Original Research Article

Antenatal umbilical cord coiling index as a predictor of pregnancy outcome

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A B S T R A C T

Context: Fetal compromise as a major contributor to neonatal morbidity is of great concern for obstetricians. Antenatal risk assessment profiles are often insufficient in picking up these cases and hence need to be improved. Antenatal Umbilical cord Coiling Index (AUCI) is one such potential predictor which helps in identifying pregnant women who need close antepartum and intrapartum monitoring. It is determined by ultrasonogram antenatally and noted to be fixed throughout the pregnancy. This study aims at determining the association between AUCI and pregnancy outcome.

Settings and Design: This was a hospital based prospective analytical study conducted in a tertiary care centre in Pondicherry from January 2019 to May 2020. 207 pregnant women were included in the study and Colour doppler was performed and AUCI was noted. Participants were followed until delivery and pregnancy outcomes were noted.

Statistical Analysis used: Chi square and Fischer exact test

Results: In the present study, among 207 subjects, 166 had normal AUCI i.e., 0.41 to 0.61. Hypocoiling was noted in 20 (< 0.41) and hypercoiling in 21(>0.61) subjects. Hypocoiling was associated with hypertension and oligohydramnios in10% cases each. Nonreasssuring fetal (NRFHR) heart rate, meconium stained liquor and low APGAR values were present in 15, 20 and 10% cases respectively. Hypercoiling was associated with diabetes (10%), hypertension (5%), oligohydramnios (10%), polyhydramnios (5%), NRFHR (10%) and meconium stained liquor (5%). However, there was no statistical significance among the above mentioned parameters.

1. Introduction

Due to paucity of effective measures in the current antenatal risk assessment profiles, a substantial amount of neonatal morbidity exists. One of the main reasons is fetal distress which is of great concern to the obstetricians. Hence, antenatal risk assessment profiles need to be improved.[1] Antenatal umbilical cord coiling index (AUCI) is one such non-invasive tool for improving the fetal outcome by early detection of pregnancies which need close antepartum and intrapartum monitoring and referring

mother to an appropriate center.[2,3] According to the existing studies, intrauterine growth restriction was significantly associated with hypercoiled cords while low birth weight, meconium stained liquor and neonatal intensive care unit admissions were significantly higher in hypocoiled cords.[4,5] Observations from the current studies stated that abruptioplacentae, hypertensive disorders, preterm labour and oligohydramnios were found to have significant association with hypocoiling and polyhydramnios and diabetes mellitus were more with hypercoiling of umbilical cord.This study was undertaken to determine whether AUCI can be recommended as a routine procedure for early identification of adverse pregnancy outcomes.

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2. Materials and Methods

This prospective analytical study was conducted in a teritary care hospital, in Pondicherry, from January 2019 to May 2020, after obtaining Institutional Human Ethics Committee approval. A sample size of 207 was calculated based on prevalence of abnormal coiling to be 16% with an α error – 0.05.[2] Inclusion criteria was viable singleton pregnancy randomly chosen with gestational age of 28 weeks or above. Multiple pregnancies, intrauterine fetal demise, single umbilical artery and congenital anomalies were excluded. Women willing to participate in the study underwent doppler ultrasonography with Mindray DC-8, LOGIC GE S-7 machine and AUCI was measured by the reciprocal of the mean pitch up to three coils from different segments of umbilical cord. Measurement of this pitch defined as the distance in centimetres, from the inner edge of an arterial wall to the outer edge of the same arterial wall of the next coil ipsilaterally. Cord coiling was considered abnormal when it was less than 10th centile (hypocoil) and more than 90th centile (hypercoil) respectively. Participants were followed up till delivery and the pregnancy outcomes were noted.

Fetal heart rate abnormalities, meconium stained liquor, birth weight, APGAR <7 @ 5 minutes and need for NICU admission > 24 hours were noted as primary outcomes. Diabetes, hypertension, intrauterine growth restriction, oligohydramnios, prelabour rupture of membranes and polyhydramnios were noted as secondary outcomes. All the data was collected and analysed using an EPI INFO 7. Quantitative variables were analysed using mean, standard deviation and independent T test. Qualitative variables were analysed as percentage and using Chi Square test. p value of < 0.05 was taken as statistically significant.

