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A study of Umbilical cord coiling index of the population of North costal Andhra Pradesh.

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Abstract: *The umbilical cord which is the life line of the fetus undergoes a lot of developmental changes during the course of pregnancy which include changes in length, diameter and coiling.Based on the length and number of coils a parameter known as "Coiling index" was derived. Knowing the normal coiling index was beneficial as abnormal coiling indices were found to be associated with adverse perinatal outcomes[10] and awareness of the coiling indices of a population would serve as risk predictors..*

Keywords: *(Umbilical cord, coiling index,ponderalindex)*

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I. Introduction

The umbilical cord is vital to the development, well-being,and survival of the fetus and forms aconnection between the fetus and the placenta, extending from the fetal umbilicus, to the fetal placenta or chorionic plate. It has a dull white, moist exterior, covered by amnion. The chief constituents of the cord being a pair of large muscular arteries which transport impure blood of the fetus, laden with co**2** and waste materials, to the placenta, from where they pass by dialysis, to the maternal blood to be finally eliminated by the mothers lungs and kidneys. An umbilical vein carries oxygenated blood with nutritive materials from the placenta to the developing fetus.The proximal end contains remnants of the yolk stalk and of the allantois in the form of interrupted solid strands of epithelial cells. The umbilical vesicle (yolk sac) lies outside, external to the amnion and may persist as a flattened atrophic sac between the amnion and the placenta.

The umbilical vessels are longer than the cord itself and tend to fold and get tortuous and frequently create nodulations on the surface, known as false knots, which are essentially varices. The vessels are characterized by spiraling and twisting which may occur in the clockwise/dextral direction or anticlockwise /sinistral direction. They are not true spirals, but are cylindrical helices in which a constant curvature is maintained equidistant from the central axis. The Extra cellular matrix is a specialized connective tissue known as Wharton's jelly, covered with a thin layer of partially cornified stratified squamous epithelium, continuous with the epidermis of the fetus. The mesoderm of the cord fuses with that of the amnion. Thus, anatomically the cord can be regarded as a component of the fetal membranes. The blood flows from the placenta through the umbilical vein to the ductus venosus and numerous small openings via the fetal hepatic circulation to the inferior vena cava and enters the primitive heart, from which it passes through the dorsal aorta into the placenta.

The umbilical cord has an average length of 55cms -100cms with a diameter ranging from 0.8cms - 2.0cms, with a normally sinister spiraling with false knots and is attached to the center of the placenta.

A length of 40cms or less are considered as short cords and can be real or apparent (due to cord loops or entanglement).The short cords have been associated with Fetal Akinesia Deformation Sequence (FADS) or Pena-Shokeir Sequence (an autosomal recessive condition and carries a 25% recurrence risk), Spinal muscular atrophy, Body-stalk anomaly (also known as short cord umbilical cord syndrome) and a lateral meningocele syndrome (also known as "familial osteosclerosis"). Umbilical cordswith a total length of over 70 cm, are associated with delivery complications, increased maternal age, respiratory distress, vertex presentation, cord entanglement, fetal anomalies and increased birth weight. Associated placental features include increased placental weight, right-twisted cords, hyper-coiled[12] cords and true knots.

Lean cords defined as the cross-sectional area of the cord, measured in a plane adjacent to the insertion into the fetal abdomen, below the 10th centile for gestational age. Lean cords have been associated with meconium-stained amniotic fluid at delivery, oligohydramnios small for gestational age at birth.If we see the development of the cord, at first, the embryo is a flattened disc, lying in between the amnion and the yolk sac. The dorsal surface grows faster than the ventral surface and the dorsal part of the yolk sac is incorporated into the body of the embryo, to form the gut. The allantois projects into the base of the body stalk, from the caudal wall of the yolk sac which later forms the anterior wall of the hind gut. With advancing pregnancy, the yolk sac becomes smaller and its pedicle relatively longer. By the middle of the third month, the expanding amnion,

obliterates the exocoelom, fuses with the chorionic laevaeand covers the bulging placental disc and the lateral surface of the body stalk. The latter is then called the umbilical cord or funis.

