1 2

UMBILICAL CORD COILING INDEX AS A MARKER OF MATERNAL AND PERINATAL OUTCOME: A RETROSPECTIVE STUDY

3

4 5 **ABSTRACT**

- 67 Introduction
- 8 The umbilical cord or funis forms the connecting link between the fetus and the placenta. An
- 9 abnormal UCI includes both hypo and hyper coiled cords. An abnormal UCI has been reported
- 10 to be related to adverse perinatal outcome.
- 11
- 12 Objectives:
- 13 To study the association between UCI and i) intrapartum events (fetal distress, meconium
- staining), ii) mode of delivery and iii) perinatal outcomes (birth weight, Apgar score, NICU
- 15 admission).
- 16
- 17 Methods:
- A prospective analytical study was performed in our institute on 200 patients over a period of 2years.
- 20 The UCI was measured by ultrasound using the method suggested by Degani et al. Its
- 21 association with various maternal and perinatal risk factors was noted. The results were
- statistically analyzed with the Chi-square test and SPSS version 13.0.
- 2324 Results:
- 25 There was significant correlation (p value 0.003) between the hypercoiled cords and intrauterine
- 26 growth restriction of the babies. Apgar score at $1 \min 4$ and $5 \min 7$ was highly significant
- 27 $(p\setminus 0.001)$ with hypocoiled cords. Meconium staining was significantly
- 28 (p value 0.001) associated with the hypocoiled cords in the present study.
- 29
- 30 Conclusion:
- 31 The hypocoiled cords are associated with the meconium staining and low Apgar score. The
- 32 hypercoiled cords are associated with intra uterine growth restriction
- 33
- Keywords: Hypocoiling, Hypercoiling, umbilical cord, Umbilical coiling index
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- 40 41

42 INTRODUCTION

- 43
- 44 The umbilical cord or funis forms the connecting link between the fetus and the placenta; it is
- 45 vital to the development, well-being and survival of the fetus [1].
- 46 Though the umbilical cord is protected by Wharton's jelly, amniotic fluid, helical patterns, and
- coiling of vessels [2, 3, 4], it is vulnerable to kinking, compressions, traction, and torsion which
- 48 may affect the perinatal outcome. [5, 6,7, 8, 9,10]
- 49

- *Coiling and its effect on the fetus:* 50
- 51 The coiling of the umbilical vessels develops as early as 6 weeks after conception and is present
- in about 95% of fetuses by 9 weeks [11] The number of twists is believed to be constant 52
- throughout pregnancy. [12, 13] It is unclear whether abnormal coiling is a cause or consequence 53
- of pathology. [14] Abnormalities of the cord can be detected antenatally with modern 54
- ultrasound techniques. [15]The umbilical coiling index (UCI) represents the umbilical cord 55
- 56 coiling. Prenatal outcomes such as fetal distress, IUGR and IUFD during parturition are linked
- to Coiling Level. Decreased and increased spiralling of the cord is currently thought to increase 57
- the risk of cord compression. [16, 15, 17] 58
- Fetuses with few or no coils (straight cords) are predisposed to develop fetal morbidity. [16, 15, 59 18]
- 60
- 61
- *Aim of the study* 62
- To study the association between umbilical cord coiling index and 63
- Intrapartum events: Fetal distress and meconium staining of liquor 64
- Mode of delivery 65
- Perinatal outcome: Birth weight, Apgar score and NICU admission due to birth asphyxia. 66
- 67

68 **MATERIALS AND METHODS;**

- This was a prospective analytical study done in our institute (Dept of obstetrics and gynecology, 69
- King George Hospital) over a period of 1year (from July 2020 to August 2021), 70
- 71
- 72 *Study population*
- All pregnant woman attending OPD, admitted in the antenatal ward and labour room 73
- The following inclusion and exclusion criteria were followed to select the study group 74
- 75
- 76 Inclusion criteria
- 77 Age: 19 - 35
- Singleton pregnancy irrespective of parity 78
- Gestational age > 34 weeks 79
- Presence of three vessel umbilical cord 80
- 81
- Exclusion criteria 82
- Gross fetal anomalies 83
- Multiple pregnancies 84
- Oligohydramnios or polyhydramnios as defined by an amniotic fluid index of <5 cm or >25 cm, 85
- respectively. [19] 86
- Presence of a single artery in the umbilical cord 87
- Pre-existing maternal medical conditions (like diabetes mellitus, hypertension, renal disorders, 88
- and anemia) that can interfere with fetal growth. 89
- 90
- Of the total antenatal women admitted within the study period, 200 women, who fulfilled the 91
- inclusion criteria were included. A thorough history was elicited and recorded. 92