3. Results

Out of 207 subjects, 10th percentile was noted for umbilical cord coiling index at 0.41 and 90th percentile at 0.61. Accordingly, umbilical cord coiling index was classified as normocoiling, hypocoiling and hypercoiling. Twenty subjects had AUCI of less than 0.41 and twenty one had greater than 0.61. The mean age of women in study group was 26.07 years. The mean age was noted to be 26.35, 26.41 and 25.47 years in hypocoiling, normocoiling and hypercoiling groups respectively. The proportion of primigravida patients were more in hypocoiling group i.e., 55% when compared to normocoiling and hypercoiling groups i.e., 45% and 52% respectively.(Table 1)

Regarding the primary outcomes, among 207 study participants, 19 women had foetal heart rate abnormalities, 3 from hypocoiling, 14 from normocoiling and 2 from hypercoiling groups respectively and there was no statistical significance between the three groups. The average weights of babies in these three groups were 2590, 3010 and 2860

gms respectively which was not statistically significant. 29 women had meconium stained liquor during labour, 4 in hypocoiling, 24 in normocoiling and 1 in hypercoiling groups respectively which had no statistical significance. Among the study participants, 4 women delivered babies with APGAR less than or equal to seven, 2 each in hypocoiling and normocoiling groups which was not statistically significant. A total of 4 babies got admitted to NICU, 2 each from hypocoiling and normocoiling groups. There was no statistical significance between the three groups regarding necessity for NICU admission. (Table 2)

Regarding maternal complications, pregnant women diagnosed as diabetics were 15(7.2%). Of these 2 were diagnosed to have overt diabetes. Among women in hypercoiling group out of 21, two were diabetics and it was not statistically significant. A total of 27 (13%) pregnant women were diagnosed to be hypertensive, 2 in hypocoiling, 24 in normocoiling and 1 in hypercoiling groups respectively. The difference between the three groups was not statistically significant. Among the hypocoiling and hypercoiling groups, 2 had oligohydramnios in each group whereas 10 from normocoiling group had the same which was not statistically significant. Two out of 207 patients were diagnosed as polyhydramnios. Among all the subjects, 14 had prelabour rupture of membranes, of which 13 were from normocoiling group and 1 from hypercoiling group which was not statistically significant. 4 women had intrauterine growth restriction, of which 3 cases were noted in normocoiling group and 1 in hypercoiling group which not statistically significant. (Table 3)

Table 1: Umbilical cordcoiling index

UCI	Value	n
Normocoiling	0.41 to 0.61	166
Hypocoiling	< 0.41	20
Hypercoiling	> 0.61	21

4. Discussion

Mean umbilical cord coiling index of the present study was 0.5 + / - 0.1. According to various studies, it was noted to be 0.24 +/- 0.09, 0.19 +/- 0.1, 0.21 +/ - 0.07, 0.26 +/- 0.09, 0.2 +/- 0.09, and 0.13 + / - 0.08 by Chitra T et al, Rana J et al, Strong TH et al, Ezimokhai AM et al., Singh S et al and Ohno Y et al respectively.[3,6–10]

Regarding intrapartum events, a study conducted by Jain et al. concluded that nonreasssuring fetal heart rate was significantly associated with both hypocoiled and hypercoiled umbilical cords.[11] This was in correlation with Mittal et al. and Pergialiotis et al.[12,13] However, in the present study, there was no such significance. Khan et al. concluded that there was no significant association between mode of delivery and umbilical cord coiling index which was in correlation with the study done by Dijk

