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Research Article

"Coils & Kinks": A Novel Technique to Evaluate the Perinatal Outcome

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Abstract

Aims & Objectives: 1. To evaluate the relationship of sonographic measurements of umbilical cord thickness, cross sectional area and coiling index in the second trimester (18 to 24 weeks) with perinatal outcome.

2. In future it can be adopted as a predictor for congenital anomalies, preterm labour, low birth weight, Intra-uterine growth restriction, small for gestational age and intra uterine death.

Material and methods: This study was conducted on 100 pregnant women visiting the obstetric outpatient department at P.B.M hospital, Bikaner, Rajasthan during the period of November 2016 to November 2017, for antenatal check-up and scheduled to deliver in the same hospital. The umbilical cord thickness, cross sectional area and antenatal coiling index were studied by ultrasonography during 18-24 weeks of gestation at the time of anomaly scan. The study to assess the relationship between these parameters and perinatal outcome in relation to gestational age at the time of delivery, mode of delivery, birth weight of the baby, APGAR score, meconium stained amniotic fluid(MSAF) and NICU admission of the baby was carried out and statistically compared.

Conclusion: Hypocoiled cords are associated with spontaneous preterm labor and low birth weights while hypercoiled cords are associated with MSAF. The umbilical cord thickness and cross sectional area are also associated with preterm labor, low birth weights and NICU admission of the baby.

Keywords: Coiling; Ultrasound; Umbilical; Surface thickness

Introduction

The umbilical cord is the life line of the fetus as it provides the nutrients, oxygen and fluids necessary for life in utero. The protection of the cord is provided by the Wharton's jelly, the amniotic fluid and the helical pattern or the coiling of the umbilical vessels [1]. The cord and its constituent's tissues, an outer layer of amnion, porous Wharton's jelly, two arteries and one vein are designed to provide and maintain blood flow to the developing fetus. Cord represents the most vulnerable link between the fetus and the mother, since it lies freely in the amniotic fluid and may be easily damaged [2].

Coiling makes the umbilical cord flexible, strong and at the same time provides resistance to external forces that could compromise blood flow to the fetus [3], coiling property of the umbilical cord was first described by Berengarius in 1521 [4] in 1954, umbilical coiling was first quantified by Edmonds. He divided the total number of coils by the umbilical cord length in centimeters and called it "the index of twist". He suggested positive and negative scores to clockwise and anticlockwise coiling respectively [5] later, Strong et al. simplified these by eliminating directional scores and named it "the umbilical cord coiling index" [6].

Hypocoiled cords are mainly associated with increased incidence of structural and chromosomal abnormalities, fetal anomalies, abnormal insertion, intrauterine death, preterm delivery, operative delivery for fetal distress and low APGAR score which marks the underlying intrinsic abnormal development and increased risk of acute reduction in blood flow due to kinking (Figure 1).

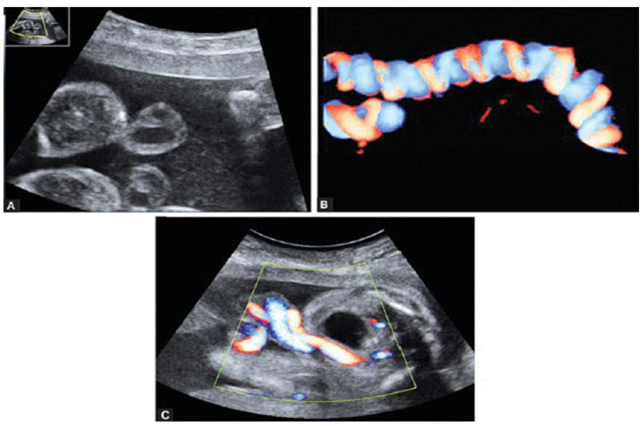

Figure 1: Shows three transabdominal USG images (A-C) depicting, A- tranverse section of the triple vessel cord, B- colour doppler of the cord in longitudnal section & C- the insertion of the cord into the abdominal wall.

Hypercoiling of the cord (Figures 1 and 2) was also associated with IUGR, intrapartum fetal acidosis and asphyxia, vascular thrombosis and cord stenosis by predisposing to compression mediated flow reduction and possible predisposition to development of fetoplacental vascular thrombosis. Thus it appears that presence of abnormal coiling indicates a chronic state established in early gestation that may have acute and chronic effects on the fetus [7].