At term the umbilical cord normally contains two arteries and one vein. The left umbilical vein persists and the right usually disappears. In no other part of the feto- placentalunit such vital blood vessels are so vulnerable to kinking,compression, traction and torsion. Protection of these bloodvessels is needed, and is provided by Wharton's jelly, the amniotic fluid, and the helical pattern, or coiling, of the umbilicalcord vessels. The origin of this coiling is unknown. The hypotheses include fetal movements, active or passive torsion of the embryo,differential umbilical vascular growth rates, fetal hemodynamic forces, and the arrangement of muscular fibers in the umbilical arterial wall. The coiling of the umbilical vessels developsas early as 28 days after conception and is present in about95% of fetuses at 7 weeks after conception. This coiling property of cord vessels was described as early as in 1521 by Berengarius[1].

In 1954, umbilical coiling was first quantified by Edmonds who divided the total number of coils by the umbilical cord length in centimeters and called it "The Index of Twist". He assigned positive and negative scores to clockwise and anticlockwise coiling, respectively[1][2].

Later, Strong et al simplified by eliminating these directional scores and named it "The Umbilical Coiling Index". An abnormal umbilical coiling index (UCI) has been reported to be related to adverse fetal outcomes[1][3]. An abnormal umbilical cord coiling index includes both hypo coiled cords (cords with an umbilical cord coiling index which is < 10^{th} percentile) and hypercoiled cords (cords with an umbilical cord coiling index which is > 90^{th} percentile). An abnormal umbilical coiling index has been reported to be related to adverse perinatal outcomes [1,2,4-6].

Furthermore,an attractive hypothesis is that antenatal detection of cordabnormalities with ultrasonography may be helpful in selectingcases in which strict fetal monitoring is warranted, antenatallyas well as intrapartum. If the umbilical coiling index can bemeasured reliably in utero by ultrasound[13], then it might be apromising prognostic marker for adverse pregnancy outcome[10]. These factors have prompted me to undertake this study.

II. Theoretical Review

It was De Snoo(1932),who suggested that the umbilical cord can withstand torsion due to the presence of abundant myxomatous stroma. Later in 1957, Kan and Eastman , observed that cord around the neck was more common with longer cords. They has also reported one loop in the nuchal cord in 20-34%, two loops in 2.5 to 5% and three loops in 0.2 to 0.5% of deliveries. Percy Malpas M.D (1960), found out the average length to be 61cm. But Walker and Pye(1960), suggested that the length of the umbilical cord can vary from 18-122cms. The twists seen in umbilical cords are not truly spirals but are cylindrical helices in which a constant curvature is maintained equidistant from the central axis was stated by Boyd Hamilton (1970) and it was Lacro RV et al (1987), who observed that 5% of cords are without coiling and Strong TH Jr et al (1993), reiterated it to be an incidence of 4 to 5%. Strong and Colleagues (1993), observed hypo coiled cords with a significant increase in various outcomes of fetuses with meconium staining, preterm birth and fetal distress. Strong et al (1994), simplified the clockwise and anticlockwise coiling scores as "The umbilical coiling Index".

Rana et al (1995), observed an incidence of 4.9% cords without coiling and also hyper coiled cords which were associated with premature delivery, low birth weight and cocaine abuse and Machin GA et al (2000), reported hyper coiled cords in 21%Shen-Schwarz and Associates (1996) reported an association between absent cord twisting with marginal and velamentous cord insertion. Blick Stein I et al (2001), observed that increase in coiling was found at the fetal end when compared with the placental end and the middle segment. Van Dijk CC et al (2002), stated the total number of coils for any particular cord was believed to be established early in gestation. The pattern of coiling developed during the second and third trimesters is due to snarls in the cord, and there could be changes in coiling as the pregnancy advances.

Pregnancy Institute, Pre- natal umbilical cord project (2002) observed that umbilical cords may be helical with either spiral, coiled or curled types, occurring in 95% and straight cords in 5% and helical patterns were found to predispose the fetus to blood flow changes and straight may be susceptible to compression. Machin G.A et al (2003), pediatric development pathologist stated that the coiled umbilical cord acted like a semi erectile organ that is more resistant to snarling, torsion or stretch and compression, than non-coiled ones. This is referred to as spontaneous internal ballottement. Haines and Taylor (2003) in obstetrical and gynecological pathology, 5^{th} edition have stated than an abnormally long cord predisposes to knotting, torsion and prolapse.Torsion may affect the whole of the cord or it may be localized and the latter was usually associated with multiple twists. Predanic M et al J. ultrasound med (2005) assessed umbilical cord coiling during the routine, fetal sonographic anatomic survey in the second trimester. They had stated that abnormal coiling index was an indication for the fetus at risk. The sensitivity values of antenatal sonography to predict hypo-coiling was 78.9% and rest was hyper-coiling.

