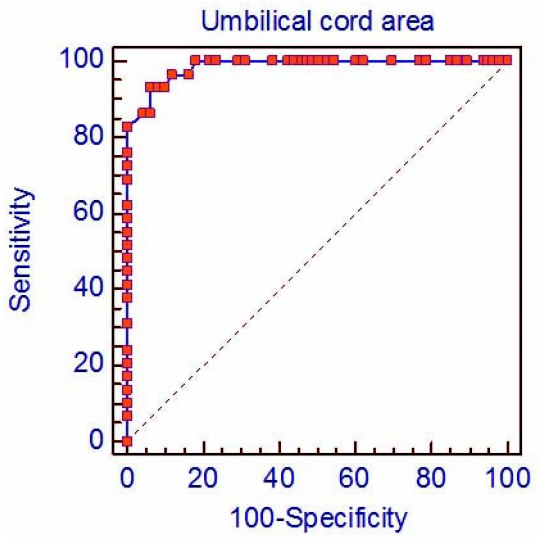
Statistically there was a significant correlation for all these parameters in group A and group B with a p value of <0.001. Using the Pearson correlation test, we found statistically significant correlation between birth weight and umbilical cord thickness (table value 0.134, Pearson's r=0.613), umbilical cord cross-sectional area (table value 0.134, Pearson's r=0.513). Umbilical cord thickness (table value 0.134, Pearson's r=0.35), umbilical cord cross-sectional area (table value 0.134, Pearson's r=0.298), also shown statistically significant correlation with 5-min APGAR scores.

ROC (Receiver operating characteristic curve analysis)

As there was a significant degree of overlap between the parameters, ROC analysis was performed and sensitivity and specificity were calculated for umbilical cord cross sectional area and umbilical cord thickness.

ROC CURVE





Parameters	AUC	Optimal Threshold	Sensitivity	Specificity
Umbilical cord cross sectional area	0.98	66	93.1%	93.7%
Umbilical cord thickness	0.98	9.8	100	90

Table 2 : Summary of Parameters based on ROC Analysis (AUC: Area under curve)

This showed that the optimal threshold for umbilical cord area was 66 mm^2 with area under curve equal to 0.98 and sensitivity of 93.1%, specificity of 93.7%. Optimal threshold for umbilical cord thickness was 9.8 mm with an area under curve of 0.98. This had a sensitivity of 100% and specificity of 90%.

Unpaired t test and pearson correlation test were performed to see the correlation of these parameters with pregnancy outcome. Umbilical cord diameter and umbilical cord were significantly related to birth weight and APGAR score.

Discussion

Though we recognize the umbilical cord importance, unfortunately we usually assess only one of the many umbilical cord features i.e. the number of the cord vessels. This is routine part of the second trimester fetal anatomic survey. Any other umbilical abnormalities e.g. cystic changes, or abnormal cord thickness and/or twisting are usually described as an incidental finding. The analysis of the umbilical cord blood flow has been found to be clinically useful. The pulsed Doppler analysis of the umbilical cord artery and its resistance to blood flow is indirectly used to assess placental function. The rest of the umbilical cord features are considered as investigational and largely ignored, though some evidence exist that cord thickness and amount of Wharton's jelly, excessiveness or lack of cord coiling and umbilical vein blood flow patterns, could be useful in evaluation of various clinically adverse ante- and perinatal events.

The goal of present study was to evaluate prognostic significance of Sonographic measurements of umbilical cord thickness and area in patients of pregnancy and their relation to pregnancy outcome and assess their prognostic significance.

It is believed that Wharton's jelly protects the umbilical cord vessels and so a reduction in its amount - due to extracellular dehydration or due to reduction in extracellular matrix - may predispose these vessels to compression or bending.[6] The present study is in agreement with previous researches that have shown association between umbilical cord thickness or cross sectional area with IUGR, LBW, or meconium staining.[6,9,10]

In our study we found that the umbilical cord diameter and umbilical cord cross sectional area measured at 20-24 weeks of pregnancy have shown statistically significant association with birth weight and APGAR score which are in concordance to previous studies. Reduction in wall thickness of the umbilical cord arteries and vein has been found in intrauterine growth retardation (IUGR) infants with abnormal umbilical artery flow as compared to IUGR infants without increased umbilical artery resistance.[11] So it can be concluded that reduction in umbilical cord thickness and diameter can compromise fetal growth. Furthermore Appiahetal[12] has concluded that a normal cord must have length in the range of 40-70 cm, a diameter range of 1.0 to 2.0 cm and umbilical coiling index in the range of 0.08-0.19 coils/cm.

A variety of nomograms for sonographic measurements of umbilical cord diameter (UCD) over gestation have been developed.[1,3,4,13] There is mounting evidence that the sonographic characteristics of the umbilical cord may be useful in predicting adverse perinatal outcomes, including fetal aneuploidy, macrosomy, growth restriction, fetal heart rate disturbances, intrauterine demise and preeclampsia.[1,14-19]

However, optimal threshold for umbilical cord diameter has not been established, which would be a easy and useful tool for the physicians specially in rural areas for monitoring of pregnancy.

In our study, ROC curve analysis showed that the optimal threshold for umbilical cord diameter was > 66 mm^2. Optimal threshold for umbilical cord thickness was > 9.8mm. There has been no study to our knowledge which has determined optimal threshold of these parameters for discrimination of IUGR.

Based on these results we propose that any patient with pregnancy in gestational age of 20-24 weeks, showing umbilical cord diameter > 66 mm^2 and umbilical cord thickness > 9.8 mm would be associated with good pregnancy outcome.

Hence we propose, the sonographic parameters (umbilical cord diameter, cross sectional area) measured between 20-24 weeks of gestation are good prognostic tool, for pregnancy outcome Because of that, it makes sense, that, when doing an ultrasound study of women with pregnancy, we should check the umbilical cord diameter & cross sectional area. It just adds may be another 5 or 10 minutes to the (ultrasound) study however there are useful predictor of pregnancy outcome. Sonographic finding of a lean umbilical cord gestation should prompt the physician for close watch of pregnancy.

Conclusion

Grey scale ultrasound, performed in pregnant patients in gestational age of 20-24 weeks is a valuable diagnostic and prognostic tool. Umbilical cord thickness and cross-sectional area are easy to measure in a free loop of umbilical cord and both are significantly correlated with LBW. Parameters derived from grey scale ultrasound can qualitatively describe the pregnancy outcome and can identify fetus at risk. Based on our results, propose that any patient with pregnancy in gestational age of 20-24 weeks, showing umbilical cord diameter > 66 mm^2 and umbilical cord thickness > 9.8 mm would be associated with good pregnancy outcome. In view of the advantages of grey scale ultrasound related to its accessibility, feasibility as well as to the rapidity of data acquisition, measurement of umbilical cord thickness and area can be easily included in routine antenatal assessment of patients.

Conflict of Interest: Authors declare no financial or institutional conflict of interest.

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