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Original Research Article

Evaluation of Umbilical Coiling Index as a Predictor of Pregnancy Outcome

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ABSTRACT

Objective: The purpose of the study was to evaluate the antenatal umbilical coiling index during routine antenatal checkup in second trimester as a predictor of pregnancy outcome.
Methods: The study includes 177 pregnant women whose Umbilical cord index was calculated between 18 to 23 weeks of pregnancy as a reciprocal value of the distance between a pair of coils (antenatal UCI=1/distance in cms) and was correlated with the following pregnancy outcomes: Premature rupture of membranes (PROM), Preterm delivery, Oligohydramnios, Meconium stained amniotic fluid (MSAF),Fetal distress ,Interventional delivery for fetal distress, Intrauterine fetal Demise (IUFD). Women with complications like Diabetes Mellitus, Multiple pregnancy, or with any congenital abnormalities of the fetus were excluded from the study.
Results: The Umbilical coiling index was recorded in all pregnant women included in the study and were divided into normocoiled (normal), hypocoiled and hypercoiled .The incidence of oligohydramnios in hypocoiled group was 78.3 %(18cases) while that of meconium stained amniotic fluid was 30.5 %(7 cases) and intrauterine fetal demise was 8.7% (2 cases).Meconium stained amniotic fluid 42.8 %(6 cases), non reassuring fetal heart rate 28.5 %(4 cases) were associated with hypercoiling.
Conclusion: The abnormal UCI during the second trimester is associated with the risk of fetal distress, meconium stained amniotic fluid, interventional deliveries, oligohydramnios and intrauterine death (that is with adverse pregnancy outcomes).

Key words: Umbilical cord, coiling index; sonography; umbilical coiling

INTRODUCTION

Umbilical cord is an intraamniotic structure fixed between placenta at one end and fetus umbilicus on the other. Function of coiling of umbilical cord of foetus has remained a mystery despite of advancement of science .Some have suggested that focal coiling is a consequence, rather than a cause, of intrauterine demise, whereas others have postulated that the over coiled cord may in itself be a contributory factor to fetal death.

The phenomenon of coiling of the vessels within the umbilical cord in regular helical pattern has long been recognized, but its precise underlying causative mechanism and presumed developmental benefit remain uncertain. Focal tight twisting of the umbilical cord has been associated with a proportion of intrauterine deaths, although the clinical significance of this association has remained unclear.

Numerous investigators have recently attempted to study further the relationship between the coiling pattern of the umbilical cord and a range of pregnancy complications. Initial studies focused on the association between under coiled cords and adverse outcomes.

With ultrasound techniques being available, it enabled study of abnormalities of the cord before birth. Under the assumption that the umbilical coiling is fully developed by the end of the first trimester and does not change thereafter but, rather, that the cord lengthens between established coils, the true UCI should be predictable from the sonographic assessment in the second trimester. [1]

Ultrasonic visualization of the umbilical cord is limited in the late third trimester because of a relative lack of amniotic fluid compared to the fetal size, resulting in most measurements being made in the middle or placental regions.

During the second trimester the amount of amniotic fluid relative to fetal size is usually greater than at term, allowing visualization of a larger part of the cord. Furthermore, it is generally believed that umbilical coiling is fully developed by the end of the first trimester and does not change after this, the cord growing continually by lengthening between coils rather than by generation of new coils. [2]

Aim of the study is to evaluate the Ultrasonographic Umbilical Coiling Index (UUCI) as a predictor of pregnancy outcome.

Objective

To measure the umbilical coiling index prenatally at 18-23 weeks.

Study the association of hypocoiling, normocoiling and hypercoiling with perinatal outcome.

MATERIALS & METHODS

Prospective study, conducted between August 2012 to August 2014, in the Department of Radiodiagnosis, Krishna institute of Medical sciences, Karad. Umbilical cord coiling of 210 antenatal women was evaluated between 18 and 23 weeks of gestation.