- The UCI was measured beyond 34 weeks of gestation using 3.5 MHz trans-abdominal
- transducer by a single sonologist using Degani et al. [13] method. It was calculated as the
- reciprocal value of the distance between a pair of coils measured in cm from inner edge of an
- arterial or venous wall to the outer edge of next coil with the same side of umbilical cord, the
- 97 direction being from placental end to fetal end. [20] The final value is the average of three
- 98 readings at three different segments of umbilical cord. [2]For term pregnancy, hypo-coiled is
- 99 UCI < 0.2 while hyper-coiled is UCI > 0.6, while the average normal UCI is 0.4. [21]. Other
 100 ultrasound parameters including fetal bi-parietal diameter, head circumference, abdominal
- 101 circumference, and femoral length, amniotic fluid index, placental position and grading were
- 102 also noted.
- Parturition details including gestational age at delivery (preterm and term deliveries), abnormal CTG patterns, color of amniotic fluid, mode of delivery (vaginal delivery or LSCS), birth weight and sex, APGAR at 1 and 5 minutes and NICU admission were recorded and tabulated. Maternal factors like age, gravidity, gestational age at delivery and mode of delivery were noted. The relationship between UCI and neonatal factors like meconium staining of liquor, birth weight, APGAR score of neonates, NICU admission were evaluated. Results of the present study were tabulated, compared and analyzed. All the women and babies,
- including those admitted in NICU, were followed till discharge.
- 111
- 112 *Ethical considerations*
- 113 The Institutional Ethical Committee clearance was obtained. Written informed consent was
- obtained from every individual of the study. Confidentiality of every patient was maintained.
- 115
- 116 *Statistical methods*
- 117 The data were entered in a Microsoft Excel spread sheet, and analyses were done using
- 118 Statistical Package for Social Sciences (SPSS) version 26.0. Descriptive analyses of data were
- done by calculating mean, median, mode, and standard deviation. Categorical variables were
- expressed as frequencies and percentages. Chi square tests were applied. p<0.05 were
- 121 considered statistically significant.
- 122

123 **RESULTS**

- 124 Incidence
- Most (151, 75.5%) of the umbilical cords were normocoiled; 27(13.5%) were hypocoiled and the remaining 22(11%) were hypercoiled
- 127 Age group
- 128 Most of the study population was in the (20-25) years age group. It was noted that the incidence
- 129 of abnormal coiling (hypo and hyper coiling) increases at extremes of age.
- 130 *Parity*
- 131 Of the 200 patients included in this study, 107 (53.5%) were primigravidas and the
- remaining 93(46.5%) were multigravidas. Table 1
- 133 *Gestational age at delivery*

- 48.1 %(13) of the women in hypocoiled group delivered before 37 weeks of gestation as
- compared to 18.18% in hyper coiled and 3.9%(4)in normocoiled groups. Table 1
- 136
- 137 *Mode of delivery*
- 138 48.1% of the hypocoiled group and 54.54% of the hypercoiled group were delivered by
- 139 caesarean section whereas only 31.1% of normocoiled group had to be delivered by
- 140 caesarean section.
- 141
- 142 Abnormal CTG
- The incidence of abnormal CTG was significantly higher in the abnormally coiled groups
 (hypercoiled group: 27.27%, hypocoiled group: 37%) as compared to normocoliled (11.9%)
 groups.
- 146
- 147 *Meconium stained liquor*
- The incidence of meconium stained liquor was significantly higher in the of the hypercoiled group (54.5%) as compared to normocoiled (11.2%) and hypocoiled (11%) groups. Table 1
- 150
- 151 *Birth weight*152

The mean birth weight in the abnormally coiled groups was significantly lower than the normocoiled group. It was 2.51 kg, 2.61 kg in the hypo and hypercoiled groups respectively and 2.74 kg in the normocoiled group. Thus, mean birth was lowest in hypocoiled group.

