**European Journal of Molecular & Clinical Medicine**

**ISSN 2515-8260 Volume 09, Issue 07, 2022**

*Original Research Article*

# Umbilical cord coiling index as a prognostic marker of perinatal outcome

**[1]Aarti Kothari, [2]Shagun Gupta, [3]Virendra Kumar Gupta, [4]Usha Shekhawat, [5]Mohammed Shoaib**

[1]Assistant Professor, Department of Obstetrics and gynaecology, Mahatma Gandhi Medical College and Hospital, Jaipur, Rajasthan, India
[2]Associate Professor, Department of Obstetrics and gynaecology, Mahatma Gandhi Medical College and Hospital, Jaipur, Rajasthan, India
[3]Associate Professor, Department of Paediatrics, Mahatma Gandhi Medical College and Hospital, Jaipur, Rajasthan, India
[4]Professor and Head, Department of Obstetrics and gynaecology, Mahatma Gandhi Medical College and Hospital, Jaipur, Rajasthan, India
[5]Assistant Professor, Department of Pharmacology, Mahatma Gandhi Medical College and Hospital, Jaipur, Rajasthan, India

**Corresponding Author:**
Mohammed Shoaib (shoaib@mgumst.org)

**Abstract**

**Introduction:** The umbilical cord supplies the fetus with oxygenated, nutrient-rich blood from the placenta. It is a delicate structure and is protected by Wharton's jelly, amniotic fluid, helical patterns, and coiling of vessels as it is vulnerable to kinking, buckling, compressions, stretching, traction, entanglement and torsion which may affect the perinatal outcome. Abnormal umbilical cord coiling index has been seen in preeclampsia and diabetes. Its determination may provide information to potential perinatal adverse events. Our present prospective analytical study aims at calculating the UCI postnatally and identifying if there is any association between coiling index and perinatal morbidity and mortality.

**Study Design:** 100 singleton live babies with >28 weeks gestational age were examined by single observer. The umbilical coiling index (UCI) of each cord was determined by dividing the total number of complete umbilical vascular coils by the umbilical cord length (in centimetres). Hypocoiled group was taken as having values less than the 10th percentile and hypercoiled group with values more than 90th percentile of the mean. Antepartum high-risk factors like medical disorders like diabetes, hypertension were noted. Intrapartum factors like mode of delivery, fetal heart rate (FHR) abnormalities, meconium stained liquor (MSL), Preterm delivery, vaginal delivery or Caesarean section were noted as per proforma & analysed. New born factors like APGAR at 1 & 5 minutes, birth weight, admission to neonatal intensive care unit (NICU), and congenital anomalies when present were noted.

**Results:** Hypocoiling had significant association with Preterm births, Maternal hypertension, Fetal distress with or without meconium stained liquor, Low birth weight, Neonatal intensive care admissions, low APGAR at 1 & 5 minutes. Hypercoiling and hypocoiling were both associated with fetal distress.

**Conclusion:** Abnormal umbilical coiling index (UCI) has a positive relationship with maternal risk factors & adverse perinatal outcome. In the future, ultrasonographic evaluation of the umbilical cord and the umbilical cord coiling index may become an integral part of antepartum fetal assessment in high risk pregnancies.

ISSN 2515-8260 Volume 09, Issue 07, 2022

**Keywords:** Umbilical cord coiling index, perinatal outcome, postnatal UCI, umbilical cord

## Introduction

The umbilical cord, also called the birth cord or funiculus umbilicalis is a trivascular conduit between the developing fetus and placenta and supplies the fetus with oxygenated, nutrient-rich blood from the placenta [1]. Normally it contains two arteries and a vein. It is a delicate structure protected by Wharton's jelly, amniotic fluid, helical patterns, and coiling of vessels as it is vulnerable to kinking, compression, entanglement and torsion which may affect the perinatal outcome. It is said that umbilical cord coiling originates from active or passive fetal movements of fetus or torsion, hemodynamic forces, different umbilical growth rates, and arrangement of muscular fibers in the arterial wall [2]. Coiling provides turgor to the umbilical unit making it strong and flexible. Lengthening occurs from the fetal end and most probably coiling of cord represents a record of fetal well-being [3]. The coiling of the umbilical vessels develops as early as 28 days after conception and is present in about 95% of fetuses by 9 weeks of conception. The helices may be seen by ultrasonographic examination during the first trimester of pregnancy [4]. An average umbilical cord is 55 cm long, with a diameter of 1-2 cm and 11 helices [5]. A coil is of 360-degree spiral course of umbilical vessels [1].

