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Original Research Article

Assessment of Antenatal Umbilical Coiling Index in Second Trimester as a Prognostic Marker of Perinatal Outcome

Deepali Jain[1], Shikha Mathur[2*]

[1]Senior Professor, [2*]Assistant Professor,
Department Of Obstetrics and Gynaecology, J.L.N. Medical College, Ajmer, Rajasthan, India.

ABSTRACT

Objectives: To evaluate the antenatal umbilical cord coiling index obtained during fetal anatomic survey in the second trimester as a predictor of adverse pregnancy outcome.

Methodology: A total of 100 pregnant women in the second trimester of pregnancy were enrolled in the study. They were subjected to ultrasound examination with a 2-5 MHz transabdominal curvilinear. The antenatal umbilical coiling index (aUCI) was calculated as the reciprocal value of the mean of three measurements of the pitch of one complete coil. These women were followed till delivery. Variables recorded during delivery included presence of pregnancy induced hypertension, gestational age at delivery, non-reassuring fetal heart status in labour, meconium staining of amniotic fluid and birth weight .Chi square test was used to evaluate the significance of association between adverse perinatal outcome and abnormal umbilical coiling index.

Results: The mean umbilical coiling index was found to be 0.38±0.11 coils per centimetres. Significant association was found between abnormal umbilical coiling index and meconium staining of liquor, non-reassuring fetal heart status and small for gestational age neonates.

Conclusion: The antenatal umbilical coiling index could be developed in the coming years as a promising noninvasive tool of fetal well-being.

Keywords: Umbilical cord, Coiling Index, Antenatal, Normocoiled, Hypercoiled, Hypocoiled, Perinatal outcome.

***Correspondence to:**

Dr. Shikha Mathur,
52, Jeevan Deep Colony,
Vaishali Nagar, Ajmer, Rajasthan, India.

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INTRODUCTION

The umbilical cord or funis is a vital structure for fetal well-being and survival of foetus. It is a trivascular conduit which allows fetal blood to flow into and from the placenta. It develops from the connective stalk which is a band of mesoblastic tissue stretching between the embryonic disc and the chorion. The vessels of the cord are like hollow cylinders which are prone to torsion, compression, tension and interruption of blood flow. The risk is minimised by their helical disposition. The coiled umbilical cord is able to resist external forces that might compromise umbilical vascular flow.[1] The coiling of umbilical vessels develop as early as 28 days after conception and is present in 95% of foetuses by 9 weeks of conception. The helices may be seen on ultrasonographic examination as early as during the first trimester of pregnancy.[2] The coiling property of vessels was first described as early as 1521 by Brengarius. In 1954 umbilical coiling was first quantified by Edmonds who divided the total number of coils by umbilical cord length in centimetres and called it 'Index of Twist'. Edmond assigned positive and negative scores to clockwise and anticlockwise coiling respectively.[3] Later Strong et al simplified it by eliminating three directional score and named it "The Umbilical Cord Coiling Index".[4] The cord shows a spiral twist from left to right as early as 12th week around the arteries. There are proposed theories to explain umbilical cord twisting. The hypothesis include fetal movement, active or passive torsion of embryo, differential vascular growth rates, fetal haemodynamic forces and arrangement of muscular fibres in the umbilical arterial wall.[1] It is 50-60cm long at term and its three blood vessels course through Wharton's jelly in helical fashion completing 10-11 coils between fetal and placental insertion sites.

Antenatal Umbilical Coiling Index is calculated as reciprocal value of distance between a pair of coils measured in centimetres from the inner edge of an arterial or venous wall to the outer edge of next coil along the ipsilateral side of umbilical cord, the direction being from placental end to fetal end.[5] Coiling pattern of umbilical cord visualised by ultrasonography has a potential value in second trimester screening.

Abnormal umbilical cord coiling is defined as hypocoiled and hypercoiled with corresponding antenatal umbilical coiling index

value less than 10th percentile and more than 90th percentile respectively.[6]

Both hypocoiled and hypercoiled umbilical cords are associated with adverse perinatal outcome such as intrauterine deaths, preterm delivery, repetitive intrapartum fetal heart deceleration, operative delivery for fetal distress, meconium staining and chromosomal abnormalities.

AIMS AND OBJECTIVES

The purpose of this study is to evaluate antenatal umbilical cord coiling index obtained during fetal anatomic survey in the second trimester as a predictor of adverse pregnancy outcome.