Out of a total of 210 antenatal women that were recruited for the study 21 were lost for follow up and 12 had not delivered as of August 30, 2014, hence their out-come variables could not be studied and were excluded from further analysis. Singleton gestation, Reliable gestational age (that is more than 18 weeks at the time of sonography, Normal amniotic fluid index (8-24cm) were included in the study and mothers with Multiple pregnancies, presence of fetal anomalies and Maternal disorder or complication of pregnancy (e.g., diabetes mellitus, hypertension, etc.) were excluded from the study.

Ultrasound scans were performed by the same person to avoid inter-observer variation. All sonographic examinations were performed using ACUSON X300 SIEMENS Ltd with transabdominal convex transducer (2-5 MHz). Dynamic colour flow imaging was used to improve visualization of the umbilical coils.

Inclusion criteria:

1. Singleton gestation
2. Reliable gestational age (that is more than 18 weeks at the time of sonography)
3. Normal amniotic fluid index (8-24cm)

Exclusion criteria:

1. Multiple pregnancies
2. Presence of fetal anomalies.
3. Maternal disorder or complication of pregnancy (e.g., diabetes mellitus, hypertension)

The pitch of one complete vascular coil was measured by ultrasonography in a midsection of the umbilical cord. Longitudinal views of umbilical cord were obtained and the distance from the inner edge of an arterial wall to the outer edge of the next was measured [1,3] as demonstrated below.

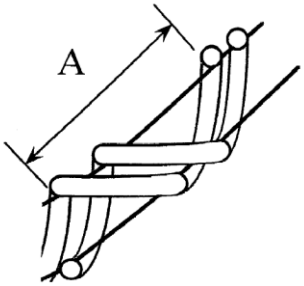


Figure1. Measurement of UCI

The Ultrasonographic Umbilical Coiling Index (UUCI) was calculated as follows:

$$\frac{1}{\text{Distance between a pair of coils (A)}}$$

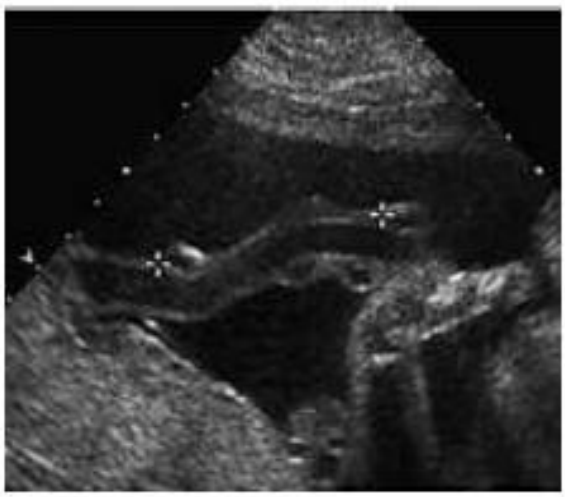


Figure2.Antenatal UCI on gray scale

Frequency distribution of UUCI was determined and based on centile values.

Hypocoiled <10th percentile
Hypercoiled >90th percentile
Normocoiled between 10th and 90th.

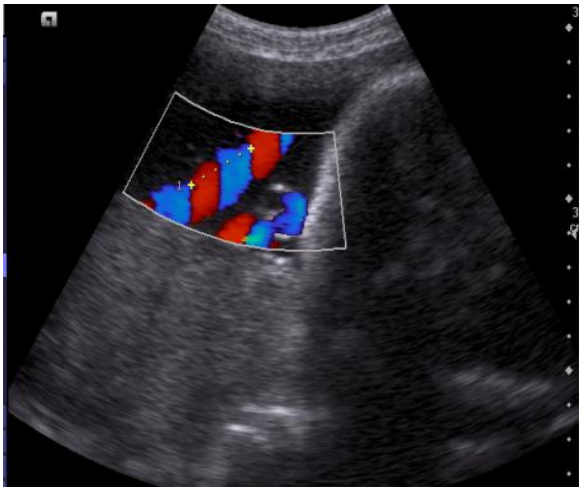


Figure3. Measurement of UUCI with Doppler imaging

Outcome variables of 177 pregnant mothers such as Premature rupture of membranes (PROM),Preterm delivery, Oligohydramnios, Meconium stained amniotic fluid (MSAF), Fetal distress, Interventional delivery for fetal distress, Intrauterine fetal Demise (IUFD), Birth weight were studied.

