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ASSESSMENT OF UMBILICAL COILING INDEX IN RELATION TO ADVERSE PERINATAL OUTCOMES

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ABSTRACT **Background:** The umbilical cord's coiling pattern, though not fully understood in origin, plays a crucial role in fetal development and outcome. Abnormal Umbilical Coiling Index (UCI) is increasingly being recognized as a marker of adverse perinatal outcomes. **Aim &Objectives:** To calculate the postnatal UCI and assess its association with maternal complications and adverse perinatal outcomes. **Methods:** A prospective hospital-based study was conducted involving 600 antenatal women with singleton pregnancies admitted in labour at ASRAM Medical College, Eluru. Umbilical cords were examined postnatally to calculate the UCI. Patients were categorized as normocoiled, hypocoiled (<10th percentile), or hypercoiled (>90th percentile), and compared for outcomes. **Results:** Hypocoiling was significantly associated with meconium-stained liquor (100%), respiratory distress (34.3%), low APGAR scores, and higher NICU admissions. Hypercoiling was associated with preterm deliveries (35.5%), IUGR (22.6%), and low birth weight (67.7%). **Conclusion:** Abnormal UCI (both hypo- and hypercoiling) is significantly associated with adverse perinatal outcomes. UCI evaluation, particularly when done antenatally, could serve as an important predictive tool for identifying high-risk pregnancies.

KEYWORDS :

INTRODUCTION

The umbilical cord serves as the critical lifeline between the fetus and placenta, facilitating the transfer of oxygen and nutrients necessary for fetal growth and development. Structurally, it contains two arteries and one vein embedded in Wharton's jelly, which acts as a protective cushion. One of the most distinctive features of the umbilical cord is its coiling, which develops during early gestation and provides resistance to external compression, preventing vascular occlusion and maintaining consistent blood flow.

The umbilical cord is a helical and coiled structure but the origin of coiling is yet unknown. Explanations for the origin of coiling is given as torsion- either by active or by the passive movements, causing the embryo to rotate around its umbilical cord axis1, it is considered that the presence of Roach muscle, which is a small bundle of muscles lying just beside the umbilical artery, contributes to the coiling, and also the hemodynamic forces of the fetus.

By 9 weeks of gestation, the Umbilical cord coiling is well established. It is not known if there are genetic factors involved in coiling or whether it is only acquired. But the degree, tensile stress and the number of coils seem to be affected by in-utero fetal movements. Taking note, the fetal movements as a theory for coiling of the umbilical cord, hypocoiling is observed in cases of fetal anomalies affecting fetal movements . For e.g.; amniotic bands, oligohydramnios, uterine malformations, twins and pregnancy are affected by chromosomal anomalies while hypercoilingis more common in parous women. Male fetus that are presumed to be more active have longer cord than female fetus.

Umbilical cord coiling is either anti-clockwise (left) or clockwise (right). Anti clockwise coiling Umbilical cord coiling is either anti-clockwise (left) or clockwise (right). Anti clockwise coiling is found to be more common. Defining the direction of coils, the umbilical cord is placed vertically and the vessels are seen on the anterior surface of the cord; if the direction is towards the left hand of the observer, it is noted as left sided. It is considered as right sided if it is directed towards observer's right hand.

Studies have observed the direction of coiling either from placental endor from the fetal end , but still, the direction of the coiling might not in fact alter if viewed from the placental or the fetal end.The prevalence of anti-clockwise coiling varies from 65 to 76%.

The Umbilical Coiling Index (UCI) is a quantitative measure of this coiling pattern and is defined as the number of complete vascular coils per centimeter of cord length. Normally, the cord has a helical twist from the fetal end to the placental end, typically with a right-handed spiral. The mean UCI ranges from 0.17 to 0.37 coils/cm, and deviations from this range—either hypocoiling (UCI <10th percentile) or hypercoiling (UCI >90th percentile)—are termed abnormal UCI.

An abnormal UCI has been increasingly associated with various adverse perinatal outcomes, such as intrauterine growth restriction (IUGR), preterm birth, meconium-stained liquor, fetal distress, low APGAR scores, and increased NICU admissions. These associations suggest that the coiling pattern may reflect the underlying hemodynamic status and adaptability of the fetus.