MATERIALS AND METHODS

The study was conducted over a period of one year at a tertiary care centre. A total of 100 pregnant women were enrolled in the study who attended the antenatal outdoor regularly and who was scheduled to deliver at our institution. Ultrasonographic fetal anatomic survey was performed for these women at 18-24 weeks of gestational age .Enrolled cases met following inclusion and exclusion criteria.

Inclusion criteria

1. Women with singleton pregnancy
2. Absence of gross fetal anomalies
3. Planned delivery at our institution.
4. Planned cases would adequate sonographic umbilical cord changes.
5. All cases with adequate demographic data like maternal age, gravidity, parity, gestational age at which second trimester ultrasound was performed, records of antenatal visits and labour data.

Exclusion criteria

1. Multifetal pregnancy.
2. Gross fetal anomaly (congenital heart, lung, gastrointestinal tract and genitourinary tract anomalies).
3. Inadequate demographic, antenatal or labour data.
4. Inadequate or an inappropriate longitudinal images of umbilical cord to allow on accurate antenatal umbilical coiling index measurement.
5. Presence of single umbilical artery.

A detailed history was taken, general and obstetric examination was done. Routine investigations including Blood haemoglobin estimation, Urine complete and microscopic examination, Blood grouping for ABORh, VDRL, HIV and Hepatitis B antigen were done. Blood sugar urea serum uric acid, creatinine, Liver function tests and any other relevant investigations were done if needed.

Doppler ultrasonographic study was done in all 100 pregnant women of 18-24 weeks gestational age (according to reliable LMP and sonologic confirmation of first trimester). Routine morphometric data were obtained, an anatomic screen for structural and functional anomaly was carried out; placenta and umbilical cord details were assessed.

METHOD

All enrolled patients were subjected to ultrasound evaluation with a 2-5 MHz Transabdominal Curvilinear (JDS-Medison 6000C).

Dynamic colour flow imaging was used to improve visualization of the umbilical cords. The pitch of one complete vascular coil was measured by ultrasonography in a midsection of umbilical cord. The mean of upto 3 coils from different segments of the umbilical cord was used for analysis. Measurement of this pitch, defined as distance in centimetres from the inner edge of an arterial wall to the outer edge of same arterial wall of the next coil ipsilaterally was taken. If the UCI was too low to measure one complete coil in view, we measured the largest segment of cord without a complete coil.

The aUCI was calculated as the reciprocal value of the mean of three measurements of the pitch of one complete coil, or as the reciprocal value of the largest length of umbilical cord without one complete coil.

The distance between two pairs of coils in a normocoiled cord is 2.61 cms.[7]

Then aUCI was calculated as

aUCI = 1/distance in cms=1/2.6=0.38

Normocoiled cord: 0.38±0.11coils/cm

Hypocolied Cord < 0.27coils/cm

Hypercoiled Cord > 0.49coils/cm

On the basis of Ultrasound findings patients were divided in two groups:

Group A: With Normal Antenatal Umbilical Coiling system

Group B: With abnormal UCI, further subdivided into B_1 and B_2 as hypercoiled and hypocolied indices respectively.

Both the groups were advised to attend antenatal clinic, regularly for evaluation of fetal growth. Signs of intrauterine growth retardation were looked for and confirmed by serial ultrasound examinations for fetal biometry, placental grading, amount of liquor and fetal weight discrepancies.

Assessment of both groups were done in labour with regard to gestational age at the time of delivery, duration of labour, signs of fetal distress, presence of meconium in amniotic fluid and mode of delivery, Apgar at birth and foetal weight at birth.

The following data were also collected during delivery:-

1) Gestational age at delivery
2) Parity
3) Maternal Age
4) Obstetrical History
5) Apgar Scores
6) Meconium staining of amniotic fluid
7) Sex and birth weight of neonate
8) Preterm Delivery
9) Instrumental delivery for fetal distress
10) Small for date infants
11) Fetal death
12) Neonatal death within 28 days of delivery

Parity was defined as the number of previous pregnancies of at least 20 weeks gestational age. Gestational age at delivery was calculated by the best estimate according to menstrual history or first trimester sonograhy or both. Preterm delivery was defined as delivery before 37 completed weeks of gestation.