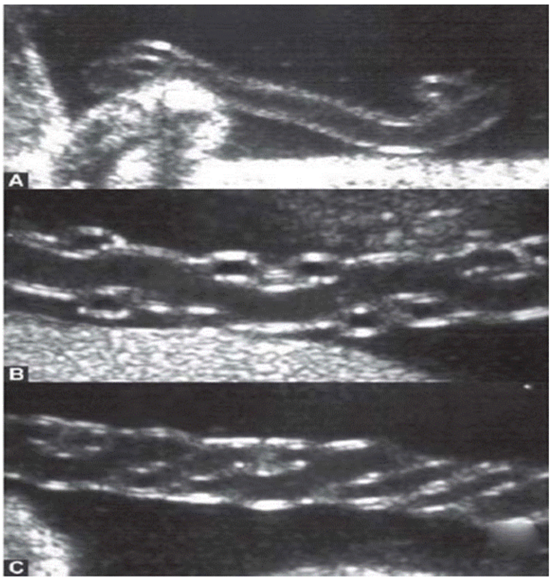

Figure 2: Shows three transabdominal USG images (A-C) depicting, A- hypocoiled cord, B- normocoiled cord & C- hypercoiled cord. The detection of umbilical cord cross sectional area <10^{th} percentile in 2^{nd} trimester was associated with 12 fold increased risk of subsequent delivery of small for gestational infants.

An association between the small diameter of the umbilical cord and the presence of oligohydroamnios, meconium stained amniotic fluid or both or without low APGAR scores are found [8] marked segmental thinning of the umbilical cord vessels is an infrequent finding of undetermined origin. Its significance may be associated with increased congenital anomalies and perinatal problems [9].

Subject and Methods

The present prospective observational study was conducted in Prince Bijey Singh memorial hospital (P.B.M), Bikaner, Rajasthan to correlate the antenatal assessment of the umbilical cord thickness, cross sectional area and coiling index at 18-24 weeks of gestation and perinatal outcome in relation to gestational age at the time of delivery, mode of delivery [10], birth weight of the baby, APGAR score, MSAF and NICU admission of the baby.

Study design : prospective observational study

Study period : November 2016 to November 2017

Statistical method : t test

The present study is conducted on 100 pregnant women referred to the department of Radiodiagnosis, outpatient department for antenatal assessment between 18-24 weeks from the department of Obstetrics and scheduled to deliver at P.B.M hospital, Bikaner, Rajasthan between November 2016 to November 2017.

Method of collection of data

All booked consenting pregnant women attending the Radiodiagnosis OPD for regular antenatal fetal surveillance between 18-24 weeks were included in the study after obtaining clearance by the ethical committee with the attached SARDAR PATEL MEDICAL COLLEGE, BIKANER, RAJASTHAN. All sonographic examination were performed by a single sonographer using standard USG machine with color Doppler (GE LOGIQ P5) and convex transducer of 3.5 to 5.0 MHz at their respective time of study.

Inclusion criteria

1. Singleton pregnancy irrespective of parity.
2. Reliable gestational age between 18-24 weeks at the time of sonography.
3. Normal amniotic fluid.
4. Presence of three vesseled umbilical cord.

Exclusion criteria

1. Multiple pregnancy.
2. Fetal congenital anomaly.
3. Maternal complications like diabetes mellitus, hypertension that could interfere with fetal growth.
4. If the patient could not be followed till delivery for any reason.
5. Any umbilical cord or placental anomaly.
6. Inadequate longitudinal image of the cord to allow accurate coiling index measurement and inappropriate cross sectional image of the fetal abdomen.

Technique of assessment of Antenatal Umbilical cord coiling index (aUCI)

An aUCI is determined as a reciprocal value of the distance between the two umbilical coils. The distance between the pair of coils is measured by placing the calipers along the ipsilateral side of the cord without crossing or measuring the distance in the middle of the cord (Figure 3). If the cord is significantly curved, it should be traced along the outer edge of the cord like the measurement of the cervical length in curved cervices. This would provide a means to standardize the antenatal ultrasound measurement of the umbilical cord coiling [10].

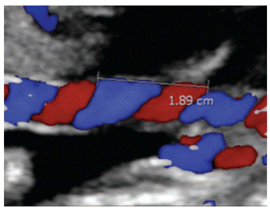

Figure 3: shows the measurement technique of antenatal umbilical coiling index (a UCI) with doppler shown as above.