Table 2: Perinatal outcome

Perinatal outcome	Hypocoiling	Normocoiling	Hypercoiling	P value
FHR abnormalities	3(15%)	14(8%)	2(10%)	0.927
Mean weight of baby	2.59	3.01	2.86	6.515
Meconium stained liquor	4(20%)	24(15%))	1(5%)	2.114
APGAR below 7	2(10%)	2(1%)	0	7.747
NICU admission	2(10%)	2(1%)	0	7.747

Table 3: Maternal outcome

Materal outcomes	Hypocoiling	Normocoiling	Hypercoiling	P value
Diabetes	0	15(11%)	2(10%)	2.458
Hypertensives	2(10%)	24 (14%)	1(5%)	2.104
Oligohydramnios	2(10%)	10(6%)	2(10%)	0.73
Polyhydramnios	0	1(1%)	1(5%)	3.587
Prelabour rupture of membranes	0	13(8%)	1(5%)	1.884
Intrauterine growth retardation	0	3(2%)	1(5%)	1.295

et al.[14,15] The present study also concluded the same. A study conducted by Razak K et al stated that hypocoiled cords were associated with more number of low birth weight babies.[16] On the contrary, Tripathy et al stated that hypercoiled cords were associated with low birth weight.[17] Tahmasebi et al. showed no significant association of AUCI with birth weight which was similar to the present study.[18]

Narayanan et al concluded that there was no association between umbilical cord coiling index and meconium stained liquor similar to Tahmasebi et al.[1,18] However, Sd et al. stated that hypocoiled cords were significantly associated with it.[19] In the present study, no such significance was found. Chitra T et al stated that there was significant association between hypercoiled cords and postpartum haemorrhage similar to Waboso et al.[3,20] The present study however did not show similar results. Gaikwad et al and Rohinidevi et al stated that low APGAR was associated with hypocoiling of umbilical cord at birth, 1 and 5 minutes whereas hypercoiling group didn't show any such association.[21,22] This was in contrast to Sd et al, Predanic et al and the present study which stated that hypocoiling group showed no association significantly.[19,23] Gaikwad et al, Sd et al concluded that hypocoiling of umbilical cords were associated with more NICU admissions.[19,22] Rahi et al. showed that both hypocoiling and hypercoiling of umbilical cords were associated with more NICU admission.[24] On the contrary, Agarwal et al stated that hypercoiling of umbilical cords were associated with NICU admission.[25] However, in the present study, there was no statistical significance between all the 3 groups.

In a study by Najafi et al, there was a significant relationship between hypocoiling of umbilical cord and gestational / overt diabetes mellitus groups.[2] On the contrary, Singh et al stated that hypercoiling of umbilical cords was associated with diabetes in pregnancy.[9] Ennazhiyil et al in 2019, suggested that gestational diabetes was associated with abnormal umbilical coiling index.[26] In the present study, there was no statistically significant association between all three groups. A study done by Milani et al, found a significant difference between abnormal umbilical cord coiling index and gestational hypertension.[27] Lv et al. concluded that hypercoiling of cord was found more predominantly in pre-eclampsia patients.[28] Similarly, a study done by Tripathy et al. concluded that there was a significant relationship between hypocoiling of umbilical cords and pregnancy induced hypertension.[17] In the present study, there was no such significant association noted.

Regarding amount of amniotic fluid, Mittal et al concluded that hypocoiling was observed to be significantly associated with oligohydramnios.[12] On the contrary, Mustafa et al found a significant relationship between hypercoiling of umbilical cord and oligohydramnios.[29] However, the present study showed no such statistical significance. Regarding polyhydramnios, Guruswamy et al found significant relationship with hypocoiling whereas Mustafa et al found the same with hypercoiling with a p value of < 0.05.[29,30] In the present study, there was no statistical significance between the groups. A study by Chitra et al. stated that there was no significant association found between umbilical cord coiling index and prelabour rupture of membranes.[3] Sahoo et al. also concluded that there was no significant association similar to the present study.[31] Bhojwani et al. concluded that intrauterine growth restriction was statistically significant with hypercoiled umbilical cords similar to Sd et al.[4,19] This was in agreement with studies by Rahi et al and Laat et al.[24,32] In the present study, however, there was no statistical significance among the 3 groups.