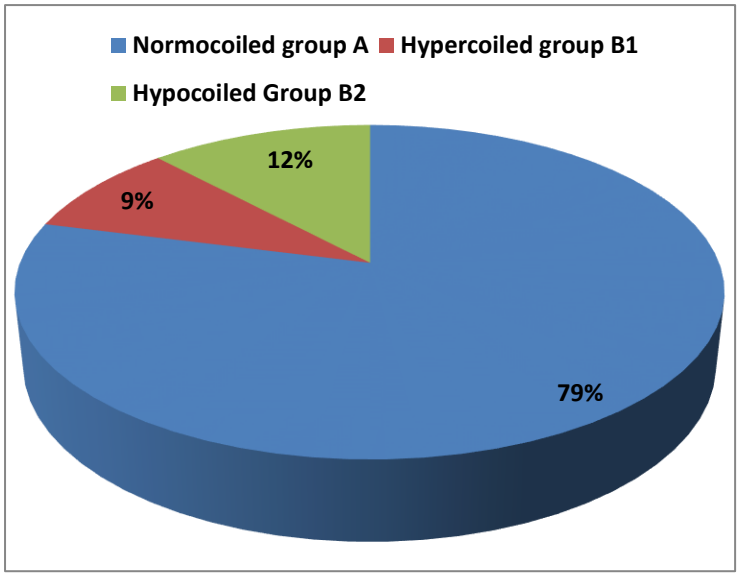
A low Apgar score was defined as a score of less than 7.Small for date infants and large for date infants were defined as having a birth weight below 10th percentile or above 90th percentile respectively. Meconium staining of amniotic fluid included meconium in amniotic fluid noticed during delivery.

Obtaining p value for significance by applying the Chi-Square test (X^2) was used to compare groups with different coiling patterns.

RESULT AND DISCUSSION

The present study was based on the clinical significance of umbilical cord coiling index measured antenatally for 100 pregnant females with colour Doppler study of umbilical cord. These subjects were followed till delivery and perinatal outcome noted.

In our study79% of the subjects had normocoiled cords and other 21% had an abnormal coiling index (9% had hypercoiled cords and 12% had hypocoiled cords).These results are shown through a graph 1.



Graph 1: Depiction of the distribution of subjects according to measured Umbilical Cord Coiling Index on Antenatal Examination

Table 1: Association of pregnancy induced hypertension and coiling pattern

Risk Factors (PIH)	Group A (Normocoiled)		Group B			
			B1 (Hypercoiled)		B2 (Hypocolied)	
	No. Of patients	%	No. Of patients	%	No. Of Patients	%
Present (14 subjects)	8	10.12	4	44.44	2	16.66
Absent (86 subjects)	71	89.87	5	55.55	10	83.33
Total	79	100	9	100	12	100

Table 2: Association between Umbilical Cord Coiling and Gestational Age at Delivery.

Gestational Age at Delivery	Group A (Normocoiled)		Group B			
			B1 (Hypercoiled)		B2(Hypocolied)	
	No. Of patients	%	No. Of patients	%	No. Of Patients	%
<37 weeks (21 subjects)	12	15.19	2	22.22	7	58.33
>37 weeks (79 patients)	67	84.81	7	77.77	5	41.66
Total	79	100	9	100	12	100

In our study PIH was diagnosed in 14% of pregnant women. 44.44% of the subjects with hypercoiled cords and 16.66%with hypocoiled cords had PIH. The relationship of hypercoiling was significant (p value <0.01). The results are shown in Table 1.

Table 2 shows that 58.33% of subjects with hypocoiled cords had preterm delivery. In subjects with normocoiled cords the incidence of preterm delivery was 15.19% and in hypercoiled group it was 22.22%.The relationship of hypocoiled cord with preterm delivery was significant (p value <0.001) whereas this association in normocoiled and hypercoiled groups was insignificant statistically (>0.05).

Meconium in amniotic fluid was more frequently observed in the groups with hypocoiled and hypercoiled cords41.66% and 22.22% respectively rather than in subjects with normocoiled cords. Hypocoiled cords and presence of meconium stained liquor show significant relationship (p value <0.05).The results are shown in (Table 3).

Table 4 shows that maximum number of fetuses with a non-reassuring fetal heart rate status caused mainly by the presence of late or prolonged decelerations in the second stage of labour were found in the abnormally coiled groups, 44.44% in hypercoiled group, and 41.66% of subjects in hypocoiled group

and in only 11.39% of the subjects with normocoiled cords. Significant association was found between coiling pattern and presence of non-reassuring fetal status (p value <0.05).