To measure the cord thickness, the measurement calipers were placed at the outer edges of the umbilical cord and measured. The cross-sectional area was measured by encircling the outer edge of the

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cord in transverse section (Figure 4). The coiling index was measured in the free floating mid segment of the cord as fixed ends are not representative of coiling pattern of most of the cord and free-floating loop is the part which is most vulnerable to kinking and compression (Figure 5).

The distance between the coils was measured from the inner edge of an arterial or venous wall to the outer edge of the next coil along the ipsilateral side of the umbilical cord to obtain the coiling index [11-25]. Each patient is included only once in the study.

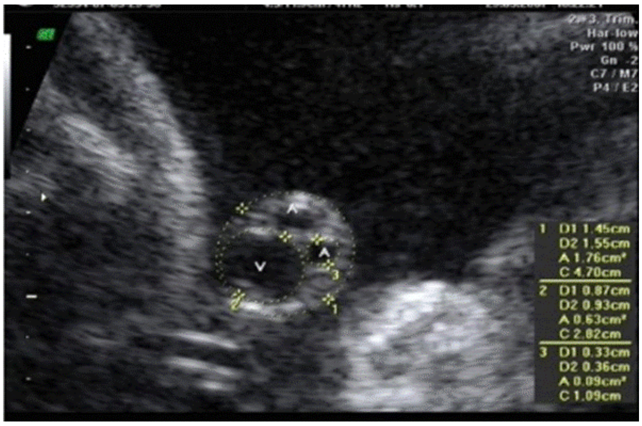


Figure 4: Shows a transabdominal image on USG of an umbilical cord showing the cross sectional area measurement technique antenatally (in yellow calipers).

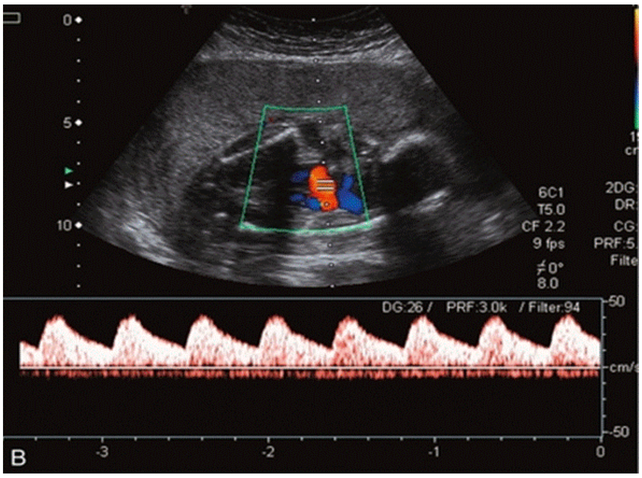


Figure 5: Shows a transabdominal USG image depicting the umbilical arterial and venous waveforms consistently being normal in a 16 week old fetus.

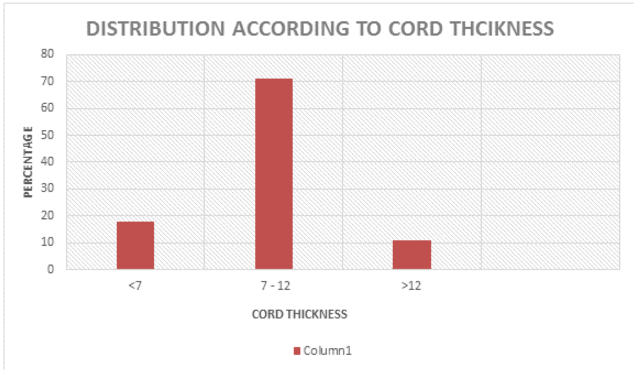
Results

100 women who fulfilled the inclusion criteria were taken in the study. The umbilical cord thickness, cross sectional area and coiling index were calculated during 18-24 weeks of gestation and women were followed till delivery and the perinatal outcome was correlated with regards to gestational age at delivery, mode of delivery, birth weight, APGAR score at 1st and 5th minute, presence of MSAF and NICU admission of the baby [26,27].

The women included in the study were in the age group of 18-40 years. Majority of the women were in the age group of 20-30 (88%), mean age group being 22.78 ± 3.36 years. There was no statistical significance (Table 1 and Graph 1).

	No. of patients	%
<7	18	18
07-Dec	71	71
>12	11	11
Mean ± SD : 8.89 ± 2.14		

Table 1: Distribution according to cord thickness.



Graph 1: Distribution according to cord thickness. The number of patients with umbilical cord thickness <7 mm are 18 (18%), those between 7-12 mm are 71 (71%) and cord thickness ≥ 12 mm are 11 (11%).