An abnormal umbilical coiling index has been found to be related to an adverse fetal outcome, it is seen more commonly in pre-eclampsia and diabetes. Determining coiling index may help in predicting pregnancy outcome and thereby helping in improving perinatal care. Earlier, only postnatal UCI has been calculated. With advances in ultrasonography, it has now become possible to calculate the antenatal UCI. Till date very limited data is available that can validate its accuracy [6].

Our study aim at calculating the UCI postnatally and identifying its association with perinatal morbidity and mortality if any with the following objectives:

1. To measure umbilical coiling index (UCI) postnatally and to study the association of hypocoiling and hypercoiling with maternal outcome.
2. To establish the impact of Umbilical Coiling Index on Perinatal Outcome
3. To study the correlation of Umbilical Coiling Index with respect to variable maternal risk factors during pregnancy.

## Materials and Methods

It was a clinical prospective analytical study conducted for 18 months after ethical clearance.

### Inclusion Criteria

- Pregnant females who are in labour, with gestational age >28 weeks.
- Booked or unbooked.
- Singleton pregnancies.
- Medical complications such as those with Pre-eclampsia, Gestational Diabetes etc. were included.

### Exclusion Criteria

- Patient not in labour.
- Preterm labour with gestational age < 28 weeks.
- Multiple pregnancies.

100 pregnant women fulfilling inclusion criteria who delivered at the hospital were examined by single observer after taking informed consent.

After delivery of the baby, the cord was tied and cut approximately 5 cm from the neonatal end. The placenta was allowed to separate spontaneously. The umbilical cord was measured entirely, including the length of the placental end of cord to the cut end and adding 5 cms to the cord length (cord stump on the baby) without any undue traction. This measurement was done without any delay since it has been studied that cord shrinks around 7 cm in the initial few hours after birth [16].

ISSN 2515-8260 Volume 09, Issue 07, 2022

The number of the complete coils or spirals was counted from the neonatal end towards the placental end of cord and direction of coiling was also assessed from neonatal end as the lengthening of the cord occurs at the fetal end.
A coil is defined as a complete 360 degrees spiral course of umbilical vessels around the Wharton's jelly.

The umbilical coiling index = No. of coils in a cord/ Total length of coil (in cms)

Hypocoiled cords were defined as those with UCI less than 10th percentile and hypercoiled cords were those with UCI more than 90th percentile.
Antepartum maternal factors like increased maternal age, parity, hypertensive disorders, Diabetes, Post term deliveries, anaemia, etc. noted in each case.
Intrapartum factors like mode of delivery, fetal heart rate (FHR) abnormalities, meconium stained liquor (MSL), chorioamnionitis, Preterm deliveries, vaginal delivery or Caesarean section were noted.

**Postpartum work up**
New Born factors like APGAR at 1 & 5 minutes, birth weight, admission to neonatal intensive care unit (NICU) and congenital anomalies were noted.
Umbilical Coiling index (UCI) was analysed & compared in deliveries with & without risk factors. Data was analysed and appropriate statistical methods like chi-square test, population test or T-test were employed to analyse data throughout study.