Table 4 shows that maximum number of fetuses with a non-reassuring fetal heart rate status caused mainly by the presence of late or prolonged decelerations in the second stage of labour were found in the abnormally coiled groups, 44.44% in hypercoiled group, and 41.66% of subjects in hypocoiled group and in only 11.39% of the subjects with normocoiled cords. Significant association was found between coiling pattern and presence of non-reassuring fetal status (p value <0.05).

In our study fetuses were found to be small for gestational age in 33.33% of the subjects with hypercoiled cords, 16.66% of subjects with hypocoiled cords and in only 7.59% of subjects with normocoiled cords. The p value was <0.05 for hypercoiled cords so the relationship was statistically significant. The results are shown in table 5.

Table 6 shows that incidence of NICU admissions was more in the abnormally coiled cord group (in 41.66% of the subjects with hypocoiled cords and in 44.44% of subjects with hypercoiled cords). The association of NICU admissions with hypercoiled cords was found to be very significant (p value <0.01) and the association with hypocoiled cords was also significant (p value <0.05).

In this study the mean aUCI was 0.38±0.11 coils per centimetres.

In our study abnormal cord coiling was associated with adverse perinatal outcomes.

The study found statistically significant association between hypocoiled cords and PIH, between abnormal coiling pattern and meconium staining and non-reassuring fetal heart status, hypercoiled cords and SGA foetuses, abnormally coiled cords and caesarean delivery and NICU admissions. Our results were in consonance with those of B.Sharma et al, [5] Shobha T. et al [8] and A.Mittal et al.[9]

Table 3: Presence of meconium stained amniotic fluid in different patterns of umbilical cord coiling

Colour of liquor	Group A (Normocoiled)		Group B			
			B1 (Hypercoiled)		B2(Hypocolied)	
	No. Of patients	%	No. Of patients	%	No. Of Patients	%
Clear	68	86.07	7	77.77	7	58.33
Meconium stained	11	13.92	2	22.22	5	41.66
Total	79	100	9	100	12	100

Graph 2: Representation of presence of meconium stained amniotic fluid in different patterns of Umbilical Cord Coiling

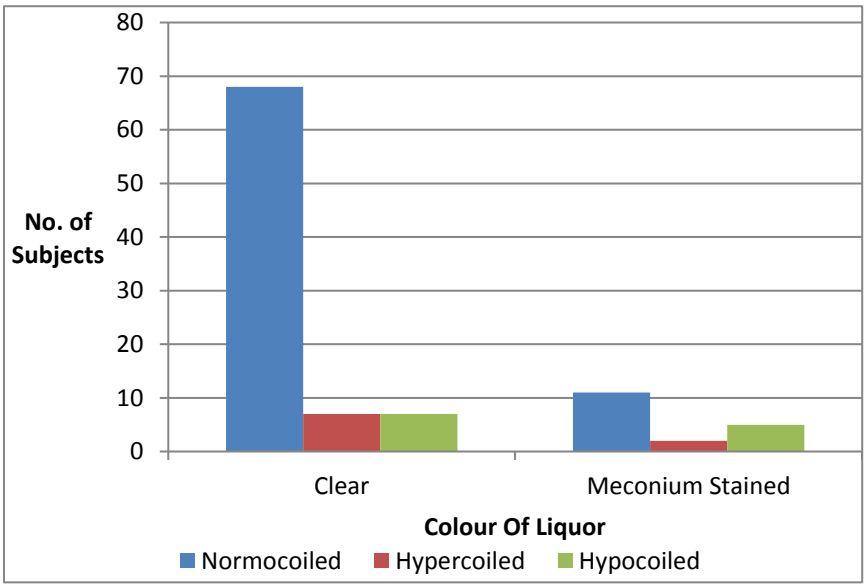


Table 4: Incidence of non-reassuring fetal heart status (NRFHS) during labour in normal and abnormal umbilical cord coiling group

NRFHS	Group A (Normocoiled)		Group B			
			B1 (Hypercoiled)		B2(Hypocolied)	
	No. Of patients	%	No. Of patients	%	No. Of Patients	%
Present	9	11.39	4	44.44	5	41.66
Absent	70	88.60	5	55.55	7	58.33
Total	79	100	9	100	12	100

Graph 3: Incidence of Non Reassuring fetal heart status (NRFHS) during labour in normal and abnormal umbilical cord coiling group