5. Conclusion

In the present study there was no association between antenatal umbilical cord coiling index and adverse pregnancy outcome. However, the number of subjects with comorbidities was not significantly high enough for the desired population, to achieve a statistically significant value. In future, we suggest that more studies have to be done over high risk groups, to find the association of AUCI with pregnancy outcome.

6. Source of Funding

7. Conflict of Interest

No conflicts of interest to be disclosed.

8. Acknowledgement

References

1. Narayanan A, Ballal P, Shetty N, Kushtagi P. Antenatal umbilical cord parameters and perinatal outcome. *Int J Reprod Contracep Obstet Gynecol*. 2016;5(4):1211–5.
2. Najafi L, Khamseh ME, Kashanian M, Younesi L, Abedini A, Valojerdi AE. Antenatal umbilical coiling index in gestational diabetes mellitus and non-gestational diabetes pregnancy. *Taiwan J Obstet Gynecol*. 2018;57(4):487–92.
3. Chitra T, Sushanth YS, Raghavan S. Umbilical Coiling Index as a Marker of Perinatal Outcome: An Analytical Study. *Obstet Gynecol Int*. 2012;2012:1–6.
4. Bhojwani P, Sharma R, Bhojwani L, Bhatnagar B. Correlation of Antenatal Umbilical Cord Coiling Index with Perinatal Outcome Using Color Doppler at Late Second Trimester. *Int J Contemp Med Res*. 2016;3(9):3.
5. Patil NS. Umbilical Cord Coiling Index and Perinatal Outcome. *J Clin Diagn Res*. 2013;7(8):1675–7.
6. Rana J, Ebert GA, Kappy KA. Adverse perinatal outcome in patients with an abnormal umbilical coiling index. *Obstet Gynecol*. 1995;85(4):573–7.
7. Strong TH, Jarles DL, Vega JS, Feldman DB. The umbilical coiling index. *Am J Obstet Gynecol*. 1994;170(1):29–32.
8. Ezimokhai M, Rizk DE, Thomas L. Maternal risk factors for abnormal vascular coiling of the umbilical cord. *Am J Perinatol*. 2000;17(8):441–5.
9. Singh S, Sharma R, Radhakrishnan G, Lakhanpal S, Lakha V. Coils in Umbilical Cord and their Perinatal Significance in North Indian Population: A Cross-sectional Study. *Indian J Neonatal Med Res*. 2017;5(3):1–4.
10. Ohno Y, Terauchi M, Tamakoshi K. Perinatal outcomes of abnormal umbilical coiling according to a modified umbilical coiling index. *J Obstet Gynaecol Res*. 2016;42(11):1457–63.
11. Jain D, Mathur S. Assessment of Antenatal Umbilical Coiling Index in Second Trimester as a Prognostic Marker of Perinatal Outcome. *Int J Med Res Prof*. 2017;3(1):60–5.
12. Mittal A, Nanda S, Sen J. Antenatal umbilical coiling index as a predictor of perinatal outcome. *Arch Gynecol Obstet*. 2015;291(4):763–8.
13. Pergialiotis V, Kotrogianni P, Koutaki D, Christopoulos-Timogiannakis E, Papantoniou N, Daskalakis G. Umbilical cord coiling index for the prediction of adverse pregnancy outcomes: a meta-analysis and sequential analysis. *J Matern Fetal Neonatal Med*. 2019;p. 1–8. doi:10.1080/14767058.2019.1594187.
14. Khan DT, Thakur DR. Association of postnatal umbilical coiling index with maternal & perinatal outcome. *Int J Clin Obstet Gynaecol*. 2019;3(1):144–9.
15. Dijk CV, Franx A, Laat MWM, Bruinse HW, Visser G, Nikkels PGJ. The umbilical coiling index in normal pregnancy. *J Matern Fetal Neonatal Med*. 2002;11(4):280–3.