UCI can be assessed antenatally via ultrasonography, particularly in the second trimester using color Doppler, or postnatally by direct examination of the delivered cord, which is considered more accurate. Despite advances in prenatal imaging, postnatal evaluation remains a reliable and cost-effective method to assess coiling.

Complicated Pregnancies And UCI

Placentas with their umbilical cords in complicated pregnancies were examined, which further showed need for histological investigation of placenta to co-relate with the following indications; which include, gestational diabetes mellitus, pre-eclampsia, intra uterine fetal demise, intrauterine growth restriction, intra-uterine infections, preterm delivery, low birth weight, fetal asphyxia, and macroscopic

abnormalities of placenta. Studies also considered further co-relation between these conditions and hypercoiling/ hypocoiling. i.e., umbilical artery pH<7.05, fetal hypoxia,fetaldemise,preterm delivery and low birth weight were observed with hypercoiling.

Conditions like chorioamnionitis, lower Apgar score were associated with hypocoiling .And, fetal demise, structural or chromosomal fetal congenital anomaly cases were seen in both.

Few studies considered prenatal assessment (USG) of umbilical cord coiling index as a predictive measure to find out adverse antenatal and perinatal outcomes as a result of association between umbilical cord index and perinatal outcomes. It is a simple examination that holds significance in cases like unexplained adverse outcome like intra-uterine fetal demise.

However, significance is still controversial. Also, there is need for larger studies, taking into account the low sensitivity of prenatal detection.

Blood flow in the umbilical cord vein and it's Mechanism

A great volume of blood is transported from the placenta to the fetus.

The amount of the blood flowing back from the fetus to the placenta is almost proportional to that flowing from the placenta to the fetus, wherein,the fetus can be considered a closed system.

These are the following methods which are noted for the movement of oxygenated blood from the placenta to the foetus –

The umbilical cord vein pressure increases from 4.5 mmHg at 18 weeks gestation to 6 mmHg at term33 and also it is noted that the blood pressure expanding the umbilical vein is greater than that in the fetal IVC. This gradient is at least because of these two mechanisms:

Normal foetal heart contractions producing a pressure gradient between the atria and ventricles, which in turn diminishes the preload in the venous circulation and allows the blood in the umbilical vein to move towards the heart

Changes in abdominal and thoracic cavity due to fetal breathing movements causing a pressure gradient between the umbilical vein and ductus venosussuch that, there is an increase in the velocity of the blood in the umbilical vein during inspiration.

Due to longitudinal distortion of arteries, there occurs passive pressure changes in the umbilical vein with each fetal heart beat. There is a peak in the pressure in the umbilical cord artery and vein that are out of phase by 180° resulting in additional effect of numerous, small pressure changes along the length of the cord with the subsequent movement of blood through the umbilical cord vein.

Anomalies of the Umbilical cord
A) 5 and more vessels cords- these are seen in conjoined twinning and have many variations.
B) 4 vessel cords
- Two arteries with two veins- seen in cases of cleft lip and palate, atrial septal defect, ectopia cordis and arteriovenous fistulas of the placenta.
- Two arteries,one vein and a duct- the duct is the remnant of omphalo-mesentric duct or allantoic duct.
- Three arteries and a vein - persistent small vitelline arteries is considered as the 4th vessel.
C) 2 vessels cords:
-Single umbilical artery- Right single artery is found to be more common than the left. Incidence is 0.2% - 1.1% of singleton and 6-11% of multiple pregnancies. It is mostly seen along with IUGR, fetal structural anomalies, still births and also with aneuploidies.
D) At the fetal and placental ends- cords can sometime present with unequal numbers of vessels.

1. Abnormal cord coiling (structure) or configuration of the blood vessels:
-Abnormal cord coiling - Usually, the umbilical cord is found to coil to the left side.
-Hypercoiling- frequency: 21%
-Hypocoiling- frequency: 4- 5%

E) UMBILICAL CORD:
- Long cords- total length more than 70cm
-Short cord- the total length of cord is 40cm or even lesser. It is seen in accordance with lateral meningocele syndrome. Fetal akinesia deformation sequence, body stalk anomaly, and spinal muscular atrophy.
-Umbilical cord constriction
-Nuchal cord loops
-Umbilical cord-Segmental thinning.

MATERIALS AND METHODS

Study Area:
Department of Obstetrics and Gynaecology, Alluri Sitarama Raju Academy of Medical Sciences, Eluru, Andhra Pradesh, India.