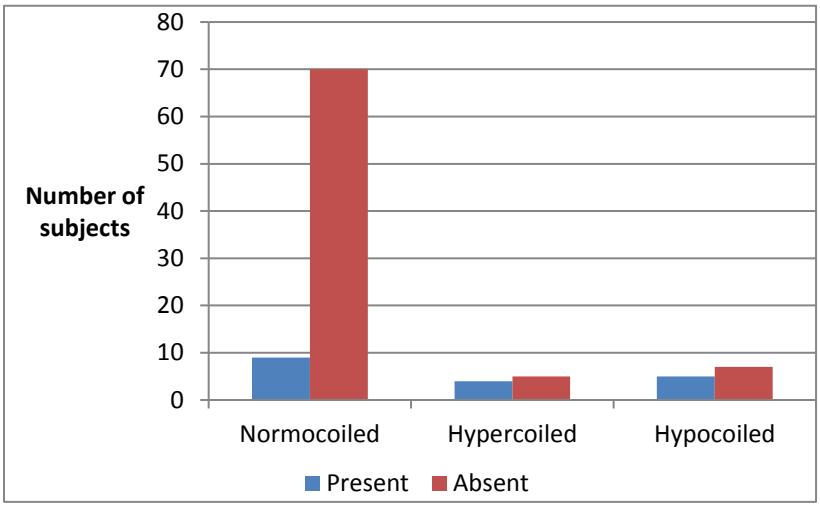


Table 5: Distribution of small for gestational age (SGA) and appropriate for gestational age (AGA) fetuses and relationship with different coiling patterns

SGA/AGA	Group A (Normocoiled)		Group B			
			B1 (Hypercoiled)		B2(Hypocolied)	
	No. Of patients	%	No. Of patients	%	No. Of Patients	%
SGA (<2.5kg)	6	7.59	3	33.33	2	16.66
AGA(>2.5kg)	73	92.40	6	66.66	10	83.33
Total	79	100	9	100	12	100

Graph 4: Distribution of Small for gestational age (SGA) and Appropriate for gestational age (AGA) and relationship with different coiling patterns

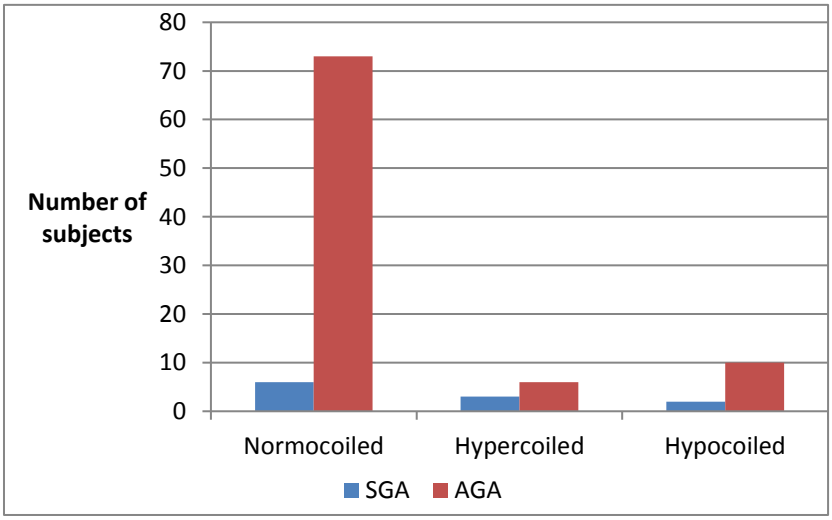


Table 6: Relationship between NICU admissions and coiling patterns

Baby shifted to NICU	Group A (Normocoiled)		Group B			
			B1 (Hypercoiled)		B2(Hypocolied)	
	No. Of patients	%	No. Of patients	%	No. Of Patients	%
Yes	9	11.39	4	44.44	5	41.66
No	70	88.60	5	55.55	7	58.33
Total	79	100	9	100	12	100

SUMMARY AND CONCLUSION

Our study concluded that antenatal evaluation of umbilical cord coiling could be considered as a useful tool for predicting adverse pregnancy outcome, without significantly increasing the ultrasound evaluation time. Statistically significant correlating trends towards higher prevalence of meconium, non-reassuring fetal heart status and SGA neonates were seen in association with abnormal cord coiling patterns.

Observation of abnormal coiling patterns and thereafter interventions to reduce fetal hypoxemia can help in improving perinatal morbidity and mortality.

The antenatal umbilical cord coiling index could be developed in the coming years as a promising noninvasive tool of fetal well-being, anticipating advent of multifold advancements in the ultrasound armamentarium.

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