Out of the 100 patients, 56% women were primigravida and 44% are multigravida.

The cord thickness of less than 7 mm was observed in 18%, between 7-12 mm it was observed in 71% and more than 12 mm of cord thickness was observed in 11%. The mean cord thickness being 8.81 ± 2.14 mm, (Table 2 and Graph 2) which correlates with the study conducted by Morteza Tahamasebi and Aligambari R (10.54 mm) [9,28].

Cross sectional area in mm^2	No. of patients	%
<20	17	17
20-30	47	47
≥ 30	36	36
Mean ± SD :25.03 ± 7.48		

Table 2: Distribution according to cross sectional area of cord.

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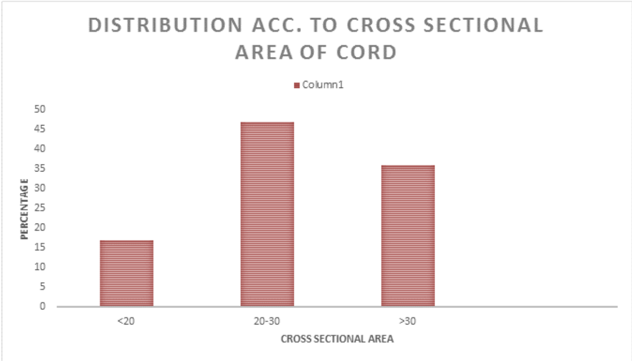


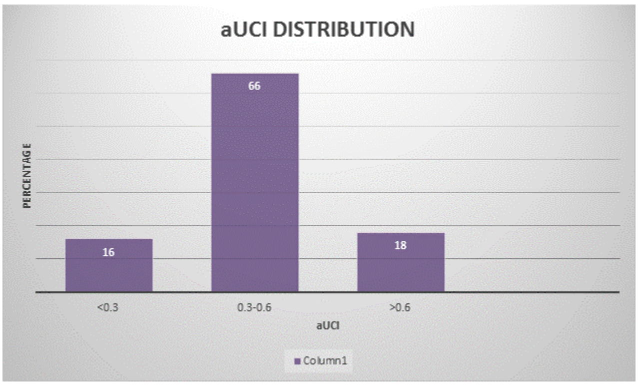
Graph 2: Distribution according to cross sectional area of cord. The cross sectional area of the umbilical cord less than 20 mm^2 is seen in 17 (17%) ; those between 20-30 mm^2 is seen in 47 (47%) and more than 30 mm^2 in 36 (36%) patients [29,30].

The cross sectional area of the umbilical cord was less than 20mm^2 in 17%, between 20-30 mm^2 in 47% and more than 30 mm^2 in 36% (Table 3 and Graph 3). The mean cross sectional area in our study is 25.03 ± 7.48 mm^2.

This correlates with the study conducted by Degani et al. (29 ± 5 mm^2) [8].

aUCI	No. of patients	%
<0.3	16	16
0.3-0.6	66	66
>0.6	18	18
Mean ± S.D : 0.44 ± 0.15		

Table 3: aUCI distribution.



Graph 3: aUCI distribution. aUCI of less than 0.3 is present in 16(16%) patients; between 0.3to 0.6 in 66 (66%) patients and more than 0.6 is present in 18 (18%) patients.

In our study, aUCI <0.3 was present in 16%, 0.3-0.6 in 66% and more than 0.6 in 18%. The mean aUCI was 0.44 ± 0.15. It was similar to the studies conducted by Morteza Tahamasebi [9], Aligambari R and Sharma et al. [1].

Out of the 100 patients studied 10% were hypocoiled, 11% hypercoiled and 79% patients were normocoiled (Figures 1 and 2). Out of several similar studies, the coiling distribution in our studies correlates with the study by Sharma, et al. [1].

In our study, 6% patients delivered before 37 weeks of gestation, 78% women delivered at term (37-40 weeks of gestation) and 16% patients delivered between 40-41 weeks.

The mean cord thickness in the preterm delivered patients is 6.33 ± 1.51 mm while in term delivery patients it is 9.05 ± 2.07 mm. The p value is 0.002 and there is a statistically significant correlation between the cord thickness and preterm delivery. Thin cords are associated with preterm delivery.

The mean cross sectional area of the umbilical cord in patients delivered preterm is 17.67 ± 7.23 mm^2 while in the term delivery patient it is 22.50 ± 7.28 mm^2 and the p value is 0.012. So there is a statistically significant correlation between the umbilical cord cross sectional area and gestational age at delivery.