Study Design: Prospective hospital-based observational study.

Sample Size: 600 pregnant women admitted in labour with singleton pregnancies.

Duration of Study: February 2023 to February 2025

Method Of Data Collection:
After placental delivery, the umbilical cord was measured from fetal end to placental insertion, and the number of complete vascular coils was counted. UCI was then calculated using the formula: Umbilical Coiling Index (UCI) = Number of complete coils / Cord length (in cm) Based on percentile cut-offs, patients were grouped into:
- Hypocoiled (<10th percentile)
- Normocoiled (10th–90th percentile)
- Hypercoiled (>90th percentile)

Inclusion And Exclusion Criteria
Inclusion Criteria:
- Singleton live pregnancies
- Gestational age > 28 weeks
- Cephalic presentation

Exclusion Criteria:
- Multiple gestation
- Abnormal fetal presentations
- Diagnosed intrauterine death (IUD)
- Fetal congenital anomalies

-Perinatal Outcome: With respect to Apgar score at 1 & 5 min, Low birth weight, Meconiumstained liquor, IUGR, Fetaldistress, NICU admission in hypocoiled and hypercoiled and hypercoiled compared

RESULTS AND ANALYSIS

Table5: Comparison Of Three Groups With Maternal Complications

Maternal complications	Hypocoiling	%	HyperCoiling	%	Normo-coiling	%	Total	%	PValue
Abruption	6	8.6	0	0.00	0	0.00	6	1.00	0.049
Anemia	0	0.00	0	0.00	2	0.43	1	0.33	NA
GDM	0	0.00	0	0.00	6	0.43	1	0.33	0.604
PIH	9	11.43	20	32.26	44	9.83	37	12.33	0.078
PIH+ Preterm	0	0.00	6	9.68	0	0.00	3	1.00	0.415
Postdated	4	5.71	0	0.00	6	1.28	5	1.67	0.685
PROM	1	0.00	0	0.00	7	0.85	2	0.67	NA

Table 2: Neonatal Complications (IUGR And Others) By Group

Complication	Hypocoiling	Hypercoiling	Normocoiling	Total	p-value
IUGR	0 (0.0%)	14 (22.6%)	12 (2.6%)	26	0.026*
IUGR + Preterm	0 (0.0%)	4 (6.5%)	0 (0.0%)	4	0.039*
Oligohydramnios	2 (2.9%)	0 (0.0%)	18 (3.8%)	20	0.584
Polyhydramnios	0 (0.0%)	0 (0.0%)	10 (2.1%)	10	0.307
Postdated Pregnancy	4 (5.7%)	0 (0.0%)	6 (1.3%)	10	0.023*
PROM	0 (0.0%)	0 (0.0%)	4 (0.9%)	4	NA

RESULTS :

Low APGAR Scores were significantly associated with hypocoiling, with a mean of 5.6 at 1 minute and 6.4 at 5 minutes, compared to normocoiled and hypercoiled groups.

Birth Weight: Hypercoiled cords were linked with low birth weight (67.7% < 2.5 kg), whereas normocoiled cords showed higher rates of normal birth weights.

NICU Admissions were highest in the hypocoiled group (54.3%) and lowest in the normocoiled group (15%).

Neonatal Complications: Hypercoiled cords had a higher incidence of IUGR and IUGR + preterm births. Postdated pregnancy was more common in hypocoiling.

Statistical significance was found across APGAR scores, birth weights, NICU admissions, and complication rates.

DISCUSSION :

The study reinforces the clinical utility of the Umbilical Coiling Index (UCI) as a prognostic indicator.

Hypocoiling correlated with immediate neonatal compromise such as respiratory distress, low APGAR scores, and higher NICU admissions.

Hypercoiling was significantly linked with chronic complications like IUGR and preterm deliveries.

These findings are consistent with previous literature, confirming that abnormal UCI reflects fetal stress or vascular compromise.

UCI abnormalities can be considered early warning signs and may warrant closer antenatal surveillance.

CONCLUSION

Abnormal umbilical cord coiling (both hypo- and hypercoiling) is significantly associated with adverse perinatal outcomes.

Hypocoiling predicts poor APGAR scores and NICU need, while hypercoiling is a risk factor for IUGR and low birth weight.

Measuring UCI, especially antenatally, may help identify high-risk pregnancies, allowing for proactive management to improve perinatal outcomes.

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