The excel and SPSS 14 version software packages were used for data entry and analysis. A p value of <0.05 was considered statistically significant.

RESULTS

Out of a total of 210 antenatal women that were recruited for the study 21 were lost for follow up and 12 had not delivered as of August 30, 2014, hence their out-come variables could not be studied and were excluded from further analysis.

Out of the 177 patients who were analyzed the incidence of PROM, Preterm delivery, oligohydramnios, nonreassuring FHR, meconium stained amniotic fluid, interventional delivery and intrauterine fetal demise were 13.6%, 14.1%, 22.5%, 11.2 %, 15.8 %, 38.4% and 1.7% respectively.

Table 1. Umbilical cord coiling index (n=177)

	10th percentile	90th percentile	Mean
UUCI	0.21`	0.59	0.4

Hence cases with UCI < 0.21 were categorized as hypocoiled and those with UCI> 0.59 were categorized as hypercoiled. Those between 0.21 and 0.59 were categorized as normocoiled.

Table 2. Categories of UCI (n = 177)

	UUCI	N=177	%
Hypocoiled	<0.21	23	12.99
Hypercoiled	>0.59	14	7.92
Normocoiled	0.21-0.59	140	79.09

Premature rupture of membranes was noticed in 5 (21.7%) of women with hypocoiled cords when compared to Hypercoiled (7.1%) and normocoiled (12.9%). However these differences were statistically not significant.

Table 3. Correlation between PROM and UCI (n = 177)

UUCI	No PROM	PROM	Total	P value
Hypocoiled	18(78.3%)	5 (21.7%)	23	0.2
Hypercoiled	13 (92.9%)	1 (7.1%)	14	0.4
Normocoiled	122(87.1%))	18(12.9%)	140	0.8
Total	153(86.4%)	24(13.6%)	177	

A statistically significant association was observed between oligohydramnios and hypocoiling. Oligohydramnios was present in 18 (78.3%) women with hypocoiling, when compared to women with hypercoiling (14.3%) and normocoiling cords(14.3%).

MSAF was seen in 7 (30.5 %) woman with hypocoiled cord when compared to 6 (42.08 %) in Hypercoiled and 18 (12.8 %) in normocoiled women. There

Table 4. Correlation between preterm delivery and UCI (n = 177)

UUCI	No preterm	Preterm	Total	P value
Hypocoiled	19(82.6%)	04(17.4%)	23	0.6
Hypercoiled	11 (78.6%)	03 (21.4%)	14	0.4
Normocoiled	122(87.1%)	18(12.9%)	140	0.6
Total	152(85.9%)	25(14.1%)	177	

Incidence of preterm delivery was more (21.4%) women with hypercoiling of the cords when compared to hypocoiled (17.4%) and normocoiled (12.9%) cords but these differences were statistically not significant.

Table5.Correlation between oligohydramnios and UCI (n =177)

UUCI	Normal liquor	Oligohydramnios	Total	P value
Hypocoiled	5(21.7%)	18 (78.3%)	23	0.01
Hypercoiled	12 (85.7%)	2 (14.3%)	14	0.4
Normocoiled	120(85.7%)	20(14.3%)	140	1.2
Total	137(77.4%)	40 (22.6%)	177	

was significant association between abnormal coiling and meconium staining of the amniotic fluid.

