Association of Umbilical Coiling Index by Colour Doppler Ultrasonography at 18–22 Weeks of Gestation and Perinatal Outcome

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Received: 4 September 2011 / Accepted: 14 June 2012 / Published online: 17 August 2012
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Abstract

Objective To study the association between antenatal umbilical coiling index (aUCI) and perinatal outcome.

Methods 600 primigravidas with uncomplicated singleton pregnancies had an ultrasonography between 18 and 22 weeks of gestation for aUCI by colour Doppler. The aUCI was calculated as the reciprocal of the distance between a pair of coils. It was then correlated with the following pregnancy outcomes: birth weight, mode of delivery, meconium staining of liquor, Apgar scores and gestational age. The results were statistically analysed by χ^2 -test.

Results The mean aUCI was 0.41. Undercoiling was associated with spontaneous preterm delivery (47.87 %), low Apgar score (52.13 %), LBW (52.59 %), FGR (21.28 %) and NICU admission (76.34 %). Overcoiling

was associated with preterm deliveries (65.38 %), increased caesarean sections (61.54 %), meconium staining of liquor (67.31 %), low Apgar score (63.46 %) and NICU admission (72.55 %). There was a positive strong correlation between aUCI and birth weight ($r = +0.426$)

Conclusions Abnormal coiling is strongly correlated with low birth weight.

Keywords Perinatal outcome · Low birth weight · Antenatal umbilical coiling index · Hypocoiling · Hypercoiling

Introduction

The umbilical cord is the life-line of the foetus as it supplies water, nutrients and oxygen. Protection of these blood vessels is needed and provided by Wharton's Jelly, the amniotic fluid and the helical pattern, or coiling, of the umbilical cord vessels.

The generally accepted method of assessing the degree of the umbilical cord coiling is by calculation of the Umbilical Coiling Index (UCI), defined as the number of complete coils per centimetre length of cord. Using this criterion, studies to date have been remarkably consistent in reporting of the normal UCI (Fig. 1).

Normal coiling index is approx 1 coil/5 cm of umbilical cord length. Antenatal UCI is calculated as a reciprocal value of the distance between a pair of coils measured in 'cm' from the inner edge of an arterial or venous wall to

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Fig. 1 Colour Doppler view showing normal coiling of the umbilical cord

Fig. 2 Both normal coiling and hypocoiling of different segments of the same umbilical cord on colour Doppler

the outer edge of the next coil along the ipsilateral side of the umbilical cord, the direction being from placental end to foetal end [1]. The final value is the average of three readings at three different segments of umbilical cord (Figs. 2, 3, 4).

Abnormal coiling is defined as hypocoiled (undercoiled) or hypercoiled (overcoiled) umbilical cords with corresponding coiling index values <10th or >90th percentile, respectively.

The purpose of this study was to evaluate early second trimester sonographic and Doppler detectable differences

Fig. 3 Almost straight umbilical cord on Doppler

Fig. 4 Hypercoiled cord on Doppler

in umbilical cord cross-sectional area, umbilical coiling and foeto-placental circulation of foetuses at risk of low birth weight (LBW).

Methods

This hospital-based observation study was conducted in the Department of Obstetrics and Gynaecology, Zenana Hospital, SMS Medical College, Jaipur during the year 2009–2010.

Inclusion Criteria

All booked singleton primigravidas in 2nd trimester of pregnancy without any known surgical/medical disorder.

Exclusion Criteria

Multifoetal pregnancy, multigravidas; gross foetal anomalies (congenital, lung, GI, genitourinary); inadequate demographical, antenatal/labour data; inadequate or inappropriate longitudinal image of umbilical cord to allow an accurate aUCI measurement; presence of single umbilical cord artery; any associated surgical/medical illness.

Eligible and consenting 600 women underwent a colour Doppler at 18–22 weeks of gestation to determine the antenatal UCI, and these subjects were then followed till term to note the various parameters like gestational age at delivery; mode of delivery; meconium staining of liquor; Apgar score at 5 min; and neonatal birth weight.

Gestational age at delivery was calculated by the best estimate according to menstrual history or 1st trimester ultrasonography or both. Preterm delivery was defined as a delivery before 37 completed weeks of gestation. A low Apgar score was defined as a score <7. Small for date infants and large for date infants were defined as having a birth-weight <10th percentile or >90th percentile, respectively. Meconium staining of amniotic fluid included the presence of any degree of meconium in the amniotic fluid noticed during delivery.

Table 1 Distribution according to aUCI

aUCI	Number of subjects	Percent
Normocoiled	454	75.67
Hypocoiled	94	15.67
Hypercoiled	52	8.66
Total	600	100.00

Table 2 aUCI and mode of delivery

Mode of delivery	Type of coiling			Total
	Hypocoiling	Normocoiling	Hypercoiling	
Preterm vaginal delivery	45 (47.87 %)	10 (2.20 %)	2 (3.85 %)	57 (9.50 %)
Full term vaginal delivery	24 (25.53 %)	408 (89.87 %)	18 (34.61 %)	450 (75.00 %)
Lower segment caesarean section	25 (26.60 %)	36 (7.93 %)	32 (61.54 %)	93 (15.50 %)
Total	94 (100.00 %)	454 (100.00 %)	52 (100.00 %)	600 (100.00 %)