A coil was defined as a complete 360 degree, spiral course of the umbilical vessels around the Wharton's jelly and the coiling index in Indian babies was found to be associated with ante partum and intrapartum outcomes by Shalu Gupta et al (2006). They have also found out that the vessels of the cord are prone to torsion, compression, tension, and subsequent interruption of blood flow, which are minimized by the helical disposition of the cord. In their study on 107 cords at birth, they have formulated, that the mean umbilical cord coiling was seen in 5.6% cases. Anticlockwise coils in 76.6% and clockwise coils were seen in 17.8% and all umbilical cords had three blood vessels. They have concluded, low umbilical coiling index as in indicator of adverse perinatal outcome associated with low apgar score, meconium staining and pregnancy induced hypertension.

The present study aimed to evaluate umbilical cord coiling indices in the population of North Costal Andhra Pradesh.

III. Methodology

The present study was done at Rajeev Gandhi Institute of Medical Sciences, Srikakulam, Andhra Pradesh, India.

3.1.Sample Of Study

100 Human placentae with an intact umbilical cord without any damage were collected from the labor room and operation theatre of the Department of Obstetrics and Gynecology. The specimens were collected without any socioeconomic status, religion, educational and pathological bias**.**

3.2.Age Distribution

Placentas with umbilical cord specimens were collected from the mothers, in the age group between 18 to 32 years as follows:

1. Between 18 - 20 years - 21 specimens.
2. Between 21- 30 years - 77 specimens.
3. Above 30 years -02 specimens.

3.3. Parity Distribution:

Parity distribution of 100 specimens was as follows.

1. 23 specimens were collected from primi gravida.
2. 61specimens from second gravida.
3. 16 specimens from third gravida.

In the present study, soon after delivery, 10 cm of umbilical cord was left at fetal end then cord was clamped, cut and numbered serially.

1. Length of the cord was measured in centimeters, from the cut end of the cord up to its placental attachment by using thread and then the length of the thread was measured by using a measuring tape. 10 cm was added to this reading to account for the umbilical cord which was left towards fetal end.

2. The transverse diameter of the cord was measured by taking one reading at fetal end and another reading at placental end.

3. A complete 360 degree spiral course of umbilical vessels around the Wharton's jelly was considered a coil. The number of complete coils or spirals were counted from the neonatal end towards the placental end of the cord and expressed per centimeter.

Depending upon the direction of the course of the vessels, umbilical cords were referred to as clockwise and anti- clock wise and based on the number of coils were labelled as hypo coiled, hyper coiled and straight cords. The coiling index was calculated based on the number of coils and the length of the cord by the following method.

Coiling index = Number of coils / total length of the cord.

Normal umbilical cord coiling index is around 0.30 +/- 0.07 (SD) coils per cm.

Hypo coilingwas defined as less than 0.07 coils/cm and hyper coiling[12] as morethan 0.30 coils/cm.

IV. Observations

In the present study, the total length of the umbilical cord from the fetal end to the placental end was measured in centimeters of which maximum length was 73.4cms, and the minimum 43.4cms with an average length of 54.5cms.

Table.1. Showing the average length of umbilical cord.

Specimen no.	Length	Length in cms.
47	Maximum	73.4
13	Minimum	43.4
	Average	54.5

4.1.Cord Coiling

It was observed that there was hypo-coiling in 70%, hyper coiling[12] in 24% and the umbilical cord was straight[4][6] in 6%.