**Results**
Out of total 100 cases, 10 patients had hypercoiling and 8 had hypocoiling while 82 had normocoiled cords.

**Table 1:** Preterm births (PT) and UCI

| UCI | PT (n=20) | Percentage | p-value |
|---|---|---|---|
| Hypocoiling (8) | 6 | 30.0 | <0.001 |
| Hypercoiling (10) | 1 | 5.0 | 0.627 |
| Normal (82) | 13 | 65.0 | - |

20 babies were born preterm. 6 were hypocoiled. 1 had hypercoiling and 13 were normocoiled. 30% of these preterm neonates had hypocoiled cords and it was statistically significant (P-value <0.001) while hypercoiling had no association.

**Table 2:** Mode of delivery and Abnormal UCI

| Mode of delivery | Caesarean sections and instrumental deliveries (23) | | Percentage | P Value | Vaginal Deliveries (77) | Percentage % | | P Value |
|---|---|---|---|---|---|---|---|---|
| Hypocoiling [8] | 3 | 13.04% | 21.6% | 0.276 | 5 | 6.4% | 16.6% | <0.01 |
| Hypercoiling [10] | 2 | 8.6% | | 0.957 | 8 | 10.2% | | <0.01 |

Total 23 caesarean sections were done for various indications.5 out of 23(21.6%) caesarean sections had abnormal UCI while 13 out of 77(16.6%) vaginal deliveries had abnormal UCI. This implies that higher percentage of patients among operative group had abnormal coiling as compared to vaginal delivery group.

ISSN 2515-8260 Volume 09, Issue 07, 2022

**Table 3:** UCI and Hypertensive Disorders

| UCI | Hypertensive Disorders (n=10) | Percentage | p-value |
|---|---|---|---|
| Hypocoiling (n=8) | 5 | 50.0 | <0.001 |
| Hypercoiling (n=10) | 0 | 0 | - |
| Normal UCI(n=82) | 5 | 50.0 | - |

10 patients had hypertensive disorders including gestational hypertension, pre-eclampsia, eclampsia and chronic hypertension. 5 out of 10 had hypocoiling (50%) which was found statistically significant. None of the hypertensives had hypertension.
62.5% of the hypocoiled cords were associated with pre-eclampsia. Eclampsia and Chronic Hypertension did not have abnormal coiling in our study.

**Table 4:** Fetal distress (FD) & UCI

| UCI | Fetal distress (FD) (21) | | | | Percentage | | p-value |
|---|---|---|---|---|---|---|---|
| Hypocoiling (8) | MSL + Abnormal CTG | Only MSL | Abnormal CTG | Total | 33.3% | Total 71.3% | <0.001 |
| | 5 | 1 | 1 | 7 | | | |
| Hypercoiling (10) | 5 | 3 | - | 8 | 38% | | |
| Normocoiling (82) | 0 | 6 | - | 6 | 28.7% | | - |

21 patients had fetal distress which was diagnosed with presence of meconium stained liquor and abnormal CTG or either of the two. Out of them 6 were normocoiled. 7 were hypocoiled (33.3%) and 8 were hypercoiled (38%). Total 71.3% of fetal distress had abnormal coiling index which was found statistically significant. Amongst hypocoiled cords 75% were associated with meconium stained liquor.

**Table 5:** Birth Weight and Abnormal UCI

| Coiling Index | Hypocoiling (8) | Hypercoiling (10) | Normocoiling (82) |
|---|---|---|---|
| Low Birth Weight (30) | 6 (75%) | 2 (20%) | 22 (26%) |
| p-value | 0.005 | 0.642 | - |

Total 30 babies had low birth weight. Out of them 22 were normocoiled. 6 were hypocoiled and 2 were hypercoiled. Out of 8 hypocoiled, 6 (75%) had low birth weight which was found statistically significant (P-Value= 0.005).