As the cord cross sectional area reduces there is increased risk of preterm delivery (Table 4, Graph 4).

Variables	NICU		TOTAL	P VALUE
	NO	YES		
Cord thickness	9.07 ± 2.05	6.88 ± 2.17	8.89 ± 2.14	0.005
Cross sectional area	25.86 ± 6.91	15.50 ± 7.58	25.03 ± 7.48	<0.001
aUCI	0.44 ± 0.15	0.41 ± 0.22	0.44 ± 0.15	0.556

Table 4: Comparison of cord thickness, cross sectional area and aUCI in relation to NICU admission.

Pre term delivery was present in 20% of the hypocoiled women and 5.15% of the normocoiled women. No preterm delivery was observed in the hypercoiled group. The mean aUCI is 0.31 ± 0.15 in preterm patients and 0.45 ± 0.15 in term patients.

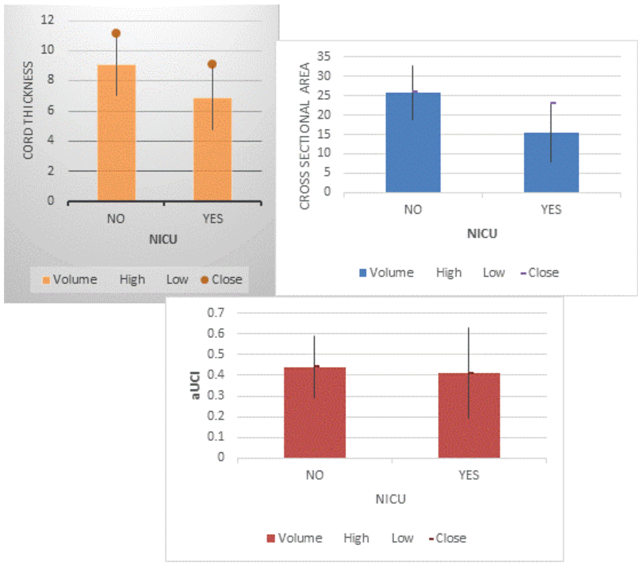
There was a statistically significant correlation between the hypocoiled cords and preterm delivery, the p value being 0.035. Thus hypocoiled cords were associated with preterm delivery.

In all these studies there is a significant correlation between Hypocoiling and preterm delivery. Our study correlates with the study by Chitra T.17

In the study conducted by Sharma et al. [1] to know the association of umbilical coiling index and perinatal outcome, Hypocoiling was observed in 15.67% cases and was associated with spontaneous preterm delivery (47.87%) with p value less than 0.001. Hypercoiling was also associated with spontaneous preterm delivery in 65.38%, but in our study no preterm delivery was seen in hypercoiled group.

The study by Sung, Dong and Guisera [16] in 226 patients, hypocoiled cords were present in 8.9% patients. The incidence of preterm deliveries in hypocoiled group was significantly greater than the normocoiled group. In this study the preterm delivery in the hypocoiled group was 36.4%, in the normocoiled group 7.7% and 16.7% in the hypercoiled group.

Thus preterm deliveries are significantly associated with Hypocoiling of the cord with a p value of 0.041.



Graph 4: Comparison of cord thickness, cross sectional area and aUCI in relation to NICU admission. Cord thickness of less than 7 mm and cross sectional area of the cord has a statistically significant relation with NICU admissions. p value being 0.005 and 0.001 but aUCI has no statistical correlation with NICU admissions. p value being 0.556.

In the study by [18]. Hypercoiling was present in 11.7% cases and preterm delivery was observed in 20.2% cases. This study also proved a statistically significant correlation between Hypocoiling and the preterm delivery with p value of 0.004.

In another study by [13] on umbilical cord coiling index in normal and complicated pregnancy, Hypocoiling of the cord was associated with spontaneous preterm delivery (OR 2.16, 95% C.I: 1.34-3.48)

In the present study out of the 100 babies 20 had a meconium stained amniotic fluid and 80 had clear amniotic fluid. Of the 20 babies with MSAF, 10% had an umbilical cord thickness less than 7mm, 85% between 7-12 mm and 5% had more than 12 mm. p value being 0.834 there was no statistical correlation between the cord thickness and the MSAF (Table 5, Graph 5).