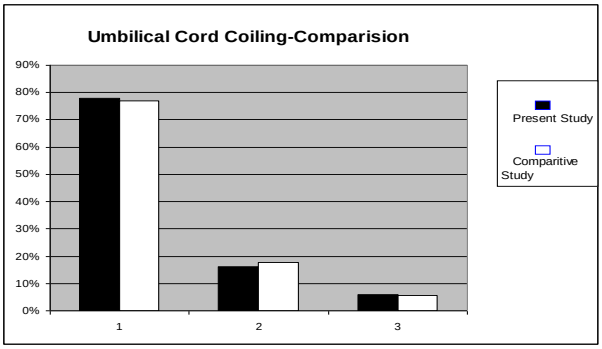
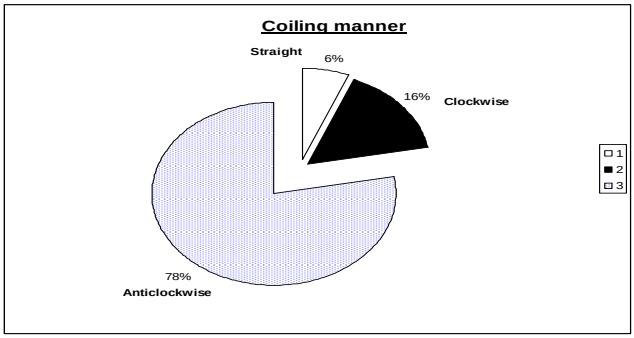


Table.2. Showing Cord coiling.

Coiling of cord	No. of specimens
Hypo Coiling	70
Hyper Coiling	24
Straight	6

Figure.1. Showing comparison with previous studies.



4.2.Coiling Manner: There was anticlockwise coiling in 78% the clockwise coiling in 16% and the coiling was absent in 6%**.**

Table.3. showing coiling manner.

Coiling Manner	No. of Specimens	%
Anti- Clockwise	78	78%
Clockwise Coils	16	16%
Absence Coils	6	6%

Figure.2.Showing percentage of coiling manner.

4.3. Coiling Index

In all one hundred specimens, the coiling index was calculated by dividing the number of coils by the length of the umbilical cord and the following observations were made.

In the present study,

The maximum length of the cord was 73.4. cm and the minimum length was 43.4 cmsand average length was 54.5 cms. Coiling was observed in 94% of cases,anticlockwise in 78%, clockwise in 16% and absent in 6% [4][6][11].

The coiling index varied from 0.08 – 0.12 with a mean of 0.01 in Hypo coiled cords and from 0.14 – 0.18 with a mean of 0.014 in hyper coiled cords.

Table.4. showing coiling index

Coiling Index	Hypo Coiled	Hyper Coiled
Maximum	**0.12**	**0.18**
Minimum	**0.08**	**0.14**
Mean	**0.01**	**0.014**

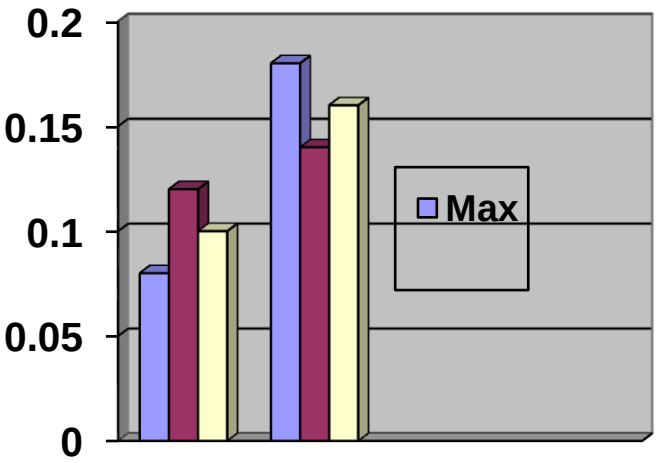


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Figure.4. Showing the Maximum, Minimum and Mean coiling Index

V. Discussion

The average length of the umbilical cord ranges from 40cms to 55 cms. Less than 4o cms cords are considered short and more than 55cms as long.The length of the cord in the study population shows to be averaging around 54.5 cms which fall into the normal range. Normal umbilical cord coiling index[8] ranged from 0.07 – 0.30 coils per cm.Hypo coilingwas defined as less than 0.07 coils/cm and hyper coiling[12] as morethan 0.30 coils/cm.

VI. Conclusion

The study conducted on the umbilical cord in the North Costal Andhra Pradesh taking into view the coiling index which is calculated by knowing the length and number of coils present in the umbilical cord is a prognostic indicator for the assessment[13] of high risk pregnancy.The coiling index in the population of North Costal Andhra Pradesh was shown to be falling into the normal range[8], showing that the population is less susceptible to perinatal complications at large. Individual cases falling into the abnormal range[9] can be helped as ante natal detection of coiling index can act as a predictor for many high risk[10] cases associated with genetic malformations, Fetal akinesia deformation sequence, low APGAR, meconium staining and for planning a difficult third stage of labor.

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