Table 3 aUCI and colour of liquor

Colour of liquor	Type of coiling			Total
	Hypocoiling	Normocoiling	Hypercoiling	
Clear	69 (73.40 %)	415 (91.41 %)	17 (32.69 %)	501 (83.50 %)
Meconium	25 (26.60 %)	39 (8.59 %)	35 (67.31 %)	99 (16.50 %)
Total	94 (100.00 %)	454 (100.00 %)	52 (100.00 %)	600 (100.00 %)

$\chi^2 = 136.400$, $df = 2$, $p < 0.001$, HS

Results

The mean aUCI in the present study was 0.41 ± 0.30 in the normocoiled group, 0.19 ± 0.4 in the hypocoiled group and 0.54 ± 0.05 in the hypercoiled group. 454 (75.67 %) of the subjects had normal coiling index, 94 (15.67 %) had hypocoiling and 52 (8.66 %) had hypercoiling (Table 1).

The number of preterm deliveries was significantly greater in both hypocoiled 45 (47.87 %) and hypercoiled 2 (3.85 %) as compared with normocoiled group 10 (2.20 %), $p < 0.001$ (Table 2).

Meconium staining of liquor was significantly high in hypercoiled group than normocoiled group [67.31 vs. 8.59 % ($p < 0.001$)] (Table 3).

This finding directly explains the rate of LSCS which was again significantly high in hypercoiled group as compared with normocoiled group [61.54 vs. 7.93 % ($p < 0.001$)] (Table 2).

This association is found because meconium staining of liquor is a predictor of foetal distress thus terminating in LSCS.

A positive correlation was found between neonatal birth weight and aUCI [$r = +0.426$ ($p < 0.05$)] with the number of LBW babies being maximum in hypocoiled group as compared to the other groups [52.59 vs. 40.74 % ($p < 0.001$)] (Table 4).

Low Apgar scores at 5 min was found to be exclusively associated with abnormal coiling only (47.62 % in hypocoiling and 52.38 % in hypercoiling), whereas Apgar 7 and above was found in 92.38 % of normocoiled babies (Table 5).

The most common complication in the present study was prematurity followed by FGR, both of which were

Table 4 aUCI and neonatal birth weight

Birth weight	Type of coiling			Total
	Hypocoiling	Normocoiling	Hypercoiling	
LBW	71 (52.59 %)	55 (40.74 %)	9 (6.67 %)	135 (100.00 %)
Normal birth weight	23 (5.16 %)	399 (85.81 %)	43 (9.25 %)	465 (100.00 %)
Total	94 (15.97 %)	454 (75.67 %)	52 (8.67 %)	600 (100.00 %)

 $\chi^2 = 180.490$; $df = 2$; $p < 0.001$; HS

 r value = +0.426
Table 5 aUCI and neonatal Apgar score

Apgar score at 5 min	Type of coiling			Total
	Hypocoiling	Normocoiling	Hypercoiling	
<5	10 (47.62 %)	0 (0.00 %)	11 (52.38 %)	21 (100.00 %)
6	39 (62.90 %)	11 (17.74 %)	12 (19.35 %)	62 (100.00 %)
7	24 (28.57 %)	43 (51.19 %)	17 (20.24 %)	84 (100.00 %)
8	21 (4.85 %)	400 (92.38 %)	12 (2.77 %)	433 (100.00 %)
Total	94 (15.97 %)	454 (75.67 %)	52 (8.67 %)	600 (100.00 %)

significantly higher in hypocoiling as compared with normocoiling (47.87 vs. 2.20 %). 81.91 % of babies with hypocoiling had complications while 96.92 % of normocoiled babies had uncomplicated outcome, thus making the difference highly significant ($p < 0.001$).

Discussion

The mean aUCI in the present study was comparable to those of the several similar studies in the past: Otsubo et al. [2], 0.39 ± 0.03 coils/cm; Degani et al. [3], 0.42 ± 0.12 coils/cm; Predanic and Perni [4], $0.403 \pm 2SD$ coils/cm; Perni [5], 0.4 ± 0.1 coils/cm; and de Laat et al. [6], 0.3 ± 0.09 coils/cm.

Rana and Ebert [7] concluded that hypercoiling is associated with an increased incidence of premature delivery. de Laat and Nikkels [8] demonstrated that both overcoiling and undercoiling were associated with preterm births.

Rana and Ebert [7] concluded that hypocoiled coils can be predictors of potential interventional delivery and intrapartum FHR disturbances. Predanic and Perni [4] found that a non-reassuring foetal status in labour was observed in 25.7 % of foetuses with abnormal coiling compared to 11 % of foetuses with normal coiling ($p = 0.007$).

Predanic and Perni [4] showed that abnormal coiling was associated significantly with small for gestational age neonates at birth ($p = 0.043$). Degani et al. [3] concluded

that the best single predictor of a small for gestational age infant was the coiling index with sensitivity of 79 %, specificity of 86.5 %, positive predictive value of 72 % and a negative predictive value of 905. Another observation in this study was that both hypercoiling and hypocoiling were significantly associated with low Apgar score as compared with normocoiling. This finding correlates with the study of de Laat [9].

Conclusion

We concluded that coiling pattern of umbilical cord visualised by sonography has a potential value in second trimester screening. In the present study, a sincere effort has been made to study the relationship between abnormal coiling of umbilical cords and adverse pregnancy outcome so that in the near future, a prediction for the same can be made, and appropriate preventive measures are taken so that every pregnancy ends in a healthy mother and a healthy baby.

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