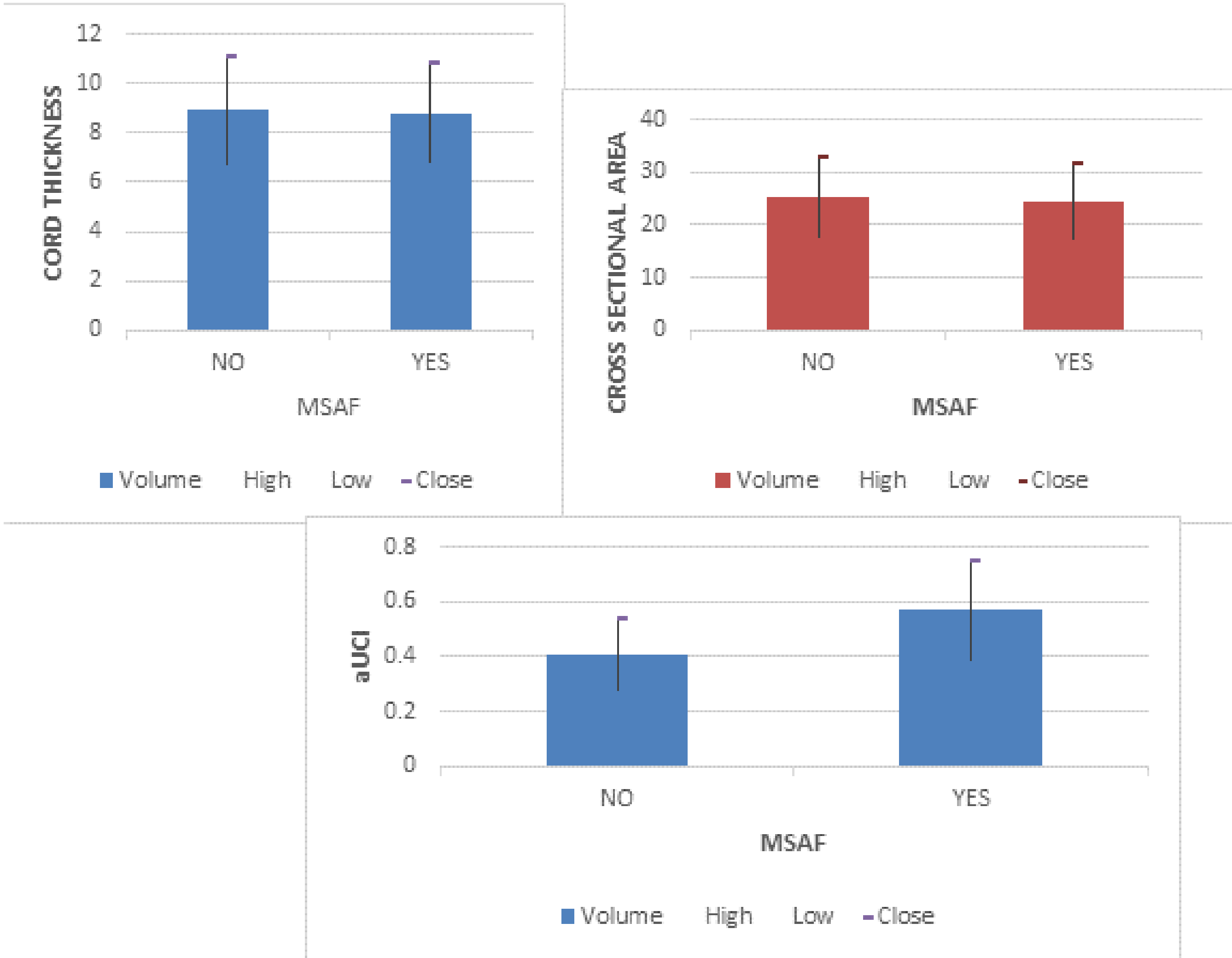
Cross sectional area of less than 20 mm^2 was present in 15% of the babies with MSAF, 50% babies had between 20-30 mm^2 and more than 30 mm^2 in 35% patient. The p value was 0.700. There was no statistically significant correlation between umbilical cord cross sectional area and the MSAF (Table 6, Graph 6). Out of the 20 babies 12.7% were normocoiled and 72.7% were hypercoiled. The p value was 0.001. Thus, there was a statistically significant correlation between MSAF and aUCI. Hypercoiling cord are prone for MSAF.