16. Razak K, Meena D, Gl M. "Coils & Kinks": A Novel Technique to Evaluate the Perinatal Outcome. *Gynecol Obstet*. 2017;doi:10.4172/2161-0932.1000457.
17. Tripathy S. Umbilical Coiling Index and Its Relationship with Perinatal Outcomes. *Indian J Neonatal Med Res*. 2014;2:4.
18. Tahmasebi M, Alighanbari R. Evaluation of umbilical cord thickness, cross-sectional area, and coiling index as predictors of pregnancy outcome. *Indian J Radiol Imaging*. 2011;21(3):195.
19. Prathibha SD. Study of umbilical cord Coiling Index and Perinatal outcome at tertiary care hospital. *Int J Clin Obstet Gynaecol*. 2019;3(3):63–6.
20. Feyi-Waboso PA. Umbilical Cord Coiling Index in Women of South-Eastern Nigeria. *J Women's Health Issues Care*. 2014;doi:10.4172/2325-9795.1000158.
21. Rohinidevi M, Jeyasingh T, Vimala V. Morphological study of umbilical cord and its embryological significance. *Int J Anat Res*. 2016;4(1):1806–9.
22. Gaikwad P, Patole K. Umbilical Coiling Index and Perinatal Outcome. *MVP J Med Sci*. 2016;3(2):118.
23. Predanic M, Perni SC, Chervenak FA. Antenatal umbilical coiling index and Doppler flow characteristics. *Ultrasound Obstet Gynecol*. 2006;28(5):699–703.
24. Rahi S, Akther G. Relationship of umbilical coiling index and perinatal outcome. *Int J Reprod Contracept Obstet Gynecol*. 2017;6(10):4433.
25. Agarwal S, Purohit RC, Jain G, Agarwal DS. Umbilical Cord Coiling Index and Perinatal Outcome in Normal and Abnormal Pregnancies; 2014. Available from: https://www.semanticscholar.org/paper/Umbilical-Cord-Coiling-Index-and-Perinatal-Outcome-Agarwal-Purohit/5b2940a4094d469d65f47106370554ad8061391e#citing-papers.
26. Ennazhiyil SV, Ramakrishnan P, Akshara V, Premlal K, Chitra S, Benjamin W. Effects of Gestational Diabetes Mellitus on Umbilical Cord Morphology: A Comparative Study. *J Clin Diagn Res*. 2019;13(7):1–4. doi:10.7860/JCDR/2019/40085.12543.
27. Milani F, Sharami S, Lili E, Ebrahimi F, DalilHeirati SF. Association Between Umbilical Cord Coiling Index and Prenatal Outcomes. *Int J Womens Health Reprod Sci*. 2018;7:85–91.
28. Lv LJ, Wu LL, Wen JY, Lei Q, Miao J, Duan HL. Excessive umbilical cord coiling confers risk of elevated nocturnal blood pressure and severe/early-onset preeclampsia. *J Hypertens*. 2019;37(1):187–96.
29. Mustafa S, Said AM. Association of Umbilical Coiling Index in Normal And Complicated Pregnancies. Available from: https://www.semanticscholar.org/paper/Association-of-Umbilical-Coiling-Index-in-Normal-Mustafa-Said/501eb2058b32b37d23cdf20dee9471ad629ac24f.
30. Gurusamy U, Thangavelu R, Venkataswamy C. Abnormalities of the umbilical cord: correlation with placental histology and perinatal outcome. *Int J Res Med Sci*. 2017;5(11):5009–16.
31. Sahoo K, Mahajan A, Shaha P, Kshirsagar NS. Evaluation of Umbilical Coiling Index as a Predictor of Pregnancy Outcome. *Int J Health Sci*. 2015;3:9.
32. Laat MWM, Alderen ED, Franx A, Visser GHA, Bots ML, Nikkels PGJ. The umbilical coiling index in complicated pregnancy. *Eur J Obstet Gynecol Reprod Biol*. 2007;130(1):66–72.

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