Table 6. Correlation between MSAF and UCI (n = 177)

UUCI	Clear liquor	MSAF	Total	P value
Hypocoiled	16(69.5%)	7(30.5%)	23	0.05
Hypercoiled	8(57.2%)	6(42.8 %)	14	0.005
Normocoiled	122 (87.1%)	18(12.8%)	**140**	0.3
Total	149(84.1%)	28(15.8%)	177	

Table 7. Correlation between Fetal Heart rate and UCI (n = 177)

UUCI	Reassuring CTG	Non reassuring CTG	Total	P value
Hypocoiled	17(73.9 %)	6(26.08 %)	23	0.02
Hypercoiled	10(71.4%)	4(28.5 %)	14	0.04
Normocoiled	130(91.0%)	10(9.02%)	**140**	0.12
Total	157(88.7%)	20(11.2%)	177	

In our study non-reassuring fetal heart pattern was observed in 28.5 % of the patients with hypercoiling of the umbilical cord and 26.08 % in hypocoiling which `was more as compared to 9.02 % in normocoiling of cords. These findings were statistically significant.

Table8 . Correlation between interventional delivery for fetal distress and UCI (n=177)

UUCI	Vaginal	Caesarean	Instrumental	Total	P value
Hypocoiled	9(39.1%)	14 (60.9%)	0	23	0.04
Hypercoiled	4 (28.6%)	10(71.4%)	0	14	0.02
Normocoiled	96(68.5%)	40 (28.5%)	4 (2.9%)	140	0.16
Total	109(61.5%)	64(36.1%)	4(2.3%)	177	

In our study, the rate of interventional delivery was more with hypocoiled (60.9%) and hypercoiled (71.4%) cords when compared to that in women with normocoiled cords. These differences were statistically significant.

Table 9. Correlation between intra uterine fetal demise (IUFD) and UCI (n =177)

UUCI	Live born	IUFD	Total	P value
Hypocoiled	21(91.3%)	2 (8.7%)	23	0.009
Hypercoiled	14(100%)	0 (0%)	14	0.6
Normocoiled	139(99.3%)	1 (0.7%)	140	0.3
Total	174(98.3%)	3(1.7%)	177	

There were a total of 3 intrauterine fetal deaths, 2 of them were in the hypocoiled-group and one was in the normocoiled group. Association of hypocoiling with the intra-uterine fetal deaths was statistically significant.

Table10. Correlation between birth weight and UUCI (n =177)

UUCI	N = 177	Mean birth weight (kg)	Std. deviation
Hypocoiled	23	2.580	0.151
Hypercoiled	14	2.635	0.161
Normocoiled	140	2.822	0.181

Figure4(a). UCI= 0.27 Normocoiled

The mean birth weights in all the three umbilical coiling categories were comparable however and there was no strong association between coiling index and birth weight.