- 157
- 158 *Gender of newborn* 159
- 160 The incidence of female child birth is significantly higher in the hypo coiled group (70.3%).
- 161
- 162 APGAR score
- 163

APGAR scores at one min were low in the abnormally coiled groups; 18.5% of the hypocoiled group and 27.3% of the hypercoiled group had an APGAR < 7 at 1 min after birth as compared to 5.9% in the normocoiled group. Table 1

- 167 Admission to NICU
- 168 The admission to NICU was more among the abnormally coiled groups: 36.4% and 37% in the
- 169 hypercoiled and the hypocoiled groups respectively, as compared to 7.9% in the normocoiled
- 170 group, which was statistically significant. Table 1

171 **DISCUSSION**

- 172
- 173 The umbilical coiling index has been found to be an effective indicator of perinatal outcome.
- 174 Several studies in the past have correlated the relationship between perinatal outcomes and the
- 175 UCI. The present study is a prospective observational study done at King George Hospital,

- 176 Visakhapatnam on antenatal evaluation of umbilical cord coiling index and its effects on
- 177 maternal and perinatal outcome.
- 178
- 179 Mean UCI

The mean UCI in the present study is 0.37 ± 0.10 . This was higher as compared to other studies. (Strong et al [15]: 0.21 + 0.07, Rana et al [16]: 0.19 + 0.1, De Laat et al [22]: 0.17 + 0.009, Chitra et al [23]: 0.24 + 0.09 and Ercal et al [24]: 0.20 + 0.07.

- 183
- 184 Incidence of abnormal coiling index
- 185 The incidence of abnormal coiling was 24.5 % in our study (hypo coiled 13.5% and hypercoiled
- 186 11%). This was similar to other studies.[Patil et al [25] Kashanian et et al [26] Chitra et al[23]
- 187 Milani et al [27]] Hussein et al [28].Table 2 188
- 189 Age
- 190 In our study, majority of the women (67%) were in the 21-25 years age group; 22% were
- under 20 years of age and 10% were over 30 years of age. The mean maternal age in this
- study in normocoiled group was 24.5, in hypocoiled group was 24.5 and 23.14 in
- 193 hypercoiled group. It was noted that the incidence of abnormal coiling (hypo and hyper coiling)
- increases at extremes of age (<20 &>30). Similar findings were observed by other authors as
- 195 well Ezimokhai et al. [11]
- 196
- 197 *Parity*
- 198 In our study, on comparing UCI with parity, there was no statistical significance between
- 199 primigravida and multigravida. Similar observations were made in other studies as well
- 200 Milani et al[27] Bhojwani et al [2] 2016 Sharma et al [3]
- 201
- 202 Gestational age at delivery

In the present study, the incidence of preterm delivery was highest in the hypocoiled group, (48.1%). The association between hypocoiling and preterm delivery was extremely significant (p value < 0.0001). Similar results were shown by Chitra et al [35] (17.09%),Bhojwani et al [2] (46.8%) and Mittal et al [29] (16.6%) though explanations regarding the cause for preterm delivery were not given. However, Gupta et al [1], observed that preterm deliveries were highest in normocoiled group (18.6%).