Variables	**MSAF**		**TOTAL**	**P VALUE**
	NO	YES		
Cord thickness	8.91 ± 2.18	8.80 ± 1.99	8.89 ± 2.14	0.834
Cross sectional area	25.18 ± 7.57	24.45 ± 7.29	25.03 ± 7.48	<0.700
aUCI	0.41 ± 0.13	0.57 ± 0.18	0.44 ± 0.15	<0.001**

Table 5: Comparison of cord thickness, cross sectional area and aUCI in relation to MSAF.

Variables	Birth weight (kg)		TOTAL	P VALUE
	<2.5	>2.5		
Cord thickness	6.19 ± 0.91	9.40 ± 1.90	8.89 ± 2.14	<0.001**
Cross sectional area	11.88 ± 6.26	27.54 ± 4.47	25.03 ± 7.48	<0.001**
aUCI	0.28 ± 0.16	0.47 ± 0.13	0.44 ± 0.15	<0.001**

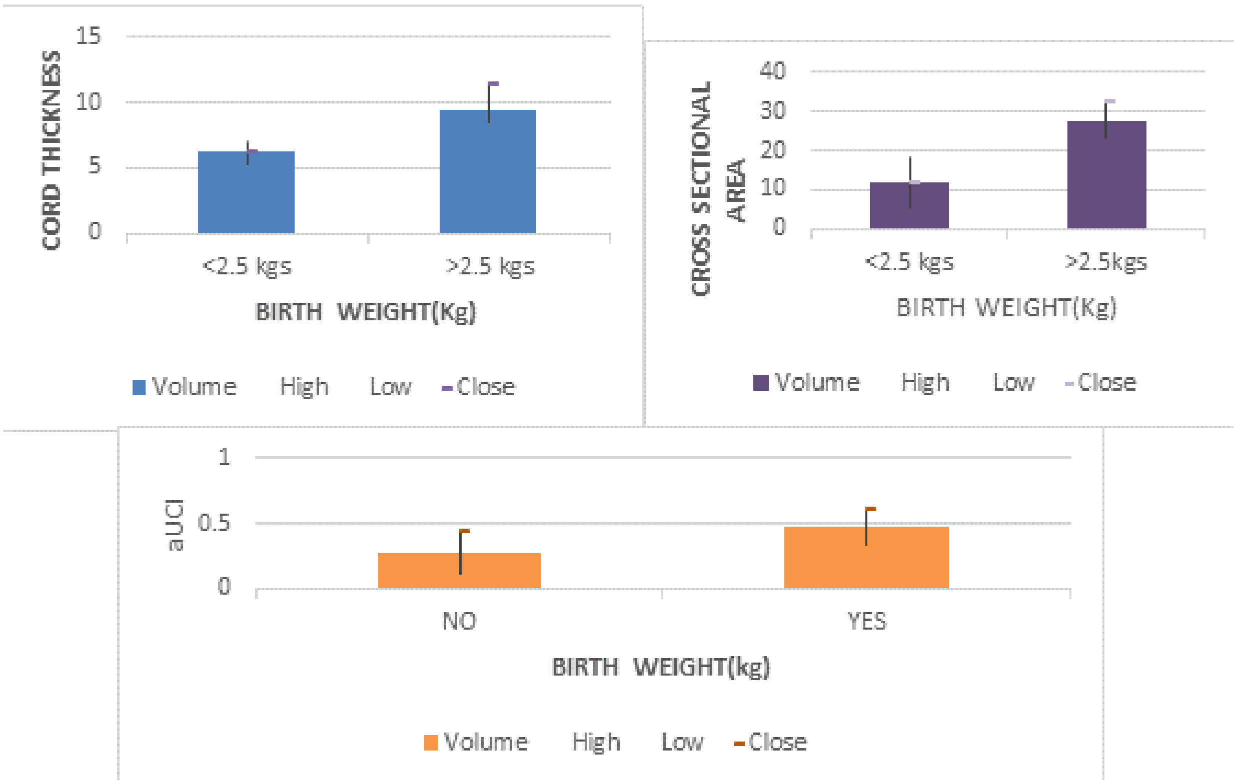
Table 6: Comparison of cord thickness, cross sectional area and aUCI in relation to birth weight (kg).



Graph 5: Comparison of cord thickness, cross sectional area and aUCI in relation to MSAF. Cord thickness and cross sectional area has no statistical correlation with MSAF. But hypercoiled cord has a statistically significant correlation with MSAF. P value being <0.001.