Figure 4(b). UCI= 0.27 Normocoiled

Figure 5(a). UCI=0.40 Normocoiled

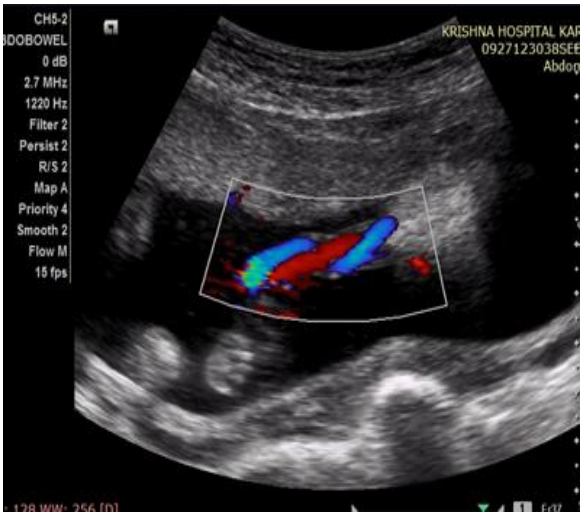


Figure 5(b). UCI=0.40 Normocoiled

Figure7(a). UCI=1.1 Hypercoiled

Figure6(a). UCI=0.66 Hypercoiled

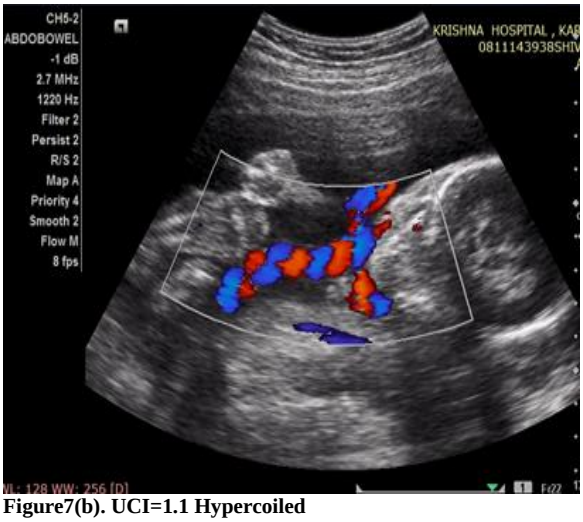


Figure7(b). UCI=1.1 Hypercoiled

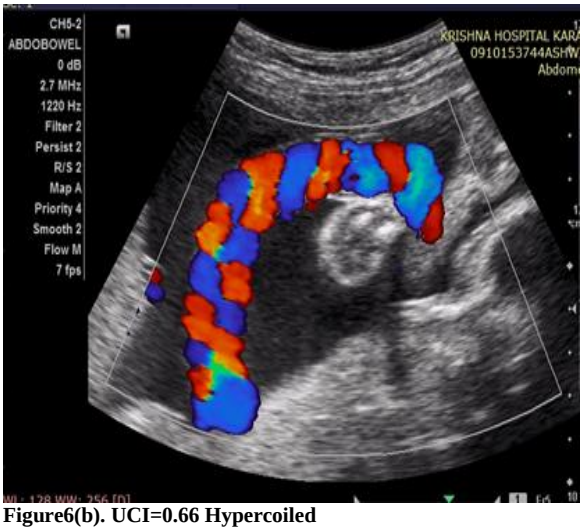


Figure6(b). UCI=0.66 Hypercoiled

Figure8(a). UCI=0.12 Hypocoiled

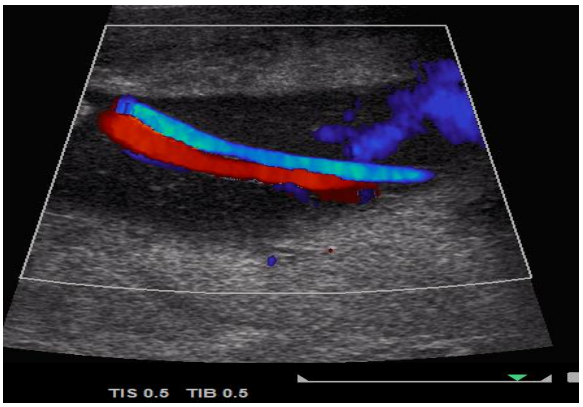
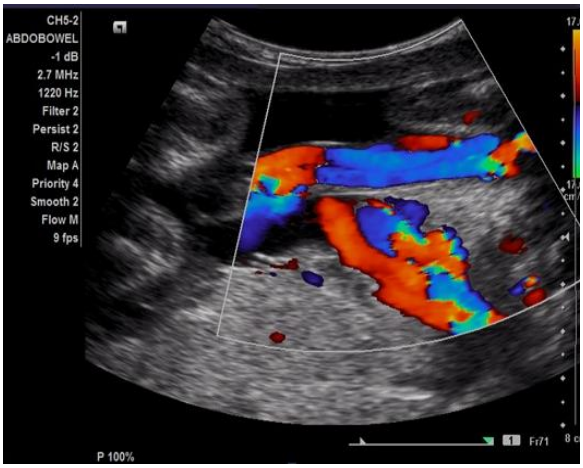


Figure8(b). UCI=0.12 Hypocoiled

Figue9(a). UCI=0.16 Hypocoiled



Figue9(b). UCI=0.16 Hypocoiled

DISCUSSION

The umbilical cord is the major fetomaternal unit that provides connection between the placenta and the fetus. However, it is prone to compression, tension, or torsion, with subsequent interruption of blood flow. [4] It is thought that coiling provides a protective effect to these forces, therefore securing an uninterrupted blood supply to the fetus.