- 209
- 210 *Mode of delivery*
- In our study 48.1% of hypocoiled group and 54.54 % of hypercoiled group underwent
- caesarean section as compared to 31.1% of the normocoiled group. Thus, abnormal coiling
- 213 was strongly associated with increased LSCS rates. (p value < than 0.0001). Many studies
- 214 (Mustafa et al [30], Chitra et al [23] Bhojwani et al [2]) have shown similar association
- between increased LSCS rates and abnormal coiling index. Mittal et al [29] have observed that
- LSCS rate were almost similar in both hypocoiled and hypercoiled groups. Table 3
- 217
- 218 Meconium stained liquor

- In the present study there was significant association between hypercoiling and meconium 219
- staining of the liquor(54.5%). (p value < 0.001). Chitra et al [23] and Mustafa et al [29] 220
- 221 showed similar results (31.57% and 31.1% respectively). However, this was in contrast to
- studies by Gupta et al 2006[1], Milani et al [27] and Bhojwani et al [2] in which meconium 222
- staining of liquor was highest in hypocoiled group, (i.e. 63.6%, 7.7% and 68.7% respectively). 223 Table 3
- 224 225

226 *Sex of the baby*

227 In our study, there was predominance of girl child (70.37%) in the hypocoiled group. However there was no significant correlation between the sex of the baby and abnormal 228 229 coiling index in other studies.

- 230
- 231 Birth weight

232 In our study, there was significant association between low birth weight babies and

- hypocoiling. (p value < 0.001). The high incidence of LBW babies in the hypocoiled group 233
- could be because of the increased incidence of preterm labour. Similar results were seen in 234
- the study by Sharma et al [3]. It is known that adequate coiling prevents compression of the 235
- cord; hypocoiling over a period of time, may compromise fetoplacental circulation, thus 236
- 237 resulting in growth restriction. [23]
- 238

239 Abnormal fetal heart rate patterns

240 In our study 37% of the hypocoiled group and 27.27% of hypercoiled group had abnormal fetal heart patterns in comparison to 11.9% of the normocoiled group. Thus, fetal heart rate 241 242 variations were significantly associated with abnormal coiling. (p value < 0.001). Chitra et al [23], Mustafa et al [30] and Mittal et al [29] also observed similar results. This can be 243 explained by the fact that abnormally coiled umbilical cords were less flexible and more prone 244 to kinking & torsion. Hence, these fetuses do not withstand the stress during labour. Coiling 245 provides turgor and compression resistant properties to the umbilical cord which 246 become compromised when it becomes hypocoiled. Rana et al [16]. Table 3 247

248

249 Low APGAR scores

In our study, abnormally coiled groups were associated with low APGAR scores at birth. The 250

- incidence of low APGAR scores was highest among the hypercoiled group. (p value < 0.001). 251
- Similar findings were observed by Chitra et al [23]. However, Bhojwani et al [2], Gupta et al 252
- [1] and Mustafa et al [30] (observed that incidence of low APGAR scores was highest in the 253
- hypocoiled group.(31.2%, 36.36% and 6.45% respectively). Table 3 254
- 255

256 Admission to NICU

- 257 In our study, 36.36% of the babies born to mothers of the hyper coiled group,
- 37% of the babies of the hypocoiled group 7.9% of babies in the normocoiled group were 258
- admitted to NICU for various reasons. Thus, admission of babies to the NICU was 259
- 260 significantly increased in abnormally coiled groups (p value < 0.001). Mustafa et al [53 30]
- and Patil et al [25] Milani et al [51 27] Bhojwani et al [2] also showed similar results. The 261

262	reason may b	be derived	linearly fro	m the	e associations	between	FHR	decelerations,	operative
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- 263 delivery, and initial low APGAR [23]. Table 3
- 264

265	CONCLUSION AND RECOMMENDATONS
266	Abnormal umbilical cord coiling can be detected during the fetal anatomic survey in the
267	second trimester without significantly increasing the examination time [3]. Our study suggests
268	that abnormal coiling index is associated with adverse perinatal outcomes. Therefore,
269	monitoring umbilical cord coiling and calculating UCI can provide valuable insights into fetal
270	development identifying potential risks and predicting adverse outcomes, enabling early
270	intervention and improved perinatal outcomes [21]
271	As results of various studies show wide variations, more and larger studies are required to
272	confirm the reliability and validity of antenatal coiling index measurement.
274	Measurement of UCI should be made an integral part of antenatal ultrasound.
275	Further research is required to determine the most appropriate time for measurement of the UCI
276	that would accurately reflect the perinatal outcome
277	and would decarately remote the permatal outcome
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LIST OF TABLES