Variables	Mode of delivery			P VALUE
	FTND/PTVD	LSCS	TOTAL	
Cord thickness	8.56 ± 2.07	9.33 ± 2.17	8.89 ± 2.14	<0.076
Cross sectional area	24.91 ± 7.56	25.19 ± 7.46	25.03 ± 7.48	<0.857
aUCI	0.42 ± 0.15	0.46 ± 0.16	0.44 ± 0.15	<0.217

Table 7: Comparison of cord thickness, cross sectional area area and aUCI in relation to mode of delivery.

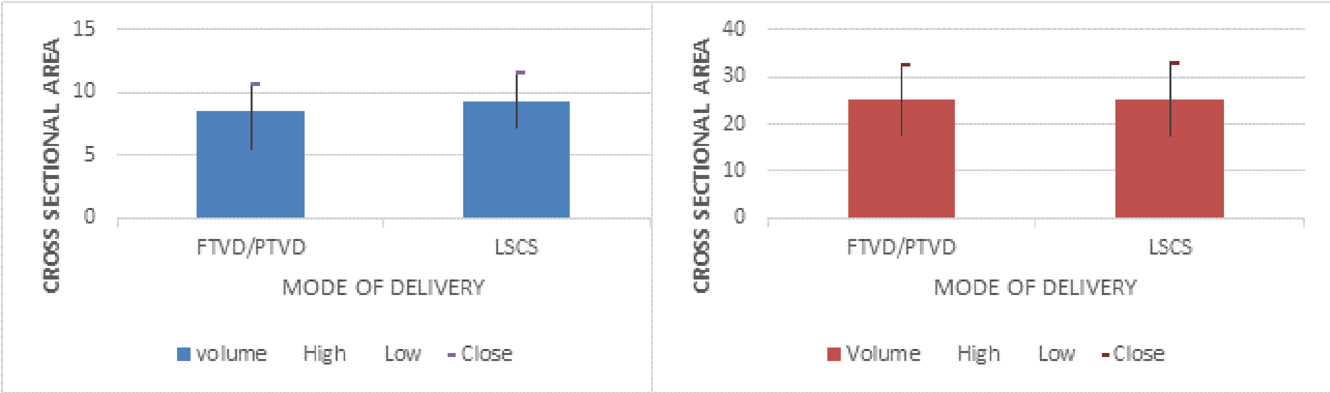


Graph 6: Comparison of cord thickness, cross sectional area and aUCI in relation to birth weight (kg). Umbilical cord thickness, cross sectional area and aUCI all have statistically significant correlation with birth weight. p values being <0.001 for all the three.

Out of the 100 babies in the present study, 8 babies had NICU admission. The mean cord thickness of the babies in NICU was 6.88 ± 2.17 mm whereas the mean cord thickness for the rest of the babies was 9.07 ± 2.05 mm, the p value is 0.005.

The mean cross-sectional area of the cord for NICU admitted babies was 15.50 ± 7.58 mm^2 whereas for the babies which did not require the NICU admission it was 25.86 ± 6.91 mm^2, the p value was less than 0.001.

Thus, there was a statistically significant correlation between the umbilical cord cross sectional area and the NICU admission of the baby. The mean aUCI in the babies admitted to NICU was 0.44 ± 0.15 and for other babies it was 0.41 ± 0.22. The p value was 0.556 (Table 7, Graph 7).



Graph 7: Comparison of cord thickness, cross sectional area area and aUCI in relation to mode of delivery. Cord thickness, cross sectional area and aUCI has no correlation with mode of delivery. p value being 0.076,0.857,0.217 respectively.

Thus, there was no statistically significant correlation between the abnormal aUCI and the NICU admission of the baby.

Conclusion

The Hypocoiling of the cord i.e., aUCI less than 10th percentile is associated with the increased rates of spontaneous preterm labor and LBW of the baby. The Hypercoiling of the cord i.e., aUCI more than 90th percentile is associated with the increased incidence of the meconium stained amniotic fluid.

The lean cords i.e., cords with reduced cord thickness and reduced cross sectional area are significantly associated with increased incidence rates of preterm labor, LBW and increased NICU admissions.

Sonographic evaluation of the umbilical cord parameters during anomaly scan is very important but most neglected. It should be routinely performed along with other fetal parameters. Any abnormality in the umbilical cord cross sectional area, cord thickness or coiling index warrants a close monitoring of pregnancy.

Timely recognisation of any abnormality, close monitoring of pregnancy and appropriate intervention can prevent untoward complications resulting in a safe pregnancy and healthy baby.

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