The normal human umbilical cord contains a helix of three blood vessels: two arteries and one vein. At term the umbilical cord has an average length of 55 cm (usual range 30-100 cm). [5] The origin of this coiling is not known. The hypotheses include fetal movements, differential umbilical vascular growth rates and fetal hemodynamic forces. [4]

Under the assumption that the umbilical coiling is fully developed by the end of the first trimester and does not change thereafter but, rather, that the cord lengthens between established coils, the true UCI should be predictable from the sonographic assessment in the second trimester. [6]

In this study patients with abnormally coiled cords had more incidence of Preterm delivery which is in agreement with the study done by Strong et al, [7] De laat et al, [8] and Rana et al [9] but the result was not statistically significant. They found hypercoiled to be significantly associated with preterm .They believed that hypercoiled was an adaptive response to fetal hemodynamic changes, which initiates preterm labour on reaching a certain threshold.

Oligohydramnios was present in 18 (78.3%) women with hypocoiling, when compared to women with hypercoiling (14.3%) and normocoiling cords which was statistically significant and was consistent with Strong et al, [7] who also showed more incidence of oligohydramnios in patients with abnormal coiling pattern. It could be due to the compression or the torsional operative forces. However it is difficult to explain as to whether it is a cause or effect.

Kashanian et al. [10] found oligohydramnios to be significantly

associated with both hypocoiled and hypercoiled. In our study, oligohydramnios had a significant association with hypocoiled. This can be explained by Edmond's hypothesis which states that twist of the umbilical cord is a result of the rotary movement imparted to the embryo, and hence more is the liquor amnii, more is the rotary movement of the fetus and more will be the coiling. The converse will be true for oligohydramnios.

In our study hypocoiling was associated with increased incidence of premature rupture of membranes. Although this was statistically not significant.

Machin et al. [11] proposed that stroma in undercoiled cords may be less turgid than the normocoiled cords. This may be related to strength of the chorionic and the amniotic membranes and to the susceptibility to infection and hence to premature rupture of membranes.

In our study, mothers with hypercoiled & hypocoiled cords had more incidence of intrapartum fetal distress (FHR variation) and meconium staining of amniotic fluid and interventional deliveries and these findings were statistically significant. These results are in accordance with the findings of Di Naro et al, [12] Monique W et al. [13]

Hypocoiled and hypercoiled cords are less flexible or more prone to kinking and torsion which makes them less tolerant to withstand the stress of labour. Coiling provides turgor and compression resistant properties to the cord which become compromised as the cord becomes hypocoiled.

There were 3 cases of intrauterine fetal demise in our study, two were in the hypocoiled category and one was in normocoiled category. One of the women with IUFD in the hypocoiled category had Dengue fever at 23 weeks of gestation and was treated conservatively with supportive therapy. She presented with IUFD at 36 weeks. Dengue fever may be a chance association since the IUFD occurred much later. The other 2 women who had IUFD (one from hypocoiled and other from normocoiled category) also had oligohydramnios.

CONCLUSION

Abnormal umbilical coiling index is associated with increased adverse perinatal outcome. It may help to explain a proportion of otherwise unexplained poor perinatal outcome.

Hypocoiled cords are mainly associated with fetal distress, meconium stained amniotic fluid, interventional deliveries, oligohydramnios and intrauterine death. They are therefore likely to possibly associated with an increased risk of acute reduction in blood flow due to kinking and therefore abrupt and marked cessation of blood flow.

Hypercoiled cords are associated with the fetal distress, meconium stained amniotic fluid, interventional deliveries. That is possibly due to flow through a coiled tube that is associated with greater resistance than a straight tube.

Abbreviations

aUCI, antenatal umbilical coiling index; UCI, umbilical coiling index

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