Table1: UCI in relation to parity, meconium stained liquor, admission to NICU & gestational age at delivery

	UCI				
	NORMAL	HYPOCOILED	HYPERCOILED	P- VALUE	
PARI	TY				
PRIMI GRAVIDA	79	14	14	0.023	
MULTIGRAVIDA	72	13	8		
MECON	IUM STAINED L	IQUOR	β		
YES	17	3	12	<0.001	
NO	134	24	10		
ADMISSIC	ONS TO NICU				
YES	12(7.9%)	10(37%)	8(36.36%)	<0.001	
NO	139(92.1%)	1(63%)	1(63.64%)		
CTG			L		
NORMAL	133	17	16	<0.001	
ABNORMAL	18	10	6		
GESTATIONAL	AGE AT DELIVI	ERY	I	I	
34-37 WEEKS	6	13	4	<0.0001	
37-40 WEEKS	113	14	16		
>40 WEEKS	32	0	2		
APGAR SCORE	AT 1 MIN	I	1	I	
<7	9	5	6	<0.001	
>7	`144	22	16		

Table 2: Incidence	of abnormal	coiling in	various	studies
Tuble 2. metuence	of automutina	coming in	various	studies

INCIDENCE OF ABNORMAL COILING					
STUDY	HYPOCOILED (%)	HYPERCOILED (%)			
Patil et al [25]	11.5	10.5			
Kashanianet et al [26]	12.4	11.1			
Chitra et al [23]	11.7	10			
Milani et al [27]	9.8	10.3			
Hussein et al [28]	15	9			
Present Study	13.5	11			

Table 3: Comparison of preterm deliveries, LCSS rates, incidence of meconium stained liqour, abnormal CTG, low APGAR score, NICU admissions in various studies.

PRETERM DELIVERIES IN VARIOUS STUDIES						
STUDY	NORMOCOILED	HYPOCOILED (%)	HYPERCOILED			
Gupta et al [23]	18.6	18.2	10			
Chitra et al [23]	8.3	17.09	14			
Mittal et al [29]	3.08	16.6	10			
Bhojwani et al [2]	2.7	46.8	0			
PRESENT STUDY	3.9	48.1	18,1			
LSCS RATE IN VARIOUS STUDIES						
Chitra et al [23]	9.29	16.1	21.5			
Mittal et al [29]	3.08	11.11	10			
Bhojwani et al [2]	28.3	34.3	20			
Mustafa et al [30]	16.1	16.1	16.1			

PRESENT	31.1	48.1	54.54			
STUDY						
MECONIUM STAI	NED LIQUOR IN VARIOU	JS STUDIES				
Gupta et al [1]	29.1	63.6	20			
Chitra et al [23]	17.11	26.49	31.57			
Mustafa et al [30]	22.3	28.5	31.1			
Bhojwani et al [2]	4.7	68.7	5			
Milani et al [27]	1.9	7.7	0			
PRESENT STUDY	11.2	11.1	54.5			
CTG IN VARIOUS	STUDIES					
Chitra et al [23]	14.9	29.05	30			
Mustafa et al	2.6	13.5	8.88			
[30]	of.					
Mittal et al ⁽⁵²⁾	5.55	33.3	20			
PRESENT STUDY	11.9	37	27.27			
APGAR SCORE <7 IN VARIOUS STUDIES						
Gupta et al[1]	9.3	36.36	0			
Chitra et al[23]	3.95	8.54	10			
Mustafa et al[30]	5.12	6.45	5.55			

Bhojwani et al[2]	10.8	31.2	15
PRESENT	5.9	18.5	27.27
STUDY			
NICU ADMISSION	IS IN VARIOUS STUDIE:	S	
Patil et al [25]	12,2	43.5	33.36
Mustafa et al[30]	2.69	5.35	7.89
Bhojwani et al[2]	8.1	28.12	5
Milani et al [27]	21.5	15.4	22
PRESENT STUDY	7.9	37	36.36