## Discussion

In our study we had total of 100 cases with 18 cases having abnormal umbilical cord coiling index (hypocoiled or hypercoiled) mean length of umbilical cord was 48.34 cm with mean number of coils 11.1. No non coiled cord was seen in our study. T. Strong *et al.* [3] in 1993, had conducted a study on 894 fetuses with noncoiled umbilical cord and suggested that the fetuses with non-coiled umbilical blood vessels were at an increased risk for perinatal morbidity and mortality. T Chitra *et al.* [6] found the mean length of the umbilical cord to be 52.87+13.49 cms. The mean number of coils per umbilical cord was found to be 12.59+5.38.
We had 30% of preterm neonates with hypocoiled cords which was statistically significant (P-value <0.001) while hypercoiling was not seen in only 5 % of preterm births (P value-0.627). In hypocoiled group, 75% fetuses were born preterm. These findings were similar to the findings of Strong T H *et al.* [3] and de Laat *et al.* [7] However, they were unable to give a satisfactory explanation for this association. Thus no positive correlation between hypercoiling and preterm births was seen.
Total 23 caesarean sections were done for various indications. 5 out of 23(21.6%) caesarean sections had abnormal UCI while 13 out of 77(16.6%) vaginal deliveries had abnormal UCI. This means that higher percentage of patients among operative group had abnormal coiling as

ISSN 2515-8260 Volume 09, Issue 07, 2022

compared to vaginal delivery group. Strong T H *et al*., Rana J *et al*. & De laat *et al*. similarly found association of caesarean section with hypocoiling. They postulated fetal distress as cause for caesarean section for fetal distress which in itself associated with hypocoiling.

10 patients had hypertensive disorders including gestational hypertension, pre-eclampsia, eclampsia and chronic hypertension. 5 out of 10 had hypocoiling (50%) which was found statistically significant. 62.5% of the hypocoiled cords were associated with pre-eclampsia. Eclampsia and Chronic Hypertension did not have abnormal coiling in our study. Not a single case of hypercoiling was seen in the hypertensive women. The findings of our study were found to be in accordance with studies done by Ezimokhai *et al*. [8], Gupta *et al*. [9] and T. Chitra *et al*. [6] who demonstrated a significant association between hypocoiled cords and preeclampsia. This might be explained by the fact that collagen content of the vessel walls increases in pre-eclampsia causing decrease in elasticity. Decreased coiling has reduced flow indices in the umbilical vein. When coils are more, the effect of the pressure-pulsations of the arteries on the vein increases and as a consequence venous flow also increases.[10]

None of the hypertensive mothers had hypercoiling. In a study conducted by Ezimokhai *et al*. it was suggested that hypercoiled cords were present in patients with hypertensive disorders but our study failed to demonstrate any such correlation. Machin *et al*. Suggested that Hyper coiling was associated with thrombosis of chorionic plate vessels, umbilical venous thrombosis, and cord stenosis. As the more the blood comes into contact with the vessel-wall, the more turbulence occurs, which slows the blood flow which eventually leads to decreased blood supply [1].

Out of 21 patients with fetal distress, 7 were hypocoiled (33.3%) and 8 were hypercoiled (38%). Total 71.3% of fetal distress had abnormal coiling index which was statistically significant. Amongst hypocoiled cords 75% were associated with meconium stained liquor. Gupta S *et al*. [9] studied 107 umbilical cords and found that in hypocoiled group, meconium staining was significantly higher than in those with normocoiled group. Padmanabhan LD *et al*. [11] studied 130 cases, where meconium staining was significant among hypocoiled group. Devaru D *et al*. [12] did a study on 100 women and found that meconium staining was significantly associated with the hypocoiled cords (UCI <10th percentile). Thus, our study reaffirms the fact that there is a statistically significant association between hypo coiling and MSL (p value <0.001). As we mentioned earlier, a hypocoiled cord is not able enough to withstand the stress of labor and any form of kinking during labor can decrease the perfusion which may in turn lead to distress in the form of MSL. In our study 75% of the hypercoiled cords were associated with MSL. Strong *et al*. [13] studied 100 umbilical cords and found that meconium staining was associated with hypercoiled cords (p-value 0.0300). In our study meconium staining of amniotic fluid had statistically significant positive association with both hypocoiled and hypercoiled cords. Similar findings were noted in studies done by Ezimokhai *et al*. and Kashanian *et al*. Study by T.Chitra *et al*. also showed that both hypocoiled and hypercoiled were significantly associated with MSL ($P$=0.020, $P$<0.001).

In our study, we found a statistically significant relation between LBW and hypocoiling (P Value= 0.005). This was consistent with a study done by Enas Abdulrasul *et al*. in Iraq [15]**.** In contrast to that some of the studies by Rana *et al*. and de Laat *et al*. [7] have shown consistent association between hypercoiling and LBW babies.

In our study, 25% of hypocoiled cord babies had severe birth asphyxia as compared to normocoiled (4.2%) ones. This shows that hypocoiling has higher association with severe birth asphyxia leading to higher NICU admissions. These findings reaffirms the belief that hypocoiling can be used as a predictor not only for severe birth asphyxia but also for NICU admissions and thus can predict adverse perinatal outcome.

## Conclusion

Based on this postnatal prospective study with small sample size, we conclude that abnormal umbilical coiling index (UCI) has a statistically significant positive relationship with preterm labour, preeclampsia, fetal distress including meconium stained liquor and low birth weight. In the future ultrasonographic evaluation of the umbilical cord and the umbilical coiling index

ISSN 2515-8260 Volume 09, Issue 07, 2022

may be integrated in fetal assessment of high-risk pregnancies.

**References**


1. Machin GA, Ackermann J, Gilbert-Barness E. Abnormal umbilical cord coiling is associated with adverse perinatal outcomes, Pediatric and Developmental Pathology. 2000;3(5):462-471.
2. Saswati Tripathy. Umbilical Coiling Index and Perinatal Outcomes, Indian Journal of Neonatal Medicine and Research. 2014 Oct;2(2):1-4.
3. Strong Jr. TH, Elliott JP, Radin TG. Non-coiled umbilical blood vessels: a new marker for the fetus at risk, Obstetrics and Gynecology. 1993;81(3):409-411.
4. Lacro RV, Jones KL, Benirschke K. The umbilical cord twist: origin, direction and relevance, American Journal of Obstetrics and Gynecology. 1987;157(4):833-838.
5. Heifetz SA. The umbilical cord: obstetrically important lesions. Clin Obstet Gynecol. 1996 Sep;39(3):571-87.
6. Chitra T, *et al*. Umbilical Coiling Index as a Marker of Perinatal Outcome: An Analytical Study.
7. De Laat MW, Van Alderen ED, Franx A, Visser GH, Bots ML, Nikkels PG. The umbilical coiling index in complicated pregnancy, European Journal of Obstetrics & Gynecology and Reproductive Biology. 2006;70(12):93-100.
8. Ezimokhai M, Rizk DEE, Thomas L. Maternal risk factors for abnormal vascular coiling of the umbilical cord. Am J Perinat. 2000;17:441-445.
9. Shalu Gupta, Faridi MMA, Krishnan J. Umbilical coiling index, J Obstet Gynecol India. 2006 July/Aug;56(4):315-319.
10. Reynolds SRM. Mechanisms of placentofetal blood flow. Obstet Gynecol. 1978;51:245-249.
11. Padmanabhan LD, Mhaskar R, Mhaskar A. Umbilical vascular coiling and the perinatal outcome. J Obstet Gynecol India. 2001;51:43.
12. Birth Asphyxia-Summary of the previous meeting and protocol overview Dr Ornella Lincetto, WHO Geneve Milano, 2007 June.
13. Strong TH, Jarles DL, Vega JS, Feldman DB. The umbilical coiling index, American Journal of Obstetrics and Gynecology. 1994;170(1):29-32.
14. M Kashanian A, A Akbarian A, Kouhpayehzadeh J. International Journal of Gynecology and Obstetrics. 2006;95:8-13.
15. Enas Adnan Abdulrasul College of Medicine/Al-Nahrain University Baghdad- Iraq International Journal of Advanced Research. 2014;2(2):101-107.
16. Moster D, Lie RT, Irgens LM, Bjerkedal T, Markestad T. The association of Apgar score with subsequent death and cerebral palsy: a population-based study in term infants. J Pediatr. 2001;138:798-803.